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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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Cover: Rhynchosauroides peabodyi (Faber 1958), trackway from the Muschelkalk of Winterswijk (The Netherlands), after Demathieu and Oosterink (1983). See the paper by Courel and Demathieu on pp. 83-91 of this issue.

SEE INSERTED LEAFLET AND PAGE 56 FOR METHODS OF PAYMENT OF ALBERTIANA 15

SUBCOMMISSION ON TRIASSIC STRATIGRAPHY

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REPORT FROM THE CHAIRMAN CONCERNING

THE FUTURE STS BOARD AND VOTING MEMBERS LIST

Dear colleagues,

Following the report published in ALBERTIANA 14 (Baud and Gaetani p. 5, 8) and the comments I have received, I submit to you the following proposals concerning the future STS board and voting members list:

- Proposed chairman: M. Gaetani
- Proposed vice chairmen: M. Orchard, H. Rieber, Y. Zacharov
- Proposed secretary: Dr Geoffrey Warrington

The actual officers will act as voting members during the next four years and I stay in the board as past chairman.

About the voting members list, it is suggested that MM. Anderson, Budurov, Demathieu, Jacobshagen, Kapoor, Ramovs, Sheng will be asked, according to the new ICS rules to act as corresponding members, Ms. Vijaya and MM. Bucher and Stanley will be proposed as voting members.

Aymon Baud

STOLEN FROM

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CHRIS MCROE

Ballot

Voting members of the STS are kindly asked to express their vote on this ballot sheet. This ballot should be filled in and sent back to Dr. Aymon BAUD, Chairman, before June 15, 1995 in order to inform the International Commission on Stratigraphy about the vote result, one year before the next IGC.

All voting members are urged to express their vote even in case of abstention. Non response will be counted as approval.

Question 1: Do you accept the election of Prof. Maurizio GAETANI as our next chairman?

Approved	
Not approved	
Abstention	

Comment (if any)

Question 2: Do you accept the election of Dr. Mike ORCHARD, Prof. Hans RIEBER and Prof. Yuri ZACHAROV as vice-chairmen of our Subcommission?

Approved	•	•	•	•	•	•	
Not approved	•	•		•	•	•	
Abstention	•	•		•	•	•	

Comment (if any)

Question 3: Do you accept the election of Dr. Geoffrey WARRINGTON as our next secretary?

Approved	
Not approved	
Abstention	

Comment (if any)

Question 4: Do you accept the election of Dr. H. BUCHER, Dr. G. STANLEY and Dr. VIJAYA as voting members?

Not approved Abstention	
Dr. Aymon BAUD	
Musée de Géologie UNIL-BFSH2	
CH-1015 Lausa Switzerland	anne
	Dr. Aymon BAU Musée de Géol UNIL-BFSH2 CH-1015 Lausa Switzerland

Forthcoming exhibition:

Keuper plants

The deciphering of a more than 200 million years old flora

During the Keuper period of the Triassic from 230 to 205 Ma in Central Europe an extended continental deposition area existed: the Germanic Basin. Only temporarily flooded by the Tethys-Sea, the geographic picture was characterised by huge fluvial drainage systems and shallow, partly saline lakes and playa-sedimentation. A vegetation developed in this amphibian environment for the timespan of almost 25 million years.

As early as the 19th century, in the early days of palaeobotany, fossil plants from the Keuper of the Germanic Triassic Basin constituted a significant part of the evolving palaeobotanical research. Unfortunately, as apparent from many modern textbooks, this floral succession appears to be nearly forgotten nowadays or at least out of fashion.

In contrast to the relatively well known fauna of the Keuper, including the spectacular finds of dinosaurs, many problems concerning the fossil plants are still unsolved.

Despite this deficiency, the Heilbronn exhibition depicts the "state of the art" for the first time. The exhibition documents comprehensive selections of fossil plants from different Keuper beds, ranging from the upper Ladinian to the Rhaetian stage. Also present are unique evidence of plant-insect interactions.

The Keuper flora of the Germanic Basin might be envisaged as an important reference area for the compilation of global Triassic palaeofloras. Regarding its completeness and diversity, the Keuper flora of South Germany is one of the richest in the entire world.

The exhibition is dedicated to the 200th birthday of FRIEDRICH AUGUST v. ALBERTI. The eminent German geologist and founder of the Triassic system was born on 4 September 1795 in Stuttgart and died on 12 September 1878 in Heilbronn.

The exhibition is a result of the cooperation in this field between the Städtischen Museen Heilbronn (Museum of Natural History) and the Faculty of Geoscience, University of Würzburg, Germany. Various private collectors and geological institutions have supported the exhibition by the loan of material.

A richly illustrated catalogue is published:

KELBER, K.-P. and HANSCH, W., 1995. Keuperpflanzen. Die Enträtselung einer über 200 Millionen Jahre alten Flora. Museo 10, ca. 120 pp., approx. 60 plates (some in colour), Heilbronn (ca. 25,- DM).

The exhibition catalogue can be ordered from: Städtische Museen Heilbronn, Deutschhofstraße 6, D-74014 Heilbronn, Germany

Hours of business of the museum:

10.00 am - 5.00 pm Wednesday and Friday to Sunday

10.00 am - 7.00 pm Tuesday, Thursday

Duration of exhibition: 13 October 1995 - 7 January 1996 (a prolongation is scheduled) For further information: Phone 07131/56-2302, FAX: 07131/56-3194

K.-P. Kelber, Würzburg; W. Hansch, Heilbronn

COMMENTS ON:

WATERHOUSE, J.B., 1994. The Early and Middle Triassic ammonoid succession of the Himalayas in western and central Nepal. Part 1 - Stratigraphy, classification and Early Scythian ammonoid systematics. - Palaeontographica, Abt. A, 232(1-3): 1-83.

A DISCUSSION BY

Maurizio Gaetani, Marco Balini, Eduardo Garzanti, Alda Nicora, Andrea Tintori, Lucia Angiolini and Dario Sciunnach

Stratigraphy

In his recent paper, which is the first of an announced series of seven, Waterhouse (1994) puts forward a stratigraphic framework for the Upper Permian to Middle Triassic succession of the Nepal Tethys Himalayas (Dolpo-Manang Synclinorium). His framework comprises a good 42 formally introduced formations and members, thirteen of which with a thickness invariably less than one metre and only nine with thickness above ten metres. Only four of these units are traced from Dolpo to Manang; none reaches a thickness of 75 metres.

Criteria for distinction are commonly subjective, subtle to unreliable, or based upon paleontological content alone. As an example, we read in Waterhouse (1994, p. 9): "the Pengba is distinguished from the underlying Gungsang Limestone by its orange exterior as opposed to more golden colour, paucity of brachiopods, and granular appearance, higher dolomitic content"; "the overlying Chegaji Member is very similar to the Pengba, and distinguished chiefly because of its biostratigraphic importance"; "the Kangla looks like the Sabche". To be noted is the fact that the overall thickness of the "Gunsang", the "Pengba", the "Chegaji", the "Sabche", the intervening "Jargeng" and the "Kangla", representing six different members belonging to three different formations, ranges from a minimum of less than two metres to a maximum of less than three metres.

Not a single stratigraphic column and not even a photograph are contained in Waterhouse (1994) to illustrate and help the definition of his many new units, which are far too thin to allow mapping (the author himself draws only four units in his Fig. 5). Not even the basic requirements of lateral continuity and mappability prescribed by international stratigraphic standards (North American Commission on Stratigraphic Nomenclature, 1983; Salvador, 1994) are thus fulfilled.

Waterhouse (1994, p. 3) states that "our knowledge of early Triassic in the Himalayas, despite its historic importance, has in no way kept pace with advances on Early Triassic in the rest of the world". In fact, he seems to totally ignore the over a dozen works published by our research group at Milano University in the latest ten years, specifically dealing with Permo-Triassic

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stratigraphy of the Tethys Himalayan Zone from Northern India (i.e., Nicora et al., 1984; Gaetani and Garzanti, 1991) to Central Nepal. Some of these already discussed at length and dismissed the unjustified proliferation of new ill-defined stratigraphical names (Garzanti and Pagni Frette, 1991), with special reference to previous works by Waterhouse himself in central Nepal (Garzanti et al., 1992, p. 277).

The confusion engendered by Waterhouse's paper stems not only from its unacceptable approach as to formal stratigraphic subdivisions and nomenclature, but raises from substantial reasons as well.

His correlations of Permian strata are at odds with palaeontologic data recently obtained from brachiopod and conodont assemblages, which testify to rapid lateral facies changes and strong heterochroneities in Manang. As an example, the base of the "topmost biocalcarenites" capping the Thini Chu Group ("Marsyangdi Formation" of Waterhouse) ranges in age from Djul-fian-Dorashamian in the west to as old as Bolorian in the east (Garzanti et al., 1994a), and thus this unit cannot overlie the "Pija black Shale Member containing rich Djulfian faunules" (Waterhouse, 1994, p. 6) throughout the area.

Paleontological data are not more consistent with Waterhouse's scheme as far as the Triassic is concerned. As an example, the Scythian/Anisian boundary is misplaced by Waterhouse (1994, p. 14 and 16) both in Manang and in Dolpo: his "Tangje Member" in Manang, reported as "likely to be basal Anisian", correlates in fact (if we properly understood his scheme) with our "second thin pelitic interval" of the Tamba Kurkur Formation, dated with conodonts as Late Smithian (Garzanti et al., 1994b), whereas his "Sungjar Formation" in Dolpo, reported as "late Scythian and early Anisian", is equivalent to the upper carbonate band of the Tamba Kurkur Formation, containing abundant conodonts of Early to Late Smithian age (Nicora, 1991).

Paleontology

1. Repository of the specimens

At the present time a clear indication of the repository of the material is a must. The studied material should be available to the scientific community. This is not the case for the material of Waterhouse. He provides inventory numbers only for the figured specimens (Fxx or Fxxx) and for holotypes and selected lectotypes from literature (GSIx; BM(NH)x; IVx). From the point of view of a reader the inventory numbers of the NOT figured specimens are much more important, because these specimens cannot be recognized in any way except from the labels, which however can be easily mixed, destroyed or lost.

The second point is about the physical repository of the specimens. On p. 30 it is reported that "Additional large collections have been donated to the Nepal Department of Mines, Lainchaur, Kathmandu". This sentence leads to suppose that there is a main collection which has not been donated to the Nepal Department of Mines. Where is this collection? Which collection includes all the figured specimens whose inventory number is Fxx or Fxxx? This acronym is not explained at all, despite of the sentence "Other repositories are explained in the text" which ends the paragraph "Repository of the collections".

2. Quality of the specimens and quality of the illustrations

Well preserved fossils are much more difficult to be found in the stratigraphical record than poorly preserved ones. Obviously, paleontologists cannot work only on nice fossils but they have to take in consideration also the ugly ones. However, the amount of the information provided by fossils is different depending on their preservation. Complex taxonomical, stratigraphical and/or paleoecological interpretations, reconstructions and correlations are possible only through good material. It seems to us that the amount of interpretations done by Waterhouse (sixteen new species, nine new genera, one new subfamily, four new families, two new suborders and three new orders) is not justified by the quality of his material. Most of the specimens are incomplete to very incomplete, and the preservation is very bad. Without any additional information, some of the specimens, cannot be identified not only as cephalopods, but even as fossil: for instance pl. 1 fig. 12, pl. 2, fig. 15, pl. 4 fig. 4. Others could be of uncertain attribution (i.e., pl. 4, fig. 2, why not a coprolith ?), or enigmatic as pl. 2 fig. 13 (it is a fossil, but it seems to be a ring, not a planispirally coiled shell: why not a rudist from inner view?). Many other incomplete specimens are difficult to interpret because their outline is difficult to be understood: the contact with the matrix is not distinguishable and/or the breakages are difficult to be evaluated. Some examples are pl. 1, fig. 10 and 12; pl. 2, fig. 16 and 18; pl. 3, fig. 13 (the periumbilical border is elliptical while the ventrolateral margin is not) and 14.

As far as the quality of the plates is concerned we remark that the specimens do not seem to be conveniently lightened so that they look flat. Maybe they are really flattened, however also the very rare ventral views lack of shadow and do not show the third dimension (i.e., pl. 1, fig. 8; pl. 2, fig. 2 and 5; pl. 4, fig. 11). In any case, the assemblage of the plates should have required much more additional information: restoration of breakages, position of umbilical margin, position of last suture (shown three times over about 50 relatively complete specimen in lateral view). Another remark on the plates is about the real outline of the specimens: sometimes they seem to be cut off roughly, as they show a polygonal outline (i.e., pl. 5, fig. 13 left side). For instance the holotype of *Zhaojinkeoceras nepalensis* on pl. 5, fig. 5 and 8 is figured two times with two different magnifications, but with two different outlines (!). Which is the real preservation of the specimens? Are they flat or not? Are they included in matrix or not? The taphonomy of the specimens is not described at all in the paper.

The drawings also require comments. A correct drawing of a suture line must include the indication of the position of the ventral and dorsal (if visible) elements with an arrow, and the position of the shoulder and/or periumbilical margin and/or umbilical seam with a dashed line. This information is absolutely necessary in case of incomplete sutures to show which part is represented. This is not done in most of Waterhouse's drawings, which are incomplete: text-fig. 6B, 6C1-3, 6E (one or two incomplete sutures?); text-fig. 75, text-fig. 9A2, 9A4, 9C, 9E2, 9E4, 9F, 9G, 9H; text-fig. 102, 103; text-fig. 12A, 12B, 12C2, 12D, 12E. These drawings are useless.

3. Comments on the classification

Species

A total amount of twenty-nine species are described: sixteen of them are new. The monotypic species seems to be four (*Zakharovites zakharovi*, *Shalshalia unda*, *Himophiceras huguanghongi*, *Mesokantoa lichanensis*), but the composition of the type series of *H. huguanghongi* and *M.*

lichanensis is not clear (one or more specimens?). The splitting index (new monotypic taxa/total number of new taxa) is 1/4, relatively low, but not ideal (0). In any case from a practical point of view the poor quality of the figured specimens does not make Waterhouse's polytypic species so different from monotypic ones. The poor quality of the specimens at hand seems to be reflected also by the choice of the holotypes: on seven new species with synonymy only in a single case Waterhouse has preferred one of his specimens to the others from literature. Perhaps this policy is forced by the quality of the material, however for *Shalshalia unda* and *Ophiceras paraserpentinum* the choice is very regretfully. These species are based on specimens respectively from Krafft and Diener (1909) and Diener (1897) not bed-by-bed collected, so their definite stratigraphic position is unknown.

However, the objections which can be raised on Waterhouse's taxonomy are not only related to theoretical (subjective) approach, but also essential. Here just some examples are listed.

The formation of the names of the new taxa does sometimes not follow the grammatical rules pointed out by the International Code of Zoological Nomenclature (Ride et al., 1985). The generic name *Shalshalia* is feminine, so according ICZN Art. 31b the species *Ophiceras himalayanum* Griesbach cannot be modified as *S. himalayanus* (masculine) but becomes *S. himalayana*. The generic name *Kymatites* is masculine (ICZN Art. 30b) then the new species erected by Waterhouse must be named *K. attenuatus*, not *K. attenuata*. The name of the new genus *Zhaojinkeoceras*, compound with the greek suffix *ceras*, is neuter, then the name *Z. nepalensis* is wrong and must be corrected as *Z. nepalense*. The explanation of the name derivation for *Tilichonia typus* (p. 54) is wrong: typical (adjective) is translated in Latin as typicus not as typus (noun) which actually means type.

Some type specimens are very badly preserved (see above), but also badly figured (see above): among the several possible examples we report the holotype of *Mesokantoa alta* (pl. 5, fig. 12 and 13) whose lateral view is the weathered surface not the undamaged side (!, fig. 13). Another example is that of the new species *Tilichonia typus*: from the figure caption it is not clear if pl. 3, fig. 11 and fig. 12 are two different fragments of the same specimen (the holotype) or if they are two different views of the same fragment. They have a different outline, but as it has been pointed out in the previous example of the holotype of *Zhaojinkeoceras nepalensis*, this does not exclude the possibility that they are two views of the same fragment. Anyway, it is sure that the restoration on page 55, text-fig. 11, is not consistent with pl. 3, fig. 11. The position of the dorsal side (pl. 3, fig. 11) is in the middle of the preserved part of the lateral side, not closer to the umbilical seam. This point to a slow coiling instead of the quick coiling restored by Waterhouse.

Some doubts arise also from pl. 5, fig. 3 and 4. The specimen, which is the holotype of *Gyronites chegajiensis*, shows tabulate venter, however it also shows (fig. 3) two compactional fractures due to body chamber collapse (longitudinal fractures of Seilacher et al., 1976), at 1/5th and 4/5th of whorl height. These compactional fractures are not reported by Waterhouse. Isn't it that the venter looks flat and the shoulder subangular due to sediment compaction?

The separation of *Lytophiceras bandoi* from *L. nakazawai* is obscure. The range of *L. nakazawai* overlaps the range of *L. bandoi*. From the diagnosis (p. 42 and 43) *L. nakazawai* differs from *L. bandoi* having subparallel flanks instead of parallel, however the drawings on text-fig. 6D are very similar, especially if the right sides are compared. The umbilical wall is "low step or gentle" in *L. bandoi* while it is "step, convex, not vertical" in *L. nakazawai*. However fig. 6D1 and 6D3 are identical in this respect. *L. nakazawai* should be distinguished because its umbilicus is "less

than whorl height at maturity". However this statement is denied by the dimensions of the specimen F14, whose umbilicus (U) is 10.5 mm while whorl height (H) is 8.5 (p. 43). Bando's specimens (one is chosen by Waterhouse as lectotype), show U<H: perhaps F14 is not mature, but more information about the mature size of L. nakazawai would have been greatly appreciated. Bando's specimens are two times larger than F14 (GSI 19457: D=49.7 mm; GSI 19452 = 54.7? mm; Bando, 1981, p. 147): does Waterhouse have specimens with intermediate size, or is the link with Bando's specimens solely based on interpretation? A final remark should be made about the choice of the photographs mounted on plates: the diagnostic features of L. bandoi and L. nakazawai are not visible at all from the pictures on plate 2, fig. 6, 7 and 8, which are, in our opinion, useless.

Genera and families

Two kinds of general remarks can be made: on the composition of the new taxa and on the immoderate splitting. The new taxa, from genus to family rank, are introduced with diagnosis and discussion, but without clear statements on the composition. This may be source of misinterpretation because species (respectively genera) of uncertain attribution are often mentioned in the discussions.

The splitting index is high and curiously increases with the taxonomic level. Of nine new genera, three (1/3) are undoubtfully monotypic: Altochonchella, Tilichonia, Zhaojinkoceras. Of five new subfamilies and families four are monotypic.

Suborders and orders

At this taxonomical level the speculation is high. Taxonomic separation may reflect subjective philosophic approach. However, is the direct experience in the field and on the classical collections that makes personal interpretation more or less accepted by other specialists and consequently more or less prominent the role of the scientist which suggests it. E.T. Tozer's more than thirty-year experience is documented by tens of papers on Triassic ammonoid taxonomy and stratigraphy. Waterhouse is a beginner in Triassic ammonoids. His speciality, well illustrated by 19 references in the paper under discussion (nobody else is so referred), are the brachiopods of the upper Paleozoic.

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AN ATTEMPT TO INTEGRATE MORE MARKERS FOR THE PERMIAN-TRIASSIC BOUNDARY

Yin Hongfu

There is now a momentum toward applying *Hindeodus parvus* (or *Isarcicella parva*) as the marker of the Permian-Triassic boundary (PTB). However, different opinions should be considered seriously. These are summarized below.

- 1. Should we prefer a multispecies over a monospecies criterion (Dickins, 1994)?
- Should we consider application of Otoceras as the marker of the Permian-Triassic Boundary (Tozer, 1994; Dagys, 1994)?
- 3. Should we consider δ^{13} carbon as the marker of the Permian-Triassic Boundary (Newell, 1994)?

The reasonability of applying multispecies for boundary markers is evident. The Guidelines and Statutes of the ICS state that multispecies fossil zones (e.g. faunal assemblages) may be preferable biostratigraphic signatures for GSSP guidance. However, because no two species can have perfectly identical time ranges, and a group of species will definitely originate at different times, theoretically using one or two species as marker(s) is in most cases unavoidable. We can use an assemblage to define a broad time-range; the narrower the range becomes, the fewer available index fossils will remain. When down to an accurate delineation where the resolution on centimetre-grade is required, the number of species which can meet the demand of world-wide and contemporaneous appearance will naturally decrease to very few, just one or two, and such are many of the cases already happened in GSSP approved by ICS. However, we need to make efforts to find as many as possible species and other markers which can meet the qualification. This question is immediately connected with the problem of *Otoceras*.

The second question has been dealt with in the Chinese PTBWG (1993). The problem that needs to be resolved is: which species of *Otoceras* is suitable as the marker for the Permian-

Triassic Boundary? Since age of *Otoceras* as a whole is disputable, independent time references are required to judge separated *Otoceras* species whether they are Triassic or Permian. The preferable time references seem to be *Hindeodus parvus* for the Triassic, and *Pseudotirolites* and *Paratirolites* for the Permian. *Clarkina changxingensis* and *C. deflecta*, brachiopod and bivalve assemblages can also help in defining the boundary. The Boreal *Otoceras* species are inadequate markers for the Permian-Triassic Boundary because of the imperfectness of the sections (especially in Arctic Canada and Greenland), the lack of above-mentioned time references and their inaccessibility (e.g. Setoraim section in Verkhoyan). In the Tethys region, it has been clearly shown by Nakazawa (in Yin, 1993) and in previous papers that the lower *O. woodwardi* Zone yields Permian brachiopods and bivalves while the upper *O. woodwardi* Zone Triassic Boundary marker.

Orchard et al. (1994) shed new lights on another Tethyan species, i.e. *O. latilabotum* from Selong, Tibet. In accordance with previous authors, he confirmed the coexistence of *O. latilabotum* and *H. parvus* in Bed 20 (10-30 cm), which overlies Bed 19 (8-17 cm) with uneven surface, the latter bed in turn overlying a fracture fill of fibrous calcite (2 cm, Geldsetzer, pers. comm.). Bed 20 has no confirmed Permian fossils and should be lowest Triassic, whereas Bed 19, formerly 'Changxingian', contains fragmented brachiopod species, the same as those in the underlying 'Prechangxingian'. *O. latilabotum* is thus synchronous with *H. parvus* and capable of serving as a PTB marker. However, it is recommended here as an auxiliary marker because it has only one occurrence (Selong), and because the Selong section does not satisfy the GSSP qualification, due to a close disconformity underneath. The paper of Orchard et al. (1994) helps to clarify that the *latilabotum* bed does not correspond to the lower *woodwardi* bed, as was suggested by the Chinese PTBWG (1993), because the latter does not contain *H. parvus*, but Permian brachiopods and bivalves instead, whereas the *latilabotum* bed does not yield Permian brachiopods, which do occur in the underlying Bed 19 ('Changxingian').

Now the third question: Should we consider $\delta^{13}C$ as the marker for the Permian-Triassic Boundary? For readers unfamiliar with $\delta^{13}C$, some data may be provided. In Meishan Chen et al. (1984) have shown the minimum excursion of $\delta^{13}C$ (-1.9%) in the lower part of Bed 27, slightly below the base of the Permian-Triassic Boundary, dropping from the latest Permian high (+2.5-3.5%). Recently Xu and Yan (1993) again detected the excursion, based on three samples taken at intervals of ca. 2 cm from the lowest 6 cm of Bed 27, the minimum of these being less than -6%. The late Permian high is about +2% and the value of Beds 25 and 26 are around 0, with a short-lived excursion in Bed 26 (sample CG672c). An iridium spike (AG253) is found in the uppermost 1 cm of Bed 26, or 9 cm below the Permian-Triassic Boundary.

In the Shangsi section, Sichuan, South China, the Permian-Triassic Boundary is set at Bed 28b where *Claraia* first occurs. There are three δ^{13} C excursions across the Permian-Triassic Boundary (Li et al., 1989). The lower and slightest one (-2.52%) in Sample 2 of Bed 27, ca 25 cm below the PTB; the middle one (-3.91%) in Sample 2 of Bed 28, within 17 cm below the PTB; the higher and strongest one(-5.28%) in Sample 4 of Bed 28, about half a metre above the PTB. In terms of stratigraphic horizons the middle one seems more in accordance with δ^{13} C excursions in other sections. An iridium spike is found in Bed 27c, within 21 cm below the Permian-Triassic Boundary.

In the Selong section, Tibet, the δ^{13} C occurs at 1.5 cm from the base of Bed 19, i.e., ca 5.5 cm below the basal Triassic 'parvus' zone (PTBWG News 3, Albertiana 14).

No δ^{13} C profile has yet been reported from the Guryul Ravine, Kashmir. However, the nearby Thongde section in Zanskar Himalaya, India shows that the δ^{13} C excursion occurs right at the base of the Triassic, overlying the Dzhulfian strata with a disconformity (Baud et al., 1989).

The carbon isotope profile in the Nammal section, Salt Range, shows a gradual decline from $\delta^{13}C = +4.5\%$ in the Upper Wargal Formation to +2% near the top of Unit 3 of the Chhidru Formation (Baud et al., 1989). Carbon isotope levels in the Mittiwali Member are variable in the range -2 to +2%. The drop through the upper part of the Chhidru Formation and the Kathwai Member is complex. An initial drop to -0.5% occurring in Unit 4 and upper Unit 3 of the Chhidru Formation may represent only diagenetic cement, because the low boron content at this horizon suggests a fresh-water inflow to the basin, and it should thus be discounted. Here the Lower Unit of the Kathwai is lacking. In the Middle Unit of the Kathwai the two sample sets agree that $\delta^{13}C$ is near +1%, dropping to about -0.5% slightly above the base of the Mittiwali Member. There is little doubt that the Permian-Triassic Boundary is crossed during a sharp drop, but due to the absence of strata immediately preceding the *parva* horizon, in Salt Range being the Lower Unit of Kathwai, the exact excursion may not be existing here.

In the Kuh-e-Ali Bashi section (Locality 1), NW Iran, in basal Triassic Bed 21 the δ^{13} C dropped from over 2% in Beds 1-20 to near zero (Baud et al., 1989). The excursion peak (sample 33) is located within Bed 21, slightly below the appearance of *H. parvus*.

In the Sovetashen section, Nakhichevan, Armenia, Transcaucasia, the minimum in the δ^{13} C curve lies within the 'uppermost Dorashamian' sensu Zakharov (Baud et al., 1989), which is now considered as basal Triassic, exactly where *H. parvus* appears.

In the Tesero section, western Dolomites, Southern Alps, Italy, the δ^{13} C drops from +3% in the Bellerophon Formation to near +1% in the lower Tesero. However, passing the Permian-Triassic Boundary or 15/16 boundary the value does not go back, but continues to decrease down to -2% in the Mazzin Member. Thus, the depletion did not actually represent a single event, but it was a complex change that spanned perhaps a million years during the latest Permian and earliest Triassic (Margaritz et al., 1988).

In the Gartnerkofel-1 core section, Carnic Alps, Austria, there is a steep drop of carbon isotopes from > +1% in the Bellerophon and lower Tesero to zero and negative in the upper Tesero and lowest Mazzin (Holser and Schoenlaub, 1991). The δ^{13} C excursion (- 1.5%) occurs at the base of the Mazzin Formation (depth 220.20 m). The Permian-Triassic Boundary or the first appearance of *H. parvus* (questioned by Gullo and Kozur, 1993) is at the top of the Tesero (depth 224.74--224.97 m). Here against the general rule, δ^{13} C postdates *H. parvus*. However, an abrupt drop from the Late Permian high (+1-2%) already began at a depth of 225 m and passed zero at Bellerophon-Tesero contact (224.52 m). Two iridium peaks at many times background level are seen, respectively at the Tesero/Mazzin contact and at about 40 m higher where δ^{13} C drops to its upper minimum.

Likewise, an abrupt drop of δ^{13} C across the Permian-Triassic Boundary has been discovered in South China (Chen et al., 1991) and throughout the Tethys (Baud et al. 1989, Holser et al., 1991), and it even occurs in Greenland (Oberhänsli et al., 1989) and Spitzbergen (Gruszczynski et al., 1989), although in the latter the drop began earlier (in the Tartarian). Thus it is a global phenomenon suitable for intercontinental correlation. There also seems to exist a consistent relationship between δ^{13} C excursion, iridium spike and the Permian-Triassic Boundary defined by *H. parvus*. Stratigraphically they are very closely distributed, and in most cases the iridium spike, δ^{13} C excursion and PTB arrange in ascending order. Because the iridium spike reflects

some sort of catastrophic environment and the δ^{13} C excursion, putting aside other factors (diagenetic cement etc.), denotes abrupt biomass loss, such an order means a succession of (1) end-Permian environmental stress, (2) mass extinction and finally (2) Triassic newcomers, and is thus theoretically correct. However, there are cases where a δ^{13} C excursion does not occur (Nammal), occurs repeatedly (Shangsi) or postdates the Permian-Triassic Boundary (Gartner-kofel). Moreover, a δ^{13} C excursion itself does not possess a chronostratigraphic meaning and are thus sometimes put in the top of the Permian, sometimes in the basal Triassic. Short-comings limit its application as the main marker for the Permian-Triassic Boundary. To sum up, a δ^{13} C excursion, and to lesser extent an iridium spike, are recommended to serve as auxiliary markers for the Permian-Triassic Boundary.

Summary

Besides *Hindeodus parvus* as the main marker of global Permian-Triassic Boundary, *Otoceras latilabotum*, a δ^{13} C excursion and, less important, an iridium spike are recommended as auxiliary markers of the Permian-Triassic Boundary. The author hopes that this suggestion may meet the requirement of ICS guidelines better.

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CONODONTS FROM THE PERMIAN-TRIASSIC BOUNDARY BEDS AND BIOSTRATIGRAPHIC BOUNDARY IN THE ZHONGXIN DADUI SECTION AT MEISHAN, CHANGXING COUNTY, ZHEJIANG PROVINCE, CHINA

Wang Cheng-yuan

Abstract

Conodonts have been found in every layer of the Permian-Triassic boundary beds in the Zhongxin Dadui section at Meishan (Changxing, Zhejiang). The first appearance of *Hindeodus parvus* Morphotype 1, which is used to define the P/T boundary, is in the middle part of boundary bed 2. This biostratigraphic boundary lies in the Zhongxin Dadui section at Meishan 15 cm higher than the eventostratigraphic boundary. This section is the best global stratotype section and point (GSSP) for the Permian-Triassic boundary as has already been proposed by Sheng et al. (1984).

In August 1993, at the meeting of the Working Group on the Permian-Triassic boundary (PTBWG), four candidate sections of the Permian-Triassic global boundary stratotype sections were recommended: (1) the Meishan section at Changxing, Zhejiang, (2) the Shangshi section at Shangshi in Guangyuan, Sichuan, (3) the Xishan section at Selong, Xizang (Tibet), and (4) the Guryul Ravine section in Kashmir, with the Changxing section ranking higherst. At the PTBWG meeting in Guiyang (August 1994), after excursions to the Meishan and Shangshi sections, 23 participants voted for Meishan (Changxing), one participant for Guryul Ravine and none for Shangshi and Selong as GSSP candidate.

In recent years, conodonts have been used for exact age determinations of the Permian-Triassic boundary beds of the Meishan sections. Only through intensive studies on conodonts a high resolution, at centimetre-level, of the Permian-Triassic biostratigraphic boundary can be achieved (Wang Cheng-yuan, 1994a,b). In these papers it was shown that the biostratigraphic data used in the past were either too general for an exact determination of the boundary level, or that they had been used in connection with the concept of the 'transitional beds' or 'mixed beds'. In the latter case, the biostratigraphic boundary was confused with the evento-stratigraphic boundary or the lithostratigraphic boundaries, a definition that is neither in agreement with the principles of biostratigraphy, nor with the existing facts, nor with the requirements set by the international stratigraphy committee pertinent to the GSSP.

Even though the extraordinary importance of conodonts at the Permian-Triassic boundary level of the Meishan sections was repeatedly recognized, they have not been subject of deep-going studies. Especially the exact range of *Hindeodus parvus* (Kozur and Pjatakova), its morphological features and taxonomic evolution need to be clarified as soon as possible.

A brief account of studies on conodonts in the boundary beds of Meishan sections

Conodonts of the Changxing Formation in the Meishan sections of Changxing were earlier studied by Wang Cheng-yuan and Wang Zhi-hao (1981). The conodont zonation of the Changh-sing Formation they established, in agreement with the Upper Permian conodont zonation of Transcaucasia by Kozur (1978), has been widely used, both in China and abroad. However, they did not find any conodonts in the Permian-Triassic boundary beds at that time. The here mentioned boundary beds correspond to the 'Mixed bed' used by Sheng et al. (1984). Instead of the 'Mixed beds' or the 'transitional beds', the present author is in favour of the traditional international term the 'boundary beds', on which the author has made a comment (Wang Cheng-yuan, 1994a).

Zhang Ke-xin (1984) first reported conodonts in the Permian-Triassic boundary beds in the Baoqing section (Meishan, Changxing) and he discovered two solid specimens of 'Gondolella' deflecta and 'G.' subcarinata changxingensis and two mould specimens of 'G.' subcarinata changxingensis and 'G.' sp. in the black mudstone (bed 26). In his opinion, the above mentioned two solid specimens might have been infiltrated by chance into bed 26. He did not find any conodonts in the real 'boundary clay' bed (Bed 25). According to Zhang (1984) Hindeodus parvus occurs in boundary bed 2 of the Baoging section but no material was illustrated. In 1987, Zhang Ke-xin published a picture of Anchignathodus parvus (Zhang Ke-xin, pl. 1, fig. 22; collection No. 85187). The cusp of this specimen is large but broken. The denticles behind the cusp are uniform in height, followed by three bigger denticles at the posterior blade. Almost all discussions about H. parvus in the boundary beds of the Meishan sections were originally based on Zhang's incomplete specimens. However, it is still disputable whether it really is H. parvus or not. Kozur (pers. comm., 1994) considered that it might be H. parvus or an advanced H. latidentatus emend., because the cusp is broken and the photo was taken in an oblique lateral-lower position. After personal examination of the figured specimen he regarded this form as a transitional form between H. latidentatus emend. and H. parvus. Zhang's specimens were collected from Meishan in Changxing, but the specific section is unknown, because there are several boundary sections at Meishan.

It should be noticed that Zhang Ke-xin (1984,1987) and Yin Hong-fu and Zhang Ke-xin (1993) placed the 'boundary clay' bed (bed 25) in the Permian, whereas the Permian-Triassic boundary was defined between bed 25 and bed 26 by the above mentioned Chinese authors and above bed 26 by Kozur (1989). The idea of Zhang's 'transitional bed' did not include the 'boundary clay' bed (bed 25), which differs from the viewpoints expressed by Yang Zun-yi et al. (1987) and Yin H.F. and Wu S.B. (1985), and by Yin et al. (1988). A majority of scholars maintained that the basal limit of the 'boundary clay' bed is obviously nothing else than the eventostratigraphic boundary. Zhang Ke-xin (1987) stated that the occurrence of 'A.' parvus was about 14 cm above the basal limit of Otoceras, that is, about 14 cm from the top of bed 25 instead of at the base of the 'boundary clay' bed. He regarded the first appearance of the ammonoid Hypophiceras as the P/T boundary (between bed 25 and 26). However, from the conodont workers' point of view this is hardly acceptable because bed 26 (= AEL 881, in this paper) is rich in Permian conodonts. It even has a richer Permian conodont fauna than Bed 25 (= AEL 880, in this paper). The base of Bed 26 is neither an eventostratigraphic boundary nor the conodont's biostratigraphic boundary. It indicates the immigration of cool-water ammonoids. Clark et al., (1986) had a collection of Neogondolella carinata, N. defleta, N. changxingensis, H. subcarinata and H. 'minutus' from the 'boundary clay' (B3, 84-2, C3) in the Baoqing section B, D, and the Zhongxin Dadui section (Zh). These boundary clay beds were placed in the Permian in line with the conodont characteristics.

Wang Cheng-yuan and Wang Zhi-hao (1981, pl. 1, fig. 20) reported *Hindeodus parvus* from the Changxing section D. The material was from the uppermost part of the Changhsing Limestone, instead of the boundary beds. Most denticles in this specimen were broken. It is unidentifiable, but surely not *H. parvus*. It may be *H. latidentatus*.

As far as the author is aware, *Hindeodus parvus* was reported and documented photographically from the Changxing section (section D) in the volume entitled 'Conodonts of Lower Yangtze Valley - Indexes for biostratigraphy and organic metamorphic maturity' (1993) published under the editorship of Wang Cheng-yuan (p. 253-254, pl. 55, fig. 2). However, this specimen occurs in a higher horizon at the lowermost part of the Qinglong Limestone, but not in the boundary beds. Summarizing, it can be said that no real *H. parvus* was reported and documented from the boundary beds of the Changxing section, especially in Zhongxin Dadui section before the Wang's paper (1994a,b).

Conodonts in the Permian-Triassic boundary beds of the Zhongxin Dadui section at the Meishan, Changxing

The section of Zhongxin Dadui quarry at Meishan is the Permian-Triassic boundary section in South China proposed by Sheng et al. (1984). It is situated 0.5 km east of section D at Meishan, presently belonging to Baoqing of Huaikan township in Changxing, but administratively not to Meishan town. The locality where the section is situated is owned by the Chang-xing cement factory in Zhejiang.

Following Sheng et al. (1984) on the Zhongxin Dadui section, no further studies have even been made. Only Clark et al. (1986) gave a brief account of the conodonts in the boundary beds of this section. Early 1993, more conodont samples were collected layer by layer from this section by Zhang Lin-xin, Wang Cheng-yuan, Zhou Zu-ren, and Xu Zi-qiang. A total of 58 kg samples has been obtained from boundary bed 2 (= mixed bed 2). These samples were cut open along the bedding surface by Wang Wen-wu, a senior engineer. One sample per 4 cm, four samples in total (AEL 882-1 -- 882-4). While making acid treatment, a buffer technique was adopted to bring the Ph value under control (between 3.6 and 4.5) and to insure the efficiency of conodont analysis. The samples from the clay beds had only to be immersed in water. After these samples had been analyzed, the amount of conodont specimens still appeared to be insufficient. During the holidays of the Spring Festival in 1994, the present author and Xu Zhi-qiang of the Changxing coalfield geological school collected 105 kg of additional sample material from the boundary beds in the same section. The following lithological descriptions and megafossils list are based on the literature of Sheng et al., (1984); new additions are largely concern conodonts. The conodont identifications were made by the present author and H. Kozur (Budapest). The new species will be described by Kozur and Wang (in press).

Stratigraphic sequences and fossils of the Zhongxin Dadui boundary section are shown in descending order:

Lower Triassic - Lower Chinglung Formation

15.	Greyish green mudstone intercalated with thin-bedded argillaceous limestone and limestone increasing upward, containing bivalves <i>Claraia fukenensis</i> Chen, <i>C. longyenen</i> -	
	sis Chen; ammonoids ophiceratid and Lytophiceras sp.	0.07 m
14.	Greyish yellow mudstone with concretions of limestone,	
	yielding C. stachei (Bittner) in the middle part and Palaeo-	
	nucula sp., Claraia sp. in the lower	6.00 m
13.	Yellow illite montmorillonite clay	0.02 m
	Boundary bed 3	
12.	Greyish yellow marl containing C. griesbachi (Bittner)	0.30 m
11.	Yellow illite-montmorillonite clay	0.02 m
10.	Greyish yellow mudstone yielding C. wangi (Patte), C.	
	dieneri Nakazawa	0.98 m
9.	Yellow illite-montmorillonite clay	0.04 m
8.	Bluish grey marl containing ophiceratids	0.46 m
7.	Grevish yellow marl yielding Cl. wangi and ophiceratids and	
	conodonts (AEL 886 - AEL 884) Hindeodus parvus Mor-	
	photype 1, H. parvus Morphotype 2, I.? turgida, Clarkina	
	carinata, Ellisonia transita	0.36 m
6.	Greyish yellow mudstone	0.02 m
5.	Grevish yellow clay containing conodonts (AEL 883) Clar-	
	kina sp: Hindeodus typicalis, Hindeodus paryus	0.01-0.02 m

Boundary bed 2

4

Light grey dolomitic marl containing brachiopods *Paryphella* triqueta (Liao), *P. orbicularis* (Liao), *Waagenites* sp., *Paracrurithyris* sp., *Fusichonetes pigmaea* (Liao), and also containing conodonts (per 4 cm for each sample, in descending order)

(AEL 882-4): *Hindeodus parvus* Morphotype 1, *H. parvus* Morphotype 2, *H. typicalis, Hindeodus* sp., *Clarkina chang-xingensis, Ellisonia* sp., compound conodont elements and fish teeth.

(AEL 882-3): Clarkina carinata, C. changxingensis, Clarkina n. sp., Hindeodus latidentatus, H. parvus Morphotype 1, H. parvus Morphotype 2, H. julfensis, I.? turgida, common Ellisonia transita, compound conodont elements and fish teeth.

(AEL 882-2): Clarkina carinata, C.deflecta, H. typicalis, Isarcicella? sp., Merrillina longidentata sp. nov., Stepanovites sp., compound conodont elements and fish teeth.

(AEL 882-1): Clarkina carinata, C. changxingensis, C. procerocarinata, Hindeodus typicalis, H. changxingensis sp. nov., H. latidentatus, Isarcicella? sp., Ellisonia transita, E. sp., compound conodont elements and fish teeth.

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Boundary bed 1

3.

Greyish yellow mudstone with small crystal of pyrite, purple-red in weathering colour, yielding ammonoids Otoceras? sp., Hypophiceras cf. martini (Truempy), H. changxingense Wang, Tompophiceras sp., Metophiceras sp., Pseudogastrioceras sp.; bivalves Peribositra baoqinensis Chen; brachiopods Paracrurithyris pygmaea (Liao), Waagenites barusiensis (Davidson), Paryphella sulcatifera Liao, Neowellerella pseudoutah (Huang), Araxathyris minuta Grunt; conodonts (AEL 881): Clarkina cf. carinata, C. changxingensis, C. dicerocarinata, C. deflecta, C. cf. sosioensis, C. xiangxiensis, C. meishanensis n.sp., Hindeodus latidentatus

Yellow or purple illite-montmorillonite clay containing conodonts (AEL 880): *Clarkina* cf. *carinata*, *C. changxingensis*, *C. deflecta*, *C.* cf. *meishanensis* n.sp., *C. xiangxiensis* 0.04-0.06 m

0.03-0.06 m

----- conformity ------

Changhsing Formation

1.

2.

Light grey thin-bedded limestone with chert nodules, bearing *Palaeofusulina* and conodonts (AEL 879 - AEL 872): *Clarkina* cf. *carinata*, (from AEL 876 and younger samples), *C. changxingensis*, *C. subcarinata*, *C. xiangxiensis*, *C. deflecta*, *C. wangi*, *C. tian*i n.sp., *Hindeodus minutus*, compound conodont elements and fish teeth.

The Zhongxin Dadui section at Changxing explicitly indicates that *Hindeodus parvus* Morphotype 1 makes its earliest appearance in the middle part of boundary bed 2 (AEL 882-3, 882-4), while some species of *Clarkina*, except *Clarkina changxingensis*, are present in the lower part of boundary bed 2. In other words, these became extinct earlier than the first appearance of *Hindeodus parvus* Morphotype 1, but *Isarcicella?* sp. appeared before, in the lower part of boundary bed 2 (AEL 882-1). The extinctions or rises of conodonts in the boundary beds were gradual, but accelerated in boundary bed 2. *Clarkina meishanensis* is an event species and also *Hindeodus changxingensis* may be possibly an event species. These are species, which appeared and disappeared during the major events in the Permian-Triassic boundary level.

Definition of the Permian-Triassic biostratigraphic boundary

There are at least 13 categories of definitions with regard to the Permian-Triassic biostratigraphic boundary that were discussed in his 1994a,b papers (Wang Cheng-yuan, 1994a,b). The Zhongxin Dadui section (Meishan, Changxing) clearly shows the event successions of the conodont faunas in the boundary beds. A more precise definition of the Permian-Triassic biostratigraphic boundary has been put forward in this paper on the basis of conodonts in the boundary beds of Changxing of Zhejiang, Xuishui and Loping of Jiangxi (Zhu et al., 1994) as well as in Kashmir and Austria: the first occurrence of *Hindeodus parvus* Morphotype 1 in the successive evolutionary lineage from *Hindeodus latidentatus* to *Hindeodus parvus* Morphotype 1. Some supplementary criteria can be used for defining this boundary: the extinction of species

like Clarkina changxingensis, C. deflecta, Hindeodus changxingensis sp.nov., H. typicalis and H. latidentatus and the first occurrence of Isarcicella? sp., I.? turgida and Claraia wangi. These additional criteria, though partly somewhat different in their stratigraphic occurrence from the P/T boundary defined with the first appearance of H. parvus Morphotype 1, they are extremely close to the horizon where Hindeodus parvus Morphotype 1 made its first appearance.

Because of its morphology *Hindeodus parvus* may be differentiated into Morphotype 1 and Morphotype 2 (Kozur, 1990). Morphotype 1 is very characteristic and easily distinguishable from *H. latidentatus*, the forerunner of *H. parvus*. It displays several small denticles having a uniform height behind the cusp and its posterior margin is straight, nearly vertical and without denticles. It has stable characteristics. *Hindeodus parvus* Morphotype 2 has unstable characteristics and shows all transitions to Morphotype 1. This latter morphotype is more similar to *H. latidentatus* and *I.? turgidus*. Very primitive *H. parvus* Morphotype 1 appears in the middle part of boundary bed 2. Advanced *H. parvus* Morphotype 1 with a very big cusp appeared in the upper part of boundary bed 2 (AEL 882-4).

This biostratigraphic P/T boundary with the first appearance of *H. parvus* in a phylomorphogenetic continuum *H. latidentatus - H. parvus* is situated 15 cm above the eventostratigraphic boundary, and it lies in successive monofacies strata, which corresponds to the requirements of the global boundary stratotype section and point (GSSP) as stipulated by the international stratigraphy committee. Thus, the Zhongxin Dadui section at Meishan may be regarded as the world's best candidate for the GSSP for the Permian-Triassic boundary.

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ZONATION OF EASTERN BOREAL LOWER TRIASSIC AND INDUAN/OLENEKIAN BOUNDARY

Algirdas Dagys

Introduction

Recently Yu. Zakharov has published two papers (Zakharov, 1994a,b) which include a revision of the zonal scheme of the Lower Triassic of Siberia (Dagys and Ermakova, 1993) and new proposals concerning the Induan/Olenekian Boundary Stratotype. Both problems are very relevant for the definition of the Induan and Olenekian stages which were recommended during the Lausanne Meeting (1991) as Standard Lower Triassic stages.

Zonation of the Siberian Lower Triassic

1. Concavum Zone

In previous stratigraphic and paleontological publications Zakharov (1971, 1978) did not recognize Otoceras concavum Tozer as independent species and as a consequence he could not recognize the Concacum Zone in the Verkhoyansk Area. Now (Zakharov, 1994a,b) he accepts O. concavum but considers that this species occurs in the Lowermost Induan of Siberia together with O. boreale Spath. Such co-occurrence seems to be based on incorrect interpretation of O. concavum. Tozer (1967) suggested that the distinguishing feature of O. concavum is its concave flanks, but most characteristic is its tabulate venter - a feature inherited from Permian Araxoceratidae. Internal whorls of O. boreale also have to a variable degree a flattened ventral side with distinctive ventrolateral shoulders, but adult specimens (120 mm and more in diameter) possess a body chamber with always acute venter. Otoceras with such morphology have never been recorded in the Lowermost Triassic of the Verkhoyansk region. O. concavum is considered to be the ancestor of O. boreale and this phylogenetic lineage is the base for the zonation of the Boreal Lowermost Triassic which is identical in Arctic Canada and Siberia.

2. Morpheos and Decipiens Zones

Zakharvov (1994a,b) proposes that only a single unit lies between the Boreale and the

Sverdrupi Zones in the Verkhoyansk Region. Dagys et al. (1986) however have described several sections at Tompo River and in the East Khandyga Basin showing three successive assemblages of ammonoids during this stratigraphic interval:

a lower fauna, solely with the genus *Tompohiceras - T. gracile* (Spath), *T. pascoei* (Spath), (incl. *Glyptophiceras nielseni* Spath, *G. extremum* Spath, *G. subextremum* Spath, *G. serpentinum* Spath, *Tompophiceras fastigatum* Popov); a middle fauna with different species of *Tompophiceras* (*T. morpheos* Popov, *T. gerbensis* (Popov), and first *Wordieoceras* and *Ophiceras*; an upper fauna which contains only species of the genus *Wordieoceras*. Based on this succession, Pascoei, Morpheos, and Decipiens Zones have been proposed. Analogues of these zones are known in other regions of Siberia (upper reaches of the Kolyma River) as well as in Western Boreal regions (Dagys and Ermakova, 1993).

3. Korostelevi Zone

This zone was rejected by Zakharov based on the supposed wide range of its index species. An ammonoid assemblage of the Korostelevi Zone was discovered for the first time by Zakharov (1978) in a section of the Burgagandzha River (Tompo River Basin) from where he described or figured *Kingites korostelevi* n. sp., *Ophiceras* sp. (Pl. VII, figs. 1, 2 = *Sakhaites* ? *verkhoyanicum* Popov) and *Episageceras dalailamae* (Pl. II, fig. 7 = *E. antiquum* Popov). Unfortunately Zakharov overlooked a series of faults and overthrusts, resulting in the mixing of different tectonic blocks with ammonoids of different stratigraphical levels (Turgidus and Korostelevi Zones). In other regions of Eastern Verkhoyansk (Delinya River Basin) without complicated tectonics there exists a small but distinctive assemblage of ammonoids - *Kingites* ? *korostelevi, Sakhaites* ? *verkhoyanicus, Episageceras antiquum* between last *Vavilovites* and first *Hedenstroemia*. This stratigraphic interval was attributed to the new Korostelevi Zone. According to its stratigraphic position beneath the Hedenstroemi Zone, the Korostelevi Zone

4. Apostolicum Subzone

I agree that Siberian specimens of *Boreoceras apostolicum* (Smith) have some distinctive features which are lacking in typical forms, described by Smith (1932) from Idaho. They are very similar to *Boreoceras demokidovi* (Popov) and differ from this species only in the appearance of low lateral bullae on 3rd - 6th whorls. This feature is very variable and Siberian *B. apostolicum* (= *Dieneroceras ogonerense* Ermakova; Dagys and Konstantinov, 1984) now are interpreted as an extrem variant of *B. demokidovi*. Accordingly this unit has to be renamed as Demokidovi Subzone.

5. Grambergi Zone

One of the most surprising aspects in the papers by Zakharov (1994a,b) is the elimination of the Grambergi Zone, which is based on a very distinctive ammonoid assemblage, from the Siberian Triassic zonal scheme. The Grambergi Zone is a biozone characterized by the endemic genus *Parasibirites*, which is a direct descendant of an other boreal genus - *Praesibirites*. *Parasibirites* is distinguished from *Praesibirites* by the appearance of ventrolateral bullae and ventral ribbing. Ontogenetic acceleration of the later feature is used for the discrimination of several successive species within the genus *Parasibirites* and this phylogenetic lineage is the base for a subzonal scheme of the Grambergi Zone. In the oldest forms (*Parasibirites kolymensis* Bychkov) ventral ribs appear only on the body chamber. Younger species (*P. grambergi* Popov, *P. mixtus* Popov) have ribbed ventral sides starting at the 5th to 6th whorl and the

youngest form (*P. efimovae* Bychkov) are ribbed from the 3rd whorl on. Zakharov's (1994a,b) data on the mixture of ammonoids characteristic for the Grambergi and the succeeding Spiniplicatus Zones are dubious. Rare species similar as or conspecific with forms of the Spiniplicatus Zone appear only in upper levels - Kolymensis Subzone. Usual forms of this Subzone are *Sibirites pretiosus* (Mojs.) *Boreomeekoceras keyserlingi* (Mojs.) and *Subolenekites altus* (Mojs.). *Olenekoceras middendorffi* (Keys.) determined from this level belongs in fact to *O. laevigatum* Dagys and Erm., *Parasibirites grambergi* - to *P. efimovae* (in previous stratigraphic literature all *Parasibirites* were attributed to one species - *P. grambergi*). For the Siberian Spiniplicatus Zone typical genera are *Olenikites, Keyserlingites, Pseudosvalbardiceras, Prosphingites* etc. which never have been recorded from the Grambergi Zone.

I do not believe that the zonal scheme of the Siberian Lower Triassic is already perfect. Future improvements, especially of such remote and insufficiently studied regions as Siberia, are to be expected. But progress in this field has to be based on original taxonomic and stratigraphic data and not on memories or observations made a quarter of a century back !

Induan/Olenekian boundary

Main problems with the definition of the Induan/Olenekian boundary are connected with the choice of stage stratotypes in different Triassic realms: The Induan is defined in the tropic, and the Olenekian in a boreal region (Kiparisova and Popov, 1956, 1964), which have essentially different marine biota. The exact geographical position of the Olenekian stratotype is unknown. Kiparisova and Popov (1956, p. 845) noted : "Stratoptype of Olenekian stage is the section of the Lower Triassic in the lower reaches of Olenek River in Arctic Siberia". Later, Lazurkin and Korchinskaya (1963) proposed as stratotype of the Olenekian Stage a section near the mouth of the Mengilekh Creek, which yielded the main ammonoid assemblages described by Mojsisovics (1886).

According to the original definition of the Olenekian Stage (Kiparisova and Popov, 1956), it included only "Olenekian Beds" with the genera *Dinarites, Prospiningites, Sibirites, Olenikites, Keyserlingites, Dieneroceras* (= Spiniplicatus Zone of recent scheme, Dagys and Ermakova, 1993), which erroneously were correlated with the Owenitan and Columbitan of Spath (1934).

Later Kiparisova and Popov (1964) concluded that Spath's Flemingites and Owenites Zones are synchronous and, essentially changed and increased the stratigraphic volume of the Olenekian Stage. After this interpretation of "stratotype sections", the Olenekian stage included 4 zones: Paranorites, Dieneroceras, Olenikites, and Prohungarites. The Prohungarites Zone with *Prosphingites* (= *Stenopopanoceras*), *Prohungarites* (= *Grambergia*), and *Karangatites* falls in the Anisian (Tozer, 1971; Dagys and Ermakova, 1984). The Olenikites Zone (= Olenekian Beds) is based on the Mengilekh Section and embraces the Grambergi (Efimovae Subzone) and the Spiniplicatus Zones of the recent scheme. From the former Dieneroceras Zone only ammonoids of the Euomphala Zone have been recorded and the Paranorites Zone according to published lists of fossils (Kiparisova and Popov, 1964), embraces stratigraphic analogues of two recent zones: Kolymensis and Hedenstroemi Zones. Sections in the basin of the lower reaches of the Olenek River so far, Hedenstroemi, Kolymensis, Euomphala, Grambergi and Spiniplicatus Zones have been recorded. Tardus and Contrarium Zones are assigned to the Olenekian Stage based on compilations from Verkhoyansk and Eastern Taimyr Regions (Dagys and Ermakova, 1993).

Despite of several gaps in the ammonoid succession in the stratotype area, the lower boundary of the Olenekian is dinstinctive and it coincides with the base of the Hedenstroemi Zone. The

Hedenstroemi Zone is recorded from vast areas of North-Eastern Asia (Dagys and Ermakova, 1990) as well as in Arctic Canada (Tozer, 1994). In both regions the Hedenstroemi Zone is succeeded by Kolymensis or Romunderi Zone whose sychronity is obvious. Subdivision and correlation of the corresponding stratigraphic interval (between Gyronitid and Prionitid faunas) in low pleolatidudes is more obscure. Smith (1932) descriminated in this interval two units - *Pseudosageceras multilobatum* and Owenites Subzones. His idea was supported by Spath (1934) who proposed the Flemingites and Owenites Zones, but Kummel and Steel (1962) argued that both zones are synchronous.

Tozer (1971) assumed that the earliest Smithian (Lower Olenekian) faunas are those of Madagaskar, the Hedenstroemi Beds of the Himalayas and Verkhoyansk and the Ceratite Sandstone of the Salt Range. This correlation was accepted by Dagys and Ermakova (1990). Such interpretation is hypothetical on two reasons: 1. Smithian prae-prionitid beds do not contain two successive faunas comparable with boreal Hedenstroemi and Kolymensis (= Romunderi) Zones in real sections; 2. In oldest southern Olenekian faunas mentioned above widely distributed genera are *Juvenites, Paranannites, Kashmirites, Arctoceras* etc.

In Boreal regions they are known only from the Kolymensis (Romunderi) Zone. Tozer's (1971, p. 1015) remark that " the earlier Smithian faunas may be correlated in a general way, but they rise many problems, which will not be resolved until more is known of the stratigraphy" retains its actuality till now.

Correlation of the boreal Hedenstroemi Zone and therefore of the lower boundary of the Olenekian Stage in Tethyan regions is conneceted with certain difficulties and Zakharov's (1994a,b) choice of a candidate stratotype section and point for Induan/Olenekian boundary in Primorye, where Early Triassic ammonoid faunas are essentially Tethyan, is at least questionable. As boundary stratotype Zakharov has proposed a section at the Ussuri Gulf, where the Lower Triassic is represented by two units: a lower one - sandstones, with *Gyronites, Flemingites, Kymatites* ?, and an upper one - Siltstones, with *Hedenstroemia, Flemingites, Euflemingites, Arctoceras* etc. From the upper 14 m of the sandstone unit *Gyronites, Ambites*, and *Hedenstroemia* have been recorded and the base of this layer was accepted as the base of Olenekian. An ammonoid assemblage (if it is natural, sensu Tozer, 1971) in which the characteristic Late Induan genus *Gyronites* dominates and which shows the first appearance of *Hedenstroemia* is quite unique, and suspect.

A correlation of this fauna with the boreal Hedenstroemi Zone and even its Olenekian age is therefore very doubtful!

In the Olenekian stratotype area there is no section which may be proposed as the stratotype for the Induan/Olenekian boundary. The Induan of the lower reaches of Olenek River is composed of tuffaceous sandstone and siltstone (lagoonal and littoral facies) with a poor assemblages of bivalves (Dagys and Kurushin, 1985) which are overlain by mudstones and siltstones with a rich Olenekian ammonid fauna. From the upper part of the Induan *Vavilovites* sp. juv. (probably Turgidus Zone) was collected and the oldest Olenekian ammonid in the stratotype area is *Clypeoceras astakhovae* Zakharov (= *Clypeoceratoides gantmanni* (Popov); Kolymensis Zone). An obvious brake in sedimentation at the Induan/Olenekian boudary also has been recorded (Dagys and Kazakov, 1984).

To the east from the Siberian platform, the lagoonal facies of the Induan is replaced by marine sediments and in the Verkhoyansk Region Induan and Olenekian sequences are dominated by

siltstones which usually have layers of carbonaceous nodules containing ammonoids. These are identical with synchronous assemblages of the Olenek Region. In the Eastern Verkhoyansk Region (Tompo River Basin) the Lower Triassic is composed of monotonous siltstone and mudstone with interbeds of thin-grained sandstone. In the Delinya River Basin (tributory of the Tompo River) Morpheos, Decipiens, Sverdrupi, Turgidus, Korostelevi, and Hedenstroemi Zones have been distinguished in strict succession (Dagys and Ermakova, 1993). Analogues of the Kolymensis Zone also are known in this region (Korostelev, 1972; Zakharov, 1978). Lower Triassic sections in the lower reaches of the Delinya River contain the most complete succession of ammonoid assemblages around the Induan/Olenekian boundary and this region offers the best perspectives in Eastern Boreal area for the search for a candidate stratotype section and point for the Induan/Olenekian boundary.

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A CONODONT-RICH PELAGIC OLENEKIAN-ANISIAN BOUNDARY SECTION IN THE SOSIO VALLEY AREA, WESTERN SICILY (ITALY)

Heinz Kozur, Karl Krainer and Helfried Mostler

A deep-water (slope to basin) Lower Triassic to Middle Carnian sequence overlying Permian deposits of the same facies is exposed about 350 m south of Pietra dei Saracini pertaining to the Sicanian paleogeographic domain of western Sicily, near the western end of the Eurasiatic Tethys. The presence of unaltered (CAI = 1) pelagic gondolellid conodonts throughout the entire Early Scythian (Brahmanian = "Induan") in section 1 of this sequence is unique in Europe. An uninterrupted and uncondensed pelagic conodont succession occurs in section 2 documented bed by bed from the Late Olenekian Neospathodus sosioensis Zone (introduced for the interval between the N. triangularis Zone of the Prohungarites-Subcolumbites ammonoid fauna and the latest Olenekian Chiosella gondolelloides Zone) up to the basal Neogondolella bifurcata Zone of the latest Pelsonian (Middle Anisian). With the discovery of Scythian and Anisian deep-water sediments, an Early Permian to Late Triassic deep-water development is known from the Sicanian paleogeographic domain.

Three depositional cycles can be distinguished within the investigated sequence. They are composed of carbonate breccias and calcarenites-calcisiltites formed by debris flows and turbidites, and of marls and pelagic to hemipelagic limestones composed mostly of bioclastic mudstones and bioclastic wackestones containing abundant radiolarians and filaments. Latest Olenekian and younger rocks are built up exclusively by pelagic limestones rich in radiolarians and filaments.

An uninterrupted pelagic conodont succession is present from the Neospathodus sosioensis Zone up to the basal part of the Neogondolella bifurcata Zone (late Pelsonian, late Middle Anisian). The N. sosioensis Zone is younger than the N. triangularis Zone that can be correlated with the Prohungarites-Subcolumbites ammonoid fauna (Orchard, 1994), but older than the Chiosella gondolelloides Zone of latest Olenekian age. Bed by bed sampling yielded very rich and excellently preserved conodont faunas (CAI = 1) from the Late Olenekian N. sosioensis Zone up to the late Pelsonian basal N. bifurcata Zone. Presence of Gladigondolella and Neogondolella species and abundant radiolarians in thin sections indicate pelagic conditions for this time interval. The pelagic limestones are uncondensed. Reworked faunas, common in older Scythian deposits of the sequence, are missing in the latest Olenekian, Early and Middle Anisian. All latest Olenekian to Middle Anisian conodont zones are in sequence and phylogenetic lineages of the most important conodont species can be observed.

The conodont-bearing part of the Scythian-Anisian sequence is shown in table 1. The Brahmanian ("Induan") yielded rich conodont faunas that consist both of pelagic gondolellid and neospathodid conodonts and of transported, but contemporaneous shallow-water conodonts (*Hindeodus, Ellisonia*) (Gullo and Kozur, 1993). Nearly all conodont zones are present.

The Early Olenekian has not yet yielded conodont faunas, because the facies is unsuitable for extraction of conodonts from the rocks (siltstones, sandstones). Only one conodont fauna may belong to this interval, but it consists of a new species similar to both the Brahmanian *Neospathodus dieneri* Sweet and to the Early Olenekian *Neospathodus discretus* (Müller), but not identical with one of these species.

The latest Olenekian *Chiosella gondolelloides* Zone is represented by an 4 m thick interval with mass occurrences of the index species. The development of *Chiosella timorensis* (Nogami) from *Chiosella gondolelloides* (Bender) is within a phylomorphogenetic continuum. The first appearance of *Chiosella timorensis* within this cline is the best marker for an applicable and correlable Olenekian-Anisian boundary.

Chiosella gondolelloides is not only the forerunner of *Chiosella timorensis*, but there is also a continuous lineage from *Chiosella gondolelloides* through *Chiosella cuspidata* n. sp. to *Nicoraella germanica* (Kozur) and *Nicoraella kockeli* (Tatge). The first appearance of *N. kockeli* in section 2 is a good marker for the base of the Pelsonian.

Surprisingly, *Nicoraella germanica* and *N. kockeli* appear in the same level. In the Germanic Basin, *N. kockeli* begins distinctly after *N. germanica*. However, the oldest representatives of *N. kockeli* are rather primitive forms, compared with the specimens from the Germanic Basin. Using the base of the Pelsonian in section 2 (first appearance of *Nicoraella germanica* and *N. kockeli*), the Bithynian/Pelsonian boundary would be in the middle part of the Germanic Lower Wellenkalk. Reported Bithynian occurrences of *N. germanica* (Nicora, 1977) are probably based on assignment of *Chiosella cuspidata* to *N. germanica*, but these forms have to be re-studied.

The Aegean *Chiosella timorensis* Zone is more than 3 m thick, whereas the *Neogondolella regalis* Zone s.str. (with *N. regalis* Mosher, but without *N. bulgarica* Budurov & Stefanov) is restricted to one bed. In this restricted scope, the *N. regalis* Zone belongs to the Aegean as well. *N. regalis* evolved in a phylomorphogenetic cline from *Chiosella timorensis*.

The Neogondolella bulgarica Zone is about 4 m thick. In the neospathodid zonation, it can be subdivided into the Bithynian Chiosella cuspidata Zone and the Pelsonian Nicoraella kockeli Zone.

The uppermost exposed bed of section 2 contains the first, primitive Neogondolella bifurcata Budurov & Stefanov. In the same bed Neogondolella bulgarica and Nicoraella kockeli are present. This level belongs to the basal N. bifurcata Zone. The co-occurrence with N. bulgarica indicates late Pelsonian age.

The investigated sequence is unique in Europe. Detailed descriptions of the facies, sedimentology and of the conodont fauna are in press. Especially important is the conodont succession across the Olenekian-Anisian boundary. The conodont fauna of this level is better preserved and richer than in any other section of the world. Section 2 is very important for establishment of a latest Olenekian-Early Anisian conodont zonation based on phylomorphogenetic clines of the index species because these clines are all recognizable in section 2.

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THE ANISIAN/LADINIAN BOUNDARY:

A CONTRIBUTION

S. Manfrin and P. Mietto

Introduction

As in the near future the Subcommission on Triassic Stratigraphy will pronounce on the redefinition of the Anisian/Ladinian boundary, also on the basis of the opinions given in the literature over the last years, the authors think they may contribute to the discussion by expressing their point of view. The subject was debated during the work aimed at the definition of a new high resolution ammonoid standard scale for the Middle Triassic in the Tethys (Mietto and Manfrin, in press). The great number of data allows the authors to be constructively critical towards the bio-chronostratigraphical setting available, and to offer new elements of reflection.

The history of the definition of the Anisian/Ladinian boundary, largely treated in the recent literature (Balini, 1993; Gaetani and Brack, 1993; Vörös, 1993a; Brack and Rieber, 1994; De Zanche and Gianolla, this volume) will not be taken into account. The results of the recent "Anisian/Ladinian Boundary Field Workshop" - summarized in Gaetani (1993b) - and the articles in the Field Guide Book (cf. Gaetani, 1993a) will mainly be discussed.

Whilst the Subcommission will also take into account other events and bioevents useful to the definition of the boundary, the authors will only treat the problem of the Anisian/Ladinian boundary with regard to ammonoids. There is no doubt, however, that in this context ammonoids have quite a conclusive importance.

The authors fully agree that the critical interval including this boundary is between the

Trinodosus Zone (Subzone), unquestionably Illyrian in age, and the surely Fassanian Curionii Zone (Subzone), as pointed out in the literature.

Recent investigations in the Southern Alps and in the Balaton Highlands have shown a succession of ammonoids, collected bed by bed, which covers the critical interval. The sections in Lombardy, in the western Dolomites (summarized in Balini et al., 1993; Brack and Rieber 1993a, 1993b, 1993c, 1994) and in the Balaton Highlands (Vörös 1993a, 1993b; Vörös and Budai 1993a, 1993b) are mainly referred to. All these data have been included and correlated in a table by Gaetani (1993b), which will be referred to as Table. This correlation scheme between the Southern Alps and the Balaton Highlands consists of a reorganization of the biostrati-graphical units into horizons/beds defined by generic and/or specific elements. On the basis of the data in the literature, the horizons/beds seem to be characterized by ammonoids with precise and well defined ranges, and therefore they seem to be excellent correlation tools.

A bed by bed investigation of many stratigraphical sections - some of them new -, allows the authors to conclude that the problem is more complex than it appears as summarized in the Table, and later confirmed in Brack and Rieber (1994).

The faunal succession has been reconstructed by the authors, chiefly by taking into account the Southern Alpine sections of Losine in eastern Lombardy, of the Gola Valley and Fricca Pass in southern Trentino, of the Latemar/Marmolada in the western Dolomites, of Punta Zonia (Cernera Massif), of Ru Sec near Dont and Rio Sala (Mt. Rite) in the eastern Dolomites (De Zanche et al., 1993; Mietto and Manfrin in press). As a general and immediate result, the very large quantity of ammonoids in these sections and their distribution give the opportunity to establish that in many cases the key-genera defining the horizons/beds at issue have quite different ranges from the ones shown in the Table.

Moreover it must be underlined that the ammonoid succession in some of the stratigraphic sections recently illustrated is not as complete as it appears at first sight.

Critical analysis of the data

The critical analysis will examine the horizons/beds of the Table one by one.

Asseretoceras beds (Southern Alps = camunum horizon in the Balaton Highlands): this level, characterized by the genus Asseretoceras, is placed at the top of the traditional Trinodosus Zone and in any case it underlies the appearance of the genus Lardaroceras Balini (1992a). Contrary to Balini (1992b), the authors think that Asseretoceras and Reiflingites are synonymous. Moreover, data from the Losine section (Camonica Valley, eastern Lombardy) testify to a substantial coincidence of the ranges of Lardaroceras and Reiflingites ex gr. camunus (Assereto), although the latter appears some time earlier.

Lardaroceras beds (Southern Alps = *meriani* B horizon in Balaton Highlands): on the basis of what has just been stated, defining the *Lardaroceras* beds versus the *Asseretoceras* beds has no significance. It should be underlined that Vörös (1993a, 1993b) had already extended the *"Asseretoceras" camunum* range into the *meriani* B horizon, in which probably also *Lardaroceras* is present.

The authors fully agree with *Lardaroceras* being replaced by the genus *Kellnerites*, although its range is confined to the range of the type species (*Lardaroceras krystyni* Balini).

Kellnerites beds: whereas in the Southern Alps and in the Balaton Highlands the FAD of Kellnerites is coincident, its LAD seems to be different. As a matter of fact, at Bagolino (cf. Brack and Rieber, 1993a) Kellnerites is replaced by Reitziites; on the contrary, in the Balaton area the two genera live together (cf. Vörös 1993a, 1993b). In the non-condensed sections of Ru Sec (Zoldo Valley) and Rio Sala (Mt. Rite) Kellnerites ecarinatus (Hauer) and Reitziites reitzi (Böckh) are associated, as in Balaton; in the Punta Zonia section (Cernera Massif) a specimen of Kellnerites has even been found together with Aplococeras avisianum (Mojsisovics). Therefore, data on this interval in the Bagolino section are not indisputable.

Within this interval, in the Southern Alps the *Kellnerites bosnensis* horizon and the overlying *K. bagolinensis* horizon have been identified; they are correlated with the same horizons in the Balaton region and are respectively marked by *K. felsoeoersensis* and *Hyparpadites liepoldti*. However, in the authors' opinion, owing to its ornamentation type, *K. bagolinensis* Brack and Rieber is to be reestablished within the genus *Hyparpadites*; furthermore, in Hungary the ranges of the species do not absolutely let the *Kellnerites* beds to be arranged into markedly separated horizons. It should also be underlined that in this interval the comparison of the ranges of the diagnostic ammonoid taxa (Võrõs 1993a, 1993b), inferred from their documentation and distribution in the stratigraphic sections, raises at least some perplexities. For example, the range of *K. bosnensis* versus *K. felsoeoersensis* does not seem to be so clear; moreover, the range of *H. liepoldti* evidently overlaps the range of *K. felsoeoersensis*. It follows that - whatever the philosophical basis adopted - so defined biohorizons do not give any chance of real correlation.

Reitziïtes beds (Southern Alps = reitzi horizon in the Balaton Highlands): considering the coexistence of *Reitziites* with *Kellnerites*, which makes the distinction between the two horizons of no significance, the presence of *Aplococeras avisianum* (Mojsisovics) within the reitzi horizon in Hungary (Vörös 1993a, 1993b) should be reconsidered. The specimens of Aplococeratidae found in the level immediately overlying the one with the last *Reitziites reitzi* (Böckh), occasionally collected by the authors in the Bagolino section, and the ones from the Fricca Pass section - the latter included in layers characterized by "*Megaceratites*" friccensis (Arthaber) - show ornamental and morphological features somewhat different from *A. avisianum*. The iconographical examination of the specimens from Levels 5 and 6 in the Mencshely section (Balaton area) - defined as *Aplococeras avisianum* in Budai et al. (1991) and in Vörös and Budai (1993b) - seems to confirm an erroneous classification.

Parakellnerites + **Hungarites** s.s beds (Southern Alps = Halilucites costosus + Stoppaniceras (ellipticus gr.) + Hungarites s.s. beds in the Balaton Highlands): the authors believe this to be the most important interval for the definition of the Anisian/Ladinian boundary, and at the same time the least well defined.

On the basis of the data in the literature and of the new data from the Losine, Ru Sec and Rio Sala sections, it is known that both *Parakellnerites* and *Hungarites s.s.* already coexist in the lower part of the *Kellnerites* beds *sensu* Gaetani (1993b) and the two genera coexist not only below but also above the interval indicated in the Table. Furthermore, the species identified by Balini (1992a) as *Lardaroceras pseudohungaricum*, also collected by the authors in the Losine section, should be considered the first representative of the genus *Parakellnerites*. On the other hand, Brack and Rieber also indicated a range of the two genera which - although not in accordance with the authors' data - is also different from the ranges in the Table. Brack and Rieber tentatively placed *Aplococeras avisianum* within this crucial interval. This problem and its repercussions on correlation with North America will be considered further on.

As for the association in the Balaton region - which is essentially equivalent to the costosus horizon in Budai and other (1991), Vörös and others (1991), Vörös (1993a, 1993b) - if the conclusive presence of the genus Halilucites is certainly documented, it should at least be placed within the Ticinites beds (sensu Gaetani 1993b; Brack and Rieber 1993a, 1993b, 1994), and not considered as a correlative of the Parakellnerites + Hungarites s.s. beds in the Southern Alps. In fact, the authors do not agree with the association of Halilucites sp. and Aplococeras avisianum within the costosus horizon - which seems to be documented in the Mencshely section - unless there has been either some mistake in the classification or some not improbable problems of condensation. Both the data in Brack and Rieber (1986, 1993a, 1993b) and the authors' field data from many sections testify that the FAD of Halilucites is subsequent to the LAD of A. avisianum. This is well documented in the Cima di Valsorda (Latemar) section and in the Punta Zonia section. In the latter the first representatives of Halilucites have been collected in association with Ticinites crassus (Hauer) and "Aplococeras" misanii (Moisisovics), just above an interval very rich in Aplococeras avisianum. Therefore, in regard to the situation in the Balaton area, the authors believe that either this interval is condensed (Mencshely), or a gap (Vaszoly) separates it from the underlying reitzi horizon or - as it happens at Felsőörs, there is an apparently barren interval. In conclusion, the authors believe that the association included in the costosus horizon is not always homogeneous.

Moreover it can be affirmed that in the Bagolino section, from which a part of the data about this interval in the Southern Alps is based, some significant bioevents are not documented.

In the authors' opinion the faunal association of the *Parakellnerites* + *Hungarites* s.s. beds partly coincides with the Avisianum Zone sensu Assereto (1969).

Ticinites beds: in the concept of *Ticinites* beds the species referred to the genus *Ticinites* in the Southern Alps are essentially considered coeval. On the contrary, a comparison between these species allow to place *T. polymorphus* Rieber and *T. ticinensis* Rieber - probably co-specific and both present within the same level of the Grenzbitumenzone (Rieber 1973) - at a stratigraphic position underlying the levels bearing *T. brescianus* Brack and Rieber and *T. dolomiticus* Brack and Rieber. However, the two latter species should be included within the previous species *T. crassus* (Hauer). The two former species occupy the interval preceding the appearance of *Halilucites* and "*Aplococeras*" misanii which, on the contrary, come from the interval marked by *T. crassus* including the first *Nevadites s.s.* and *Celtites*. Since the specimen indicated by Brack and Rieber (1986: Tav. IV, figs. 1-2) as *Nevadites* sp. should on the contrary be considered a *Ticinites*, in the Prezzo section the LAD of *Ticinites* is in this way documented. Its FAD is to be placed at the appearance of *T. hantkeni* (Mojsisovics), which in the Balaton area is associated to *Reitziites reitzi*. Therefore the FAD and LAD of *Ticinites* define an interval too large to be used in biostratigraphy.

Nevadites + Stoppaniceras (ellipticus gr.) beds: in the Table and in Brack and Rieber (1994), this interval corresponds to the total range of Nevadites. However, Nevadites appears earlier, in the interval characterized by Halilucites (e.g. H. ex gr. rusticus) + "Aplococeras" misanii + Ticinites crassus, as documented in the La Grea and Pian dei Fiacconi (Marmolada) sections and moreover in the Punta Zonia section (Mietto and Manfrin, in press). The difference between the authors' data and the data in the Table seems to be more apparent than real. In fact all the Nevadites overlying the "Ticinites beds", included by Brack and Rieber (1994) within their (Nevadites) Secedensis Zone, are morphologically and maybe taxonomically different from the Nevadites present in the so called Ticinites beds. The authors consider the former as Nevadites I.s.: in their opinion Balatonites dealessandrii Airaghi, B. ambrosionii Airaghi, Nevadites

secedensis Brack and Rieber, N. avenonensis Brack and Rieber and Nevadites crassiornatus Brack and Rieber belong to this taxon.

On the contrary, *Trachyceras fedaiae* Salomon and *T. symmetricum* Salomon are to be ascribed to *Nevadites s.s.*; they occupy a stratigraphical position quite underlying the position of the *Nevadites l.s.* In this way the opinion of Brack and Rieber (1994) concerning the morphological diversities between the *Nevadites s.s.* in Nevada (that is *N. hyatti* Smith and *N. humboldtensis* Smith) and the ones in the Secedensis Zone is justified by the fact that the later are younger.

In conclusion, it is clear that the base of the Secedensis Zone does not coincide with the FAD of the genus *Nevadites*.

Chiesense horizon: as for this biochronological interval, the authors agree with the Table, although their data (e.g. Gola Valley section) emphasize that it defines a precise stratigraphical interval and not a thin biohorizon.

A new high resolution standard scale

The above outlined ammonoid succession has made it possible to work out a new high resolution standard scale (Mietto and Manfrin, in press). As a table, it has been presented in advance in De Zanche et al. (1992, 1993), Gianolla (1992), Gianolla et al. (in press) and also used, as an example, in Gradstein et al. (1994). The authors cannot but refer to their work in press in which both their philosophical ground and data are illustrated. In their present work they just want to underline the key-elements defining the subzonal succession proposed for this interval. They regret that their opinion is supported by a work which, due to a delay in printing, is not yet available, but they do not feel this drawback to be so weighty as to prevent them from expressing their opinion on the basis of the collected data.

Trinodosus Subzone: base marked by the FAD of Paraceratites trinodosus (Mojsisovics).

Reitzi Subzone: base defined by the appearance of the first representatives of Hungaritidae ["Hungarites" inconstans (Reis)]. For this reason in the Southern Alps this subzone includes the upper portion of the Lardaroceras beds, the Kellnerites beds and the Reitziites beds (cf. Gaetani 1993b). In the Balaton Highlands it corresponds to the upper part of the meriani B horizon and it does not completely coincide with the Reitzi Zone sensu Vörös (1993a, 1993b). In fact, as above mentioned, the authors do not fully understand the meaning of the upper boundary of the reitzi horizon, and, in any case, they exclude the costosus horizon from the correlation.

Avisianum Subzone: base defined by the FAD of *Aplococeras avisianum* (Mojsisovics). It corresponds to the total range of the type species.

Fig. 1 Correlation scheme between Gaetani's table (1993b), supplemented with the biozonation proposed by Brack and Rieber (1994), and the authors' new scale. In the scheme the ranges of the key genera for this interval are defined in detail, according to the new data from the Southern Alps, partially supplemented with data from the Balaton Highlands (cf. Vörös 1993a). A correlation with Nevada - through the comparison of genera common to the two areas and/or analogous species - is also proposed.



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Crassus Subzone: base marked by the appearance of the genus *Nevadites s.s.* [e.g. *N. fedaiae* (Salomon)] and of *Ticinites crassus* (Hauer).

Serpianensis Subzone: base defined by the appearance of *Nevadites I.s.* (e.g. "*N.*" secedensis Brack and Rieber). It is clear that this subzone includes a part of the Secedensis Zone in Brack and Rieber (1994).

Chiesense Subzone: base defined by the FAD of Chieseiceras chiesense (Mojsisovics).

Fig. 1 emphasizes the correlation between the scale in use (adopted in the Table) and the new scale proposed.

Real possibilities of correlation

Due to the different conclusions drawn about the ammonoid succession in the Southern Alps, the authors do not agree with the proposal of correlation with the Nevada area outlined in Brack and Rieber (1994). In accordance with the ingenious intuition of Assereto (1969), the authors think that a fundamental key-element of correlation is the succession of the various taxa of Aplococeratidae. Unfortunately, this key was not used by the Hungarian and Swiss authors.

In the Southern Alps the most ancient representatives of the family so far found consist of specimens morphologically similar to *Aplococeras smithi* Silberling and Nichols in Nevada; surprisingly these specimens were found in a level immediately overlying the one with the last *Reitziites reitzi* in the Bagolino section, and in the level with "*Megaceratites*" friccensis (Arthaber) at Fricca Pass. In the Punta Zonia section the LAD of *A*. aff. *smithi* and the FAD of *A*. avisianum (Mojsisovics) seem to be coincident. In Nevada the same relationship exists between *A*. smithi and *A*. vogdesi (Hyatt and Smith); the correlation between *A*. vogdesi and *A*. avisianum has been already proved by Assereto (1969). Practically, the LAD of *A*. avisianum coincides with the FAD of "*A*." misanii (Mojsisovics); the latter seems to be quite correlatable with *A*. parvus (Smith) in Nevada. Moreover, in the Southern Alps "*A*." misanii is associated with a new species of *Aplococeras* with an extremely narrow range extending from the top of the Avisianum Subzone to the base of the overlying Crassus Subzone.

Therefore, on the basis of these data, a correlation of the boundary *F. nevadanus* beds/*P. meeki* beds in Nevada and the boundary Reitzi Subzone/Avisianum Subzone in the Southern Alps can be suggested. As a consequence, the *F. nevadanus* beds and the *G. blakei* beds are included in the Reitzi Subzone; as the first Aplococeratidae (?*Metadinarites*) are included within the *P. cricki* beds in Nevada, the latter may also be included within the Reitzi Subzone. However, the available data do not enable to make a correlation of the base of the same subzone in Nevada and in the Southern Alps.

The Avisianum Subzone clearly includes the *P. meeki* beds and the *P. dunni* beds. The appearance of *Nevadites s.s.* - and its relationships with Aplococeratidae - makes a remarkable correlation between the base of the Crassus Subzone and the base of the Occidentalis Zone possible. Only *N. hyatti* and *N. humboldtensis* beds can be included in the Crassus Subzone; furthermore, due to the lack of sure *Nevadites* - in accordance with Tozer (1994) both *N. furlongi* (-) and *N. gabbi* (-) can be referred to the genus *Paranevadites* - the younger *N. furlongi* and *N. gabbi* beds are probably correlatable with the Serpianensis Subzone, and probably with the Chiesense Subzone. The appearance of *Eoprotrachyceras*, both at the base of the Curionii Subzone and of the Subasperum Zone, is a new impressive correlation tool.

The documentation of *Nevadites hyatti* Smith (= *N. merriami* Smith, in Westermann 1963) within the Toad Formation in the Eastern Cordillera (British Columbia), although in a stratigraphical position not completely checked (cf. Tozer 1967), confirms the correlation between the Chischa Zone in Canada and the Occidentalis Zone in Nevada. This is also proved by the presence of the genus *Paranevadites* (Tozer, 1994) in both zones. Contrary to the suggestion in Silberling and Nichols (1982), the possibility that the *P. dunni* beds in Nevada may be included within the Chischa Zone is not proved. Therefore, the Chischa Zone is correlatable both with the Crassus Subzone and with the Serpianensis Subzone, at least in the Southern Alps.

Lastly, the posterior appearance of the genus *Eoprotrachyceras* in British Columbia makes it possible to correlate the base of the Matutinum Zone with the base of the Subasperum Zone in Nevada and with the base of the Curionii Subzone in the Southern Alps.

What proposal for a stage boundary based on ammonoids?

Concerning the Anisian/Ladinian boundary, in the literature three alternative proposals (cf. Gaetani 1993b; Brack and Rieber 1994) have been suggested. The authors have redefined them as follows, on the base of their proposed standard scale: (1) base Reitzi Subzone; (2) base Avisianum Subzone; (3) base Crassus Subzone; (4) base Curionii Subzone.

Considering both the actual possibilities of correlation of low-mid latitudes ammonoid faunas and the importance of the recorded faunal turnovers, the following points should be emphasized.

- 1 Neither the base of the Reitzi Zone nor the base of the Reitzi Subzone in the Southern Alps are correlatable with the succession of fossiliferous beds in Nevada. No meaningful faunal turnover is recorded in the two realms. Up to now no other correlation tool - with the probable exception of palynomorphs - has been found in the Tethys area (cf. Gaetani 1993b). The choice of defining the Anisian/Ladinian boundary in this position seems to be only supported by disputable (cf. De Zanche and Gianolla this volume) historical considerations;
- 2 The base of the Avisianum Subzone is perfectly correlatable in the Southern Alps and in Nevada, practically on the only ground of the Aplococeratidae evolution. In this case, too, significant faunal turnovers or other correlation tools supporting this proposal seem not to exist;
- 3 Taking into account the possibility of correlation with British Columbia (Chischa Zone), the documented correlation (made possible by the FAD of *Nevadites*) between the base of the Crassus Subzone and the base of the Occidentalis Zone in Nevada has a fundamental meaning. Furthermore the succession of the Aplococeratidae similar both in the Southern Alps and in Nevada is significant. Here the first major faunal turnover is recorded both in Nevada and in the Southern Alps (e.g. FAD of *Nevadites* and *Celtites* = *Tozerites* p.p.⁽¹⁾;

⁽¹⁾ The composition of the genus *Tozerites* as exposed by Silberling and Nichols (1982) does not seem satisfactory. The first species quoted - i.e. *T. gemellaroi* (Arthaber) - shows morphological features and suture different from the type species and on the contrary ascribable to *Tropigastrites*. The features of the type species of *Tozerites* [*T. humboldtensis* (Smith)], and of the other American species ascribed to it [*T. polygy-ratus* (Smith)] do not allow to maintain the validity of this genus in relation with the previous *Celtites* Mojsisovics (1882).

in the Southern Alps the turnover is emphasized by the FAD of *Halilucites* and *Parasturia*). Although the Crassus Subzone does not coincide with the Secedensis Zone, it should be noted that in this interval some major changes in the conodont fauna exist, at least in the Tethys realm (Gaetani 1993b);

4 The FAD of *Eoprotrachyceras*, recorded in the Southern Alps, in Nevada and in the British Columbia, is an excellent correlation marker, although is associated neither with significant turnover nor with other correlation tools.

Therefore, as so far other tools (conodonts, palynomorphs, radiolarians, paleomagnetics, etc.) seem not to offer conclusive indications (cf. Gaetani 1993b), it is advisable to found the choice on ammonoid data. On this basis it is evident that the latest two hypotheses are the most consistent.

Some important aspects of the genus *Nevadites* from the taxonomical, phyletical and stratigraphical point of view should be underlined. In the Southern Alps a proterogenetic specimen, bearing a *Nevadites*-like body chamber and "*Anolcites*" (ex gr. *recubariensis*)-like inner whorls (cf. Mietto and Manfrin, in press), on the one hand allows a full recovery of Smith's (1914) original opinion - considering *Nevadites* as belonging to Trachyceratids - and on the other hand clears up some phyletic lineages. On the basis of the onthogenetic investigation on their *Nevadites* specimens, Brack and Rieber (1993a) seem to accept that this genus is a forerunner of the Trachyceratids.

It follows that the appearance of the genus *Nevadites s.s.* coinciding with the appearance of the Superfamily Trachycerataceae is fundamental. This bioevent is the most important throughout the critical interval within which the Anisian/Ladinian boundary should be placed.

Thus, the final prevalence of the Trachyceratids, also through the appearance of the genus *Eoprotrachyceras*, seems to be a less important event in order to establish the Anisian/Ladinian boundary at the base of the Curionii Subzone-Subasperum Zone-Matutinum Zone, as suggested e.g. in Brack and Rieber (1994).

Therefore, the most consistent hypothesis for placing the Anisian/Ladinian boundary is the proposal founded on the appearance and the correlation of *Nevadites s.s.* The hypothesis is confirmed by the fact that the appearance of *Nevadites* is part of a trend of bioevents recorded in detail and perfectly consistent both in the Southern Alps and in Nevada, while the same does not apply to the appearance of the genus *Eoprotrachyceras*.

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REMARKS ON THE ANISIAN-LADINIAN BOUNDARY

H. Kozur

The position of the Anisian-Ladinian that boundary was discussed in detail by Brack and Rieber (1994) and Kozur and Mostler (1994). The authors came to very different conclusions. Brack and Rieber (1994) came to the conclusions that (1) "an objective choice of any priority argument is obviously problematic"; (2) "such arguments can hardly be a constructive contribution to the boundary problem"; (3) the base of the *Eoprotrachyceras curionii* Zone would be the best choice for the Anisian-Ladinian boundary; (4) the Bagolino section would be the best stratotype for definition of the Anisian-Ladinian boundary.

According to Kozur and Mostler (1994) priority plays an important role for stability in stratigraphic research. It should be only abandoned, if there is a large scale overlap or gap of several biozones between two major biostratigraphic units, the boundary of which was the priority boundary between two stages. This is, for instance, the case at the Induan-Olenekian boundary, where the overlap according to the original definition of these stages by Kiparisova and Popov (1956) comprises almost an entire substage (see Kozur, 1993). If the priority boundary can be recognized by major stratigraphic groups and there is no major overlap or gap at this boundary, the priority should not be changed. A somewhat "better" boundary will be always found by using other fossil groups or other scientific methods. But to disregard the priority would in such cases replace the search for the best and widest recognizable boundary by a struggle of different schools for using their boundary or for using a certain fossil group. After the huge progress in micropaleontological studies in this century the subdivision of the fossils in "orthostratigraphic" ammonoids and "parastratigraphic" other fossils should be not more used, if the biostratigraphy will remain also in the future the basis for the chronostratigraphy.

All fossils with high evolutionary rate, for instance, Triassic ammonoids, conodonts and radiolarians should be used without discrimination of one group. Moreover, also fossil groups with rather low evolutionary rate can be very important, if these fossils have a very wide distribution and occur in deposits, in which fossils with high evolutionary rates are missing. For this reasons, Triassic sporomorphs (mega- and miospores, pollen), megaplants, charophytes, foraminifers, bivalves (some with high evolutionary rates), gastropods, brachiopods, echinoderms (some with high evolutionary rates), conchostracans (some with high evolutionary rates),

ostracods (some with high evolutionary rates), scolecodonts, microproblematica, tetrapod and arthropod tracks. Even forms with low evolutionary rate may be in some levels, facies or some regions important guide forms. Thus, *Costatoria* (benthic bivalves) of the *C. costata* group with more than 13 extra-areal ribs occur only in the Anisian and therefore the *Costatoria* lineage can be used in the Olenekian-Anisian boundary level for correlation of the hypersaline marine facies of the Tethyan marginal seas with the Tethyan scale. Also rare fossils with high evolutionary rate, like tetrapods, are in some deposits excellent guide fossils.

Because according to Kozur and Mostler (1994) the priority of the Anisian-Ladinian boundary is clearly at the base of the Reitziites reitzi Zone and this Zone can be recognized by ammonoids. microfaunas and sporomorphs, there is no reason to abandon this priority boundary in favour of any younger ammonoid boundary. For this reason, Kozur and Mostler (1994) proposed to maintain the priority boundary at the base of the Reitziites reitzi Zone. Independent from the priority, this boundary is the only boundary that can be well recognized by ammonoids, Daonella, radiolarians, sporomorphs, foraminifers and conodonts. It is also near to the base of the Diplopora annulata dasycladacean boundary. The younger ammonoid boundaries can be only recognized by ammonoids, the base of the Nevadites secedensis Zone also by Daonella, the base of the Eoprotrachyceras curionii Zone perhaps by conodonts (not yet investigated in detail). After careful correlations, there may be also minor changes in some other fossil groups, but surely not such large changes as at the base of the Reitziites reitzi Zone, because the next younger major changes in different fossil groups (e. g. sporomorphs, radiolarians, foraminifers) are only at the base of the Late Ladinian Budurovignathus mungoensis Zone or still later. Therefore, the base of the Reitziites reitzi Zone has not only the priority, but is also that boundary, which can be easily correlated with all different facies from the oceanic radiolarites (with radiolarians) through pelagic and shallow marine deposits to continental areas (with sporomorphs). This is not shown, and in this broad facies range surely not possible, for the other two proposed ammonoid boundaries at the base of the Nevadites secedensis Zone or at the base of the Eoprotrachyceras curionii Zone.

Some remarks are necessary to the paper of Brack and Rieber (1994). According to these authors at least four different versions existed for the base of the "Norian Stage" sensu Mojsisovics (that included originally except the present Norian Stage also biozones of other stages, among them of the Ladinian Stage), but they show only three different versions with biostratigraphic background. From these three versions, the base of the Wengen Beds has never been taken into consideration for the base of the Ladinian Stage. The Wengen Beds were placed by Mojsisovics (1869) in the "Norian Stage" together with the Partnach Dolomite, Pötschen Limestone, Reichenhall Limestone, Hallstatt salt deposits, the Pinacoceras metterichi beds of the Hallstatt Limestone and the Zlambach beds. Thus, the original Norian comprised according to the present stage subdivision, beds of Dzhulfian, Changxingian (both Late Permian), Early Triassic, Early Anisian, Late Ladinian, Norian and Rhaetian ages. There is therefore no priority for the base of the Wengen Beds with Daonella lommeli as base of the Ladinian. In that time, where the term Ladinian was introduced by Bittner (1892), only the Buchenstein and Wengen Beds were regarded as Ladinian and the Wengen Beds were clearly considered as Late Ladinian (Longobardian). Permian, Anisian and Norian deposits were never regarded as part of the Ladinian Stage.

The second priority, mentioned by Brack and Rieber (1994), is the base of the *Eoprotrachyceras* curionii Zone. However, this priority never existed. Mojsisovics (1882, 1892) used the terms *Ceratites reitzi* Zone and *Trachyceras curionii* Zone always in such a broad sense that the other zone was included. Mojsisovics (1882) used the term *C. reitzi* Zone including the modern *T.*

curionii Zone, whereas Mojsisovics (1892) included the horizon with "Ceratites" reitzi in his T. curionii Zone. Therefore, whether he used the terms reitzi Zone or curionii Zone, these terms always included both the R. reitzi and the E. curionii Zones in their present scope. For this reason, always the R. reitzi Zone was at the base of the Ladinian (or in that time at the base of the Norian Stage), even if this zone was named as T. curionii Zone with the C. reitzi horizon at its base ! Later this fact was recognized by all workers and the base of the Ladinian was generally placed at the base of the R. reitzi Zone. This clear priority was unchanged more than 100 years. For this consideration is not important that the R. reitzi Zone was used in a broader sense than today and included also the Nevadites secedensis and Eoprotrachyceras curionii Zones, because the type R. reitzi Zone of the Balaton Highland was always included into this Zone and into the Ladinian. Moreover, the E. curionii Zone was likewise used in a very much broader sense than today including the interval of the present R. reitzi Zone to the present E. curionii Zone.

In papers, were the term *T. curionii* Zone (with the horizon of "*Ceratites*" *reitzi* at its base!) was used, the *Aplococeras avisianum* Zone was placed into the Ladinian above that *T. curionii* Zone. Kozur (1972 and later papers) had followed this priority and placed the *A. avisianum* Zone into the Ladinian because it has according to his opinion the same Early Ladinian conodont fauna as the *R. reitzi* Zone. The ammonoid workers have in the beginning attacked this view and pointed out that according to the ammonoids the *R. reitzi* Zone is clearly Ladinian, but the *A. avisianum* Zone Anisian. This view was overtaken also by other stratigraphers. Thus, Tollmann (1976, pp. 65, 96) wrote: "Die Obergrenze des Anis wird heute ganz allgemein... im Gegensatz zur Auffassung von H. Kozur ...über und nicht unter die *Avisianum* Zone gelegt. Die ladinische Stufe umfaßt das Fassan (*Reitzi*-Zone und *Curionii*-Zone)". Meanwhile also the ammonoid workers (e.g. Brack and Rieber, 1993) have recognized that the *A. avisianum* Zone is not older than the *R. reitzi* Zone, but contemporaneous with the upper *R. reitzi* Zone and somewhat younger beds. Independently from this question the statement of Tollmann (1976) has shown that there was a long priority for placing the *R. reitzi* Zone at the base of the Ladinian as correctly stated by him.

The proposal of Brack and Rieber (1994) to use the Bagolino section as boundary stratotype for the Anisian-Ladinian boundary cannot be accepted, independently from the position of this boundary. The conodonts of this section show a CAI of 3.5-4, indicating a considerable thermal alteration. Most of the conodonts are black. According to the rules for establishment of boundary stratotypes, section with thermal alteration must be avoided. Sections with CAI 3.5-4 are unsuitable for paleomagnetic and isotope investigations and not well suitable for sporomorph investigations. We should avoid to choice any section from which we know that future physical methods for correlation and boundary definition will be never applicable. This section has therefore, for instance, no potential for correlations).

For the above reasons, the priority base of the Ladinian at the base of the *R. reitzi* Zone used for more than 100 years should be preserved. This boundary is well recognizable by ammonoids (as the two younger levels). Therefore this boundary is also applied by a part of the ammonoid workers (see Voros, 1993). Additionally, it is also recognizable by the following other fossil groups:

1. Sporomorphs

A distinct change from a typical Anisian to a typical Ladinian association with Kuglerina meieri Scheuring, Cannanoropollis scheuringi Brugman, Cannanoropollis brugmani Góczán & Oravecz-

Scheffer occurs immediately below the base of the *R. reitzi* Zone s.str. (as defined by Vörös, 1993) in the *Lardaroceras* ammonoid fauna that should be included into the *R. reitzi* Zone, as also proposed by Brack and Rieber (1994). The next younger change in the sporomorph association occurs at the base of the Longobardian *Budurovignathus mungoensis* conodont Zone (Góczán and Oravecz-Scheffer, 1993, Kovács et al., 1994).

2. Dasycladacea

This algae group is important for the stratigraphy of the Dasycladacean limestones and dolomites that have a wide distribution in the Tethyan carbonate platforms and have in general no other guide forms. Therefore the exact correlation with any other zonation is difficult, but generally the presence of the Ladinian *Diplopora annulata* association in the *R. reitzi* Zone is indicated (Bystricky, 1964 and later papers). However, it is not clear, whether this association begins at the base of the *R. reitzi* Zone. But surely *D. annulata* is present long before the base of the *E. curionii* Zone.

3. Pelagic bivalves

Change of the *Daonella sturi* group to the *Daonella elongata* group (Brack and Rieber, 1994). *Daonella* may be also used for separation of the *R. reitzi* and *N. secedensis* Zones, but the differences are not so distinct as between the *P. trinodosus* Zone and the *R. reitzi* Zone. So far, no application of the *Daonella* stratigraphy is possible at the base of the *E. curionii* Zone.

4. Radiolarians

At the boundary between the P. trinodosus- and the R. reitzi ammonoid zone several Anisian guideforms disappeared, such as the genus Pseudosepsagon Kozur & Mostler, Parentactinia lata Kozur & Mostler, Pentactinocarpus awaensis (Nakaseko & Nishimura), Pentactinorbis dumitricai Kozur & Mostler, Tetraspinocyrtis laevis Kozur & Mostler. In the same level several taxa (genera and species) appeared, which are typical for the entire Fassanian or even the entire Ladinian, e.g. Oertlispongus, Yeharaia, Triassocampe deweveri (Nakaseko & Nishimura), T. scalaris Dumitrica, Kozur & Mostler. The changes in the radiolarian faunas at the base of the R. reitzi Zone are the strongest changes in the radiolarian faunas of the Triassic and one of the strongest changes in the radiolarian faunas of the Phanerozoicum. The next strong changes in the radiolarian faunas occur, like in the sporomorph associations, at the base of the Longobardian Budurovignathus mungoensis Zone. If the base of the N. secedensis Zone or the base of the E. curionii Zone would be chosen as base of the Ladinian, typical Fassanian radiolarian faunas could be only determined as Late Anisian-Early Ladinian radiolarian faunas. This would be a strong disadvantage for the correlation of the oceanic sequences in the Circum-Pacific realm and in the Tethys. In radiolarites the number of radiolarian taxa that can be solved from the rocks, is by far smaller than in pelagic limestones. Therefore only the wide zonal scope proposed by Kozur and Mostler (1994) can be applied and the base of the N. secedensis and E. curionii Zones cannot be recognized in such faunas, because they do not coincide with the boundaries of any radiolarian zone.

The distinct changes in the radiolarian faunas can be found not only in the Tethys, but also in the Boreal and Notal realms. Aita (1994 and lecture at the Radiolarian Symposium in Osaka, 1994), Bragin (1994 and poster at the Radiolarian Symposium in Osaka, 1994) and Simes (poster at the Radiolarian Symposium in Osaka, 1994) presented rich and well preserved radiolarian faunas from the Boreal realm of NE Siberia and from the Notal realm of New Zealand.

Several guide forms of the Tethys and of the Circum-Pacific area are missing in these faunas, but a good correlation is possible by the *Silicarmiger* lineage (Kozur and Mostler, 1994) and by other phylomorphogenetic lineages.

5. Foraminifers

Distinct changes in the foraminifer associations can be found at the base of the *R. reitzi* Zone s.l. exactly in the level, in which the Ladinian sporomorph association begins (Góczán and Oravecz-Scheffer, 1993, Kovács et al., 1994). No changes in the foraminifer associations can be observed at the base of the *N. secedensis* Zone and at the base of the *E. curionii* Zone.

6. Ostracods

The ostracod faunas of the *P. trinodosus* Zone and the *R. reitzii* Zone are very different, but it is not clear, where the changes of the ostracod complexes occur. The youngest Anisian ostracod faunas has been derived from the middle part of the *P. trinodosus* Zone, whereas the oldest Ladinian type ostracod fauna is known from the upper part of the *R. reitzi* Zone. Therefore the ostracods can in the moment not used for defining the boundary. However, no distinct changes can be observed in the ostracod faunas from the upper *R. reitzi* Zone up to the uppermost Fassanian. Therefore, surely no changes will be present at the base of the *N. secedensis* Zone and at the base of the *E. curionii* Zone.

7. Conodonts

At the base of the *R. reitzi* Zone and inside the *R. reitzi* Zone some changes of the conodont faunas can be observed. No changes occur at the base of the *N. secedensis* Zone and the conodont distribution around the base of the *E. curionii* Zone is not yet well known.

Conodont faunas, in which the gondolellid elements display a foreward-shifted basal cavity, have typical Ladinian aspect. Such forms begin first at the base of the *R. reitzi* Zone, but are in this level in general rare. Most characteristic is the first appearance of *Neogondolella mesotrias-sica* (Kozur & Mostler). A junior synonym of this species is "*Gondolella*" constricta postcornuta Kovács, 1994. Faunas with *Paragondolella ? trammeri* (Kozur) and *Paragondolella alpina* (Kozur & Mostler) have a typical Early Ladinian character. However, *P. alpina* (junior synonym "*G*." *szaboi* Kovács) begins not at the base of the *R. reitzi* Zone, but somewhat below its middle part. *P. ? trammeri* is strongly facies dependent. It occurs only in fully pelagic sediments, but it is very rare or missing in pelagic dark, bituminous limestones from semirestricted basins. It has been never found in North America and in the Boreal realm and it is therefore unsuitable for the definition of the Anisian-Ladinian boundary. On the other hand, a fully pelagic conodont fauna with *P. ? trammeri* is one of the best indicators for a Ladinian conodont fauna, because in the open-sea deposits of the Tethys this species is very abundant and characteristic. However, if species is not present, a Ladinian age cannot be excluded, because it is missing in many pelagic faunas (especially dark limestones) of undisputed Ladinian age.

There are several taxonomic problems concerning the Middle Triassic conodont faunas that hinder the application of this fossil group for definition of the Anisian-Ladinian boundary. The smooth *Neogondolella* and *Paragondolella* of this time are difficult to determine and therefore often the determination was influenced by the assumed age of the deposits. A good example was discussed by Kozur et al. (1994). *P. ? trammeri praetrammeri* (Kozur & Mostler) from *Parakellnerites*-bearing beds of the *reitzi* Zone was regarded by Krystyn (1983) and Kovács et al.

Series	Stage	Substage	Cor	nodont !	Zone	2	
		Deleonian	Neogondolella	bifurca	ata	1	
والمختلا		Personian	Veccondolella	Nicorae	ella	a kockel	i
Triassic	Anisian	Bithynian	bulgarica	Neosp.	cus	spidatus	
		logoan	Neogondolella	regalis	s		
		Aegean	Chiosella time	orensis			
			Chiosella gond	iolelloi	ides	5	
			Neospathodus s	sosioens	sis		
		Late	Neospathodus t	riangu]	lari	s	
		OTEHERTAN	Neospathodus h	nomeri			
	Olonekian		Icriospathodus	s collir	nsor	ni	
	Otenextan		Neospathodus h	nungario	cus		
Early		Forly	Neospathodus w Scythogondole]	vaageni- lla mil:	- leri		
Scythian		Olenekian	Neospathodus w Clarkina moshe	vaageni eri	-		
			Chengyuania ne	epalensi	is		
			Neospathodus c	cristaga	alli		
		Gandarian	Noospathodus	dieneri	N.	dieneri	Sz.
	Brahmanian		Neospachouus o	Trener 1	N.	kummeli	Sz.
			Clarkina carir	nata			
	Thuuan		Neospathodus g	priscus	fau	ina	
		Ellesmer.	Isarcicella is	sarcica			
			Hindeodus parv	rus			

Table 1: Early Triassic to Pelsonian pelagic conodont zonation. Modified after Kozur (1990).

- = Conodont-proven in sections 1 or 2 by autochthonous faunas.
- = Conodont-proven only by reworked faunas. .
- ? = Conodont faunas of unproven age.

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(1990) as a typical Ladinian P. ? trammeri trammeri and therefore the beds with P. ? trammeri praetrammeri were placed into the Nevadites fauna (circular conclusion). The re-investigation of the ammonoid fauna by Krystyn (pers. comm. see Kozur and Mostler, 1994) has shown that the ammonoids belong to the R. reitzi Zone as shown by Tichy (in Kozur and Mostler, 1982). P. ? trammeri praetrammeri and P. ? trammeri trammeri are very similar. For stratigraphic purposes the first appearance of the species P. ? trammeri and not of the subspecies P. ? trammeri trammeri is therefore important. All three authors, who wish to define the base of the Ladinian with the first appearance of P. ? trammeri trammeri have misidentified P. ? trammeri praetrammeri as P. ? trammeri trammeri. They concluded from this misidentification that the ammonoid determination must be wrong to maintain the view that P. ? trammeri begins at the base of the N. secedensis Zone and characterizes a typical Ladinian fauna that begins according to these authors at the base of the N. secedensis Zone. By this, they have confirmed that the R. reitzi Zone contains a typical Ladinian conodont fauna, because the above mentioned P. ? trammeri praetrammeri has been derived from ammonoid-dated R. reitzi Zone now also confirmed by the re-investigation of the ammonoids by Krystyn (pers. comm.). Moreover, Kovács (1994) found P. trammeri trammeri in the upper R. reitzi Zone and he wishes now (Kovács in Kovács et al., 1994) to place this part of the R. reitzi Zone into the Nevadites fauna to maintain his view that P. trammeri begins at the base of the Nevadites fauna. However, P. ? trammeri praetrammeri begins in suitable facies even in the lower part of the R. reitzi Zone and it is surely present in beds with the index species. These beds cannot be placed into the Nevadites fauna (N. secedensis Zone sensu Brack and Rieber, 1994, this term is preferred herein).

In North America *Neogondolella aldae* Kozur, Krainer & Mostler is a characteristic Early Ladinian form that occurs in the *meeki-*, *occidentalis* and lower *subasperum* Zones, but the first appearance of this species is not yet well known. It is rarely present also in the Tethys.

The use of conodonts is additionally complicated by the use of junior synonyms and unjustified revisions of species in Nicora and Kovács (1984) and especially in Kovács (1994).

Whereas at the base of the *N. secedensis* surely no distinct conodont change can be observed [may be, the rare *N. transita* (Kozur & Mostler) begins near to this level], the conodont fauna near the base of the *E. curionii* Zone are not yet well investigated. *Budurovignathus truempyi* (Hirsch) occurs in the upper *E. curionii* Zone, but *B. gabriellae* Kozur, Krainer & Mostler, may appear at the base of the *E. curionii* Zone. In this case the base of the *E. curionii* Zone would be in the Tethys well defined by a very important conodont event. Also *Neogondolella ladinica* Kozur, Krainer & Mostler may appear near this level. This form was figured under *Neogondolella cornuta ladinica* n. subsp., but by a printing mistake not described in Kozur et al. (1994). It is described in an other paper (in press).

In contrast to the ammonoid distribution data, Kovács (1993) placed the *E. curionii* Zone directly above the *R. reitzi* Zone. For this reason the conodont range charts by Kovács (1993) are additionally difficult to interpret. Gaetani (1993b) postulated a gap or condension in the Balaton Highland above the *R. reitzi* Zone and below the *E. curionii* Zone, seemingly in reaction of the view by Kovács (1993) that the *E. curionii* Zone follows in Felsőörs directly above the *R. reitzi* Zone. However, in the Felsőörs section, all Fassanian and Early Longobardian radiolarian and conodont zones are present. If ammonoids are missing, this do not mean that no sediments of the age of a missing ammonoid zone were deposited. Meanwhile *Chiesieceras* was found in the Felsőörs section and further ammonoid collection will perhaps yield also ammonoids from the missing part of the *N. secedensis* Zone. In any case the radiolarians and conodonts of the Felsőörs section indicate that neither a gap nor condension is present between the top of the *R.*

reitzi Zone and the base of the Longobardian Budurovignathus mungoensis Zone (conodonts) and the contemporaneous base of the Muelleritortis cochleata Zone (radiolarians).

After evaluation of all available fossil data at the three discussed versions of the Anisian-Ladinian boundary (base of R. reitzi Zone, base of N. secedensis Zone and base of E. curionii Zone), the priority boundary at the base of the R. reitzi Zone is the best suitable boundary that can be correlated with all different facies from the continental facies to oceanic deep-sea deposits. The well accessible classical Felsőörs section in Hungary is the most suitable boundary stratotype. The section is well exposed (partly by deep artificial trenches) and uninterrupted and uncondensed pelagic beds are present from the upper Pelsonian (Middle Anisian) up to the lower part of the Late Ladinian. The lithostratigraphic succession is well described (Lóczy, 1916, Haas et al., 1985). Ammonoids are common in the Paraceratites trinodosus Zone and in the entire Reitziites reitzi Zone and very rare in the upper Nevadites secedensis Zone. The ammonoid distribution of the P. trinodosus Zone (Anisian) and the R. reitzi Zone (Early Ladinian) was revised by Vörös (1993). The upper part of the Parakellnerites sp. aff. meriani B Subzone (equivalent of the Lardaroceras fauna should be included into the Kellnerites felsoeoersenis Subzone of the basal R. reitzi Zone sensu Voros (1993). Ostracods (Kozur, 1970, Monostori, 1991) conodonts (Kozur and Mostler, 1971, Kozur and Mock, 1972, Kovács et al., 1990, Kovács, 1994), foraminifers (Haas et al., 1985, Oravecz-Scheffer, 1987, Góczán and Oravecz-Scheffer, 1993), radiolarians (Kozur and Mostler, 1981, 1994, Kozur, 1984, Dosztály, 1993) are common in the entire section and numerous zonal index species of these fossil groups were described from this section (Kozur, 1970, Kozur and Mostler, 1971, Kozur and Mock, 1972, Kozur and Mostler, 1981, 1994, Kozur, 1984). The CAI is 1, therefore paleomagnetic, isotope and palynologic investigations are possible. Isotope investigations are under investigation by Dr. Korte, Bochum. The sporomorph distribution is well known from borehole in adjacent areas with the same succession (Góczán and Oravecz-Scheffer, 1993). Abundant tuffs and tuffites in the P. trinodosus Zone and in the R. reitzi Zone allow radiometric age determinations.

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THE ANISIAN/LADINIAN BOUNDARY INTERVAL AT BAGOLINO (SOUTHERN ALPS, ITALY): I. SUMMARY AND NEW RESULTS ON AMMONOID HORIZONS AND RADIOMETRIC AGE DATING

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Introduction

In this short note, we summarize and illustrate the most important data on the distribution of ammonoids at the Anisian/Ladinian boundary, and present first radiometric results for Bagolino (Southern Alps, Italy). Because this is at present the best exposed, easily accessible south-Alpine section with a large number of distinct ammonoid levels in sequence, the interval has been proposed as a candidate for the positioning of the Global Stratotype Section and Point (GSSP) of the base of the Ladinian stage (Brack and Rieber, 1994; Gaetani 1994).

The Middle Triassic strata at Bagolino comprise a fully exposed fossiliferous pelagic succession (Figs. 1-2: Prezzo Lst., 'Buchenstein Beds', 'Wengen Beds') spanning the Late Anisian to Late Ladinian time interval (Brack and Rieber, 1986, 1993; Gaetani [Ed.], 1993). The succession includes all positions suggested to date for the Anisian/Ladinian stage boundary. It is visible in a series of outcrops on the banks, and in the partly dry Caffaro river bed to the east and west of the Romanterra bridge below the village of Bagolino. Additional man-made exposures showing a lithologically identical succession are situated along a track on the southern slope of Monte Pizza approximately 1 km westsouthwest of Romanterra (for an overview see Fig. B06 in Gaetani [Ed.], 1993).

On the basis of ammonoids, Daonellas and lithostratigraphic markers, the complete Bagolino succession or portions of it can be correlated in detail with equivalent sections in adjacent areas (Brescian Prealps and Giudicarie) and with important south-Alpine Anisian/Ladinian boundary intervals further afield (Southern Switzerland: Monte San Giorgio; Northwestern Dolomites: Seceda; for details see Figs. 7 & 11 in Brack and Rieber, 1993). Far reaching correlations of the macrofossil succession at Bagolino with sequences in Hungary (Felsőőrs/Balaton Highland), Greece (Epidhavros) and North America (Nevada: Humboldt Range) have been illustrated and discussed in a recent issue of ALBERTIANA (Brack and Rieber, 1994).

Correlation of the most relevant Anisian/Ladinian boundary sections in the Brescian Prealps and Giudicarie: Bagolino - Pèrtica - Prezzo (Fig. 3)

The Anisian/Ladinian boundary interval in the Brescian Prealps and Giudicarie includes a stratigraphic succession ranging from the uppermost Trinodosus Zone through the Reitzi Zone, the (Nevadites) Secedensis Zone to the Curionii Zone. This interval is 15 m thick (between the 51 and 66m-levels on the Bagolino column) and corresponds lithostratigraphically to the upper part of the Prezzo Limestone, the 'transitional beds' and the lower portion of the 'Buchenstein Beds',



Fig. 1 Geological sketch of the vertical to slightly overturned Middle Triassic beds to the south of the village of Bagolino. A continuous exposure of the entire succession from the uppermost Angolo Limestone to the 'Wengen Beds' is found with only minor scree-covered intervals on the banks of the river Caffaro at site [A]. The 'Buchenstein Beds' and the lower portion of the 'Wengen Beds' are fully exposed in a spectacular outcrop in the dry riverbed in the surroundings of the Romanterra bridge (site [B]; for a map of this locality see Fig. 4 in Brack and Rieber, 1986). The best bed-by-bed exposure of the upper part of the Prezzo Limestone and the Anisian/Ladinian boundary interval (51-66m-level) lies further downstream at site [C]. Man-made exposures of the 'transitional beds' and the 'Buchenstein Beds' are found along a track on the southern slope of Monte Pizza (site [D]).

respectively. More than 20 distinct ammonoid-bearing levels have been identified to date in this interval. Discrete fossil horizons and the occurrences of sets or individual, centimetre to decimetre thick and readily identifiable volcanic tuff beds serve as ideal time markers for bed by bed correlations with additional sections in the Brescian Prealps and Giudicarie (Brack and Rieber, 1986; 1993). Of particular importance are the correlations with equivalent successions at Pértica and Prezzo 11 and 18 kilometres southwest and northeast of Bagolino, respectively. These sections provide six additional ammonoid horizons which can be accurately located in the boundary interval at Bagolino (Fig. 3).

Fig. 2 Stratigraphic column of the Middle Triassic succession at Bagolino. Well exposed portions of the column at Sites A-D (see Fig.1) and important fossil groups are indicated. Age values in [Ma]: weighted mean 206Pb/238U ages (95% confidence level) of single grain measurements on zircons of volcaniclastic layers at Bagolino and Seceda.

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Three distinct, thin volcaniclastic layers around the 51m-level of the Bagolino column are unambiguous markers for the correlation with the Prezzo Limestone intervals at Contrada Gobbia (Contrada Gobbia and La Baita sections) and in the area of M. Corona (Stabol Fresco and Adanà sections; Balini 1992a, Figs. 2.09-14 in Gaetani [Ed.], 1993). Fossils of the latter sections characterize the entire Trinodosus Zone The abundance and documentation of ammonoid horizons is outstanding when compared with equivalent successions in Western Tethys. Cross-sections of ammonoids are also visible in corresponding layers at Bagolino and Pèrtica; however, in both areas, only a few fossils have as yet been isolated from the hard rock matrix. Nevertheless, within the upper part of the Prezzo Limestone at Bagolino the presence of *Judicarites, Semiornites, 'Beyrichites'*, the '*Ceratites' abichi* group (sensu Balini et al. in Gaetani [Ed.], 1993) and Paraceratites is confirmed (Brack and Rieber, 1993: Fig.7).

Fossil Horizons

From bottom to top the following fossil horizons can be identified in the Anisian/Ladinian boundary interval at Bagolino, Pèrtica and Prezzo (Fig.3; note that the metre-scale at Bagolino serves as a reference, but interval thicknesses may vary between 5-10% among the different outcrops at Bagolino; individual beds can be identified in all places):

- The Asseretoceras camunum horizon (= 'Contrada Gobbia' Bed Nr. 5; 'Stabol Fresco' Bed Nr. 105a) of Balini et al. (in Gaetani [Ed.], 1993) is bracketed by two thin tuff layers below and a single thin layer above. This bed is unambiguously identified both at Bagolino and Pèrtica.
- At Pèrtica, a layer with Lardaroceras is found five beds above this level (around 1 m higher up). It corresponds closely to the Lardaroceras pseudohungaricum horizon situated 6-8 beds above the Asseretoceras horizon at Contrada Gobbia, Adanà and Stabol Fresco (Balini et al. in Gaetani [Ed.], 1993).
- At Bagolino, the first Kellnerites (K. halilucensis) occur together with Norites at the 53m-level, i.e. only three layers above the bed equivalent with the Lardaroceras horizon at Pèrtica.
- At Bagolino and Pèrtica, the subsequent interval up to the Ta/a -tuff layer (54.7m-level at Bagolino) is characterized by the occurrence of *Kellnerites bosnensis* among other *Kellnerites* and *Hungaritids*.
- Kellnerites bagolinensis occurs at three levels between the Ta/c-tuff and a volcaniclastic bed at the 56.6m-level.
- Reitziites reitzi is abundant in two layers, in a bed just below the volcaniclastic horizon at the 56.6m-level and in a bed around one meter higher. Inbetween and in the successive beds Parakellnerites arthaberi also appears.
- A single specimen of Aplococeras avisianum was found in the uppermost 'transitional beds' at Prezzo.
- Only few macrofossils (*Hungarites zalaensis, Parakellnerites* sp.) could be extracted from the lowermost two metres of typical siliceous 'Knollenkalke' (58-60m-interval at Bagolino).
- A distinct groove at the 60m-level of Bagolino (= Fossil horizon I in Fig.7 of Brack and Rieber, 1986) can be readily identified in the various sections and yielded a fauna with *Ticinites brescianus* along with *Parakellnerites* aff. *boeckhi, Stoppaniceras* sp. and *Aplococeras* sp.
- Slightly higher up at Bagolino, Halilucites cf. obliquus occurs just below the bed with the first Nevadites sp. from Prezzo. The latter is the oldest true Nevadites (see Plate 4 / Figs.1-2 in Brack and Rieber, 1986) known so far in the Southern Alps. Its position lies immediately below a distinct crystal tuff at the base of the Tc tuffaceous groove.

- Within the Tc tuffaceous groove the first specimens of 'Stoppaniceras' of the *ellipticus*-group were found. Representatives of this group are also present immediately above the Td-tuff (at Prezzo) and in the 'Chiesense-groove'.
- At the base of the Td-Tuff a single specimen of *Halilucites* cf. *arietiformis* was identified at Pèrtica.
- The siliceous 'Knollenkalk'-beds just above the Te-tuff layer yielded representatives of *Nevadites* (*N. avenonensis*, *N. sp.*) close to *Nevadites* from Monte San Giorgio and Seceda (e.g. *Nevadites secedensis*; Brack and Rieber, 1993).
- The conspicuous 'Chiesense-groove' at the 63.2m-level on the Bagolino column is 20-30 cm wide and contains abundant specimens of *Chieseiceras chiesense* along its lower surface and as nodules in a marly matrix together with few '*Stoppaniceras'*, *Monophyllites* and *Epigymnites*. This groove becomes somewhat less distinct at Marcheno and Biogno in Val Trompia to the southwest of Pèrtica. In these localities *Chieseiceras chiesense* occurs within a narrow stratigraphic interval of 50-70 cm thickness (Brack and Rieber 1986, Fig. 7).
- The lower surface of the bed immediately overlying the 'Chiesense-groove' bears frequent *Eoprotrachyceras curionii*. Not a single specimen of *Eoprotrachyceras* has hitherto been found below this level throughout the Brescian Prealps and Giudicarie!
- In an interval 0.7 2.5 m above the top of the 'Chiesense-groove' several ammonoid bearing layers were located at Bagolino, Prezzo and Pèrtica. *Chieseiceras perticaense* appears in its lower portion but then overlaps with *Eoprotrachyceras rieberi* and *Eoprotrachyceras recubariense*. The latter two ammonoid species also occur slightly higher up.
- At the 68.75m-level at Bagolino the first specimen of a possible *Protrachyceras*, i.e. (Eo) *Protrachyceras margaritosum* was discovered.
- The upper 'Knollenkalke' above the 75m-level at Bagolino yielded true *Protrachyceras (P. cf. longobardicum, P. steinmanni)* and *Arpadites arpadis.* Several Daonella-bearing layers (*D. pichleri* [at M. Corona], *D. cf. indica, D. lommelii*) occur in the topmost portion of the 'Buchenstein Beds'.

The scheme of ammonoid zones and possible positions for the stage boundary

The formal biostratigraphic subdivision of the ammonoid succession in the Anisian/Ladinian boundary interval has been discussed exhaustively in the past few years. Below we present but a short overview of the most recent ideas (for a more extensive review see e.g. Balini in Gaetani [Ed.], 1993; historical aspects were discussed by Brack and Rieber, 1994)¹. Clear indications are given for the exact location of the zone boundaries in the Bagolino reference section (Fig.3):

A) The (Paraceratites) Trinodosus Zone usually contains most of the classical fauna in the upper part of the Prezzo Limestone. Whether the 'Lardaroceras beds' (equivalent with the 51-53m-interval on the Bagolino column) of Balini et al. (in Gaetani [Ed.], 1993) shall be

A modified version of a 'new' scheme on ammonoid zones and subzones introduced by De Zanche et al. (1993) is also reported in a recent compilation for a Mesozoic time scale (Gradstein et al. 1994). Unfortunately neither the basic (bio)stratigraphic data nor any definitions for the (sub)zones mentioned in these schemes have been published to date. At present it is therefore not possible to judge or discuss the schemes.

declared as a subzone or as an independent unit remains unclear. In any case, its inclusion in the Reitzi Zone appears to be unlikely.

- B) The (Reitziites) Reitzi Zone starts with the first *Kellnerites*, i.e. at the 53m-level on the Bagolino column.
- C) The base of the (Nevadites) Secedensis Zone is drawn at the first occurrence of Nevadites which is in the Prezzo section just below the crystal tuff at the bottom of the Tc tuffaceous groove. The zone boundary therefore corresponds to the 60.60m-level on the Bagolino column. In earlier publications we supported the inclusion of *Ticinites* in the Nevadites Zone (e.g. Brack and Rieber, 1993). The reason for this was the recognition of a distinct *Ticinites* horizon in a number of south-Alpine sections. Although this would imply only a slight downward expansion of the Secedensis Zone, *Ticinites* is presently known only from the Southern Alps and thus appears not to be a particularly suitable marker for the definition of a standard zone boundary.
- D) The (Eoprotrachyceras) Curionii Zone is fixed with the first occurrence of *Eoprotrachyceras*, which is at the lower surface of the bed immediately overlying the 'Chiesense groove'. The zone boundary therefore corresponds to the top of the groove, i.e. to the 63.25m-level of the Bagolino column.
- E) The base of a successive zone boundary cannot yet be drawn precisely. This is because the (Protrachyceras) Gredleri Zone proposed by Krystyn (1983) still lacks a clear definition. If this zone includes (*Eo*)Protrachyceras margaritosum, its base could be fixed at the 68.7m-level of the Bagolino column.

The correlation of the ammonoid sequence of south-Alpine Anisian/Ladinian boundary intervals with other important low latitude boundary successions in Hungary (Felsőörs), Greece (Epihavros) and Nevada (Humboldt Range) are illustrated in Fig.1 of Brack and Rieber (1994). The comparison with the Felsőörs and equivalent sections in the Balaton Highland of Hungary (e.g. Voros, 1993; Kovács et al., 1994) has shown an excellent match of the ammonoid successions up to and including the horizon of Reitziites reitzi (Gaetani, 1993). However, the costosus horizon above this level in Hungary seems to contain ammonoids and conodonts (e.g. Halilucites; Gondolella trammeri, G. fueloepi) which, in the Bagolino section, only occur higher up, around the level with Ticinites. Moreover, conodonts such as Gondolella liebermani and G. constricta cornuta continue in the Bagolino section well beyond the reitzi horizon. This means that the inclusion of the costosus horizon into the Reitzi Zone in the sense of Vörös (1993) may include fossils which, at least in part, could be ascribed to the successive (Nevadites) Secedensis Zone. According to our information, no unambiguous ammonoid faunas documenting the Secedensis, Curionii and Gredleri Zones have been reported to date in sequence from a continuous section in Hungary. Interestingly, no indications exist for the occurrence of either Ticinites or unambiguous Nevadites in the Balaton sections although Kovács et al. (1994) mention a recent find of Chieseiceras in the Felsőörs section.

The three principal alternatives for the stage boundary position (at the base of the Reitzi Zone, of the (Nevadites) Secedensis Zone or of the Curionii Zone, respectively) have been reviewed by Gaetani (1993), Brack and Rieber (1994) and Kovács et al. (1994). All possibilities appear to have advantages and disadvantages:

1) The base or any position within the Reitzi Zone seem to be the least suitable candidates for far-reaching correlations based on ammonoids. *Kellnerites* and *Reitziites* are known only from a small number of localities in the western Tethys. The former is known from mostly condensed, discontinuous successions of Hallstatt (and/or Bulog) Limestones; the latter species has been documented so far only from the Balaton Highland and from the Brescian Prealps. Nevertheless, the base of the Reitzi Zone appears to be accompanied by important palynological changes (Brugman, 1986; Kovács et al., 1994) and some variation in the occurrence of conodonts and radiolarians (Kovács et al., 1994; Kozur and Mostler, 1994). However, in the Balaton area according to former authors these changes apparently do not exactly coincide with the ammonoid zone boundary. Moreover, the conodont distribution at Bagolino suggests some significant differences in comparison with the results from Hungary (Nicora and Brack, 1995).

- 2) Alternatively, the base of the (Nevadites) Secedensis Zone has a higher correlation potential on the basis of ammonoids within low latitude Triassic successions. Although the condont species *Gondolella trammeri* seems to be restricted to the Tethys, its first abundant occurrence could be a useful additional element for correlation with lithologies poor in age-indicative macrofossils. At Bagolino this occurs around the *Ticinites* horizon somewhat below the ammonoid zone boundary. However, a precise correlation of the base of the Secedensis Zone with higher latitude sequences may be difficult.
- 3) We maintain that the youngest alternative for the Anisian/Ladinian boundary, i.e. at the base of the Curionii Zone, is an ammonoid marker which can be identified most probably in a larger number of important low latitude Triassic successions. Representatives of the first *Eoprotrachyceras* are relatively easy to recognize and immediately postdate *Chieseiceras chiesense*, another key ammonoid for detailed correlation. Moreover, this boundary position seems to have a higher potential for correlation with high latitude Triassic successions and also coincides with the North American convention on the stage boundary (Silberling and Tozer, 1968). The latter has widely been adopted in recent sea-level charts. It lacks, however, a clear break in the condont evolution (Nicora and Brack, 1995) and requires further detailed palynological investigations.

A frequently quoted argument against this youngest position for the base of the Ladinian has been the apparent reduction in time of the 'Fassanian' substage. In an earlier discussion we emphasized that, provided the substages must remain, the 'Fassanian' should include at least the Gredleri Zone (Brack and Rieber, 1993). According to original concept by Mojsisovics et al. (1895) the 'Fassanian' is represented by the 'Buchenstein Beds' and the 'Marmolada Limestone' in the Dolomites. The former beds definitely reach into the basal Archelaus Zone, independent of which definition is eventually chosen for its base. Thus, besides the first occurrence of *Protrachyceras*, there is no plausible argument for the inclusion of the Gredleri Zone into the Upper Ladinian 'Longobardian' substage, as suggested by Krystyn (1983). As a consequence the 'Fassanian' could equally comprise two ammonoid zones.

Preliminary results of radiometric age dating of volcanic tuff layers in the Bagolino and correlative sections

High-resolution, single-grain U-Pb age dating has been performed on zircons from a number of individual volcaniclastic intercalations (Mundil et al., 1995) in the Bagolino and closely correlated south-Alpine sections (Seceda, Monte San Giorgio). In this section, we briefly outline relevant results that allow a better numerical constraint on the Anisian/Ladinian boundary. The age of crystallisation of the zircon grains is taken as an approximation for the time of deposition of the volcaniclastic layers. A full discussion of the results, their interpretation and analytical procedures will be presented elsewhere.

Age determinations obtained for a thin crystal tuff layer at the base of the Tc tuffaceous groove (60.70m-level on the Bagolino column, lower part of [Nevadites] Secedensis Zone) are of special importance for the stage boundary. This layer is 1-2 cm thick and consists predominant-

ly of phenocrysts of feldspar, quartz and biotites, with zircons as accessory minerals. The bed can be traced over long distances (see Fig.11 in Brack and Rieber, 1993) throughout the western Dolomites (Seceda), Giudicarie and Lombardy (Bagolino and equivalent sections) as far as Monte San Giorgio in southern Switzerland (Grenzbitumenzone). Results from seven concordant zircons give a weighted 206 Pb/ 238 U mean age of 241.0±0.5 Ma (95% confidence level) for this tuff layer at Seceda. Preliminary results of zircons from a slightly younger bed (Bed Nr. 71 at Monte San Giorgio) corresponding to a layer within the Tc tuffaceous groove at Bagolino (Fig. 3), confirm this age.

These values are almost 8 m.y. older than, but still within the error limits of the average 233 ± 9 Ma K/Ar and Ar/Ar age obtained for the equivalent tuff layers in the Grenzbitumenzone at Monte San Giorgio (Hellmann and Lippolt, 1981). Up to now the latter values have been considered as one of the few high-quality anchor points in the calibration of the numerical time-scale of the Triassic (Forster and Warrington, 1985; Brack and Rieber, 1993).

Another volcaniclastic layer in the middle portion of the 'Buchenstein Beds' at Bagolino has been dated by four concordant zircon analyses to be 238.8 ± 0.4 Ma. This layer is situated above a bed with *(Eo) Protrachyceras margaritosum* and may therefore be ascribed to the Gredleri Zone. The age is thus in correct stratigraphic order with the older dated level in the [Nevadites] Secedensis Zone.

A 'best' estimate of 240.5 Ma is obtained for the age of the base of the Curionii Zone (and hence of the suggested Anisian/Ladinian boundary) with a linear interpolation using the thickness values of the pelagic sediment fraction between the two dated markers.

Conclusions

Whatever decision may eventually be made on the position of the Anisian/Ladinian stage boundary, all possibilities suggested to date can be accurately pinpointed in the Middle Triassic succession at Bagolino. This and equivalent sections in the Brescian Prealps and Giudicarie are at present the only non-condensed successions with a high resolving, long-ranging ammonoid control in the western Tethys.

The Middle Triassic rocks at Bagolino have suffered slightly elevated temperatures during their burial history. This is indicated by the conodont coloration and paleomagnetic results (Muttoni and Kent, 1994). Preliminary results on fission track dating of apatites and zircons on samples from Bagolino suggest, however, that burial-temperatures did exceed 110°C but remained presumably below 250°C.

This drawback is, at least in part, compensated by the detailed and unambiguous correlations of the Bagolino column with south-Alpine sections at a less advanced stage of diagenesis. Sections which are more suitable for palynological and/or paleomagnetic investigations are found at Monte San Giorgio and around Val Gardena (Seceda and related sections). A paleomagnetic study is indeed being carried out on samples from Frötschbach. However, in spite of their local abundance in ammonoids and Daonellas, these sections show more restricted (in time) fossil records and are therefore less suitable as a standard reference.

Specific bio- and chronostratigraphic advantages of the Bagolino section in the evaluation of the GSSP candidates for the base of the Ladinian stage are the following:

An ammonoid control with the highest resolution documented so far for a single, noncondensed and fully pelagic boundary section in the western Tethys.

- A clearly defined distribution of relevant conodont species in spite of the generally poor yields of samples (Nicora and Brack, 1995).
- The abundance throughout the entire boundary interval of volcaniclastic layers suitable for radiometric age dating and first results bracketing the Curionii Zone.
- The high resolving correlation with sections in the northwestern Dolomites, i.e. with the implied original type-area of the 'Ladinian' (Bittner, 1892).
- The full exposure and easy accessibility of different natural and man-made outcrops of the boundary interval at Bagolino.

The location of the GSSP at Bagolino would allow this point to be integrated in a larger (bio-) stratigraphic context within a continuous succession representing the entire Late Anisian to Late Ladinian time interval (Fig. 2). Moreover, this section can be correlated in detail with the most relevant low latitude sections in the western Tethys and North America (Brack and Rieber, 1994).

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THE ANISIAN/LADINIAN BOUNDARY INTERVAL AT BAGOLINO (SOUTHERN ALPS, ITALY): II. THE DISTRIBUTION OF CONODONTS

A. Nicora and P. Brack

Introduction

The aim of this short contribute is to illustrate the distribution of conodont species relevant for the location of the Anisian/Ladinian boundary. The sampled interval in the Middle Triassic succession at Bagolino comprises the 'transitional beds' following on top of the Prezzo Limestone and the 'Buchenstein Beds'. This section has been proposed as a candidate for the GSSP of the base of the Ladinian stage. A summary of the most important information including the location of outcrops at Bagolino along with data on macrofossil occurrences (ammonoids, Daonellas) and radiometric ages is the subject of a companion paper (Brack et al., 1995). In the latter article the ammonoid zones and potential positions for the stage boundary are discussed. Reference is also made to the relevant recent publications on this topic.

Conodonts have been described from the Upper Anisian to Ladinian Stabol Fresco section in the area of Monte Corona around 20 kilometres to the northeast of Bagolino (Kovács et al., 1990). This section is closely correlated with the Bagolino column on the basis of ammonoids and lithostratigraphic marker horizons (see Figs.7&10 in Brack and Rieber, 1993). At Bagolino preliminary conodont data were obtained by De Lama and Mietto from Padova University and have been referred to by Brack and Rieber in Fig.B10 of Gaetani [Ed.] (1993). However, detailed information on these results are still not available.

Following the I.U.G.S. field workshop on the Anisian/Ladinian boundary in the Southern Alps and Balaton Highland (Gaetani, 1993) a new sampling campaign was initiated. More than 80 rock specimens were collected for conodont analysis in three major outcrops at Bagolino. The average weight of the samples was around four kilograms. In spite of relatively small numbers of conodonts obtained per sample, the distribution of age indicative species appears to be representative.

Additional rock samples from Pèrtica (Brescian Prealps) and Frötschbach are currently being analysed. A complementary study is planned for the Seceda section in the northwestern Dolomites. Preliminary results obtained on few rock specimens from these localities show an even smaller content of conodonts.

In order to achieve a coherent interpretation, the conodont material from the Stabol Fresco section has been re-examined after the recent publications by Kovács (1994), Kovács et al. (1994) and Kozur et al. (1994).

Conodont data

Samples were collected at three sites (B,C,D) of overlapping sections (Tab.1). Two sites (B and C) are natural outcrops along the Caffaro river below the village of Bagolino the third one (site

D) is a man-made exposure along a forest track on the southern slope of Monte Pizza (for a map see Fig.1 in Brack et al., 1995). Sample numbers are also labelled with metre-levels referring to the Bagolino reference column reported in Brack and Rieber (1993) and in Gaetani [Ed.] (1993). Sample spacing is closest for the 'transitional beds' and the lower portion of the siliceous 'Knollenkalke' of the 'Buchenstein Beds', i.e. for the Anisian/Ladinian boundary interval.

Table 1 provides a list of all specimens so far collected, together with indications of the most important ammonoid and Daonella horizons and the zonal scheme based on ammonoids. Table 2 reports the distribution and abundance of conodonts. The main bioevents are summarized in Fig. 1.

Below, the most important features are emphasized in roughly chronological order; the number of conodonts was particularly low at Site C and in samples from the upper part of the 'Buchenstein Beds'.

- Samples RE11-14 are characterized by massive *Gondolella constricta cornuta* (Budurov & Stefanov), *G. c. balkanica* (Budurov & Stefanov; = *G. c.* beta in Kovács et al., 1990 and *G. longa* Budurov & Stefanov).
- Samples MP1-4 from the Kellnerites beds are characterized by the occurrence of Gondolella constricta cornuta, G. c. balkanica (Budurov & Stefanov, = G. c. beta in Nicora & Kovács, 1984), G. liebermani Kovács & Krystyn, G. basisymmetrica (Budurov & Stefanov), G. longa (Budurov & Stefanov), G. mesotriassica Kozur & Mostler. The alpina-group including Gondolella alpina alpina Kozur & Mostler and G. a. szaboi Kovács (both species have a similar distribution at Bagolino) is rarely present in the Kellnerites beds and becomes more abundant only from the Ticinites horizon upward. Gondolella constricta postcornuta Kovács also occurs in the Kellnerites beds but it is more frequent below and above the 'Chiesense-groove'.
- Starting with a layer between the *Reitziites* horizons (RO 101, 57-m-level) *Gondolella* aff. *eotrammeri* Krystyn appears along with the aforementioned species.
- From the 59.30m-level onward (sample N8) the latter species becomes abundant. At the same level *Gondolella fueloepi* Kovács occurs with few juvenile specimens.
- Juvenile *Gondolella trammeri* Kozur were obtained from the *Ticinites* horizon (sample RE17, 60.00m-level). Above a layer corresponding to the oldest *Nevadites* found at Prezzo (see Fig.2 of Brack et al., 1995), *Gondolella trammeri* is abundant (sample N5, 60.75m-level).
- At the same level representatives of *Gladigondolella* Huckriede appear. Above this level the latter are usually abundant. The *Nevadites* interval is characterized by *Gondolella trammeri*, less frequent *G.* aff. *eotrammeri*, *G. c. postcornuta*. From sample N12 (61.90m-level) onward *G. fueloepi* persists.
- Slightly below the 'Chiesense-groove' the first juvenile specimens of *Gondolella* ? praehungarica Kovács occur together with few *Gondolella bakalovi* (Budurov & Stefanov).
- The 'Chiesense-groove' itself (samples N10, MP15) is characterized by the abundance of *G. trammeri* and *G. c. postcornuta. Gondolella fueloepi* and *Gladigondolella tethydis* are less frequent. Few *Gondolella excelsa* (Mosher) also occur and *G.* aff. *eotrammeri* appears for the last time.
- Almost the same conodont fauna is found in the lower *Eoprotrachyceras* beds. Sample RO108 (65m-level) yielded *Gondolella bakalovi* and *G. lindstroemi*. With few exceptions rock specimens from siliceous nodular limestones above this level turned out to be particularly poor in conodonts. Nevertheless a small number of significant conodonts were found in the subsequent beds with *Protrachyceras*.
 - A single specimen of *Budurovignathus truempyi* (Hirsch) was provided by sample MP21 (70.80m-level).

- In the interval with *Protrachyceras steinmanni* juvenile forms of *Budurovignathus hungaricus* (Kozur & Vegh) were obtained from sample MP24 (79.50m-level).
- Few metres below the top of the 'Buchenstein Beds' well developed specimens of Budurovignathus mungoensis (Diebel) were found in samples RE*8-9 (87.30-88.40minterval).

A brief comparison with other sections

Stabol Fresco:

The re-examination of the conodont material from Stabol Fresco (Kovács et al., 1990) suggests that in comparison with Bagolino these faunas are even poorer. Moreover, the frequency of sampling was significantly lower. Nevertheless, very similar evolutionary trends come out from both data sets, although a major difference is observed in the distribution of *Gondolella fueloepi*. The latter conodont species appears at Stabol Fresco (Stabol Fresco II section) clearly below a level corresponding to the *Ticinites* horizon. At Bagolino this conodont species starts only slightly below the latter and persists through the upper portion of the *Nevadites* interval into the subsequent lower *Eoprotrachyceras* beds. In the Brescian Prealps and Giudicarie *Gondolella fueloepi* fueloepi presumably occurs for the first time in the upper part of the Reitzi Zone.

Balaton Highland:

The excellent ammonoid control of conodonts in the Brescian Prealps and Giudicarie (Bagolino and Stabol Fresco II sections) provides a good basis for a comparison with the distribution of equivalent conodonts recorded in the ammonoid horizons of the Balaton Highland (Kovács, 1994; Kovács et al., 1994). The following similarities and differences have been noticed:

- a) In both areas the *constricta* lineage (sensu Kovács, 1994), *Gondolella liebermani* and *G.* aff. *eotrammeri* show similar ranges (although at Bagolino these extend generally somewhat further up).
- b) Significant differences are observed in the range of the *alpina*-group. In Hungary this group appears to be restricted to the *reitzi* and *costosus* horizons. At Bagolino it seems to start earlier and also reaches clearly higher up into the Curionii Zone.
- c) In the Balaton Highland *Gondolella trammeri* is reported to occur from the base of the *costosus* horizon while at Bagolino it starts to be abundant at the *Ticinites* horizon.
- d) A similar observation is made may the onset of *Gondolella fueloepi* although the difference seems to be less pronounced.
- In contrast, Gondolella ? praehungarica is present at an apparently older level (uppermost [Nevadites] Secedensis Zone) at Bagolino compared with its distribution in the Balaton Highland (Curionii Zone).
- f) The first occurrence of *Budurovignathus* in a layer above the level with *(Eo)Protrachyceras* margaritosum again appears to be younger than the corresponding indications for Hungary (*recubariense* (?) horizon).

The apparent mismatches in the ranges of important conodont species and groups seem to be more pronounced for the rock intervals above the *reitzi* horizons in both areas. These differences cannot be explained by the presumably much lower number of conodont specimens at Bagolino alone. Several conodont species which apparently start near the base of, or are restricted mainly to the *costosus* horizon in Hungary (G. trammeri, G. fueloepi, G. alpina-group, G. aff. eotrammeri) appear well above the *Reitziites* horizons or continue significantly higher up



at Bagolino! Provided the differences are not a result of pronounced provincialism, this observation casts doubts on the reliability of the ammonoid reference horizons above the *reitzi* level in the Balaton Highland (Kovács et al., 1994). According to our information, no unambiguous representatives of either *Ticinites* or *Nevadites* have been mentioned from this area to date. Moreover, we are not aware of any single section that gives good ammonoid evidence for the (Nevadites) Secedensis and subsequent zones in sequence.

Final remarks

On the basis of their distribution at Bagolino, the following general remarks can be made on the evolution and diffusion of important conodonts in the Anisian/Ladinian boundary interval (Tab.2: conodont events I-V):

- 1) As emphasized by Kovács (1994) and Kovács et al. (1994) the constricta lineage (sensu Kovács, 1994) indeed shows a low evolutionary rate. Gondolella c. cornuta, G. c. postcornuta and G. mesotriassica occur at the base of the Kellnerites beds. Around the level of the Ticinites horizon and in the Nevadites interval specimens of Gondolella longa, G. pseudolonga and G. mesotriassica appear sporadically. Up to the Eoprotrachyceras bearing beds only rare, primitive Gondolella transita (reported as aff. transita) were detected. In the Nevadites interval representatives of the constricta lineage are always less abundant than the excelsa and trammeri lineages (sensu Kovács, 1994). Higher up, this trend is reversed. In the lower Kellnerites beds (sample MP1) a change in the constricta lineage along with specimens of the alpina-group and G. liebermani. This could be a first conodont event for the Anisian/Ladinian boundary, i.e. corresponding to 'Variant 1' in Kovács et al. (1994).
- 2) Gondolella fueloepi first appears below the *Ticinites* horizon. Its acme is around the 'Chiesense-groove'. This taxon may be of far reaching importance because the *excelsa* lineage is also well represented in conodont material from Nevada (see G. sp. A partly corresponding to G. liebermani, G. fueloepi and G. postexcelsa (Budurov & Sudar) in Nicora and Kovács, 1984). The first occurrence of G. fueloepi could be a second conodont event for the location of the stage boundary.
- Gondolella trammeri (represented by juvenile onthogenetic stages) occurs at the *Ticinites* horizon. Its existence in the Triassic of Nevada is doubtful. However, it may be considered as an important Tethyan marker.
- 4) Gondolella ? praehungarica might appear only slightly below the Curionii Zone. However, this conodont species is usually rare and its geographical distribution is largely unknown.
- 5) The first representatives of Budurovignathus were identified significantly above the base of Eoprotrachyceras but still below the beds bearing true Protrachyceras. Budurovignathus mungoensis is clearly present at a level with Daonella pichleri. This is presumably only slightly younger than the first occurrence of B. mungoensis at Epidhavros (Krystyn, 1983).
- Fig. 1 Illustration of an extended Anisian/Ladinian boundary interval at Bagolino (modified after Brack and Rieber, 1994; Fig.1) with indications of the main conodont events. Note that only the thickness of the pelagic sedment fraction is diplayed; the volcaniclastic layers are marked by thin bars of 'zero thickness'.

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Tab. 1 Distribution of conodont samples and of the most important ammonoid horizons in the Bagolino reference column. Note that the conodont samples have been collected at different outcrops of largely overlapping sections (Sites B,C,D). See Fig.1 in Brack et al. (1995) for a map of the outcrops. For convenience, the ammonoid horizons of the Balaton Highland (Kovács et al., 1994) are also indicated. Metre-numbers refer to the section displayed in Brack & Rieber, 1993 and to Fig. 3 of Brack et al., 1995).

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INTERCALIBRATED AMMONOID AND CONODONT SUCCESSION, UPPER ANISIAN-LOWER LADINIAN OF NEVADA

H. Bucher and M.J. Orchard

Introduction

The present account provides a preliminary summary of the Anisian-Ladinian ammonoid and conodont succession of the Prida Formation (Star Peak Group) in the Humboldt Range of northwestern Nevada, specifically at the "Fossil Hill" and "Saurian Hill" sites documented by Silberling and Nichols (1982). This was the type area where Silberling and Tozer (1968) defined the Upper Anisian Rotelliformis, Meeki, Occidentalis zones, and the Lower Ladinian Subasperum Zone. Our subsequent reinvestigation of this key-section emphasizes the intercalibration between ammonoid and conodont successions.

AMMONOIDS (HB)

The Upper Anisian and Lower Ladinian ammonoid sequence of the Fossil and Saurian hills was established in great detail by Silberling and Nichols (1982). Intensive new sampling fully confirms and strengthens the outstanding sequence established by these authors. Occurrences of ammonoids of the Rotelliformis and Meeki zones remain unchanged. New additions to the latest Upper Anisian Occidentalis Zone and Lower Ladinian faunas are briefly outlined in this report.

1. Summary of present results

Occidentalis Zone

As first established by Silberling and Nichols (1982), the biochronologic subdivisions of the Occidentalis Zone comprise the *Nevadites hyatti* beds, *Nevadites humboldtensis* beds, *Paranevadites furlongi* beds, and *Paranevadites gabbi* beds, in ascending order.

Ceratites karpinskyi Smith is reported to strictly occur in the Furlongi beds. This taxon was previously synonymised with *Frechites occidentalis* by Silberling and Nichols (1982). However, the distinctive morphology of newly collected specimens of *C. karpinskyi* allows it to be separated from the co-occurring *Frechites occidentalis*. *C. karpinskyi* typically has small spiny umbilical nodes, lateral spines, somewhat clavate marginal nodes, and a broad flat venter. Although trituberculation appears as unusual characters among beyrichitids, the broad flat venter suggest some phylogenetic affinity with *Frechites*. A distinct genus name will be made available to better emphasize the peculiar combination of characters of *C. karpinskyi*.

Pleurofrechites johnstoni (Silberling and Nichols) was previously recorded from strata of Lower Ladinian age only (Silberling and Nichols, 1982). It is now documented to range down into the Gabbi beds.

Occurrence of *Trachyceras* (*Anolcites*) gracile Smith is here reported from the Furlongi and Gabbi beds, exclusively. It is interpreted as a distinct nevaditid genus showing either some affinities or parallelism with *Chieseiceras*. Comparison with other nevaditids suggest that loss of lateral tubercles as well as any potential intermediate rows of nodes constitute the derivate character of this genus.

Lower Ladinian

The first occurrence of protrachyceratids has been regarded as defining the base of the Ladinian stage. *Pleurofrechites johnstoni* (Silberling and Nichols) and *Aplococeras* n. sp. are found to occur throughout the entire sequence of fossiliferous strata of Lower Ladinian age. The zonal index *Eoprotrachyceras subasperum* appears to have a very restricted range. Formalization of the improved biochronologic precision will rely on an improved taxonomic understanding of the many species of protrachyceratids used by Smith (1914), as well as integration of additional new forms. In ascending order, the following sequence is established: *Eoprotrachyceras sp. A* beds, *Eoprotrachyceras lahontanum* beds, *Eoprotrachyceras subasperum* beds, *Progonoceratites* n. sp. beds, and (?*Eo*)*Protrachyceras* sp.C beds.

The index species of the *Eoprotrachyceras* sp. A beds (loc. HB521 & 520) cannot be assigned with confidence to any of the previously known congeneric species, and may subsequently be erected as a distinct species. The *E. lahontanum* beds (loc. HB508) contain *Eoprotrachyceras* sp. B, the earliest representatives of *E. meeki*, a new distinctive protrachyceratid genus combining *Protrachyceras*-like inner whorls with *Anolcites*-like outer whorls, and *Proarcestes* of the *bicinctus* group. The *Eoprotrachyceras* subasperum beds (loc. HB517, 539, 502, 503) are recognized on the basis of the short range of the highly diagnostic index species. They also yielded rare specimens of *Tuchodiceras poseidon*, previously known only from northeastern British Columbia only (Tozer, 1994). In addition to the index genus which is here newly recorded in North America, the *Progonoceratites* beds (loc. HB 504) yielded a non-tuberculate and evolute protrachyceratid (recubariense-gortanii group?) so far undescribed from Nevada, *Epigymnites alexandrae*, and *Monophyllites*. *Eoprotrachyceras meeki* also has its last occurrence in the *Progonoceratites* beds. The index species of the (?*Eo)Protrachyceras* sp. C beds (loc. HB516, 534, 512) was hitherto not known from Nevada. It has a distinctive compressed whorl shape with a narrow sulcate venter bordered by clavate tubercles.

2. Comments on correlation with Alpine Europe

- i) The Secedensis Zone of Brack and Rieber (1994) shares representatives of *Nevadites* s.s. with the Hyatti and Humboldtensis beds of the Occidentalis Zone. The Furlongi and Gabbi beds could possibly intercalate between the Secedensis Zone and the Curionii Zone.
- Aplococeras ranges up into faunas of Lower Ladinian age. Unless used at the species level, Aplococeras appears as a long ranging genus of limited value for correlations. A comparable range is also known from the Lower Ladinian succession of the Calcare di Esino (Fantini Sestini, 1994).
- iii) *Reiziites, Parakellnerites, Latemarites, Ticinites, Serpianites, Stoppaniceras, Halilucites,* and *Repossia,* all known from Alpine Europe, have not been recorded from Nevada, so far.
- iv) The proliferation of commonly ill-defined taxa of early protrachyceratids seriously hamper the construction of correlations in the Lower Ladinian. Progress on this point can be made by addressing intraspecific variability of bedrock-controlled successive populations. It is anticipated that the apparent diversity of these protrachyceratids of Lower Ladinian age may be a mere taxonomic bias.

CONODONTS (MJO)

1. Previous work.

Conodonts were first reported from the Humboldt Range by Mosher and Clark (1965), who described several species of *Gondolella*, most of which are now regarded as examples of different growth stages of *Neogondolella constricta* (Mosher and Clark), a species that these authors introduced for relatively small specimens. Later, Nicora and Kovács (1984) provided a reassessment of the fauna and differentiated two dominant species, an older *N. constricta* succeeded by *N. mombergensis* (Tatge). Ritter (1989) subsequently undertook a morphometric analysis of the "mombergensis-constricta plexus" and concluded that the elements of this group represented a monospecific continuum, for which the name *N. mombergensis* had priority. However, after restudying the holotype of *N. mombergensis*, the author is of the opinion that this species does not occur in Nevada during the interval under study. Most recently, Kozur, Krainer and Mostler (1994) assigned many representatives of the *N. constricta* group from Meeki and higher beds to a new species, *N. aldae*.

In addition to representatives of the *Neogondolella constricta* group, a further species described from the study area is *N. pridaensis* (Nicora, Kozur and Mietto). Nicora et al. (1981) based this species on specimens of diverse morphology from both the Rotelliformis and Subasperum zones. Recently, Kozur et al. (1994) differentiated two additional conodont taxa amongst the specimens of *N. pridaensis* illustrated by Nicora et al. (1981). The current work also concludes that several short-ranging species have formerly been submerged in *N. pridaensis*.

Both Mosher and Clark (1965) and Nicora and Kovács (1984) also illustrated a few representatives of the *Paragondolella excelsa* Mosher group plus *N. cf. trammeri* (Kozur), but the Nevadan taxa other than *N.* ex gr. *constricta* have received less attention in the past. As summarized below, these elements do however provide the basis for a more highly resolved zonation of the Anisian-Ladinian boundary interval in Nevada.

2. Summary of present results

Two levels of significant conodont faunal change are identified within the upper Anisian-lower Ladinian Prida Formation of northwestern Nevada. One corresponds to the base of the Occidentalis Zone (*N. hyatti* beds), the other to the *Eoprotrachyceras lahontanum* beds(loc. HB508), beneath the incoming of *Eoprotrachyceras subasperum*.

Beneath the lower datum, within the Rotelliformis and Meeki zones, *Neogondolella constricta* sensu stricto occurs in association with *N. szaboi* (Kovács) and fewer *N. alpina* (Kozur & Mostler) and *N.* n. sp. A. *Paragondolella liebermani* (Kovács & Krystyn) accompanied by *P.* aff. *liebermani* occurs in the lower part of the Rotelliformis Zone, but no paragondolellids have been found above the *Paraceratites vogdesi* beds through the entire Meeki Zone. *N. szaboi* and *N.* n. sp. A range through the middle of the Meeki Zone, but disappear shortly after the appearance of *N. aldae*. Samples from about a calcareous sandstone marker near the top of the Meeki Zone contain only monospecific *N. constricta* faunas.

The first clear conodont datum corresponds to the base of the Occidentalis Zone. Several new taxa appear, and others reappear at this level. Amongst the *N. constricta* group, *N. aldae* dominates, and *N. excentrica* Budurov & Stefanov morphotypes with extended basal scars [*N.*

transita (Kozur & Mostler) of some authors] become more common. Paragondolella liebermani reappears and remains a constant element of the conodont faunas through the remainder of the studied section. Derivatives of *N. szaboi-N. alpina* are assigned to *N. pridaensis*, *N.* n. sp. C (three morphotypes), and *N.* n. sp. D, all of which become common and occasionally dominant (over the *N. constricta* group) in the Occidentalis Zone. Reduction in overall size and in platform development is characteristic of these species, so that small platformless specimens are common in Occidentalis Zone faunas. *Neogondolella* n. sp. D also appears in, and ranges through this zone. It represents the first step in the evolution of *Budurovignathus*.

The second distinctive conodont datum occurs in the *P. lahontanum* beds. It is marked by the mass appearance of *Budurovignathus praehungaricus* (Kovács), and new *Paragondolella* species tentatively assigned to *P.* aff. *fuelopi* (Kovács) and *P.* aff. *curta* Budurov & Sudar; there are also rare occurrences of *N.* aff. *transita* and distinctive elements of *Cornudina* sp. sensu formo. Most conodont taxa found in the Occidentalis Zone range through the Subasperum beds and into the *Progonoceratites* beds (loc. HB504), where several new unnamed taxa appear.

Bed HB504 potentially represents a third conodont datum, but it is less well known at present. Above this level, diversity drops dramatically and only the *N. constricta* group accompanied by rare *N.* aff. *mombergensis* occur in the Upper member of the Prida Formation.

3. Comments on correlations with Europe

Correlations within Europe, and between there and Nevada, are hampered by differing conodonts taxonomic concepts. However, the two regions appear to have more in common than is evident in previous accounts of the conodont faunas, and improved correlation of the Nevadan and Europe successions is anticipated as the taxonomy stabilizes. Meanwhile, the following observations can be made:

- i) Conodonts common to both Nevadan and European successions are represented by the groups of Neogondolella constricta, N. szaboi-N. alpina, Paragondolella spp., and N. n. sp. D-Budurovignathus praehungaricus. In contrast, some taxa that are common in Europe, for example Gladigondolella spp., do not occur in Nevada, and others, like N. trammeri, are poorly represented (if at all).
- ii) The taxonomic differentiation of the *N. constricta* group in this study differs from that of previous workers, and *N. c. postcornuta* (Kovács) is not identified in the Nevadan material. Therefore, the datum identified by Kovács (1993, fig. 6) as Event 1 in the Balaton Highland succession cannot be recognized in Nevada.
- iii) In the Balaton, N. szaboi and N. alpina occur most commonly in the purplish-red crinoidal limestone beds overlying the lower Buchenstein Formation at Mencshely. These beds represent the Halilucites costosus ammonoid horizon of the Reitzi Zone (Vörös, 1993). Associated Paragondolella species are referred to P. fuelopi by Kovács (1994), whereas in Nevada, only P. liebermani is associated with N. szaboi and N. alpina. The last three species only occur in the Rotelliformis Zone in Nevada, although a correlation with the Meeki Zone is also possible.
- iv) Neogondolella trammeri is a common species in European successions and its appearance has been proposed as the index for an Anisian-Ladinian boundary drawn at the base of the Nevadites beds in Europe, which is aligned with the base of the Occidentalis Zone in Nevada (Krystyn 1983, Kovács et al. 1990, Event 2 of Kovács, 1993). In Nevada, a species that appear at the base of the Occidentalis Zone is assigned to N. n. sp. B, which resembles some small specimens previously assigned to N. trammeri. However, large

specimens of *N. trammeri* have yet to be found in Nevada, so our current understanding of that species precludes it as a satisfactory index for international correlation and boundary definition.

iv) The definitive conodont of the higher Nevadan datum (loc. HB 508), Budurovignathus praehungaricus, occurs in the upper part of the Felsőörs section in the Balaton. Its appearance constitutes Event 3 of Kovács (1993), which is therefore supported as the most easily recognizable conodont datum for international correlation at this time. The species occurs above the Costosus Zone (Kovács, 1994, p. 476-7) in yellowish-grey to red nodular limestones with red chert nodules (the Nemesvámos Limestone member). Although regarded as belonging to the Curionii Zone, these beds contain no ammonoids.

Summary

New data on the ammonoid and conodont successions from the Anisian-Ladinian boundary interval of northwest Nevada are presented. New ammonoid data are mostly from the latest Occidentalis Zone and younger strata, and feature new protrachyceratid faunas. Current interpretation of the conodont data recognizes two clear conodont faunal boundaries, both of which correspond to an ammonoid faunal change.

The conodont fauna that appears at the base of the Occidentalis Zone marks the first conodont datum. Within the range of this conodont fauna, *Eoprotrachyceras* sp. A appears. This is the oldest of the protrachyceratids, traditionally taken as indicating the base of the Ladinian.

The second conodont datum corresponds to the appearance of *Eoprotrachyceras lahontanum* and the conodont *Budurovignathus praehungaricus*. Kovács (1993, event 3) has correlated the appearance of *B. praehungaricus* with the Curionii Zone, the base of which is recommended as the Anisian-Ladinian boundary by Brack and Rieber (1994), who have discussed the alternatives.

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THE ANISIAN/LADINIAN BOUNDARY: VOTING OR CONSENSUS?

A. Vörös

The Working Group on the Triassic Stage Boundaries of the international Subcommission on Triassic Stratigraphy is about to come to a decision by voting in the matter of the base of the Ladinian. This was preceded by a period of intensive research in several countries to clear the stratigraphy of the interval in question. A great amount of data was presented and discussed in a workshop meeting (Southern Alps - Balaton Highlands, 27 June - 4 July 1993) (cf. Gaetani 1993). I also contributed to the workshop and expressed my views in a paper (Vōrōs 1993). The threatening approach of the poll urges me to comment on some aspects of the problem at hand.

The circular by Gaetani (1993) and a subsequent paper by Brack and Rieber (1994) gave a comprehensive review of the recent opinions on the position of the base of Ladinian: (1) at the appearance of *Kellnerites* (i.e. Reitzi Zone), (2) at the appearance of *Nevadites*, and (3) at the appearance of *Eoprotrachyceras (i.e.* Curionii Zone). The question is how to decide between them.

Priority

I have been a stiff protagonist of the application of the rule of priority in stratigraphical nomenclature for what I was scolded and mockered at some international meetings. So I do not want to dwell too long at this point.

Brack and Rieber (1994, p. 29) wrote that the priority arguments are problematic and priority cannot give a constructive contribution to the Anisian/Ladinian boundary problem. And they supported this opinion soundly. Kozur and Mostler (1994, p. 149) wrote: "The Anisian-Ladinian boundary is according to the priority the clearest boundary within the Triassic.". And they supported this opinion soundly.

Poor other Triassic stage boundaries! But let me leave this question with the sad remark that until we do not formulate a rule of priority in bio-/chronostratigraphy, we shall remain in a dark and confuse, pre-Linnean phase of the stratigraphical nomenclature.

Usefulness

In solving stratigraphical problems and drawing stage boundaries, most colleagues prefer usefulness against priority (and especially against formalism, egoism or chauvinism). Here I want to join them for a short time.

What are the criteria of usefulness, i.e. what are the useful tools for stratigraphical practice in our case? In my view, at this point we have to differentiate between stratigraphical subdivision and correlation.

By tradition and practice in the Triassic, ammonoids have been preferred for biostratigraphical subdivision and in most cases, though sometimes bitterly, also for correlation. The participants of the workshop meeting mentioned above might be convinced by the extremely detailed subdivision of the type sections in the Giudicarie and the Balaton areas and the excellent correlation between them (see also Brack and Rieber 1994, Fig 1). Continued collections in the Felsőörs section (Balaton area) revealed a 'Ticinites' layer just above the costosus horizon of the Reitzi Zone and a layer with Chieseiceras after an unfossiliferous 1 m thick interval (Nevadites and Eoprotrachyceras curionii are still wanted but collecting work will be continued in 1995). Nevertheless, the detailed subdivision of the critical interval is given in both areas (Giudicarie and Balaton) and the correlation is also perfect - within this short distance. We may try to choose between the three candidates for the Ladinian base: the Kellnerites datum (1), the Nevadites datum (2), or the Eoprotrachyceras datum (3). In the first case we have two candidate sections (Bagolino and Felsőörs), in the second or third case Bagolino seems to be the only nominee at the moment. I strongly recommend to choose the first possibility (i.e. the Kellnerites datum) and not by chauvinist reason. Frankly, I am not keen on having a golden spike in my garden. However, I am keen on usefulness.

Here I turn to the problem of correlation. In contrast to their great potential in subdivision, Triassic ammonoids seem less useful in worldwide correlation. It is, of course, not an inherent shortcoming but an empirical condition, notably, that ammonoids cannot be collected in the necessary amount wherever you just want. Even in fossiliferous localities it takes enormous work, lasting several collecting seasons, to reach a sound stratigraphical conclusion. Ammonoid workers may say some words to this. On the other hand, microfossils (first of all conodonts, radiolarians and palynomorphs) may help to overcome these difficulties because they can be obtained from smaller rock samples or even drill cores; moreover, they have worldwide distribution. If a good standard is used (i.e. taken from well studied sections subdivided by ammonoids) these microfossil groups have really great potential in correlation of stage or zonal boundaries. But in order to use this potential, we have to choose a datum or chron in our detailed ammonoid scale, where the microfossil groups show marked changes. For evolutionary reasons, these marked changes occur in the record of microfossils more rarely than in the

ammonoids (perhaps except for the conodonts).

Conodonts seem to offer a large choice: evolutionary events are frequent in the stratigraphical interval under consideration and some of them fit well with the ammonoid "events", e.g. with the *Kellnerites* datum (Reitzi Zone) and the *Eoprotrachyceras* datum (Curionii Zone)(see Kovács 1993, Kovács et al. 1994).

Radiolarians are more rigorous. Within the discussed interval the single but radical evolutionary change occurs at the *Kellnerites* datum (i. e. at the base of the Reitzi Zone)(Dosztály, in Kovács et al. 1994, Kozur and Mostler 1994).

Palynomorphs show a significant change slightly below the *Kellnerites* datum (in the top part of the *'Lardaroceras* beds'?) and no change can be detected in the palynomorph associations until the Longobardian (Góczán, in Kovács et al. 1994).

Clearly, usefulness of a stratigraphical boundary lies in the potential of its correlation. It is shown above that from among the three candidates for the base of Ladinian only the lowermost one, i. e. the *Kellnerites* datum (the base of the Reitzi Zone) can be correlated by means of the three most important microfossil groups. Therefore, in the present state of knowledge, *it is strongly recommended to choose the base of the Reitzi Zone as the base of the Ladinian*. In any other case we would decrease the potential of correlation and the usefulness would be lost.

Voting or consensus?

Although the procedure seems to be fairly democratic, I am not in favour of voting in this matter and especially not at this time. It is not because I do not want to be a loser but because I do not want to see a wrong decision (which does not make a big difference in this peculiar case). Also Gaetani (in a Working Group circular, October 12, 1994) wrote: "it is better to wait than to take a bad decision."

Is it reasonable to decide by voting in this matter? I do not believe so. The participants of the A/L Workshop Meeting in 1993 may remember that afternoon session in the cellar of the Vörösberény hotel when a strictly informal voting was initiated and the three possible positions of the Ladinian base got nearly equal number of votes. I am afraid that the views did not converge too much in the meantime and a large majority will not be reached in a poll. And I am afraid that, even if it is reached, a majority verdict will subsequently be neglected by those remaining in minority. It would be bad and nasty and, moreover, dangerous because it would increase confusion. I would rather recommend to continue discussions and try to reach consensus on the most reasonable solution.

Is it reasonable to postpone voting for a few years? I would say yes. After almost one hundred years, the problem of the Anisian/Ladinian boundary was picked up again and studied by modern methods by Brack and Rieber (1986). This gave a strong impetus to the Hungarian and Italian (mainly of the Milano school) workers. At the time of the mentioned Workshop Meeting, in 1993, we were just in medias res with our work. Ammonoid collections and microfaunal investigations are still in course in both regions. In the meantime, colleagues at the Padova University (Mietto, De Zanche, Gianolla, pers. comm.) have started detailed collections and studies in the Eastern Dolomites where they found promising sections of the critical interval, less condensed than in the Balaton or even in the Giudicarie area. It seems that this period of scientific resurgence or prosperity is not yet terminated and its fruits are not fully ripen.

I strongly believe that further hard work and a next workshop meeting within two or three years would bring a final solution and consensus in the Anisian/Ladinian boundary problem. Perhaps the Beijing Congress will survive without the formal adoption of the Ladinian GSSP.

In conclusion, in my opinion a voting in the matter of the Anisian/Ladinian boundary problem is untimely. Still, if it cannot be avoided, usefulness speaks strongly in favour of the base of the Reitzi Zone (= Kellnerites datum) as the base of the Ladinian.

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BUCHENSTEIN - LADINIAN - REITZI ZONE: A MORE THAN A CENTENNIAL MISUNDERSTANDING

Vittorio De Zanche and Piero Gianolla

Before the Subcommission on Triassic Stratigraphy takes into consideration the proposals on the definition of the Anisian/Ladinian boundary we think it worthwhile to take part in the discussion and to try to clear up a misunderstanding which, in our opinion, has been one of the main causes for the protraction of the problem and for interminable debates. Only recently have some researchers (e.g. Brack and Rieber, 1994) begun to delve into the inextricable, more than centennial muddle. However in our opinion the Anisian/Ladinian boundary field workshop (Southern Alps - Balaton Highland, 1993) did not succeed in fully clarifying it either (cf. Gaetani, 1993a).

Trying to keep out of the academic polemics which, according to some, seem to typify the Alpine researchers, we think that the problem arose from:

- 1 the somewhat vague original definition of Ladinian (Bittner, 1893, p. 392)
- 2 the lack of a stratotype, although the indication of at least a type-area is unquestionable (Richthofen, 1860, p. 65)
- 3 Mojsisovics's uncertainty about the ammonoid zones which ought to define the base of the Ladinian (see the evolution of Mojsisovics's thought on this subject in Brack and Rieber, 1994);
- 4 the confusion that has been created and which, up to a point, is still being created, between Ladinian, Reitzi Zone and "Buchenstein beds", that is between chrono-, bio- and lithostratigraphy.

On this occasion we should prefer not to query the definition of the base of the Ladinian and the biostratigraphy in this interval (see Manfrin and Mietto, this volume), but we would rather dwell on the fourth point. As a matter of fact, we think that, if a typically stratigraphical operation like the definition of the stratotype of the base of the Ladinian is ever to be accomplished, it should be performed within a clear and unambiguous lithostratigraphic setting.

The first problem concerns the term "Buchenstein" and what it means. As Lombardy and the Balaton Highland seem to be the candidates for hosting the type-section of the A/L boundary, we will write about these regions. However we cannot leave out the Dolomites which originally were indicated as the type-area both of the "Buchenstein" and the Ladinian.

The Buchensteiner Schichten were defined by von Richthofen (1860, p. 65) in the Southern Alps, in the Livinallongo area (Cordevole Valley, central Dolomites) and not near Pufels/Bulla (Gardena/Gröden Valley) as suggested in Brack and Rieber (1993, p. 425) and in Gaetani and Brack (1993, p. 2). Its name derives from the ancient Buchenstein Castle (Buchenstein Schloss), today Castello di Andraz (von Richthofen, 1860, p. 65). In the neighbourhood of the latter a typical section of the Buchensteiner Schichten crops out (von Richthofen, 1860, p. 65). Richthofen separated the Buchensteiner Schichten from the under- and overlying systems ("Systeme")



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and described their petrographic features as cherty, irregularly nodular, charcoal grey limestones bearing mostly dark brown chert.

There is no doubt that von Richthofen (1860, p. 64) defined the Buchensteiner Schichten as the stratigraphical interval bounded by the "Mendola-Dolomit" below and the Schlern-Dolomit above, like that exposed in the western Dolomites, e.g. in the Seceda section (Fig. 1). To-day the name "Mendola-Dolomit" has been abandoned and in the western Dolomites corresponds to the Contrin Formation (Assereto et. al., 1977; Farabegoli et al., 1977, p. 670). Still in the same region, the latter can be replaced by the Moena Formation (cf. Masetti and Neri, 1980; De Zanche et al., 1993).

Instead of "Buchenstein Beds" or "Buchenstein Formation", over the past fifty years Italian researchers in the Dolomites have preferred the name of "Strati di Livinallongo" or Formazione di Livinallongo, considering Buchenstein and Livinallongo, near but separate localities, to be synonyms. On the contrary, in the rest of the Southern Alps (Lombardy and often Carnia) the term "Buchenstein" has remained in use. In our opinion the formal definition of Formazione di Livinallongo (Scudeler Baccelle, 1971) also suffers the effects of the same uncertainties and inaccuracies which we complain of. The type section in Scudeler Baccelle (1971) is placed between Caprile and Colle S. Lucia in the Cordevole Valley, a few kilometres to the SE of Pieve di Livinallongo and Castello di Andraz.

Not many years ago Viel (1979) completed an excellent revision of the Ladinian lithostratigraphy in the Dolomites. He distinguished and defined some new units, previously belonging to the "Strati di Buchenstein" or "di Livinallongo" and to the "Strati di Wengen" or "di La Valle". As mentioned above, the Italian researchers considered the terms Buchenstein and Livinallongo (as well as Wengen and La Valle) synonymous. On account of priority Viel raised the name Buchenstein to group rank, including in it the Livinallongo Formation, the Zoppè Sandstones and the Acquatona Formation (the latter also known as "Pseudobuchenstein" or "Pseudolivinallongo", cf. Assereto et al., 1977; Rossi and Viel, 1977). Previously, according to Authors and/or areas, the lithozones corresponding to the Zoppè Sandstones and the Acquatona Formation were considered as belonging to the "Buchenstein Beds" or the "Wengen Beds". For the sake of clarity Viel (1979, p. 95) re-defined the Livinallongo Formation and indicated a new type section (p. 101) at Rio Pignazza, 1 km to the NW of the type section in Scudeler Baccelle.

Mojsisovics (1979) and many following researchers (e.g. Mutschlechner, 1933; Klebelsberg, 1935; Viel, 1979) already made distinctions within the Buchensteiner Schichten in the Dolomites, distinctions which are currently used today, from bottom: Plattenkalke, Knollenkalke and Bänderkalke.

Fig. 1 - Stratigraphic sections in eastern Lombardy (Bagolino), in western Dolomites (Seceda), in eastern Dolomites (Zoldo Valley and Mt. Rite), in Balaton Highland (Vászoly). Legend: 1 - limestones and dolomites of the carbonate platforms; 2 - carbonate breccias and dolorudites; 3 - slumping; 4 - even-parallel limestones and marly limestones; 5 - grey nodular micritic cherty limestones; 6 - red and grey micritic nodular limestones; 7 - dark siliceous limestones, laminated calcisilities and subordinate microturbidites; 8 - distal turbidites (silty marls, arenites and calcisilities); 9 - marls, silty marls and sandstones; 10 - volcaniclastics and pyroclastics layers ("pietra verde"); 11 - fault; a - whitish; b - dark grey; c - pale grey; d - greenish; e - reddish; f - variegated; g - yellowish.

Whereas in the western Dolomites the Livinallongo Formation (= Buchenstein Beds in Brack and Rieber, 1993a) directly overlies a carbonate platform (Contrin Formation) or the Moena Formation, in the eastern Dolomites, where the Upper Anisian - Ladinian interval is often basinal, the Livinallongo Formation overlies the Ambata Formation (Fig. 1).

In eastern Lombardy the Buchenstein Formation overlies the basinal Prezzo Limestone. In the Bagolino section Brack and Rieber (1993, p. 437) have recently separated the uppermost Prezzo Limestone as "transitional beds". On the contrary, in areas not far away, the same interval was referred to the Buchenstein Formation by Gaetani (1986, p. 111). Brack and Rieber could be right, as in Lombardy the first facies actually comparable with the "Buchenstein" in the Dolomites consists of nodular cherty limestones (Knollenkalke) overlying the "transitional beds"; in Lombardy the Plattenkalke (= lower Plattenkalke in Brack and Rieber, 1993) do not exist.

Working on the biostratigraphy of this interval, Mojsisovics (1870, p. 102) correlated the nodular limestones bearing *Arcestes tridentinus* in the Balaton region with the Buchensteiner Schichten in the Southern Alps. Böckh (1874) agreed with this, and moreover he considered the *Ceratites reitzi* beds to be older than the *Tridentinus* nodular limestones (cf. Budai and Dosztály, 1990). Later, after Gümbel collected and Mojsisovics determined the notorious *Trachyceras* cf. *reitzi* in the "Buchenstein Beds" (this specimen was never illustrated and was never again recognized, nor do we exactly know from what lithozone it was collected) in the Bulla/Pufels Valley (Gardena Valley, western Dolomites), the misunderstanding concerning the equivalence Buchenstein Beds = Ladinian = Reitzi Zone arose in the Triassic stratigraphy in Hungary, and not only in that country.

However, it is a fact that in Balaton Triassic stratigraphic descriptions after 1874 (our earliest source is Laczkó, 1911), the correspondent of the South Alpine Buchensteiner Schichten is no longer the *Tridentinus* nodular limestone, as stated originally by Mojsisovics, but the underlying unit, bearing R. reitzi. This is how the idea that the Reitzi beds in the Balaton Highland are the true correspondents of the Buchenstein Beds in the Southern Alps arose. To cap it all, as the latter were considered to be the type of the Ladinian (Bittner, 1893), the Buchenstein Beds in the Balaton area became Ladinian and the Reitzi Zone was thought to be the Ladinian basal zone (cf. Mojsisovics, 1882; Laczkó, 1911; Szabó, 1972; Vörös, 1993; Gaetani, 1993b). It is undeniable that Hungarian geologists have recently tried to clarify the Triassic stratigraphic setting in the Balaton Highland. However we have the impression that misunderstandings still remain. Budai (1992, fig. 1) named "Buchenstein Group" the interval bounded by the Megyehegy Dolomite or the Tagyon Limestone below, generally referred to the Anisian, and the Veszprèm Marl or the Budaõrs Dolomite above. In it he distinguished three units: Felsöörs Limestone, Buchenstein Formation and Füred Limestone. In this way the nodular Tridentinus limestones (Nemes-vámos Limestones) were again included in the Hungarian Buchenstein Formation. However, the underlying tuffitic and calcareous lithozone (reitzi bearing interval), the theme of debate and cause of misunderstanding, are also included. In this regard we have the impression that in the literature on Triassic, not only Hungarian, excessive importance has been given to the presence of tuffaceous material as a discriminating element in the definition both of "Buchenstein" and of Ladinian. We should like to underline that in the successions in the Southern Alps "pietra verde"-like beds are present from the lower Illyrian to the Tuvalian.

Summing up, the true Buchenstein Beds (according to the original definition in von Richthofen, 1860) correspond to the Livinallongo Formation in the Dolomites: in the western Dolomites it directly overlies the Contrin Formation or the Moena Formation; in the eastern Dolomites, where the succession is fully or mainly basinal, the Plattenkalke of the Livinallongo Formation directly

overlie the Ambata Formation (Daonella Marls Auct.).

Whereas in Lombardy Brack and Rieber proved the presence of *Reitziites* within the "transitional beds", and while it is at least doubtful whether the same species has been documented in the western Dolomites (cf. Brack and Rieber, 1993a, p. 438), new clarifying data have come from the eastern Dolomites. A detailed investigation on ammonoid biostratigraphy has been carried out in the Ru Sec (Dont) and Rio Sala (Mt. Rite) sections (Fig. 1). The *Kellnerites* + *Reitziites* ex gr. *reitzi* association, therefore the same both in the Balaton area and at Bagolino, was located within the upper part of the Bivera Formation, close to the boundary of the overlying Ambata Formation. In detail, *R. reitzi* have been collected from red and green micritic, lightly nodular, limestones alternated with mainly greenish siltstones. Just below, as documented in Hungary and in eastern Lombardy, faunas characterized by *Paraceratites* and belonging to the Trinodosus Zone/Subzone have been found. Lastly the *Daonella* Marls (upper member of the Ambata Formation) bear *Aplococeras avisianum* and *Parakellnerites rothpletzi* which, as is well known (cf. Brack and Rieber, 1993a, b; Mietto and Manfrin, in press), lie at a higher stratigraphic position than the *Reitzi* beds.

In our opinion, in eastern Lombardy the separation of the "transitional beds" from the Prezzo Limestone or from the Buchenstein Formation is a groundless problem, although the Prezzo Limestone/Buchenstein Formation boundary does seem to be transitional. However we think it important to underline that the uppermost centimetres of the "transitional beds" at Bagolino (above the highest bed with *R. reitzi* in Brack and Rieber, 1993) correspond to tens of metres of a succession (Bivera Formation *p.p.* and Ambata Formation) rich in ammonoids in the Dolomites. Thus in our opinion, in eastern Lombardy if not a hiatus, at least an extremely low sedimentation rate is testified. In fact at Bagolino neither the uppermost Reitzi Subzone (*sensu* Mietto and Manfrin, in press), corresponding to the "*Megaceratites*" friccensis beds at Fricca Pass (cf. Arthaber, 1916) and which we found at the top of the "transitional beds" in the Fosso Sercolo section in eastern Lombardy, nor the lower portion of the overlying Avisianum Subzone seem to be documented.

Comparing the Seceda and the Bagolino sections, Brack and Rieber (1993a) suggest that at least a part of the "transitional beds" correspond to the Plattenkalke. However a comparison of the ammonoid successions in the two sections clearly shows that the age of the Plattenkalke is different from that of the "transitional beds" and moreover that the Plattenkalke at Seceda are more likely to correspond to the lowest Knollenkalke in eastern Lombardy. Potentially the "transitional beds" could only be the equivalent of the Moena Formation in the western Dolomites (see Manfrin and Mietto, this volume).

In conclusion we should again like to underline what was said above, that is that a chronostratigraphic definition must be made within a clear stratigraphic setting in which no misunderstanding exists. We hope, beyond any polemic, that we have succeeded in expressing our opinion and in contributing to clarifying the subject.

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BRITISH TRIASSIC PALAEONTOLOGY: SUPPLEMENT 19

G. Warrington

Since the completion of the writer's previous supplement (No.18; ALBERTIANA, 14: 70-72) 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. 1994. Late Triassic to Middle Jurassic extinctions among the continental tetrapods: testing the pattern. Pp. 366-397 in FRASER, N.C. and SUES, H.-D. (eds) (q.v.).
- BENTON, M.J. and SPENCER, P.S. 1995. British Triassic fossil reptile sites. Pp. 33-95 in BENTON, M.J. and SPENCER, A.S. (eds). Geological Conservation Review Series 10: Fossil Reptiles of Great Britain. Chapman & Hall, London.
- BENTON, M.J., WARRINGTON, G., NEWELL, A.J. and SPENCER, P.S. 1994. A review of the British Middle Triassic tetrapod assemblages. Pp. 131-160 in FRASER, N.C. and SUES, H.-D. (eds) (q.v.).
- CUNY, G. 1993. Discovery of mammals in the Upper Triassic of the Jura (France). Pp. 95-99 in LUCAS, S.G. and MORALES, M. (eds) (q.v.).
- EVANS, S.E. and KERMACK, K.A. 1994. Assemblages of small tetrapods from the Early Jurassic of Britain. Pp. 271-281 in FRASER, N.C. and SUES, H.-D. (eds) (q.v.).
- FRASER, N.C. 1993. A new sphenodontian from the Early Mesozoic of England and North America: implications for correlating Early Mesozoic continental deposits. Pp. 135-139 in LUCAS, S.G. and MORALES, M. (eds) (q.v.).
- FRASER, N.C. 1994. Assemblages of small tetrapods from British Late Triassic fissure deposits. Pp. 214-226 in FRASER, N.C. and SUES, H.-D. (eds) (q.v.).
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TENTATIVE STRATIGRAPHIC CORRELATION USING ICHNOLOGICAL DATA FROM CONTINENTAL SANDSTONE SERIES AND MARINE FAUNAS IN THE MIDDLE TRIASSIC OF EUROPE

Louis Courel and Georges Demathieu

This paper seeks to show how ichnological data may be used in an attempt to establish stratigraphic correlations between nonmarine and marine sandstone series.

The wide morphological variety of vertebrate footprints implies diversity in the trackmakers' pes skeleton architectures. First the different types of prints were fitted into regional stratigraphy and the stratigraphic value of the ichnological assemblages established and checked (Courel et al., 1968; Demathieu, 1970, 1977, 1984; Demathieu et al. 1984). Then the evolutionary variations in pes features in assemblages from numerous imprint-rich sites in the South East Basin of France were used to propose a phyletic grade dating in the Anisian/Ladinian period. Early attempts were made for assemblages from the SE France Basin. These are synthesised in this paper and supplemented by new stratigraphic and sedimentological data.

I - Geological setting

In France, nonmarine Triassic deposits are well represented in the Lorraine Basin in the East of the country and along the margin of the South-East Basin on the eastern edge of the Variscan Massif Central (Fig. 1). The scope of the present paper is confined to marginal fluvial/lagoonal sandstone formations (10 to 30 m thick) overlying the crystalline basement along a 10-20 km wide outcropping zone, from Dijon (North) to Lodève (South). They are known from N to S as "Grès inférieurs de Mâlain, Grès inférieurs du Mâconnais, Grès inférieurs du Lyonnais, Grès du Roubreau", "Grès inférieurs" in the Lodève area and the external alpine domain on the Franco-Swiss border (Finhaut) (Courel et al., 1984 a; Courel and Durand, 1984). In this paper, the general term Lower Sandstones will be used for these formations which are characterised by a large onlap of first fluvial, then lagoonal-marine series over the Peri-Tethyan western margin and the Vindelician ridge.

Footprints have been collected in the Lower Sandstones at the surface of medium to fine sandstone slabs interbedded with grey or black siltstones/mudstones (Cula and Courel, 1987). Numerous halite pseudomorphs are associated with the footprints. A few metres above the footprint rich strata, an open marine microfauna in carbonate cemented siltstones characterises a maximum flooding surface in the Ardèche and in the Mâcon and Lyon areas (foraminifera, conodonts: Finelle 1981; Courel 1973; Courel et al., 1984b) (Fig. 2). The footprint rich Lower Sandstones and the carbonate cemented marine siltstones capping them are interpreted as a fluvial/lagoonal to lagoon-marine transgressive systems tract. They represent the first Mesozoic transgression over the Variscides in Western Europe.



Fig. 1 - Map of France showing the location of the Middle Triassic outcrops.

Other footprint types have been collected from coarse sandstones with carbonate cement and from the Upper Sandstones in the Lyon and Largentière area (Fig. 2). Ichnofauna from the Lower Sandstones can be easily distinguished from those from the Upper Sandstones.

II - Age of the footprint-containing lower sandstones and the overlying carbonate cemented siltstones

Anisian/Ladinian palynological assemblages have been described from footprint-rich Lower Sandstones in the Macon and Largentière areas (Adloff and Doubinger, 1979; Fauconnier 1994). The carbonate cemented siltstones capping the Lower Sandstones were dated by conodonts (Finelle, 1981; Courel et al., 1984b determined as *Pseudofurnishius hudlei* which seem rather to be Lower Ladinian, determination of F. Hirsch, unpublished, 1984). Moreover, black siltstones overlying the carbonate cemented siltstones were dated by palynological assemblages as Upper Ladinian (Doubinger and Adloff, 1977). An Anisian/Ladinian age for the

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Lower Sandstones footprint series is consistent with all the micropalaeontological and biostratigraphic data. The Upper Sandstones in the Largenière area where other types of footprints were collected are however dated as Carnian by pollen assemblages (Fauconnier, 1994). They overlie dolomitic limestones and dolostones (Fig. 2) dated as early Carnian (Doubinger and Adloff, 1977).



(3) Palynological assemblage (Doubinger et Adloff, 1977)

(2) Conodont: Pseudofurnishius and palynologic assemblage (Courel et al., 1984)

(1) Footprints (Demathieu et al., 1984)



This work will attempt more particularly to show changes in imprint shapes in the ichnological assemblage of the Lower Sandstones (Middle Triassic) and to test the stratigraphic value of these variations.

III - Archosaur pes evolution

Known as early as the Upper Permian, Archosaurs ("the ruling reptiles") spread during the Triassic in mainfold shapes and sizes. The Thecodonts (Carrol, 1988) provide the best record of pes skeleton evolution. The primitive architecture is illustrated by *Chasmatosaurus* Haughton 1924 (Fig. 3a) and *Neoaetosauroides* Bonaparte 1978 (Fig. 3b). Their pentadactyl pes is similar in shape to the lacertoid pes where digit IV is the longest. In *Euparkeria* Broom 1913 (Fig. 3c) digit IV shortens while III is slightly longer. So the pes become mesaxonic, *Ticinosuchus* Krebs



Fig. 3 Pes skeletons of Triassic Archosaurs showing the characteristic evolution of the pes in the reduction of the number of toes.

Digit IV is still the most prominent in: (a) Chasmatosaurus vanhoepeni Haughton 1924, (b) Neoaetosauroides engaens Bonaparte 1978

It becomes second longest after digit III in: (c) Euparkeria capensis Broom 1913, (d) Ticinosuchus ferox Krebs 1965, (e) Prestosuchus chiniquensis Huene 1938, (f) Hesperosuchus agilis Colbert 1952

Digit V is never important. Short and slender in the Thecodonts where it had only a modest function, it disappears almost totally in the Dinosaurs, e.g. (g) Coelophysis bauri Cope 1889, (h) Herrerasaurus ischigualastensis Reig 1980 (in Bonaparte 1978)



Fig. 4 Archosaur footprints from the eastern and southern border of the Massif Central (France) illustrating Archosaur pes evolution.

(a) Synaptichnium argantobrivense *Demathieu & Gand 1886 possibly made by Neoaetosauroides (Fig. 3b),* (b) Synaptichnium priscum *Demathieu 1970 where IV is as long as III.* (c) Chirotherium mediterraneum *Demathieu & Durand 1991 possibly made by* Euparkeria capensis

(d) Chirotherium barthii Kaup 1835 known in Africa, Europe and North America. Shows a very prominent Illrd toe and a slight reduction of the lst toe.

Reduction of V in: (e) Brachychirotherium circaparvum Demathieu 1971, (f) Isochirotherium coureli Demathieu 1970

Reduction of the 1st and Vth begins in: (g) Sphingopus ferox Demathieu 1966 and is functionally complete in (h) Grallator bibractensis Demathieu 1971

1965 (Fig. 3d) and *Prestosuchus* Huene 1942 (Fig. 3e). Reduction of digit V is particularly visible in the crocodilian pes, and also in the thecodont pes *Hesperosuchus* Colbert 1952 (Fig. 3f) and *Herrerasaurus* Reig 1963 (Fig. 3h). Digit I shortens and is no longer functional in *Coelophysis* Cope 1889 (Fig. 3g) but only exceptionally does it completely vanish. The pes become functionally tridactyl in bipedal dinosaurs (*Fabrosaurus* Ginsburg 1964, *Coelophysis*, *Halticosaurus* Huene 1938) with mere remnants of digits I and V.

Manus architecture exhibits few evolved characters: while Thecodonts are pentadactyl, digits IV and/or V are reduced in dinosaurs (theropodes, Sauropodes pro parte).

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The different patterns of Sauropod and Ornithischian autopodium evolution during the Jurassic and Cretaceous lie outside the scope of this paper.

It should be observed that Archosaur pes evolution was not linear, i.e. the various groups of this sub-class did not exhibit the same changes in toe length at the same time.

While the IVth, Vth or the 1st digits shortened in some, others retained the ancestral status, i.e. a more or less similar architecture to the lacertoid shape.

Therefore we can see in the Middle Triassic that Archosaur autopodia exhibited varied architectures represented by numerous ichnogenera providing evidence of manus or pes evolution. For example, *Rhynchosauroides peabodyi* (Faber, 1958) (see cover) has the features of lacertoid tracks with the exception of the scales under the fingers. The trackmaker has been classified as an archosaur from the shape of these scales which are rounded whereas Lepidosaur scales are rectangular.

IV - Archosaur footprint evolution

The foregoing is an abridged survey of pes evolution among archosaurs during the Triassic. Three features can be recognised from the footprints made by these reptiles.

For example, the pes of *Synaptichnium argantobrivense* Demathieu & Gand 1986 (Fig. 4a) exhibits a lacertoid design, but not the manus. *Synaptichnium priscum* Demathieu 1970 (Fig. 4b) shows the relative loss of the prevalence of digit IV, *Chirotherium mediterraneum* Demathieu & Durand 1991 (Fig. 4c) and *Chirotherium barthii* Kaup 1835 (Fig. 4d) exhibit a mesaxonic pes with the main support on digit III. A reduction of digit V is apparent in *Brachychirotherium circaparvum* Demathieu 1971 (Fig. 4e) and in *Isochirotherium coureli* (Demathieu 1970) (Fig. 4f) only the digitometatarsal pad is visible.

The partial reduction of digits I and V is illustrated by the footprint *Sphingopous ferox* Demathieu 1966 (Fig. 4g). Finally, *Grallator* (= *Anchisauripus*) *bibractensis* (Fig. 4h) suggests a functional tridactyl pes. All these footprints occur in the study area.

Among the other Triassic ichnogenera, *Brachychirotherium* hold a unique position. Known in the oldest footprint beds of the German Triassic (Hardegsen Folge), with *Br. kuhni* Demathieu & Haubold 1982, a very primitive form, *Brachychirotherium* is found until the late Triassic in the Newark Basin (Passaic formation) with *Brachychirotherium parvum* Hitchcock 1889 in the Chinle Formation (Arizona) and the Dockum Group in Texas.

From Lower until late Triassic, the ichnospecies of this ichnogenus underwent modifications such as reduction of the Vth toe, loss of the claw on the IVth, lengthening and curvature of claws I, II and III. These modifications provide simple criteria for identifying several ichnospecies of this ichnogenus. In addition, digit II tended to exceed IV in length.

The first dinosaurid tracks appear in the Lower Sandstones of the French Massif Central and. in the Middle Triassic of Nottinghamshire (UK) (Sarjeant, 1967). These tridactyl footprints belong to the very narrow trackways with high pace angle ($\approx 180^{\circ}$). Notwithstanding their small sizes, these trackways are similar to the ones of Newark basin.

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This similarity, together with the increasing number of such dinosaurid traces throughout the Middle Triassic leads to the conclusion that the makers of these dinosaurid tracks actually were Dinosaurs.

V - Tentative grade dating

If we compare the Ichnofaunas of the different tracksites of the Lower Sandstones, i.e. Lodève, Alès, Largentière, Lyon, Mâcon, Autun, Valais, it is easy to see (Table 1) from South to North:

	LODEVOIS	GARD (Alès)	ARDECHE (Largentière)	LYONNAIS	MACONNAIS	AUTUNOIS
Ichnospecies recognized on more than 3 sites						
Isochirotherium delicatum	-		*	*	* *	*
Brachychirotherium circaparvum	*		* *	* *	* *	*
Rotodactylus rati			*	*	* *	* * *
Chirotherium barthii	* *		*	* *	* *	×
Local ichnosnecies						
Brachychirotherium pachydactylum						* *
Isochirotherium Coureli				* * *	* *	
Isochirotherium felenci			* * *			
Brachychirotherium gallicum	* * *	*	-			
<u>*</u> Only o	ne footprint is know	יי	* U	ncommon		

* * Relatively frequent *** Frequent

Tab. 1 Vertebrate palaeoichnology of the Middle Triassic of the eastern and southern border of the Massif Central (France).

- The decreasing number of true pentadactyl footprints i.e. five functional toes, such as Brachychirotheirum gallicum, Chirotherium barthii.
- Increasing frequency of the evolved features, four functional toes in the ichnospecies Brachychirotherium circaparvum and Isochirotherium coureli and three functional toes in ichnogenera Sphingopus, Coelurosaurichnus and Grallator.

The above-mentioned considerations suggest that the ages of the Lower Sandstone tracksites could be arranged across the Anisian/Ladinian and perhaps the Lower Ladinian period in the following order (from oldest to youngest): Lodève, Alès, Largeniètre, Lyon, Mâcon, Autun (Table 2).

VI - Conclusion

The Lower Sandstones Formation, at the base of the Triassic series of the SE France Basin, onlaps over the Variscan crystalline basement of the Massif Central and the outlying crystalline

AG	ΈE	SOUTHERN AND EASTERN BORDERS OF MASSIF CENTRAL FRANCE						ALPINE AREA
UPPER TR	Carnian							Vieux
MIDDLE TRIASSIC	Anislan Ladinian	Lodève	Gard: Alès	Ardèche: Largentière	Lyonnais	Māconnais	Autunois	Emosson

Tab. 2 Putative stratigraphic scale between the different track sites in the Lower Sandstones of the southern and eastern boundaries of the Massif Central (France).

massifs of the Alps. It is dated to the Anisian/Ladinian and the Lower Ladinian by pollen assemblages and conodonts. Throughout this formation, the ichnological assemblies collected were also first dated to the Anisian/Ladinian and Lower Ladinian without further precision. A study of the evolution of imprint shapes allows us to locate the deposits studied, from the earliest primitive assemblages to more evolved younger assemblages (Table 2). These ichnological data are consistent with the lithostratigraphic and sedimentological data on the advance of this transgressive series. It is in fact increasingly younger as it onlaps the Variscan basement. This phyletic grade dating study seems directly applicable to other regions where Archosaur imprints have been found.

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BIOCHRONOLOGY OF TRIASSIC MARINE REPTILES

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Abstract

Marine reptiles represent an untapped resource for Triassic biochronology. Placodonts have proven regional biochronological potential along the western margin of Triassic Tethys, and ichthyosaurs have strong potential for global Triassic biochronology.

Introduction

Ammonoids and conodonts provide most of the biochronological basis for subdivision of the Triassic time scale. Bivalves and some other marine fossils also are useful. But, marine reptiles, which are widespread and locally abundant in Triassic strata, have not been employed. Here, I review the Triassic record of marine reptiles (Fig. 1) and its biochronological utility. This review demonstrates the problems and possibilities of these reptiles for Triassic correlations. The six groups of Triassic marine reptiles -Hupehsuchia, Nothosauria, Thallatosauria, Plesiosauria, Placodontia and Ichthyosauria - represent a wide range of biochronological potential.

Hupehsuchia, Nothosauria, Thallatosauria, Plesiosauria

Hupehsuchia consists of two genera from a single Middle Triassic horizon in Hubei Province, China (Carroll and Dong, 1991). Until huhpehsuchians are discovered elsewhere, they are of no biochronological significance.

Nothosaurs are a paraphyletic assemblage of primitive sauropterygians (Storrs, 1993) best known from the Middle Triassic of Europe and China, although their stratigraphic range extends into the Upper Triassic, and two genera are known from the upper Lower Triassic (Storrs, 1991). Nothosaur genera are endemic to one modern continent, but the stratigraphic ranges of European Middle Triassic nothosaurs are well established and of some regional biochronological value (Fig. 2).

Thallatosaurs are known only from the Middle Triassic of Switzerland and western North America (e.g., Kuhn-Schnyder, 1974). Genera are endemic to both regions, so the biochronological significance of thallatosaurs is limited.

Plesiosaurs first appeared during the Late Triassic (Rhaetian) (Storrs, 1993) and persisted until the end of the Cretaceous (Fig. 1). During the Jurassic-Cretaceous, plesiosaurs had an essentially global distribution, but their single first occurrence in Rhaetian strata is of no value to Triassic biochronology.



Fig. 1 Temporal distribution of Mesozoic marine reptiles.

Placodontia

Placodonts are known only from the Middle and Upper Triassic of Europe, North Africa and the Middle East (e.g., Sues, 1987); their distribution was restricted to the western periphery of Triassic Tethys and associated seaways (Pinna and Mazin, 1993). Virtually all the genera are from Europe where they have established stratigraphic ranges of regional significance (Fig. 2). However, the geographic restriction of placodonts makes them insignificant to global biochronology.

REPTILE TAXA	MUSCHELKALK				
		lower	middle	upper	
Mixosaurus atavus					
Shastasauridae					
Tholodus			-		
Placodus					
Paraplacodus					
Cyamodus					
Neusticosaurus pusillus					
Pachypieurosauridae					
Anarosaurus			-		
Dactylosaurus					
Simosaurus					
Paranothosaurus					
"Nothosaurus"			╶┼╾╸╺╍┽╼		
Nothosaurus mirabilis					
Cymatosaurus					
Pistosaurus					
"Tanystropheus" antiquus					
Tanystropheus conspicuus					
Blezingeria ichthyospondyla					
Hagdorn's biozones	anystropheus" antiquus	Tholodus	Anarosaurus	Pistosaurus	

Fig. 2 Stratigraphic ranges and reptile biozones from the German Middle Triassic Muschelkalk (after Hagdorn, 1993).

Hagdorn (1993) recently published the stratigraphic ranges of all reptiles known from the marine Middle Triassic Muschelkalk of Germany (Fig. 2). These reptiles have been collected and studied for well over a century and can be directly correlated to conodont and ammonite (ceratite) zonations. Hagdorn's range chart thus represents a robust regional biostratigraphic record.

Hagdorn (1993) defined five "mögliche Biozonen mariner Reptilien" from these data, but his *Tholodus* zone does not correspond to the stratigraphic range of *Tholodus* and can be abandoned. Nevertheless, four obvious range zones, a variety of interval zones and other biostratigraphically useful horizons can be identified from Hagdorn's compilation. The temporal resolution of the Muschelkalk marine reptiles does not rival that of conodonts, which define 10 biozones in the Muschelkalk (Kozur, 1974), but it does produce temporal resolution below the level of stage/age for regional correlations.

Ichthyosauria

Ichthyosaurs appeared during the Early Triassic and persisted until the beginning of the Late Cretaceous (Cenomanian). These most specialized and fishlike of the marine reptiles achieved a global distribution by the Middle Triassic (see below). Many ichthyosaur genera are well known from widespread localities, and taxonomy relies not just on cranial features but on the highly distinctive and durable vertebral centra. Ichthyosaurs thus have strong potential for Triassic biochronology, the highest of all the marine reptile groups.

Using data compiled by Callaway and Massare (1989), with recent additions from Mazin et al. (1991), Massare and Callaway (1994) and Lucas and Gonzalez-Leon (1995), the temporal ranges of Triassic ichthyosaur genera can be plotted (Fig. 3). This biochronological organization identifies three intervals of Triassic time (labelled A, B and C), as was long the case with Triassic terrestrial tetrapods (Lucas, 1990).

The oldest known ichthyosaurs are generically indeterminate fossils from early Olenekian (Smithian) strata in British Columbia and Svalbard (Cox and Smith, 1973; Callaway and Brinkman, 1989). The oldest generically identifiable material is of late Olenekian (Spathian) age from widespread localities - Anhui, China

(Chaohusaurus), Svalbard (Grippia, Svalbardosaurus, Omphalosaurus), Honshu, Japan (Utatsusaurus), Idaho and Nevada, USA (Omphalosaurus, Cymbospondylus) and Thailand (Thaisaurus). The oldest Mixosaurus is from the late Olenekian of British Columbia (Callaway and Brinkman, 1989). The lack of cosmopolitanism of these primitive ichthyosaur genera - most are known from only a single location - renders them of little biochronological utility, although the Early Triassic can be identified as a time of primitive ichthyosaurs. However, Motani (1994), in an abstract, recently suggested that Utatsusaurus and Chaohusaurus are synonyms of Grippia. If this conclusion can be fully documented, it identifies a Grippia biochron of late Olenekian age.

During the Middle Triassic (interval B) the cosmopolitan genus *Mixosaurus* is known from Alaska, the Northwest Territories, British Columbia, Nevada, Timor, Turkey, China, Italy, Switzerland, Germany, France, Poland and Svalbard (Callaway and Massare, 1989). Like *Mixosaurus, Cymbospondylus* has its earliest (single locality) occurrence during the late Olenekian, but has a cosmopolitan distribution during the Middle Triassic. This parallels the greater cosmopolitanism of ammonoids during the Middle Triassic (Dagys, 1988). Most of the other Middle Triassic ichthyosaurs are restricted to the Germanic basin Muschelkalk and/or

Svalbard. The Middle Triassic this corresponds to a *Mixosaurus-Cymbospondylus* abundance biochron; species-level revisions of these genera might produce even more refined correlations within this interval (Brinkman et al., 1992).



Fig. 3. Temporal ranges of Triassic ichthyosaur genera (from data in Callaway and Massare, 1989; Mazin et al., 1991; Massare and Callaway, 1994; Lucas and Gonzalez-Leon, 1995). Note that the Chinese Late Triassic giant shastasaurid genera Tibetosaurus and Himalayasaurus are not included because both are nomina dubia. Also note that contrary to Brinkman et al. (1992), Phalarodon is a valid taxon (J. Callaway, oral commun., 1993).

The Late Triassic shastasaurids were also a cosmopolitan group with principal occurrences in Oregon, Nevada, California, Sonora, New Zealand, New Caledonia, Russia, Tibet, Switzerland and Austria (Callaway and Massare, 1989). Most of these are occurrences of *Shastasaurus* or of generically indeterminate large shastasaurid fossils. A shastasaurid biochron - interval C of Figure 3 - encompasses the Late Triassic, one which can hopefully be refined and subdivided with further collecting and more precise taxonomy.

In conclusion, Triassic ichthyosaurs discriminate three time intervals: (A) Early Triassic primitive ichthyosaurs; (B) Middle Triassic - *Mixosaurus-Cymbospondylus* abundance biochron; and (C) Late Triassic shastasaurid biochron. Ichthyosaurs resolving three intervals of Triassic time equivalent to the three Triassic Series may not seem like impressive resolution. But, we do well to remember that as recently as 1975 terrestrial reptile biochronology only resolved the same three intervals of Triassic time globally (Lucas, 1990). Twenty years of patient work by terrestrial biostratigraphers has improved this resolution, and the Triassic ichthyosaur record is ripe for such improvement.

Conclusions

Vertebrate paleontologists have long neglected the biochronological potential of Triassic marine reptiles. Recent stratigraphic organization of their record, however, shows that placodonts and ichthyosaurs can resolve intervals of Triassic time at the series, stage or sub-stage levels. Certainly, Triassic marine reptiles do not yet provide the level of temporal resolution possible with ammonoids and conodonts; they probably never will do so for all of the Triassic. But, Triassic marine reptiles do represent an untapped biochronological resource, one which can and should be developed in the future.

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Recently published literature

Robert A. LONG and Phillip A. MURRY, 1995. Late Triassic (Carnian and Norian) Tetrapods from the Southwestern United States. New Mexico Museum of Natural History & Science, Bulletin 4: i-v + 1-254.

The Bulletin of the New Mexico Museum of Natural History and Science in Albuquerque has again published a volume which is entirely devoted to Triassic stratigraphy and palaeontology. After the publication of the symposium volume of the Nonmarine Triassic meeting in 1993 (Bulletin No. 3), a monograph on Late Triassic (?middle Carnian to early Norian) tetrapods has been issued now.

This volume consists of twelve chapters. The first chapter gives on overview of the history of vertebrate collecting in the Chinle Formation of Arizona, and the Upper Triassic of New Mexico and Texas. The second chapter deals with the amphibia of the southwestern Triassic. Chapters 3 and 4 discuss respectively the primitive archesauropmorphs and phytosaurs and the classification and relationships of the Parasuchia. Chapter 5 deals with an ?ornithosuchid from the Upper Triassic of Texas. A review of the aetosaurs of North America and a discussion on their classification and relationships are presented in chapter 6. The next five sections deal with the Ruaisuchia and a proposed new family of Rauisuchians (chapter 7), crocodiles and a new genus of crocodylomorphs (chapter 8), Triassic dinosaurs and a new genus of herrerasaurid (chapter 9), new ?archesauromorphs (chapter 10), and dycnodonts (chapter 11). The last chapter discusses the faunal turnover in the Late Triassic of the Southwestern United States and its biostratigraphic implications, including the Lucas/Hunt 'biochrons' and 'land vertebrate faunachrons'. The concepts presented herein differ considerably from those proposed by Lucas and Hunt. The Upper Triassic vertebrate fossil-bearing localities in Arizona, New Mexico, Utah and Texas, and the geology of the fossiliferous units are summarised in Appendix I. Appendix II lists all referred specimens of Late Triassic amphibians and reptiles from the Western United States. The book includes an extensive bibliography and an alphabetical index. Several new taxa are introduced, a new family, a new subfamily and several new genera and species.

The book is well produced and richly illustrated with a large number of drawings and photographs. The line drawings are of excellent quality and most of the photographs are good, although some are rather greyish. This very reasonably priced volume will surely find its way to nonmarine Triassic workers. Those who still do not have it yet can order it with the order form included elsewhere in this issue.

Hans Kerp

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LATE TRIASSIC (CARNIAN AND NORIAN) TETRAPODS FROM						
THE	SOUTHWESTERN					
U	NITED STATES					
B With ill	By Robert A. Long and Phillip A. Murry Iustrations by Roderick T. McCrea and Pat Lufkin					
	BULLETIN 4, 1995					
This extensive 25 tetrapods from	4-page volume reviews the amphibians, dinosaurs and other m the Upper Triassic of the southwestern United States.					
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Albertiana 15, May 1995

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SEDIMENTARY EVENT IN THE TRIASSIC OCEANIC BASIN OF SIKHOTE-ALIN

Galina I. Buryi

In the oceanic basin of Sikhote-Alin underwater erosion of bottom sediments apparently took place in Triassic time. This can be evidenced by the appearance of the conodont mixed different-age complexes at the Anisian-Ladinian boundary in the middle-Upper Triassic cherts occurring as three blocks (12, 5 and 6 m thick, correspondingly) in Upper Jurassic-Lower Cretaceous (?) mixtites on the Lyamfana Creek right bank (right inflow of Matai River) (Fig. 1) (Buryi et al., 1990; Buryi and Philippov, 1991).



Fig. 1 Locality maps. The solid circle indicates the location of the studied chert blocks.

The lower part of the section in all blocks is represented by grey platy cherts in which the middle Anisian *Neogondolella* cf. cornuta Budurov and Stefanov (sample 24), *Neospathodus kockeli* (Tatge) (samples 25, 37-39), *N.* cf. *kockeli* (Tatge), *Gladigondolella tethydis* (Huckriede) (sample 63), middle-late Anisian *Paragondolella* cf. *bifurcata* Budurov and Stefanov (sample 27), late Anisian *Neogondolella pridaensis* (Nicora, Kozur and Mietto) sample 65, 68, 69, 71, 75), *Paragondolella navicula* (Huckriede) (samples 69, 75), as well as late Anisian - early Ladinian *Neogondolella mombergensis* (Tatge) (samples 33, 34) and *Paragondolella excelsa* Mosher (samples 35, 40) are found. Mixed different-age complexes of conodonts occur above (Fig. 2).

System	Series	Stage	Substag e	Conodont zone and bed	Block 1 Sample N	Block 2 Sample N	Block 3 Sample N	
		Rhaetian		Misike ll a , posthernsteini				
I C P E R			Sevatian	Epigondolella bidentata	40			
	Norian	Alaunian	Epigondolella poslera	42				
		Lacian	Epigondolella abneptis		67			
SS	S S		Tuvalian	Metapolygnathus nodosus	41			
T R I A MIDDLE U	Carnian	Julian	Paragondolella					
		Cordevolian	polygnalnitormis			79,80		
		Ladinian	Langobardian	Paragondolella foliata			77	
	Ш		Fassanian	Paragon- —				
	DD	Anisian	Jllyrian	dolella Neogondole- excelsa lla prida- ensis beds	33-35 27 40	65	71,75 68,69	
		Pelsonian	Neospathodus kockeli	24,25 37-39	63			

Fig. 2 Stratigraphic distribution of the redeposited conodont complexes in cherty deposits on the Lyamfana Creek right bank. 1: normally stratified cherts, 2: washout intervals of cherts, 3: the conodont mixed different-age complexes, 4: redeposited cherts.

In the first block the early Ladinian Neogondolella constricta (Clark and Mosher), N. excentrica Budurov and Stefanov, late Ladinian Carinella japonica (Hayashi), early Carnian Metapolygnathus pennicus (Hayashi), and late Carnian M. nodosus (Hayashi) were found jointly (sample 41). In the second block, the early Norian conodonts Metapolygnathus spatulatus (Hayashi) were observed together with late Anisian Paragondolella hanbulogi Sudar and Budurov (sample 67). In the third block, the early Ladinian Neogondolella mostleri Kozur and late Ladinian Carinella japonica (Hayashi) exist in common (sample 77). In these complexes more ancient conodonts are redeposited and represented by large, often broken specimens, mostly platform

elements, and differ from younger ones in dark colour. In chert samples with different-age conodonts washouts are observed. These are thin (2-3 mm) laminae enriched in clay matter and containing fine fragments of the washed-out cherts. The lower boundaries of the laminae are sharp and gently wavy. The mixed complex of the first block includes non-redeposited conodonts - late Carnian *Metapolygnathus nododus*. The washing out of the sediments took place during early Ladinian to middle Carnian. The break in sedimentation in the second block covers late Anisian, Ladinian, and Carnian ages, and redeposition of conodonts occurred in early Norian. In the third block, a break of short duration is fixed (early Ladinian). In the first block, above the level with the different-age complex, the cherts dated with *Epigondolella bidentata* Mosher (sample 42) as middle-late Norian occur and in the third block the sediments accumulated that had been washed out from the neighbouring areas of the basin and redeposited in the reverse sequence - first with early Ladinian *Paragondolella excelsa* Mosher and *Neogon-dolella* cf. *pseudolonga* Kovacs et Kozur (samples 79, 80) and then with late Anisian *P. hanbulogi* Sudar et Buduroy (sample 81).

Grading of the redeposited conodonts and washouts indicate that the latent stratigraphic breaks in the lithologically homogenous cherty mass occurred when the poorly lithified sediments were eroded by powerful underwater currents. The beginning of the erosion event lies near the boundary of the Anisian and Ladinian stages. The age of the sediments overlying the disconformity in the first two blocks shows the washout duration to be 10-15 m.y. The washed out sediments were redeposited in the neighbouring areas of the basin. This can be seen from the pattern of accumulation of the third block upper layers. Near-bottom currents eroding the cherty deposits might be the contoured currents which play the most significant role in the breaking the recent deep-sea deposits (Bezrukov, 1976; Kennet, 1987; Lisitsyn, 1988). Thus, the intraformation breaks in the Sikhote-Alin Triassic cherty deposits formed under the pelagic environment and, apparently, with the contoured current participation.

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BURYI, G.I. and PHILIPPOV, A.N. 1991. Latent hiatuses in Triassic silicons of Sikhote-Alin. Izvestiya Akademii Nauk SSSR, Ser. Geol. 7: 136-139 (in Russian).

KENNET, G.P., 1987. Morskaya geologiya (Marine geology). V.2, Moskva, Mir, 383 p. (in Russian).

LISITSYN, A.P., 1988. Lavinnaya sedimentaciya pereryvy v osadkonakoplenii v moryakh i okeanakh (Avalanche sedimentation and breaks in sedimentation in seas and oceans). Moskva, Nauka, 309 p.

THE VITAL ROLE OF DETAILED AMMONOID STUDIES FOR HIMALAYAN CORRELATIONS: A REPLY

J. Bruce Waterhouse

An attempted critique on my Triassic ammonoid studies in the Dolpo and Manang regions by Gaetani and colleagues extrapolates fancied correlations without supporting evidence for over 1000 km.

Stratigraphy

1. Gaetani et al. object to detail and fine scale mapping, to defend their own very crude style of geology. Let me give an example. The Thini Chu was named in the early 1960's for sequences in the Kali Gandaki which span (a) thick early Carboniferous black shale and quartzite, (b,c) non-marine plant-bearing mid-Permian sandstone above nearby non-marine ?early Permian diamictite, (d) distinctive very thin late Permian marine clastics and carbonates, and (e) very thin early Triassic dolomite and shale. Retention of more than one of such disparate formations in a massive single unit is absurd. But of course there are advantages to geologists in a hurry. It allows a simplistic and inaccurate style of mapping. It also excuses paleontological focus on a few measured and sampled sections. That in turn allows unfettered extrapolation beyond scientific control, and dependent merely on guesswork, from few data points.

2. The International stratigraphic guide stresses that formations must show integrity and recognisably distinct character. I am well aware of this, having been a member of ISSC active in helping to prepare the first and second editions. In the Himalayas, many pre-Cambrian and Paleozoic units are a kilometre or more thick, consistent over extensive distances, and should be mapped as such. Late Paleozoic and early Triassic units of comparable integrity are thin, yet distinctive, and some very impersistent. Middle Triassic thickens again. Nomenclature should reflect reality, not some arbitrary formula constrained by thickness. The complexities of the late Permian-early Triassic sedimentary patterns cannot be revealed by massive lumping of units. But of course you must map at an adequate scale, say 1:25,000, from a basic scale close to 1: 10,000, at least for critical areas. Practioners of hasty mapping may be upset by refined subdivisions, because it reveals the shortcomings of their own work, but their resistance delays full understanding of sedimentary patterns, correlation, and tectonic history.

3. The use of formal names rather than a code of numbers and letters is a matter for judgement by the researcher. Where sedimentary units change or disappear and re-enter laterally, with paraconformities and facies change, numbers become haphazard, and arbitrary. The subsequent discovery that the numbers ought not to be in an unbroken serial sequence either leads to confusion, or to a strong effort to hide and deprecate the revelation that the early work was flawed. Named units offer far more flexibility. In my judgement, the late Permian and early Triassic of Manang and Dolpo represent just such a situation.

4. For all that the members in Manang are thin, they are further subdivided into informal units (see Waterhouse 1994, table 5, p. 75), with faunules carefully evaluated.

5. It is curious that on the one hand, ammonoids are supposed to be collected bed by bed, as most of mine were, and yet there are complaints that none of my new units are thicker than 75 m. The material that I collected was controlled within beds, shell layer by shell layer. One day conodonts will be collected the same way, mm by mm, and for hundreds of metres at least along strike. The collection of large lumps of rock, with many populations, possibly reworked, from a few or even only one section, is crude, and not comparable with my collecting.

6. The Nepal work is on paleontology, not stratigraphy. The later parts of my study contain further illustrations and documentation: there is no reason to cram everything into an introductory section. In the meantime, details in text and tables provide measurements. Other ammonoid studies, such as those by Tozer and Russians, not to mention Milan-based paleontological studies in their house journal, provide far less information on stratigraphy and lithology.

Correlations

The correlations mooted by the Gaetani team from Zanskar for 1000 km to Manang are blatantly speculative, and denied by their own data.

7. For example, they claim that basal Marsyangdi contains conodonts ranging from Djulfian-Dorshamian in the west to Bolorian in the east, and assert that I say that Marsyangdi rests everywhere on Djulfian Pija Shale. They should reread the text. Page 7, which they studiously avoid mentioning, summarizes my papers in 1987 and 1991 which showed that the Pija black shale, with late Djulfian faunules, feathered out against a high over the Kali Gandaki-Marsyangdi divide, and further showed that shallow water conglomerates entered the succession. Plantbearing sandstones, now known to include *Glossopteris* (=Barakar), are involved. In short, the claims of transgression through time were pre-empted and well established by my work, from 1987. They cannot truthfully claim to have originated the model.

8. There are further revealing flaws. Pretending that a satisfactory age control in Zanskar can be achieved by a date of "Djulfian-Dorashamian" is simply not good enough. This interval spans four major Permian zones, and could range into early Triassic (W. Sweet, H. Kozur, A. A. Shevyrev, and Y. Bando). My age control is much more precise. Also, no proof whatsoever is offered that Marsyangdi, or correlates, are present in Zanskar. They seem, with some ambiguity, to imply they have collected from genuine Marsyangdi. I am left wondering if they even failed to find the critical ammonoid *Otoceras*, which would have provided a secure age.

9. The claim that the Tangje Member of Manang correlates with late "Smithian" of Zanskar is embarrassing. This Tangje unit has *Stenopopanoceras* and other Anisian genera. The real "Smithian" in Nepal is older, and contains *Anakashmirites, Flemingites, Anaflemingites, Meekoceras* etc. If by some lucky guess, their correlation is correct, then their Zanskar conodonts are in Anisian beds, and have been misidentified, or reworked from "Smithian". Did they test for reworking? No. In addition, Smithian as a term is obsolete, abandoned even by its author. Their work is archaic in terminology and understanding.

10. The Sunjar Formation is also misrepresented as "Smithian". It overlies richly fossiliferous beds with genuine "Smithian". Although their conodonts may be reworked, it seems also likely that once again, their work lacks rigour. This seems to be becoming a tradition, to judge from work in Iran on Permian, and Chios on Triassic.

11. My publication details only the *Otoceras* and *Ophiceras* levels. Yet Gaetani et al. offer no comparison with Zanskar. This reflects their failure to carefully map and date that most critical part of the column.

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12. It is clear that the Gaetani team field work and correlations within the Manang-Dolpo regions are inadequate. Their remarks on ammonoids are no better. I do not accept the pseudadoanalyses of the descriptions and figures. They conjure up many weird suggestions, so I address one as an example. A figured Gyronites with its body chamber partly crushed, was thought to be falsely identified because the crushing would have produced a tabulate venter. Just how crushing turns a rounded venter into a spiral planar surface with two regular subparallel edges was not explained. Nor was explained how the crushing managed to deform the shell completely around the circumference, and in earlier whorls, and identically affect several non-figured specimens. Gaetani and team are not serious, but just undertaking a silly smear campaign. They should look again at the sutural diagrams, which do provide ventral arrows (although this offends purists), and provide more information than given by the esteemed colleague, the late Dr R. Assereto in his lengthy Lombard ammonoid paper, and do at least provide sutural data, more that their other worthy colleague did on the Chios cave deposit ammonoids, central to the type Aegean Stage. In point of fact, the arrows are mere convention, and not necessary, even to the Gaetani team, if they look carefully enough. I think a very few of the diagrams might have inadvertently lost the arrows stuck on, which annoys and embarrasses me, but there is no way that the ventral saddle or dorsal lobe can be misinterpreted.

13. The matter of a repository is simply explained. Two institutions had funding uncertainties imposed, leading to uncertainties over adequate curation. Thus the repository had to be edited out of the text. The repository will be settled as soon as possible. Some institutions number all specimens, others do not.

Classification

14. Gaetani et al evidently find it easier to accept one particular authority on ammonoid classification, and ignore the more recent and far more studious work by Shevyrev (1986). Elevating a supreme dictator saves having to think. It means that new information, or different views do not have to be assessed on merit, but just ignored, and preferably censored. So Shevyrev and I are relegated to the outer darkness. Their preferred father-figure himself has never defended his views in detail, and keeps adjusting - wisely so - and is in dispute with other authorities, Russian and German, past and present. In view of such wide discrepancies, it is timely to put together a comprehensive and thorough overview, and such is discussed in detail, and documented. The fact that I have studied brachiopods - and Gaetani omits to mention, many Mollusca (as did Diener and Waagen), means that I am open to apply classification principles from related groups, and so enter what has become a classification ghetto for Triassic ammonoids, unbelievably different from other Mollusca, and different from Paleozoic ammonoids. The reasons for this classification anomaly are carefully outlined in the Introduction (pp. 17-20). As the studies proceed, further and full discussion will be provided, as for example on Pseudosageceras and Tompophiceras, where their preferred guru has already taken a hammering, and not from me. Nothing stands still in science, nor would we expect it to, given our shortcomings, and new discoveries. It is disappointing to find that we seem to have to be increasingly on guard against those who oppose change and advance, and, alas for the realities of nature, complexification. This aggression against ongoing study and improvement, may be because some geologists get away with work of low value - especially if aided by being free to publish in an in-house journal.

15. They offer a curious argument based on proportion of new species. Once again, the Gaetani team wants everything to be regimented. In nature, as reflected in objective study, the number of new taxa depends on what is there, not some sterile formulaic approach, which, instead of accepting evidence as it comes hand, is prejudgemental and constrictive. The denigration of

courteously naming types and new names from the original type material, shows a weird if not egocentric view of procedures. The same understanding of courtesy may have prevailed in their failing to send me their copycat Kali Gandaki study, which recycles the French and my work, with a couple of modern terms thrown in, and nothing new. They also perpetrate another ingenuous misquote, from my p.3, in seeking to excoriate my overview for failing to mention their Zanskar study. But I also do not mention opposing Zanskar studies, such as by G. Fuchs, or A. Steck et al. I am clearly writing about Himalayan ammonoids, not, as they pretend to believe, Himalayan stratigraphy.

Why bear false witness ?

16. The Gaetani team unscrupulously slurs me in pretending that I am in any way like Gupta or what he is supposed to be. The material provided to me by Gupta was carefully compared with the Diener types at Calcutta, and assessed accordingly. Gupta did not pull any fast ones over the Carboniferous or Triassic. As soon as the problem was publicised, I was quick to point out one dubious Permian example, about which I am considerably annoyed, as a victim. As well, Ahluwalia alleged that Permian "Spirifer vihiana" was suspect, presumably having come from beyond the Indian subcontinent. Yet the only previous known material of *S. vihiana* came from the western Himalayas, collected in the 1860's. Thus Gupta's material almost certainly did come from the Himalayas, and was a valuable find.

An invitation to see for one's self

17. Since the real upset to Gaetani & co. seems to involve the fancied sight of ignoring their own self-esteemed work, I may say that I would be very happy indeed to conduct a field trip to the region, with them and anyone else. They may not only see for themselves the stratigraphy, but will be able to collect for themselves to their heart's content.

What I wonder would be the betting that the invitation to Manang will be refused? They evidently think they know it all already.

Conclusions

Although the attack by Gaetani et al. might suggest personality problems, and some indignation that their irrelevant studies in Zanskar were left unmentioned, and their Kali Gandaki foray unknown (unavoidably, as publications were in the same year), there are larger and more important issues. Gaetani et al. are just one example of a well funded team engaged in coarse mapping, with overemphasis on sectional rather than strike geology, and contented with rough ages. They also exemplify a willingness to overstate the relevance of their work to other regions. Zanskar work covers Zanskar, and only Zanskar. We cannot yet extrapolate to Manang. The Zanskar Permian-Triassic sequences are still poorly known, and under very poor age control, and the sea-level profiles unduly speculative, and probably full of gaps. Their papers may be fashionable, but in their haste and focus on sections and coarse mapping, are of ephemeral value, and bear an obvious similarity to articles in the popular press. For enduring valve, monographs, and extensive mapping, are of great and lasting value, the Waagen-Diener volumes providing a prime example. At the heart lies the need for far better and more detailed mapping, much more meticulous collecting, and more rigorous age determinations, matters that should be precious to geologists, but which are now avoided by so many, especially from universities.

Albertiana 15, May 1995

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WATERHOUSE, J.B., 1994. The early and middle Triassic ammonoid succession of the Himalayas in western and central Nepal. Part 1. Stratigraphy, classification and early Scythian systematics. Palaeontographica A, Bd. 232: 1-83.

WATERHOUSE, J.B. and SHI, G.R., 1991. Late Permian brachiopod faunules from the Marsyangdi Formation, north-central Nepal, and its implications for the Permian-Triassic boundary. *In:* D.L. MacKinnon, D.E. Lee and J.D. Campbell (eds.), Brachiopods through time, Balkema, Amsterdam, p. 381-387.

SUBMISSION OF MANUSCRIPTS FOR ALBERTIANA

Contributions should be sent to the editor on MS-DOS formatted floppy discs, preferably in WordPerfect 5.1 or any other kind of word-processing program that can be converted into WordPerfect 5.1 (e.g. Word, WordStar or as a plain ASCII file) together with a printed hard copy. Those who do not have the possibility to submit a manuscript in electronic format, are kindly requested to send smooth and clearly typed manuscripts in a 12-point typeface with single line spacing. Tables and schemes should be in camera-ready format, clearly drawn or printed; only originals can be accepted, poor xerox copies cannot be accepted. Due to time restrictions it is not possible to redraw tables and schemes.

Special attention should be paid to grammar and syntax. References should be in the format used in the 'Annotated Triassic Literature'. The use of names of names of biostratigraphic units should be in accordance with the International Stratigraphic Guide:

- "The formal name of a biostratigraphic unit should be formed from the names of one, or preferably no more than two, appropriate fossils combined with the appropriate term for the kind of unit in question."
- "The writing and printing of fossil names for stratigraphic units should be guided by the rules laid down in the International Code of Zoological Nomenclature and in the International Code of Botanical Nomenclature. The initial letter of generic names should be capitalized; the initial letter of the specific epithets should be in lowercase; taxonomic names of genera and species should be in italics. The initial letter of the unit-term (Biozone, Zone, Assemblage Zone) should be capitalized; for example, Exus albus Assemblage Zone."
- "The name of the fossil or fossils chosen to designate a biozone should include the genus name plus the specific epithet and also the subspecies name, if there is one. Thus *Exus albus* Assemblage Zone is correct. After the first mention, the genus name may be abbreviated to its initial letter if there is no danger of confusion with some other genus beginning with the same letter; for example, *Exus albus* may be shortened to *E. albus*. On the other hand, the use of the specific epithet alone, in lowercase or capitalized, in italics or not (*albus* Assemblage zone, *Albus* Assemblage zone, albus Assemblage zone, or Albus Assemblage zone), is inadvisable because it can lead to confusion in the case of frequently used species names. However, once the complete name has been cited, and if the use of the specific epithet alone does not cause ambiguous communication, it may be used, in italics and lowercase, in the designation of a biozone; for example, *uniformis* Zone."

From: SALVADOR A. (ed.), 1994. International Stratigraphic Guide. Second Edition. International Commission on Stratigraphic Classification of IUGS International Commission on Stratigraphy. IUGS/-GSA, Boulder, Co, p. 66

The deadline for the submission of contributions for ALBERTIANA 16 is October 15th, 1995

ANNOTATED TRIASSIC LITERATURE

Hans Kerp and Henk Visscher'

ADACHI, S., IGO, H., AMPORNMAHA, A., SASHIDA, K. and NAKORNSRI, N, 1993. Triassic coral buildups observed in the Chaiburi Formation, near Phatthalung, Peninsular Thailand. Ann. Rep., Inst. Geosci., Univ. Tsukuba, 19: 27-31.

Light coloured carbonate rocks extensively crop out in the southern part of Peninsular Thailand. Their distribution further extends to the south and crosses the national border of Thailand and Malaysia. These limestones were originally assigned to the Permian Ratburi Limestone, but Igo et al. (1988) reported the occurrence of lower Middle Triassic conodonts in one of the limestone hills, Khao Chiak, about 5 km west of the Phatthalung city area. More recently, Sashida and Igo (1992) added new data of geochronology based on radiolarian biostratigraphy. Recently, Apsorn Ampornmaha (1993, MS) has studied the geology of the Phatthalung area. She further subdivided this carbonate formation into the Phukhaothong Dolomite Member, Chiak Limestone Member, and Phanomwang Limestone Member in ascending order. This formation attains a total thickness of more than 400 m. According to her biostratigraphic reconnaissance, this formation ranges from Dienerian to early Carnian in age, but the lower part of this formation probably grades into the Upper Permian. Microfacies of these carbonate rocks was also studied. Coral buildups were found in the basal part of the Phanomwang Limestone Member exposed in a quarry of Phanom Wang about 9 km north of Phatthalung. Triassic coral buildups have not been fully known in calcareous facies of southeastern Asia. Fontaine and Gafoer (1989) reported the presence of reefal limestone in the Sibaganding Limestone exposed near Lake Toba, northern Sumatra, but they did not document any details of this limestone. The coral buildups from Phanomwang and their geologic significance are discussed.

ALLEN, M.B., SENGÖR, A.M.C. and NATAL'IN, B.A., 1995. Junggar, Turfan and Alakol basins as Late Permian to ?Early Triassic extensional structures in a sinistral shear zone in the Altaid orogenic collage, Central Asia. J. Geol. Soc. London, 152: 327-338.

The Junggar, Turfan and Alakol basins in northwestern China and Kazakhstan formed as Late Permian to ?Early Triassic extensional structures in a broad sinistral shear zone between large strike-slip faults that separate two main domains of the Altaid orogenic collage. This extension was in response to an inferred large (> 1 000 km) sinistral motion of the East European craton with respect to the Angaran craton during this time. Deformation associated with the formation of the basins was taken up in part by counter-clockwise rotations of crustal blocks with respect to the Altaid orogenic collage and to the Angaran craton. This event is the only important phase of extension in a region otherwise dominated by compressional tectonics throughout the Phanerozoic.

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The help of Sabine Gibas, Heike Hagemann and Gaby Swenzien (Münster), Dr. Zwier Smeenk (Utrecht) and Dr. A. Ramovš (Ljubeljana) in tracing relevant literature and compiling this bibliography is gratefully acknowledged. Of some papers which contain no (English) abstract only the title is listed.

ANSORGE, J., 1994. *Rhoeniella granulata* gen. et sp. nov. (Insecta: Hemiptera) from the Upper Buntsandstein of the Rhön mountain (Hessen/Germany). Senckenbergiana lethaea, 74(1/2): 325-327.

The forewing of a new species of Hemiptera is described from the Lower Rot (Upper Buntsandstein) of the Rhon mountain in northern Hessen and assigned to a new genus, *Rhoeniella granulata* gen. et sp. nov. Besides another forewing, found in beds of approximately the same age in Lower Franconia and described under open nomenclature, it is the first evidence for the occurrence of the family Ipsviciidae outside Australia and Asia.

Ash, S., 1994. *Donwelliacaulis chlouberii* gen. et sp. nov. (Guaireaceae, Osmundales) one of the oldest Mesozoic plant megafossils in North America. Palaeontographica, Abt. B, 234(1-2): 1-17.

Donwelliacaulis chlouberii gen. et sp. nov. is an arborescent axis about 10-22 cm in diameter and several meters tall which has a broad mantle composed of adventitious roots and widely separated, spirally arranged petiole bases. Although the fossil is similar to some of the axes usually included in the Osmundaceae, it can not be assigned to that family because it also has certain characters not typically found in the family. These atypical characters include an undifferentiated cortex and oval petiole bases which lack stipular wings and sclerotic rings surrounding the petiolar vascular trace. Such characters, however, do occur in axes assigned to the newly defined family Guaireaceae, also in the Order Osmundales, and the new tree fern is assigned to that family. Donwelliacaulis chlouberii is found in abundance in the Middle Triassic (Anisian Stage) Holbrook Member of the Moenkopi Formation in east-central Arizona and is noteworthy because it is the oldest Mesozoic plant megafossil to be described completely from North America. The new tree fern inhabited a broad coastal plain near the western edge of Pangaea, about 15 degrees north of the equator where it probably lived in a humid tropical climate and may have formed the canopy in open areas on this plain. The tree fern axis Itopsidema vancleaveii DAUGHERTY (1960) from the Upper Triassic Chinle Formation of east-central Arizona is also assigned to the Guaireaceae.

BACKHAUS, E., BINDIG, M., SHAOMING FAN and MAXEINER, T., 1993. Ephemer-fluviatile und äolische Sedimentation unter ariden Bedingungen im Mittleren Buntsandstein von Lissingen (Westeifel). Jber. Mitt. oberrhein. geol. Ver., N.F., 75: 255-273.

With special consideration of the evaluated grain size analysis, the lithofacial units of the sedimentary rocks of the middle Buntsandstein were examined in a well exposed quarry in the Westeifel and interpreted by using the architecture-element-analysis to reconstruct its environments. The sequence is part of a climatically controlled cycle with fluvial sediments in the lower range and eolian in the upper one. Initially ephemeral braided rivers were formed, which gradually changed to flash-floods. Subsequently barchanoid dunes developed due to decreasing alluvial activity.

BALINI, M., 1994. Middle Triassic ceratitids (Ammonoidea) collected by C. Renz from Hydra (Greece). Riv. It. Paleont. Strat., 100: 351-364.

This paper is focused on the description of a previously undescribed assemblage of ceratitids collected more than 50 years ago by C. Renz from the Han-Bulog Limestone of Hydra (Greece). The identified forms are Asseretoceras camunum (Assereto, 1963), Megaceratites aff. fallax Balini, 1992b, Ronconites sp.n. A, 'Kellnerites' sp.ind., Nevadites sp.ind. Two ceratitids of uncertain attribution are also described. These species have only paleoecological implications, since a stratigraphic bed-by-bed sampling has not been performed. A. camunum and the genera Megaceratites and Ronconites are reported for the

first time from the Han-Bulog Limestone. *Megaceratites* and *Ronconites* are for the first time recorded outside the Southern Alps.

BANDEL, K., 1994. Comparison of Upper Triassic and Lower Jurassic gastropods from the Peruvian Andes (Pucará Group) and the Alps (Cassian Formation). Palaeontographica, Abt. A, 233: 127-160.

The gastropod fauna of the Late Triassic to Jurassic Pucará Group contains fewer taxa than that of the Upper Ladinian to Karnian Cassian Formation. While only a few species are closely related to each other, in both assemblages the general character of groups (genera and families) is similar and both Upper Triassic faunas differ from Paleozoic and later Mesozoic faunal assemblages. The Peruvian species with a slit in the shell are few in number and usually poorly preserved, while there are many species in the Alps. While Peruvian Trochomorpha differ from those of the Alps, the Neritimorpha show closer relationships to each other. The same systematic groups (i.e. families) of Caenogastropoda are presented by different genera and species in both faunal assemblages. Among the Heterostropha, mathildids and cylindrobullinids are closely related while other groups show little in common. The following new species from the Pucará Group are described: Cassianastraea stanleya, Cryptaulax variformatum, Ladinula peruviana, Rhynchocerithium peruvianum, and several species are revised. The continuity of a number of Triassic groups into the Jurassic is demonstrated. Upper Triassic faunas of Peru and northern Italy belong to two different faunal provinces which during Triassic time had very little direct connection to each other. Some species of the Pucará, in contrast, have relationships with the Jurassic of Europe. During Jurassic time faunal provinces had more contact with each other.

BASSO, D. and TINTORI, A., 1994. New Triassic isopod crustaceans from Northern Italy. Palaeontology, 37: 801-810.

Two new Triassic isopod crustaceans from the southern Calcareous Alps are described on the basis of well preserved specimens. This small assemblage comes from the late Norian Calcare di Zorzino, which is especially well-known for its vertebrate fauna. At least two new genera of Isopoda are present, here assigned to the Sphaeromatidae and Serolidae. *Triassphaeroma magnificum* is erected for specimens whose single first pleonal unit comprises five fused tergites, a feature peculiar to Sphaeromatidae. *Elioserolis alpina* is the first definitive fossil representative of the Serolidae so far known; attribution is on the basis of the round shape, head inserted in the first pereionite, and reduced number of pleionites. Specimens are preserved in a way which indicates that the biphasic moulting of Recent isopods had already evolved in late Triassic serolids.

BELL, C.M. and SUAREZ, M., 1994. The sedimentation and tectonics of a marine fan-delta developed on an active continental margin: the Triassic San Félix Formation in the Andes of northern Chile. J. South Am. Earth Sci., 7: 403-413.

The Middle Triassic (Anisian) San Félix Formation of northern Chile (29° S, 70° 30' W), represents deposits of an extensional (probably transtensional) basin developed on an active continental margin. Over 4000 m of mainly marine clastic sedimentary rocks are intercalated between volcanic sequences. The thick sedimentary section wedges out over a distance of 12 km, suggesting a steep, fault-controlled basin margin. Distinct lateral and vertical facies changes probably reflect tectonic control on the sedimentation. Most of the clastic material was derived from adjacent active silicic and andesitic volcances. Deposition took mostly place from suspension and subaqueous mass-flow processes in still water on a submarine fan-delta. The deposits of the coarse-grained delta slope include both cohesive

and cohesionless debris flows. Further offshore, sedimentation on the muddy prodelta was from suspension and low-density turbidity currents. The common mass-flow events, redepositing coarse-grained clastic material in a shallow water submarine environment, are indicative of an abundant sediment supply, frequent flood events and steep slopes. Intermittent subaerial exposure is indicated by lake-shore sediments at the base and fluvial sediments at the top of the succession.

BELL, C.M. and SUÅREZ, M., 1995. Triassic alluvial braidplain and braided river deposits of the La Ternera Formation, Atacama region, northern Chile. J. South Am. Earth Sci., 8: 1-8.

The La Ternera Formation is a thick (> 2100 m) succession of terrigenous clastic sediments, with andesitic and basaltic intercalations, exposed in the Quebrada de Paipote area of the Atacama Region, northern Chile. The strata were deposited in an active rift basin during the Late Triassic to (?)Early Jurassic. The lower 1000 m of the clastic succession comprises pebbly paraconglomerates, unconformably overlying Upper Paleozoic sedimentary successions, volcanics, and granitoids. These sediments were derived from the east and are interpreted as braid-plain deposits. The upper 800 m of the succession comprises interbedded orthoconglomerates, sandstones and mudstones. Abundant plant fossils include trees in growth position and carbonaceous horizons.

BELLANCA, A. DI STEFANO, P. and NERI, R., 1995. Sedimentology and isotope geochemistry of Carnian deep-water marl/limestone deposits from the Sicani Mountains, Sicily: Environmental implications and evidence for a planktonic source of lime mud. Palaeogeogr. Palaeoclimatol. Palaeoecol., 11: 111-129.

The upper Triassic Halobia-bearing marl/limestone deposits from the Sicani Mountains (Sicily) record the sedimentary evolution of the Sicanian Basin through the middle and late Carnian time. Dark marls and interbedded grey calcilutites of Julian age are characterized by abundant pyrite, sparse bioturbation and negative carbonate carbon δ^{13} C values. They accumulated in a basin with dominantly anoxic to dysaerobic bottom waters. Lower Tuvalian dark-grey pyritic marls and calcilutites, which contain carbonate minerals with relatively high Mn contents and widely fluctuating δ^{13} C signatures, were deposited under dysaerobic conditions. Middle and upper Tuvalian cherty limestones show intense bioturbation and nearly invariable positive δ^{13} C values (around 2‰ for calcite). They form a thick and monotonous succession accumulated in a deeper and more oxygenated basin. The *Halobia*-bearing deposits preserve some calcareous nannoplanktonic forms. The nannofossils, varying in size from 7 to 32 μ m, are significantly abundant in the cherty limestones pointing to a notable role of the calcareous nannoplankton as a source of carbonate mud in the deep-water basins of the southern Tethys during the late Triassic time.

BIGOZZI, A., 1994. Storia evolutiva ed inquadramento sequenziale dell'area del Gran Sasso nell'intervallo Trias superiore-Lias inferiore (Evolution and sequence analysis of the Gran Sasso area during the Late Triassic-Early Liassic interval). Atti Tic. Sc. Terra, (Ser. spec.) 2: 73-95.

Stratigraphical and sedimentological analysis have been carried out in order to establish the sequential and paleoenvironmental evolution of the Gran Sasso platform-basin system, during the Late Triassic-Early Liassic interval. In this system, four depositional sequences have been recognized. The sequences, which have a length varying from 5 to 9 my., have been referred to the second order. (1) The sequences are mainly composed of asymmetrical cycles in which only the regressive interval is represented, while the transgressive one is lacking, (2) the sequence boundaries do not correspond to unconformities sensu VAN WAGONER et al. (1988), but they usually coincide with maximum flooding surfaces,

separating different phases of the basin evolution. Sequence boundaries were controlled by tectonic factors as subsidence rate variations and tectonic uplift, due to the rifting regime connected with the opening of the liguride ocean. The internal arrangement of the sequences was controlled by ecologic, tectonic and eustatic factors: (1) Ecologic factors as the type of biological community (as the absence of reef building organisms) influenced the carbonate productivity and as consequence the sedimentation rate, (2) tectonic factors produced paleogeographic modifications which caused important paleoenvironmental changes; this latter also influenced the biological community, (3) eustatic factors were also important on a fourth and fifth order scale, determining the cyclicity of the shallow water successions, but were negligible on a third order scale. The sedimentary evolution of the Gran Sasso platform-basin system, during the Late Triassic-Early Liassic, can be summarized as follows: a) Norian: the Gran Sasso area was characterized by shallow water carbonate platform facies (Dolomia Principale) and by euxinic facies deposited in a pullapart basin (Gran Sasso basin) due to transtensional tectonics, probably of Norian age. b) Raethian: an extensional tectonic phase produced the progressive opening of the Gran Sasso basin and together with a climatic variation improved water circulation and seabottom oxygenation. As consequence, the euxinic sedimentation in the basin ended, while calcareous-dolomitic facies were deposited on the platform (Dolomia Principale).

BIZZARINI, F. and BRAGA, G., 1994. *Corynotrypoides ladina* gen. et sp. nov., a questionable cyclostomatous bryozoan from the Upper Triassic of the Eastern Dolomites (NE Italy). In: P.J. Hayward, J.S. Ryland and P.D. Taylor (editors), Biology and Palaeobiology of Bryozoans, Olsen & Olsen, Fredensborg, Danmark, pp. 29-32.

An adnate bryozoan with a primitive budding pattern is described from the Upper Triassic of the Eastern Dolomites (NE Italy). After a general review of the zoarial and zooecial features of the main groups of uniserial cyclostomes (Hederellida, Corynotrypidae, Stomatoporidae), the new genus *Corynotrypoides* and species *Corynotrypoides ladina* are established. Family assignment is uncertain owing to the peculiar morphology of *C. ladina*.

BLENDINGER, W., 1994. The carbonate factory of Middle Triassic buildups in the Dolomites, Italy: a quantitative analysis. Sedimentology, 41: 1147-1159.

Middle Triassic carbonate buildups of the Dolomites were high in relief (500-1000 m) and small in size (one to a few square kilometres in area), A paradox results from the carbonate platform model that invokes the platform top, including reef rims, as the carbonate factory and flanking beds as talus deposits. Most buildups consist largely of clinoforms (inclined at 10-50°) whereas massive reef rocks and stratified buildup interiors are poorly developed or absent. Facies and modal analysis of 323 thin sections from buildups of the Marmolada indicate that clinoforms are: (i) predominantly composed of *in situ* boundstones (56% of all samples); (ii) primarily made up of early cements (37 vol.%), microbial crusts (17 vol.%), micritic intraclasts (10 vol.%) and *Tubiphytes* (8 vol.%); and (iii) contain diagnostic shallow water grains (dasyclads, coated grains) that are less abundant by 1-2 orders of magnitude compared with buildup interior facies. These data suggest that the clinoforms themselves and massive reef rocks were apparently not a prerequisite for buildup growth and clinoform progradation.

CRICK, R.E. and SOBOLEV, E.S., 1994. *Perunautilus quadratus* n. gen. et sp. (Cephalopoda, Nautilida) from the Triassic (Norian) of central Peru. Palaeontographica, Abt. A, 233: 161-167.

The new genus and species *Perunautilus quadratus* (Cephalopoda, Nautilida, Liroceratidae) is described from Triassic (Norian) strata of central Peru. The general details of the

stratigraphic distribution of family Liroceratidae is presented together with specific details of the stratigraphic and geographic distribution of Triassic species. The biogeographic implications of this occurrence are discussed in the context of the family and Triassic paleogeography.

CUNY, G., GODEFROIT, P. and MARTIN, M., 1995. Micro-restes de Vertébrés dans le Trias Supérieur du Rinckebierg (Medernach, G-D Luxembourg) [Micro-rests of vertebrates from the Upper Triassic of Rinckebierg (Medernach, Grand Duchy of Luxembourg)]. N. Jb. Geol. Palãont., Abh., 196: 45-67.

New vertebrate micro-remains from the Upper Triassic of Rinckebierg include Actinopterygii, Dipnoi, Temnospondyli, Sauropterygia, carnivorous Archosauria, Crocodylotarsi, Pterosauria, Cynodontia and Mammalia. The faunal composition suggests a Norian age for this bone-bed and a deltaic depositional environment.

Dossin, T.M., Dossin, I.A., CHARVET, J. and BONHOMME, M.G., 1995. K-Ar chronology of a Mesozoic dike swarm from southern Espinhaço Region (SE Brazil). J. South Am. Earth Sci., 8: 47-53.

Dikes which cut Archean and Proterozoic sequences and the Brasiliano structures in the Southern Espinhaço Region were dated using the conventional K-Ar method. The particular petrographic characteristics of the swarm in relation to those of the Precambrian, abundant in the region, provide no evidence of deformation or metamorphism. The geochronological results indicate that emplacement of the dikes was related to the Mesozoic extensional tectonics and point to a period of magmatic activity during Upper Triassic/Lower Jurassic, between 170 and 220 Ma. Data indicate that the swarm is earlier than the main Phanerozoic swarms of southeast Brazil which are related to the opening of the South Atlantic, and that the dikes were emplaced during the initial breakup of Gondwana.

EMMERT, U., 1994. Die volkstümlichen Bezeichnungen: Kipper bzw. Keuper, Letten, Steinmergel und Stubensand, im fränkischen Keuperland. Jber. Mitt. oberrh. geol. Ver., N.F., 76: 245-252.

The terms 'Kipper', 'Letten', 'Steinmergel' and 'Stubensand' are explained and their relation to the Keuper of Franconia is discussed.

EMMERT, U., 1994. Hat Leopold von Buch den Formationsbegriff 'Keuper' wirklich definiert? Geol. Bl. NO-Bayern, 44: 261-266.

L. von Buch would have introduced the term 'Keuper' in a letter in 1822. However, in his later publications of 1825 and 1826 he did not use this formation definition in the modern sense.

FANTINI SESTINI, N., 1994. The Ladinian ammonoids from Calcare di Esino of Val Parina (Bergamasc Alps, northern Italy). Pt. 1. Riv. It. Paleont. Strat., 100: 227-284.

This paper deals with the description of a rich ammonoid assemblage collected in calcareous lenses outcropping within the Ladinian Calcare di Esino of Val Parina (Northern Italy). The faunas come from lenses outcropping on the northern slope opposite of Val di Lavaggio. More than 60 species were identified, including about twenty new species and three new genera: *Parinaia* (fam. Ceratitidae), *Rossiceras* (fam. Hungaritidae) and *Gervasuttia* (fam. Aplococeratidae). The new taxa give a substantial contribution to the knowledge of the poorly studied Tethyan faunas of the Ladinian. Whether these faunas are endemic or not is at present difficult to determine. The fossiliferous levels extend from 550 m to 850 m altitude. In this interval 5 assemblages were recognized. FLUGEL, E., RAMOVS, A. and BUCUR, I.I., 1994. Middle Triassic (Anisian) limestones from Bled, northwestern Slovenia: microfacies and microfossils. Geologija, 36: 157-181.

Microfacies types (predominantly intrabioclastic grainstones) and microfossils (predominantly dasycladacean algae and diverse foraminifera) characterize the Anisian carbonates near Bled (Castle Hill) and in the area WNW of Bled as subtidal to intertidal shelf sediments deposited in the inner part of the Julian carbonate platform. The age of the carbonates is Middle Anisian (Pelsonian) according to the biozonation based on foraminifera and dasycladaceans.

GARZANTI, E., NICORA, A. and TINTORI, A., 1994. Triassic stratigraphy and sedimentary evolution of the Annapurna Tethys Himalaya (Manang area, central Nepal). Riv. It. Paleont. Strat., 100: 195-226.

After initial opening of Neotethys in the Permian, thermal subsidence and deepening continued in the Triassic. In the Scythian, three pelagic nodular carbonate intervals of Early Griesbachian to Early Dienerian, Early to mid-Smithian and latest Smithian to earliest Aegean age are interbedded with shelfal shales (Tamba Kurkur Formation). Ammonoid- and conodont-rich condensed carbonates were deposited on the outer shelf, with maximum depths around 150-200 m reached during transgressive stages. The Anisian to lowermost Norian shelfal succession mostly consists of marly limestones and marls (Mukut Formation). Thick calcareous siltstones rapidly accumulated in the Carnian, testifying to a new stage of tectonic extension affecting the Tethys Himalayan passive margin. The thick Tarap Formation of largely mid-Norian age points to strong continuing subsidence. Interbedded siltstones and subarkosic sandstones ('lower member') are locally overlain by coral-bearing patch reefs ('middle member'). Chamosite-bearing hybrid arenites deposited at transgressive stages characterize the 'upper member'. The Triassic succession is capped by subarkoses and guartzarenites, interbedded with dolomitic to bioclastic hybrid sandstones and silty limestones ('Quartzite Series'), in turn overlain by the Kioto Limestone.

GAWLICK, H.-J., STRAUSS, R. and VORTISCH, W., 1994. Metabentonite in dolomitisierten oberladinischen Beckensedimenten westlich von Abtenau (Nördliche Kalkalpen, Salzburger Land, Österreich). Jb. Geol. B.-A., 137: 35-41.

In the pelagically influenced (= kalkhochalpin) Dachstein limestone facies zone occur metabentonites incorporated in upper Ladinian (Langobard 1-2) basin dolomites. The metabentonites consist predominantly of illite-smectite. Other silicate minerals are very rare. The composition of the metabentonites suggests that they are derived from glass-rich volcanic ashes, deposited immediately in the platform slope of the Hallstatt Basin. Possibly they are suitable as key layers for the correlation of Hallstatt Basin sediments and platform carbonates.

GLAUB, I. and SCHMIDT, H., 1994. Traces of endolithic microboring organisms in Triassic and Jurassic bioherms. Kaupia - Darmstätter Beitr. Naturgesch., 4: 103-112.

The spectrum of microborings in Triassic and Jurassic bioherms was studied, based on 150 samples of macrobenthic organisms. The specimens originate from bioherms of the Upper Muschelkalk (SW-Germany), the Upper Cassian Formation (Central Dolomites), Malm β (Swabian Alb, Plettenberg) and Malm δ 3 (Swabian Alb, Hochwanger Steige). All samples were prepared using a special cast embedding technique. These casts were studied and phenotypic descriptions were made by SEM-investigations. A great morphological diversity of microborings was discovered in the bioherm samples. About 25 ichnotaxa and -forms were distinguishable. These microborings resemble traces of modern cyanobacteria, rhodophycean algae, Chlorophycean algae, fungi, phoronoids, annelids, sponges and

brachiopods. The microboring assemblages of the Muschelkalk, Upper Cassian Formation and the Malm $\delta 3$ bioherms indicate a depth of sedimentation within the upper euphotic zone. In contrast, the endolith association of the Malm β bioherms is characteristic of the lower euphotic zone.

GOROCHOV, A.V., 1994. Permian and Triassic Phasmoptera (Insecta) from Eurasia. Paleont. Zhurn., 1994, 4: 54-75. (in Russian with English summary).

Arguments are given for the substantiation of the rank and scope of three superfamilies from the Paleozoic and Mesozoic. Many families belonging to these superfamilies are characterized. The genus *Prochresmoda* Sharov with two species are redescribed. A new genus and eight new species are described from the Triassic of Central Asia. Discovery of remains assigned tentatively to the oldest Phasmoptera in the Lower Permian of the Urals is mentioned. Phylogenetic relationships of all pre-Cenozoic families are discussed.

GUANGHUA LIU, 1992. Permian to Eocene sediments and Indian passive margin evolution in the Tibetan Himalayas. Tübinger geowiss. Arb., A 13, 268 pp.

Based on field investigations and recent publications, a comprehensive study on the lithofacies, paleogeography, sequence stratigraphy, and subsidence history of the central Tethyan Himalayas has been carried out. The sediments from the Late Permian to the Eccene document a complete Wilson cycle of the Neo-Tethyan evolution from its opening, through spreading to closing and final uplifting. Up to the Late Permian, the sedimentary history of this areas was dominated by an epicontinental shallow-marine basin of the Gondwanan supercontinent. This phase ended with regional uplift in response to pre-rift crustal upwarping. A Neo-Tethys rift system developed during the Triassic, leading to northward drifting of the Lhasa block. The rift began to open in the Early Triassic and became mature in the Norian. The basin was filled with a huge clastic-dominated sediment wedge, consisting of about 1700 m of shallow-marine deposits in the southern areas and > 5000 m of flysch deposits in the northern zone. These sediments formed four depositional sequences, which reflect relative sea-level changes and the development of the rift system. Deepening-upward sequences, condensed sections with radiolarites, olistostromes and basalt indicate that the rift reached its maximum depth in the early Norian. Extensive progradation of delta systems on the shelf, slope aprons with hemi-pelagic sediments in the basin center, and decreasing tectonic subsidence during the late Norian and earliest Jurassic mark the transition to the drift stage, in which the Lhasa block was separated from the northern margin of Gondwana. This view is also supported by subsidence analysis and paleomagnetic studies.

HAGDORN, H., 1995. Farbmuster und Pseudoskulptur bei Muschelkalkfossilien. N. Jb. Geol. Paläont., Abh., 195: 85-108.

Three types of colour patterns are observed in the aviculopectinid bivalve *Pleuronectites laevigatus*: (1) most common is a pattern of radial colour bands or bundles of bands on the convex left valve; (2) zigzag-patterns (var. *derognatil*) or (3) concentric colour bands (var. *zonata)* are less common. During diagenetic pressure solution, the less soluble, pigmented shell portions became transformed into pseudosculpture, which may be combined with the normal solution shadows of growth lines. Transformation of colour patterns into pseudosculpture also occurs among *Entolium* cf. *discites* (Bivalvia, Entoliidae), *Neritaria* sp. (Gastropoda, Neritacea) and *Coenothyris vulgaris* (Brachiopoda, Dielasmatacea).

HALLAM, A., 1994. Strontium isotope profiles of Triassic-Jurassic boundary sections in England and Austria. Geology, 22: 1079-1082.

Strontium isotope profiles are provided from the Austrian Salzkammergut and southwest England, two of the best available marine sections across the Triassic-Jurassic boundary. The results in the English section have been affected by diagenesis, but the Austrian results are excellent and demonstrate that, in favourable circumstances, trustworthy Sr isotope results can be obtained from pure or nearly pure limestones, and oxygen isotope data provide the best means of obtaining an independent check. Although the Triassic-Jurassic boundary was marked by significant sea-level changes, this is not reflected in the Sr isotope results, which show no change across the boundary, in contrast to what has been claimed for the Cretaceous-Tertiary and Permian-Triassic boundaries.

HAUNSCHILD, H., 1994. Neue Daten zum Schilfsandstein-Vorkommen in und um Lichtenau bei Ansbach (Mittlerer Keuper, Trias). Geol. Bl. NO-Bayern, 44: 133-172.

A discussion on the formation of the Schilfsandstein in the area around Lichtenau near Ansbach.

HAUSCHKE, N., 1994. Late Triassic lacustrine deposits from the Middle European Keuper Basin: a Lower Middle Keuper sequence in northwest Germany. In: E. Gierlowski-Kordesch and K. Kelts (editors), 1994. A Global Geological Record of Lake Basins, Cambridge University Press, pp. 143-146.

Two disctinct cycles can be recognised in the Lower Middle Keuper (Ladinian-Carnian) of the Lippisches Bergland (NW-Germany), one in the Ladinian and one in the Carnian. The sedimentology and palaeoenvironmental interpretations are briefly discussed.

HELING, D., 1992. Die Sedimentologie des Schilfsandsteins zwischen Stromberg und Kraichgau (Exkursion G am 24. April 1992). Jber. Mitt. oberrh. geol. Ver., N.F., 74: 67-72.

A road log of an excursion in the Schilfsandstein with special attention for sedimentological features.

HELING, D. and BEYER, M., 1992. Glaukonit im Schilfsandstein: Schlüssel zur kontroversen Faziesanalyse? Jber. Mitt. oberrh. geol. Ver., N.F., 74: 191-213.

The sandfacies of the Schilfsandstein near Eppingen (SW-Germany) is very likely to have been deposited as a greensand, because the sand contained abundant glauconite-bearing pellets at the time of deposition. Recently glausconite can only form in weakly reducing environment and at low sedimentation rates. Such conditions are prevailing in shallow marine basins. The silt facies was depoisted further off-shore. The minerology and depositional history of the Schilfsandstein are discussed.

HOFMANN, T. and GRANIER, B., 1994. A guide to the collection of Julius Pia. 1st Part: "Neue Studien über triadische Siphonae verticilatae" Julius v. Pia, 1912. Beitr. Paläont., 19:149-151.

This work is the first published part of a guide with comments which can help algal researchers work with the thin section collection of Julius Pia located at the Museum of Natural History in Vienna.

HUNT, A.P. and LUCAS, S.G., 1994. Ornithischian dinosaurs from the Upper Triassic of the United States. In: N.C. Fraser and H.-D. Sues, In the shadow of the dinosaurs, Cambridge University Press, pp. 227-241.

Ornithischian dinosaurs are rare components of Late Triassic vertebrate assemblages, and the described taxa comprise *Pisanosaurus mertii* Casamiguela, 1967 from Argentina

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(Bonaparte, 1976), 'Thecodontosaurus' gibbidens Cope, 1878 from eastern North America (Huene, 1921; Olsen, 1980; Galton, 1983), and Technosaurus smalli Chatterjee, 1984 and Revueltosaurus callenderi Hunt, 1989 from western North America. In addition, there have been several reports of isolated ornithischian teeth that usually are described as 'fabrosaurlike' from Morocco and the western United States. This chapter reviews all the skeletal evidence pertaining to the presence of ornithischian dinosaurs in Upper Triassic strata of the United States. This necessitates a review of the utility of dinosaurian taxa based on isolated teeth. Several new taxa are recognized, and tooth function in Triassic ornithischian dinosaurs is briefly reviewed. The ichnogenus Atreipus occurs in late Carnian-middle Norian strata of the Newark Supergroup in eastern North America and has been attributed to an ornithischian dinosaur (Olsen and Baird, 1986). Because this chapter concerns the skeletal records of ornithischians, the authors do not consider this ichnotaxon in detail. However, they do note that the comparatively elongate pedal digit III of Atreipus (Olsen and Baird, 1986) is most comparable to that of saurischians. Were it not for the presence of manus impressions, Atreipus undoubtedly would be considered saurischian in origin. The authors consider it most parsimonious to consider Atreipus a saurischian, as the pedal structure suggests, rather than an ornithischian, based on the presence of a manus imprint but ignoring the structure of the pedal imprint.

JALIL, N., LUCAS, S.G., and HUNT, A.P., 1995. Biochronological significance of aetosaurs and phytosaurs (Reptilia, Archosauromorpha) in the Triassic Zarzaitine Series of Algeria. N. Jb. Geol. Paläont. Mh., 3: 173-181.

The aetosaurs *Paratypothorax* sp. and aff. *Desmatosuchus* sp. and the phytosaur cf. *Angistorhinus* sp. are documented from the Lower Zarzaitine Series in southeastern Algeria. These taxa indicate a Late Carnian age for part of the Zarzaitine Series.

JURKOVŠEK, B., 1994. Karnijske plasti s školjkami južno od Rovt. Geologija, 36: 195-205. (In Slovenian with English summary).

A short report on the rich locality of the Carnian (Upper Triassic) pelecypods *Pachycardia rugosa* Hauer and *Myophoria kefersteini* (Münster) is given. The remains of solenomorphs appear individually, and the *Trigododus* fauna is absent.

KAJIWARA, Y., ISHIDA, K., TANIKURA, Y. and ISHIGA, H., 1993. Sulfur isotopic data from the Permian/Triassic boundary at Sasayama in the Tanba Terrane in southwestern Honshu, Japan. Ann. Rep., Inst. Geosci., Univ. Tsukuba, 19: 67-71.

Continuing and extending the work of Kajiwara et al, (1993, this issue) dealing with the sulfur isotopic characterization of the Permian/Triassic (P/Tr) boundary section at Tenjinmaru in the Chichibu Terrane in eastern Shikoku, Japan, a similar systematic investigation has been carried out in the P/Tr boundary section at Sasayama in the Tanba Terrane in snuthwestern Honshu, Japan. The continuous pelagic sequence at this locality records a drastic increase in ³⁴S/³²S ratios in sedimentary and/or diagenetic sulfide beginning at the lowermost Upper Permian and persisting into the Lower Triassic, with a temporary distinct negative shift just at the suspected P/Tr boundary, which is analogous to what has been recognized in the Tenjinmaru section.

KAJIWARA, Y., YAMAKITA, S., ISHIDA, K., ISHIGA, H. and IMAI, A., 1994. Development of a largely anoxic stratified ocean and its temporary massive mixing at the Permian/Triassic boundary supported by the sulfur isotopic record. Palaeogeogr. Palaeoclimatol. Palaeoecol., 111: 367-379.

Systematic sulfur isotope data for whole-rock sulfides have been obtained from the chertdominated, continuous, pelagic sedimentary sequences spanning the Permian/ Triassic (P/Tr) boundary at Tenjinmaru in the Chichibu Terrane and at Sasayama in the Tanba Terrane in Japan. The P/Tr boundary is characterized by the occurrence of siliceous shales in association with a carbonaceous black mudstone which is similar in appearance to the worldwide distributed Cretaceous/Tertiary (K/T) boundary claystone. The observed data clearly demonstrate a significant bimodalism. The 34S/32S ratios with respect to CDT are generally low throughout the Middle Permian (ca.-39 to -25‰) and show a remarkable increase beginning in the lower Upper Permian and persisting into the Lower Triassic (ca. -20 to -2%), with a temporary and drastic negative shift, down to roughly the same isotopic level as in the Middle Permian, just at the suspected P/Tr boundary (ca. -41 to -23‰). Interestingly, the mode of isotopic excursion across the P/Tr boundary is in striking contrast to that across the K/T boundary which was recently described at Kawaruppu in Hokkaido, Japan. The apparent extent of fractionation, with respect to contemporaneous seawater sulfate, in the high ${}^{34}S/{}^{32}S$ group lies within the range of -25 ± 10‰, which is quantitatively equivalent to the currently confirmed range of kinetic isotope effect during bacterial dissimilatory sulfate reduction, and that in the low 34S/32S group mostly exceeds this range, giving the values typically in the range of $-45 \pm 10\%$, which is similar to what is generally observed in the present-day oceanic sediments. The present data would provide strong evidence for the development of a largely stagnant, anoxic, stratified ocean which presumably began to form in the lower Upper Permian and persisted into the Lower Triassic, and for a brief episode of its temporary massive mixing just at the suspected P/Tr boundary. Such an oceanic oxic-anoxic history may account to some extent for the relatively high enrichments of chalcophile elements in basal Triassic sediments in the world and add a significant constraint to the current arguments on the cause and consequence of the terminal Permian mass extinction.

KAJIWARA, Y., YAMAKITA, S., KOBAYASHI, D. and IMAI, I, 1993. Sulfur isotopic data from the Permian/Triassic boundary at Tenjinmaru in the Chichibu Terrane in eastern Shikoku, Japan. Ann. Rep., Inst. Geosci., Univ. Tsukuba, 19: 59-65.

A temporary and drastic decrease in ³⁴S/²²S ratio of whole rock sulfide has been recognized at the suspected Permian/Triassic (P/Tr) boundary at Tenjinmaru in the Chichibu Terrane in eastern Shikoku, Japan, which is characterized by the occurrence of a carbonaceous black mudstone similar in appearance to the well known, world-wide distributed, Cretaceous/ Tertiary (K/T) boundary claystones. The observed isotopic profile in the P/Tr section at the present locality is in striking contrast in mode of ³⁴S/³²S excursion to what was recently disclosed by Kajiwara and Kaiho (1991, 1992) at the K/T boundary at Kawaruppu in eastern Hokkaido, Japan, and is expected to add a significant geochemical constraint to the current arguments on the palaeoenvironmental changes during the time of terminal Permian mass extinction. In this report, we only make a brief description of the analytical data obtained, and their genetic implications will be given elsewhere.

KAMOUN, F., MARTINI, R., PEYBERNES, B. and ZANINETTI, L., 1994. Caractérisation micropaléontologique du 'Rhétien' dans l'Axe Nord-Sud (Tunisie centrale); comparaison avec le Rhétien de la dorsale et de la plate-forme Saharienne. Riv. It. Paleont. Strat., 100: 365-382.

The micropaleontologic study of the oolitic dolomites from the Fkirine Formation, outcropping along the north-south axis, allows to characterize the Upper Triassic (Norian?-Rhaetian) in Central Tunisia based on the discovery of Agathammines (*Hoyenella inconstans* and *Agathammina austroalpina*) and *Aulotortus*. This 'Rhaetian' benthic foraminiferal assemblage, well known in the Peritethyan areas and locally associated with

Gandinella falsofriedly, partially occurs in the type-locality of the Fkirine Formation ('Dorsale Tunisienne') and within the Zerzour Formation from the Saharian Shelf (Jeffara).

KAMPHAUSEN, D. and ORTLAM, D., 1993. *Heptasaurus cappelensis* (Wepfer), Stegocephalia, aus dem Oberen Buntsandstein (Trias) des Schwarzwaldes (SW-Deutschland). Jber. Mitt. oberrhein. geol. Ver., N.F., 75: 217-226.

The natural cast of a palate, formerly designated as *Capitosaurus* is described. The specimen is in all anatomic features according to *Heptasaurus cappelensis* (Wepfer). The sediments are identified as the lower part of the 'Röttone' (so 4a, Upper Bunter). The place of the discovery is presumably one of the quarries east of Freudenstadt. *Heptasaurus* is an early representative of the family Mastodonsauridae. A description of the specimen is ingenious, because there are two specimens of *Meyerosuchus* Oćev (formerly described as *Capitosaurus fuerstenberganus* H. v. Meyer 1855, T. Edinger 1937) which are very similar in the condition of conservation.

Kolar-Jurkovšek, T., 1994. Karnijski mikrofosili iz Bevškega. Geologija, 36: 61-67. (in Slovenian with English summary)

In the section west of Bevško with prevailing platy limestone the association consists of foraminifers, ostracods, conodonts and fish remains. The conodont *Neogondolella polygnathiformis* indicates the Carnian (Upper Triassic).

Kozur, H. and Mostler, H., 1994. Anisian to Middle Carnian radiolarian zonation and description of some stratigraphically important radiolarians. Geol. Palāont. Mitt. Innsbruck, Sonderbd. 3: 39-255.

Triassic radiolarian faunas have been investigated in several sections in Hungary (Balaton Highland: Felsőörs, Köveskál; Darnóhegy area between Mátra Mts. and Bükk Mts.), Italy (Passo della Gabiola, road cut between Mte. Spitz and Mte. Fallison, San Ulderico, all Vicentinian Alps; and Sosio Valley, Sicily) and Austria (Großreifling, Göstling, Öfenbachgraben). Additionally, several single samples have been investigated. They have been derived from China, Turkey, Greece, Italy, Austria, Hungary, Yugoslavia. Four families, fouteen genera, 141 species and 23 subspecies have been newly established. The biostratigraphic investigations have been concentrated on the Anisian to early Ladinian, early Longobardian to Julian, and Norian to Hettangian time intervals. The development of the radiolarian faunas from the upper Anisian and lower Ladinian is discussed in detail. The following radiolarian zones have been established: Parasepsagon robustum Zone (upper Pelsonian), Tetraspinocyrtis laevis Zone (Illyrian sensu P. trinodosus Zone), Spongosilicarmiger italicus Zone (lower Fassanian sensu 'X.' reitzi Oppel Zone, Ladinocampe multiperforata Zone (middle Fassian, ? lower part of upper Fassanian), Muelleritortis cochleata Zone (middle and upper Longobardian), Tritortis kretaensis Zone (Cordevolian, including Frankites sutherlandi Zone), Psyeudosaturniforma carnica Zone (Julian), Nakasekoellus inkensis Zone (Tuvalian), Capnodoce ruesti Zone (lower Norian), Livarella densiporata Zone (Rhaetian). Very distinct changes in the radiolarian faunas occur at the base of the 'X.' reitzi Oppel Zone, within and at the top of the Kellnerites faunas of the lower 'X.' reitzi Oppel Zone. These fundamental changes in the radiolarian faunas support the original position of the Anisian-Ladinian boundary at the base of the 'X.' reitzi Oppel Zone or at the base of the 'X.' reitzi Range Zone (= base of the A. avisianum Subzone). According to the radiolarian faunas, the A. avisianum 'Zone' is not older than the 'X.' reitzi Oppel Zone, but contemporaneous with the upper half of the 'X.' reitzi Oppel Zone. Very distinct changes in the radiolarian faunas occur also at the base of the Trachyceras archelaus Zone, at the base of the Cordevolian (including the Frankites sutherlandi Zone),

near the Lower/Middle Carnian boundary and at the base of the Sevatian (including the *Halorites macer* Zone).

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 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.subsp., *Neogondolella aldae* n.sp., *Neogondolella ensp.*, *Neogondolella n.sp.*, *Neogondolella n.sp.*, *Neogondolella n.sp.*, *Neogondolella ensp.*, *Neogondolella ensp.*, *Neogondolella ensp.*, *Neogondolella ensp.*, *Neogondolella n.sp.*, *Neogondolella n.sp.*, *Neogondolella n.sp.*, *Neogondolella n.sp.*, *Neogondolella ensp.*, *Neogondolella ensp.*, *Neogondolella ensp.*, *Neogondolella ensp.*, *Neogondolella n.sp.*, *Neogondolella ensp.*, *Neog*

KUHN-SCHNYDER, E., 1994. Bemerkungen über Pachypleurosaurier aus der Mitteltrias des Monte San Giorgio, Schweiz. Eclogae geol. Helv., 87: 1023-1027.

Pachypleurosaurus edwardsii (Cornalia) is an independent genus and species. It is not subordinated to the genus Neusticosaurus. In Neusticosaurus the whole axial skeleton shows low neural spines. Among the little Nothosaurs there are two different types: Formes with only low neural spines (Neusticosaurus) and formes with low and high neural spines (Pachypleurosaurus, Serpianosaurus). The same specification is recognized in the great Nothosaurs: Paranothosaurus with only low neural spines and Nothosaurus with both low and high neural spines. Therefore, the Monte San Giorgio Pachypleurosaurudae do not represent a monophyletic taxon, as M. Sander (1989) suggested.

LAPIERRE, H., CHARVET, J., BLEIN, O. and ROUER, O., 1994. The Permian-Triassic arc sequences of northwestern Nevada (USA): key elements in the geodynamic evolution of the Cordilleran. Bull. Soc. géol. France, 165: 541-557.

In western Nevada, two types of Palaeozoic-Triassic arc sequences are exposed. The first type known as Bilk Creek sequence consists of Carboniferous chert-quartzite arenites overlain conformably by Permian fusulinids-bearing carbonates and Triassic volcaniclastic sandstones and radiolarian cherts. The Permian arc is composed of calc-alkaline pillow basalts and tholeiitic rhyolites. The Bilk Creek Palaeozoic-Triassic arc sequence shows striking similarities with the eastern Klamath Mountains and Blue Mountains arc terranes: i.e. Permian fusulinids and Permian-Triassic radiolarian faunas; Carboniferous and Triassic siliceous and detrital sedimentation; Permian calc-alkaline mafic lavas and arc-tholeiitic rhyolites. The second type of sequence is exposed at Pine Forest Range. The Lower Carboniferous consists of detrital and volcaniclastic sediments while brachiopod and crinoid-bearing carbonates prevail in the Upper Carboniferous and Permian sequence. The Triassic beds made up of carbonates, sandstones and volcaniclastic rocks as well as calc-alkaline volcanic and pyroclastic rocks rest unconformably on the older strata. This unconformity, marked by a basal conglomerate and hard grounds on the Permian carbonate

surface, is linked to the late Permian Sonoma orogeny. The Pine Forest Palaeozoic rocks are affected like those of the northern Sierra terrane by the Sonoma orogeny. The difference between these two arc sequences lies in the presence of arc volcanism during the Triassic in the Pine Forest Range. Such a volcanism is unknown in Sierra Nevada. Thus, the intra-oceanic eastern Klamath-Blue Mountains arc sequences of Palaeozoic-Triassic age extend up to western Nevada. Similarly, the continent-based arc sequence of northern Sierra terrane can be correlated with coeval Permian arc rocks exposed in southern and western Nevada. Thus, during the late Palaeozoic-Triassic times, the North American Cordillera encompasses a complex set of mostly sub-marine arc sequences built on continental and oceanic fragments located above an oceanic subduction. The authors suggest that these various late Palaeozoic-early Mesozoic arc segments rimmed the North American craton much as the Recent Sunda-Banda arcs rim Asia and Australian cratons.

LENZENWEGER, H., 1995. Nicht alltäglich: Ein großer Ammonit aus der alpinen Trias. Fossilien, 12: 16-18.

A description of an over 70 cm large specimen of *Pinacoceras metternichi* (Hauer) from the Hallstatter Schichten (Anisian) of the Hallstatt area (Austria).

LONG, R.A. and MURRY, P.A., 1995. Late Triassic (Carnian and Norian) tetrapods from the Southwestern United States. New Mexico Mus. Nat. Hist Sci., Bull. 4: 1-254.

This book reviews the history of collection, geographic and stratigraphic distribution, and taxonomic status of the ?middle Carnian to early Norian medium- to large-sized tetrapods from the American Southwest. Buettneria perfecta is a large metoposaurid amphibian that is very common in Carnian-age sediments throughout the SW-United States. Metoposaurus bakeri is only known from one ?middle Carnian locality. The small metoposaur Apachesaurus gregorii is found primarily in strata of Norian age. The distribution of the large archosauromorph Trilophosaurus sp. and the rhynchosaur Otischalkia elderae are discussed and are differentiated. The ?procolophonian Chinleogomphius jacobsi is from the lower Petrified Forest Member of the Chinle Formation in Arizona. Six phytosaur genera are recognized from Upper Triassic deposits of the southwestern United States. These are distributed among two families. Paleorhinus is the sole American representative of the Family Mystriosuchidae. The new subfamily Paleorhininae (Paleorhinus, Arganarhinus nov.) is recognized. The paleorhinines are restricted to Carnian deposits. Highly derived mystriosuchids of the subfamily Mystriosuchinae are presently known only from Norian-age European deposits (Mystriosuchus). The remaining southwestern phytosaurs can be placed within the Family Rutiodontidae nov. American representatives of this subfamily are Angistorhinus and "A." maximus. The Subfamily Rutiodontinae nov. is more derived than the Angistorhininae. Contrary to statements of previous authors, no Rutiodon sensu stricto can be demonstrated as occurring outside the Sanford Basin of North Carolina, and this material may be restricted to ?middle Carnian-age deposits. In late Carnian-age deposits of the American southwest, two rutiodontine genera are recognized: Leptosuchus and Smilosuchus gen. nov. At present, the Rutiodontinae is restricted to Carnian deposits of North America. All identifiable Norian North American phytosaurs can be referred to the rutiodont Subfamily Pseudopalatinae nov. Southwestern pseudopalatine genera include Pseudopalatus and Arribasuchus gen. nov. The Norian phytosaur Nicrosaurus kapfii and slender snouted skulls referred to "Belodon" plieningeri can be placed within the pseudopalatinae. Seven genera of aetosaurs are recognized from the Upper Triassic of the southwest. Lucasuchus hunti gen. et sp. nov. is a large (3 m long) primitive ?middle Carnian aetosaur from Howard County, Texas. Longosuchus meadei, also from Howard County, is a 3 m long aetosaur. Stagonolepis wellesi is a common 3 to 4 m long late

Carnian aetosaur. Desmatosuchus haplocerus, a large (4 to 6 m long), massively-built aetosaur, is found within both Carnian and Norian sediments. The aetosaur Typothorax coccinarum is of Norian age. Paratypothorax is neearly entirely known on the basis of its distinctive, transversely expanded, dermal armor from the Carnian and Norian. Acaenasuchus geoffreyi gen. et sp. nov. is a very small, narrow-bodied aetosaur known only from the lower Petrified Forest Member of the Chinle Formation. Postosuchus kirkpatricki is a four- to five-meter long, heavily built, deep-skulled, short-necked quadrupedal rauisuchid. Postosuchus has been recovered from Carnian and Norian sediments throughout the southwestern United States. The 3 to 4 m long Poposaurus gracilis is a relatively rare Carnian poposaurid rauisuchian. Lythrosuchus langstoni gen. et sp.nov. is a huge (at least 5 m-long) poposaurid from the lower Dockum of Texas. Chatterjeea elegans gen. et sp. nov. is a 2 to 3 m long, gracile rauisuchian (Chatterjeeidae, fam.nov.) from the ?middle Carnian to early Norian. A specimen from Petrified Forest National Park, Arizona indicates that the range of the sphenosuchian crocodylomorph Hesperosuchus agilis extends into the early Norian. A robust, possible sphenosuchian, Parrishia mccreai gen. et sp.nov., is described from late Carnian sediments from Arizona, New Mexico, and Texas. Several unusual, evidently highly-specialized archosauromorphs are recognized from Carnian deposits. The heavily armored Doswellia kaltenbachiis reported from the lower Dockum of Texas. Acallosuchus rectori gen. et sp.nov. is a unique Carnian ?archosauromorph. Vancleavea campi gen. et sp.nov. is based on postcranial material from Carnian deposits. A single complete femur from the ?middle Carnian near Otis Chalk, Texas may represent the only ornithosuchid specimen from North America. Chindesaurus bryansmalli gen. et sp.nov. is a 2 to 3 m-long herrerasaurid dinosaur from the ?middle Carnian to early Norian of Arizona, New Mexico and Texas. It is the most primitive dinosaur from North America and an Otis Chalk occurrence represents the oldest dinosaur body fossil from the American West. Rare remains of indeterminate theropod prosauropod and ornithischian dinosaurs are also found within the Upper Triassic of the American Southwest. With the exception of the Placerias Quarry (Arizona specimens, remains of dicynodonts are extremely rare within the Carnian of the southwest, but at least two dicynodont genera occur The biostratigraphic distribution of ?middle Carnian to early Norian vertebrates from Arizona, New Mexico and Texas is discussed. Two periods of vertebrate extinction are recognized one at the ?middle Carnian-late Carnian boundary and another at the late Carnian-early Norian boundary. Each of these even was marked by extinction of more than 50% of the middle- to large sized Upper Triassic vertebrate species. We provide tentative correlations of the southwestern Triassic strata, based primarily on the distribution of vertebrate fossils.

Lu, H., JIA, D., WANG, Z., GUO, L. and ZHANG, Q., 1994. Tectonic evolution of the Dongshan terrane, Fujian Province, China. J. South Am. Earth Sci., 7: 349-365.

Many isolated metamorphic complexes in the coastal region of Fujian Province are juxtaposed with the Mesozoic volcanic rocks in the interior mountainous region of Fujian. The metamorphic rock belts comprise the Dongshan terrane. The protoliths, an early Paleozoic volcanic arc assemblage, were metamorphosed to high greenschist facies and low amphibolite facies during Late Triassic to Middle Jurassic time. At the same time, the Dongshan Terrane amalgamated with the Changchun seamount, and a composite terrane, the Min-Tai Terrane, was formed. The Min-Tai Terrane represented a microcontinent at the juncture of the paleo-Pacific and Tethys oceans. It migrated northward as a part of the subducting Kula plate until it collided with the southeast tank of the Late Jurassic-Early Cretaceous Zhejiang-Fujian volcanic arc during the late Early Cretaceous.

Lucas, S.G., 1994. Triassic tetrapod extinctions and the compiled correlation effect. Pangea: Global Environment and Resources, Canadian Soc. Petrol. Geol., Mem. 17: 869-875.

Most published correlations are at the level of stage-age and do not allow the resolution of patterns of extinction over shorter time intervals. The temporal ranges of taxa in global (or regional) literature compilations are only as precise as the published relative age data, and this produces a compiled correlation effect (CCE). The CCE not only obscures the complexity and duration of some mass extinctions, but it can also 'create' a mass extinction as a methodological artifact of compilation. Elimination of the CCE reveals the Permo-Triassic tetrapod 'extinction' to have been a long and complex evolutionary turnover. Without the CCE there is no evidence for a tetrapod extinction at the Carnian-Norian boundary. Detailed evidence of a tetrapod extinction at the Triassic-Jurassic boundary has not been discovered.

LUCAS, S.G. and ANDERSON, O.J., 1994. The Camp Springs Member, base of the Late Triassic Dockum Formation in West Texas. West Texas geol. Soc. Bull., 34: 5-15.

The oldest strata of the Late Triassic Dockum Formation in West Texas are assigned to the Camp Springs Member, which is up to 15 m thick and is dominantly micaceous litharenite, arkose, and extrabasinal siliceous conglomerate. This conglomeratic unit is a distinctive marker bed throughout most of West Texas that allows easy recognition of the Permian-Triassic boundary. It rests with profound unconformity on Late Permian strata and is disconformably overlain by red beds of the latan or Tecovas Members of the Dockum Formation. Fossil vertebrates (*Metoposaurus, Paleorhinus*) from the Camp Springs Member indicate it is of late Carnian (Tuvalian) age. Rising base level resulted in Camp Springs deposition by rivers on an incised topography developed in Late Permian strata. The base of the Dockum Formation is rarely a mudstone or siltstone. No Early or Middle Triassic strata are known in West Texas where the Permian-Triassic contact is a profound unconformity that represents about 25 million years.

LUCAS, S.G. and HECKERT, A.B., 1994. Triassic stratigraphy in the Lucero uplift, Cibola, Valencia and Socorro Counties, New Mexico. New Mexico geol. Soc. Guidebook, 45th Field Conference, Mogollon Slope, West-Central New Mexico and East-Central Arizona, pp. 241-254.

Triassic strata exposed in the Lucero uplift of Cibola, Valencia and Socorro Counties are nonmarine red beds of the Moenkopi Formation and Chinle Group. Moenkopi Formation strata disconformably overlie Middle Permian (Guadalupian) limestones and dolomites of the San Andres Formation and are mostly grayish red, trough-crossbedded and ripplelaminated micaceous litharenites intercalated with beds of intraformational conglomerate and grayish red, micaceous siltstone and mudstone. Charophytes, ostracods and capitosauroid amphibians indicate the Moenkopi Formation in the Luccro uplift is of Middle Triassic (early Anisian) age. Overlying Chinle Group strata consist of (ascending) the Shinarump, Bluewater Creek, Petrified Forest, Owl Rock and Rock Point Formations. In the Lucero uplift, strata of the San Pedro Arroyo Formation laterally replace Bluewater Creek Formation strata south of the Rio Salado. Shinarump Formation strata are extrabasinal conglomerates (mostly Paleozoic limestone clasts) and sandstones as much as 17 m thick that disconformably overlie Moenkopi strata. Locally, pedogenically modified sandstones, conglomerates and siltstones - the 'mottled strata' - laterally replace Shinarump conglomerates and sandstones. Bluewater Creek Formation strata are at least 70 m thick and are mostly reddish brown siltstones, mudstones and ripple-lami-nated sandstones The distinctive McGaffey Member - 5-6 m of mostly ripple-laminated sandstone - is present in the upper half of the Bluewater Creek Formation in the northern part of the Lucero uplift. Below the McGaffey Member, the Bluewater Creek Formation contains an Adamanian (late Carnian) tetrapod fauna that includes cf. *Buettneria*, indeterminate phytosaurs and *Stagonolepis*. The base of the Petrified Forest Formation in the Lucero uplift is the Sonsela Member; evidently the Blue Mesa Member has been removed by erosion at the pre-Sonsela unconformity. Sonsela strata are as much as 15 m thick and are mostly trough-crossbedded micaceous litharenite and intrabasinal calcrete-pebble conglomerate. Overlying Painted Desert Member strata are mostly reddish-brown bentonitic mudstone at least 100 m thick. Owl Rock and Rock Point strata are only exposed in the Petaca Pinta area (SW 1/4 T6N, R6W and SE 1/4 T6N, R7W). The Owl Rock is mostly grayish-red and very pale green, calcareous mudstone and grayish-red purple bioturbated sandy siltstone and is up to 37 m thick. Rock Point strata are up to 70 m thick and consist of laterally extensive beds of massive, moderate-reddish brown sandy siltstone and laminar to trough-crossbedded moderate reddish brown quartzose sandstone.

LUCAS, S.G. and HUBER, P., 1994. Sequence stratigraphic correlation of Upper Triassic marine and nonmarine strata, western United States and Europe. Pangea: Global Environment and Resources, Canadian Soc. Petrol. Geol., Mem. 17: 241-254.

Upper Triassic strata of the nonmarine Chinle Group, the marine/nonmarine Star Peak and Auld Lang Syne Groups (western United States) and the nonmarine Germanic Keuper and marine/nonmarine Alpine Triassic comprise third order sequences that can be divided into systems tracts. Nonmarine sequences of these strata begin with fluvial conglomerate and sandsheets that represent infilling of incised topography, overlain by fluvio-lacustrine clastics (TST), with HSTs of pedoturbated/paludal siltstone and/or sheet sands that display offlap geometry. Marine sequences of these regions contain more heterogeneous facies that define either unconformity bounded, upward deepening cycles, or more discrete transgressive-regressive cycles. The nonmarine and marine sequences of these regions can be correlated by tetrapod and ammonoid biochronologies. These correlations suggest that during the Late Triassic third order global eustatic cycles significantly influenced sedimentation in nonmarine basins far inland from strandline areas.

LUCAS, S.G. and HUNT, A.P., 1994. The chronology and paleobiogeography of mammalian origins. In: N.C. Fraser and H.-D. Sues, In the shadow of the dinosaurs, Cambridge University Press, pp. 335-351.

During the past decade there has been renewed interest in the origin of mammals, prompted by new discoveries and by new analyses, especially cladistic, of mammalian phylogeny. Recent hypotheses concerning the phylogeny of the earliest mammals (e.g., Rowe 1988; Hopson, 1991; Wible, 1991; Crompton and Luo, 1993) have been based solely on morphological data and have not been discussed in light of the chronological and paleogeographic distribution of non-mammalian cynodonts and mammals. To facilitate such discussion, the authors review the chronology and geographic distribution of the earliest mammals (those of Late Triassic and Early Jurassic age) and the most advanced non-mammalian cynodonts, the Traversodontidae, Tritylodontidae, and Tritheledontidae. They first review the geographic distributional data for these groups, present a group-by-group summary, and conclude with a discussion of the implications of these data for paleobiogeography and current phylogenies of mammalian origins.

MACNAUGHTON, R.B. and PICKERILL, R.K., 1995. Invertebrate ichnology of the nonmarine Lepreau formation (Triassic), southern New Brunswick, Eastern Canada. J. Paleont., 69: 160-171.

Alluvial fan and braided fluvial redbeds of the Triassic Lepreau Formation of southern New Brunswick, eastern Canada, contain a moderately diverse and abundant invertebrate ichnofauna. Fourteen formal ichnotaxa are recognized: *Ancorichnus coronus, Ancorichnus*

cf. ancorichnus, Aulichnites isp., Cruziana problematica, Fuersichnus isp., Gordia marina, Palaeophycus striatus, Palaeophycus isp., Planolites isp., Rusophycus isp., Skolithos linearis, cf. Skolithos isp., and Taenidium isp. Two vernacular ichnotaxa, 'inclined meniscate burrows' and 'surface pit structures,' also occur. All these ichnotaxa are figured and briefly described. Collectively, the entire assemblage can confidently be assigned to the Scoyenia ichnofacies that, in the Lepreau Formation, represents a fluvial channel ichnocoenose. Specimens have been subject to marked taphonomic effects due to weathering and preservation in lithologies showing either insufficient variation in grain size or a grain size too coarse to preserve subtle morphological variations; as a consequence, ichnotaxobases are commonly obscured or obliterated. This may have influenced the apparent diversity of the assemblage, especially with regard to meniscate and simple horizontal burrows. It is proposed that application of 'taphoseries', theoretical series including ichnotaxa that may potentially be mistaken for each other with increasing taphonomic overprint, provides a safeguard against ichnotaxonomic misidentifications.

MADER, D., 1995. Aeolian and adhesion morphodynamics and phytoecology in recent coastal and inland sand and snow flats and dunes from mainly North Sea and Baltic Sea to Mars and Venus. Peter Lang/Europäischer Verlag der Wissenschaften, Frankfurt am Main, 2348 pp. (2 volumes).

A very voluminous contribution on aeolian and adhesion morphodynamics and phytoecology in recent coastal and snow flats and dunes from The Netherlands to Russia and the U.S.A. Comparisons are made with the Rotliegend, Buntsandstein and Keuper.

MADER, D., 1995. Taphonomy, sedimentology and genesis of plant fossil deposit types in Lettenkohle (lower Keuper) and Schilfsandstein (middle Keuper) in Lower Franconia (Germany). Peter Lang/ Europäischer Verlag der Wissenschaften, Frankfurt am Main, xvi + 164 pp.

A taphonomical and sedimentological approach of the well known Keuper floras from Franconia, primarily on the basis of fossil plant material collected by K.P. Kelber.

MATTERN, F., 1993. Late Carboniferous to early Triassic shear sense reversals at strike-slip faults in eastern Bavaria. Zbl. Geol. Paläont. Teil I, 1993 (9/10): 1471-1490.

Analyses of mylonite fabrics and the fault pattern as well as considerations of radiometric data reveal that dextral slip occurred at the East Bavarian shear zone during the late Carboniferous. During the Rotliegend, northern parts of that shear zone were reactivated left-laterally. Finally, dextral movements are documented again for the early Triassic. Mylonite fabrics which reflect the reversal of the shear sense from dextral to sinistral are depicted.

MAY, A., 1994. Ein problematisches Mikrofossil aus dem Oberen Muschelkalk Ost-Westfalens. Dortmunder Beitr. Landeskde., naturwiss. Mitt., 28: 33-42.

The 'Trochitenkalk' and the 'Terebratelkalk' limestones of the upper Muschelkalk from Eastern Westphalia frequently contain a problematical microfossil. Up to now, it was known only from the upper Muschelkalk of Southern Germany. This problematical microfossil is interpreted as sparite-filled tube-like cavities of filamentous algae. This microfossil occurs preferentially in special microfacies types (floatstones and wackestones of shells and ooids). It probably increased the micrite content of these microfacies types by binding the sediment. In this paper short information is given about the microfacies types and the sedimentary environment.

MCROBERTS, C.A. and NEWTON, C.R., 1995. Selective extinction among end-Triassic European bivalves. Geology, 23: 102-104.

Ongoing controversies surrounding the end-Triassic extinction highlight the need for identifying a causal mechanism leading to extinction. Bivalve data from Lombardia (Italy), Northern Calcareous Alps (Austria and Germany), and northwest Europe (England and Wales) provide the biologic signal of selective extinction to compare two competing extinction hypotheses: (1) sea-level change and associated anoxia and (2) reduced primary productivity. The end-Triassic extinction eliminated 71% of Lombardian species, 85% of northern alpine species, and 90% of northwest European species. The extinction was independent of body size and geographic distribution. With respect to living habits, species from the three regions show a significantly greater proportion of infaunal bivalve extinction. The greater survival of epifaunal bivalves is correlated to their more efficient feeding and suggests that the infaunal bivalves may not have been able to meet their nutritional requirements. This pattern of selective extinction is inconsistent with anoxia and/or sealevel change as a causal factor in which higher survival of infaunal detritus and filter feeders would be predicted. Instead, the pattern is consistent with a reduction of primary productivity. Several regional and global mechanisms, including bolide impact, would have been capable of altering primary productivity levels to affect the food sources for Late Triassic bivalves, thus leading to extinction.

MEDINA, F., AHMAMOU, M. and EL FARIATI, A., 1993. Superimposed compressional and extensional tectonics in the Triassic formations at the southwestern termination of the Tizi n'Test fault zone (western High Atlas, Morocco). Gaia, 7: 6-17.

The study of the southern part of the Argana valley, where the Oued Issen fault, one of the segments of the Tizi n'Test fault zone dies out, allows determining two superimposed episodes of deformation. The first is a NW-SE to ENE-WSW extension related to the early rifting of the Central Atlantic, to which are related eastward-dipping normal faults unmapped before. These faults show moderate to low-angle planes remobilizing former Hercynian thrusts. In addition to the syndepositional small-scale faulting, large-scale paroxysmal faulting occurred before the Late Triassic and during the earliest Liassic. The second episode is a NNE-SSW to NNW-SSE compression to which are related folds and reverse and strike-slip faults. The Oued Issen fault appears to have played a minor role during the Triassic, as a transfer fault, without important horizontal displacement. In Tertiary times, it acted as a reverse fault with a slight sinistral component (only 1 km). Therefore, the main segment of the Tizi n'Test fault zone, offsetting the Mesozoic series of the EI Jadida-Agadir and EI Ayoun-Tarfaya basins, which outcrops further east, near Time Mellil, must be located south of the studied area.

MERCURY, J.-P., BONIN, B., BARDINTZEFF, J.-M. and PLATEVOET, B., 1994. the Monte Cinto cauldron: a detailed section of the Permo-Triassic volcanic deposits within the Upper Asco Valley (Corsica). Géol. France, 2: 3-19.

Western Corsica constitutes the northern part (150 km x 50 km) of the 400 km-long, 50 km-wide Corsican-Sardinian batholith (Ghezzo et al., 1989). It is made up of two contrasting Carboniferous magma suites (Orsini, 1980; Rossi and Cocherie, 1991). The earlier Lower to Middle Carboniferous suite (Marre et al., 1982; Cocherie et al., 1992), is of Mg-K calc-alkaline (MKCA) composition (Ferré, 1989), whereas the later, Middle to Upper Carboniferous suite (Cocherie, 1984), is dominantly calc-alkaline (CASS) (Bralia et al., 1980; Poli et al., 1989). The plutonic rocks intruded Lower Palaeozoic metamorphic units, now preserved as enclaves and rafts (Palagi et al., 1985; Ménot and Orsini, 1990).

MICHALÍK, J., 1994. Shell ultrastructure of the Rhaetian rhynchonellid brachiopods. Acta Universitatis Carolinae-Geologica, 1-2: 151-153.

MONOSTORI, N., 1994. Ostracod evidence of the Carnian salinity crisis in the Balaton Highland, Hungary. N. Jb. Geol. Palāont. Abh., 1993(3): 311-331.

In 1990 Gierry et al. demonstrated a major salinity crisis in the Carnian of the Western Tethys. During the investigation of the Upper Julian-Tuvalian Sándorhegy Limestone (Balaton Highland, Hungary) ostracod associations have been found indicating this salinity crisis. The *Kerocythere-Renngartenella - Simeonella* predominance line is a signal of the developing salinity crisis. The systematic part contains the descriptions of nineteen species (five of them are new).

MORAD, S., BEN ISMAIL, H.N., DE ROS, L.F., AL-AASM, I.S. and SERRHINI, N.-E., 1994. Diagenesis and formation water chemistry of Triassic reservoir sandstones from southern Tunisia. Sedimentology, 41: 1253-1272.

The fluvial Triassic reservoir subarkoses and arkoses (2409-5-2519-45 m) of the El Borma oilfield, southern Tunisia, were subjected to cementation by haematite, anatase, infiltrated clays, kaolinite and K-feldspar at shallow burial depths from meteoric waters. Subsequently, basinal brines controlled the diagenetic evolution of the sandstones and resulted initially in the precipitation of quartz overgrowths, magnesian siderite, minor ferroan magnesite and anhydrite. The enrichment of siderite in ¹²C isotope ($\delta^{13}C_{ros} = -14.5$ to -9%) results from derivation of carbon from the thermal decarboxylation of organic matter. During further burial, the precipitation of dickite and pervasive transformation of kaolinite into dickite occurred, followed by the formation of microcrystalline K-feldspar and quartz, chlorite and illite, prior to the emplacement of oil. Present day formation waters are Na-Ca-Cl brines evolved by the evaporation of seawater and water/mineral interaction and are in equilibrium with the deep burial ≤ 3.1 km) minerals. These waters are suggested to be derived from the underlying Silurian and Devonian dolomitic mudstones.

MUTTONI, G., CHANNELL, J.E.T., NICORA, A. and RETTORI, R., 1994. Magnetostratigraphy and biostratigraphy of an Anisian-Ladinian (Middle Triassic) boundary section from Hydra (Greece). Palaeogeogr. Palaeoclimatol. Palaeoecol., 111: 249-262.

On the island of Hydra, the Anisian/Ladinian boundary is exposed in a 24 m thick section of nodular reddish Han-Bulog Limestone. This paper is focused on the magnetostratigraphy and conodont biostratigraphy of this section. The Anisian/Ladinian boundary is defined by the First Appearance Datum (FAD) of the conodont species *Gondolella trammeri* Kozur (base of the Nevadites ammonoid zone), and occurs in a normal polarity zone. Microfacies analysis has distinguished a lower and upper lithofacies recording gradual shallowing from pelagic conditions to a platform margin paleoenvironment.

MZOUGHI, M., KILANI-MAZRAOUI, F. and PEYBERNES, B., 1994. Micropaleontologic evidences of Triassic series within the offshore wells from the Gulf of Gabès (Tunisia). Geobios, 27(4): 413-420.

An offshore well, close to Djerba (Gulf of Gabès, Tunisia), has penetrated a 560 m thick series of Triassic rocks, that can be subdivided into five lithologic units including carbonates and/or clays and sandstones. Thanks to their palynomorphs and their benthonic foraminifera, mainly Involutinacea, some units can be dated within the late Scythian-Carnian interval and compared to the formations known in the onshore wells or in the outcrops from the Southern Saharian Shelf, as well in Tunisia as in Libya.

ORCHARD, M., 1994. Late Triassic (Norian) conodonts from Peru. Palaeontographica, Abt. A, 233: 203-208.

A newly obtained Late Triassic conodont collection from the lower Pucará Group of central Peru is characterized by *Epigondolella mosheri* Kozur & Mostler, within which new morphotypes A and B are distinguished. The specimens from Peru are referred to morphotype B, the North American occurrences of which suggest that the Peru fauna is referable to the Upper *bidentata* Zone of the Late Norian, which correlates with the Amoenum Zone of the ammonoid standard. The only previously described Triassic conodonts from Peru are also Late Norian but may represent the slightly older Lower *bidentata* Zone.

ORCHARD, M.J., 1995. Taxonomy and correlation of Lower Triassic (Spathian) segminate conodonts from Oman and revision of some species of *Neospathodus*. J. Paleont., 69: 110-122.

Exceptionally well preserved Lower Triassic conodonts from Oman include an array of Neospathodus species, many of which are new. Those from the upper Lower Triassic, or Spathian, are described in conjunction with a restudy of conodont type material from Chios, Greece, and an assessment of contemporary collections from Pakistan and western North America. The taxonomic scope of three key species from Chios, Neospathodus homeri, N. triangularis, and N. gondolelloides, is revised. Seven new species are described from Oman: N. abruptus, N. brevissimus, N. brochus, N. crassatus, N. curtatus, N. pusillus and N. symmetricus; and one new species, N. clinatus, is described from Pakistan. The allied Icriospathodus collinsoni is also described from Oman. The occurrence and range of Neospathodus species are presented in the context of the ammonoid succession in the Spathian of North America. Both N. homeri and N. triangularis, as revised, have shorter ranges and are more age diagnostic than previously thought. Neospathodus gondolelloides is a distinct taxon, and not synonymous with Chiosella timorensis. Five informal faunal divisions are identified based on Neospathodus and allied species. In ascending stratigraphic order, these are typified by Icriospathodus collinsoni, Neospathodus homeri, N. triangularis, N. symmetricus, and N. gondolelloides. Oman collections represent three of these faunas, which occur also in the Columbites through Prohungarites/Subcolumbites ammonoid beds of western U.S.A.

PASQUINI, C. and VERCESI, P.M., 1993. The M. Spinale and Pietra Grande Rhaetian (Madonna di Campiglio). Stratigraphic-sedimentological characters and paleogeographic considerations. Natura Bresciana, Ann. Mus. Civ. Sc. Nat., Brescia, 29: 5-20.

The so-called «Rhaetian» deposits of the north-west area of the Dolomiti di Brenta (western Trentino region, Southern Alps) are examined. They are subdivided into two new formations: the «Formazione del Graffer» and the «Calcare degli Orti della Regina». The lower unit (Formazione del Graffer), about 100 metres thick, is very rich in marl and clay. The upper formation (Calcare degli Orti della Regina), about 200 metres thick, chiefly consists of limestone and dolomite and it is characterized by peritidal shallowing-upward cyclicity, with subtidal fossiliferous bioturbated limestone overlain by supratidal stromato-litic dolomite. Both the formations exhibit intermediate characters between the coeval Lombardian sequences to the west, and the Venetian sequences to the east. The former is characterized by a very thick succession partly basinal in nature, and consists of alternations of limestone and claystone; the latter is represented by peritidal dolomites (Dolomia Principale), fully carbonatic in lithology, classically referred to a tidal flat environment. Among the main tectonic dislocations observed, the most important seems to be the «Vedretta dei Camosci» Line, normal fault, laid at the Lias, which has caused the lowering

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of the west area. The paleogeographic considerations have led to the identification during the Rhaetic of a depositional slope structure of the basin, caused by a sequence of normal faults, with the lower area at west.

POLLARD, D. and SCHULZ, M., 1994. A model for the potential locations of Triassic evaporite basins driven by palaeoclimatic GCM simulations. Global and Planetary Change, 9: 233-249.

A simple model of evaporite basins is driven by seasonal meteorological forcing from general circulation model (GCM) simulations of the Triassic climate. The basin model bridges the gap between the GCM meteorology and (some of) the physical processes involved in evaporite deposition that are not included in the GCM. It serves as an explicit objective link between the large-scale GCM results and the small-scale occurrences of a particular climate proxy. The model consists of a single column of saline lake water at each GCM grid point. Negative annual precipitation minus evaporation at the lake surface is interpreted as a necessary condition for the formation of Triassic evaporite deposits. Good agreement is found between observed and predicted evaporite sites in the Carnian (225 Ma), with less agreement in the Scythian (245 Ma). We suggest that some of the disagreements may be due to the lack of small-scale topography and the lack of ocean dynamics in the GCM. The basic approach of using secondary land-surface models in conjunction with GCM meteorology could also be profitable for other palaeoclimatic proxies such as coal, bauxites and karsts. We briefly discuss the importance of more objective methods for validating model maps against observed proxy distributions, the desirability of predicting both necessary and sufficient conditions for proxy formation, and uncertainties due to spatially incomplete geologic sampling.

RAMOVŠ, A., 1994. Epigondolella abneptis and E. spatulata in the Lower Norian in the central Kamnik Alps, Slovenia. Geologija, 36: 69-74.

Epigondolella abneptis (Huckriede 1958) and *E. spatulata* (Hayashi 1968) from the Lower Norian (Upper Triassic) deeper marine micritic limestones with chert nodules and lenses in the locality Sleme, central Kamnik Alps, are presented.

RAMOVŠ, A., 1994. Karnische Conodonten (Obertrias) vom Rjavčevgraben, Julische Alpen. Die Frage des dortigen Auftretens von *Epigondolella abneptis*. Rudar.-Metal. Zbornik, 41: 19-23.

Black tabular Karnian limestones have yielded the following conodonts: *Epigondolella nodosa* (Hayashi 1968) and *Paragondolella polygnathiformnis* (Budurov & Stepanov 1958). *Epigondolella abneptis* (Huckriede 1958) has not been found in the studied samples.

RAMOVŠ, A., 1994. Eine Obertrias-Conodontenfauna (Karnium) aus dem unteren Abschnitt der "Kalke und Dolomite von Železniki" (Eisnern, West-Slowenien). Abh. Geol. B.A., 50: 381-385.

In the lower portion of the Kossmat's limestones and dolomites of Železniki (Eisnern) west of Škofja Loka, West Slovenia, the black and dark gray micritic limestones contain the following platform conodonts: *Epigondolella nodosa* (Hayashi 1968), *Gladigondolella malayensis* Nogami 1968 and *Paragondolella tadpole* (Hayashi 1968). The Upper Carnian (*E. nodosa* - A.Z.) is proved by these remains. *G. malayensis*, which does not range higher than Middle Carnian, must consequently be retransported. Owing to the stratigraphic position of 'limestones and dolomites of Železniki' this lithostratigraphic unit should not be correlated with the Norian and Rhaetian Bača Dolomite with chert.

RAMOVŠ, A., 1994. Mitteltrias- (Ladin)-Conodonten von Pečevje, nordöstlich von Ljubljana (Slovenien). Razprave IV. cl. Akad. Sci. Art. Slovenica, 35: 111-119.

Ladinian black tabular limestones from the Pečevje locality north of Lukovica and the Orni

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Graben contain the conodonts *Budorovignathus mungoensis* (Diebel 1956) and *Paragon-dolella inclinata* (Kovács 1983). South of the Orni Graben several outcrops in the same limestones yielded only *Pseudofurnishius marcianus* Van den Boogaard 1966.

RAMOVŠ, A., 1994. Conodonten aus den obersten Amphiclinen-Schichten und die Karn/Nor-Grenze im voralpinen Raum der Julischen Alpen. Razprave IV. cl. Akad. Sci. Art. Slovenica, 35: 101-109.

On the northern side of the Otavnik stream, NW of Cerkno (western Slovenia), the darkgrey micritic limestones of the *Amphiclina* Beds contain platform the conodonts *Epigondolella triangularis triangularis* (Budurov 1973) and *Metapolygnathus slovenicus* n.sp. *E. triangularis* indicates an early Norian age. The Karnian-Norian boundary is thus situated in the upper part of the *Amphiclina* Beds and does not correspond with the lithological boundary between the *Amphiclina* Beds and the Bača Dolomite.

RAMOVŠ, A., 1994. Mitteltrias- (Longobard)-Kalke mit *Budurovignathus mostleri* (Conodonta) von Šurkovac bei Ljubija, Nordwest-Bosnien. Razprave IV. cl. Akad. Sci. Art. Slovenica, 35: 121-127.

Black, well stratified micritic limestones of Šurkovac north of Ljubija, east of Prijedor (NW Bosnia) have yielded an interesting small conodont fauna. *Budurovignathus mostleri* (Kozur 1972) indicates upper Longobardian, *Budurovignathus diebeli* Assemblage-Zone.

RENESTO, S., 1994. A new prolacertiform reptile from the Late Triassic of Northern Italy. Riv. It. Paleont. Strat., 100: 285-306.

A new diapsid reptile is described from the locality of Cene (Seriana Valley, near Bergamo, Lombardy, Northern Italy) from an outcrop of the Zorzino Limestone Formation (Middle Norian, Late Triassic). It is based on virtually identical specimens, differing only in size. Analysis of available diagnostic characters allows it to be included in the Prolacertiformes, representing a new genus and species, *Langobardisaurus pandolfii* probably related to *Macrocnemus*, possibly to *Cosesaurus*, and to the Tanystropheidae. It is assumed here that *L. pandolfii* was adapted to a terrestrial mode of life and probably to an insectivorous diet.

REIN, S., 1994. Bißverletzungen auf Ceratitensteinkernen. Veröff. Naturhist. Mus. Schleusingen, 9: 85-90.

Structures on casts of several species *Ceratites* from the Thuringian Muschelkalk are interpreted as regenerated bite infractions.

RIEPPEL, **O.**, 1994. The status of the sauropterygian reptile *Nothosaurus juvenilis* from the Middle Triassic of Germany. Palaeontology, 37: 733-745.

The holotype and only known specimen of *Nothosaurus juvenilis* from the Hauptmuschelkalk of Germany is redescribed and compared with the type material of all other *Nothosaurus* species described from the Muschelkalk of central Europe. *N. juvenilis* proves to be a valid species diagnosed by morphological features and by cranial proportions, as well as by its small overall size. It overlaps in stratigraphical and geographical distribution with a medium-sized and a large species of the genus *Nothosaurus*, and thus provides the first evidence for niche partitioning among coexisting species of that genus.

RIEPPEL, **O.**, 1995. The status of *Anarosaurus multidentatus* Von Huene (Reptilia, Sauropterygia), from the Lower Anisian of the Lechtaler Alps (Arlberg, Austria). Paläont. Z., 69: 289-299.

The holotype of Anarosaurus multidentatus von Huene (1958) from the lowermost Anisian

of the Austrian Alps is redescribed and referred to the genus *Cymatosaurus*. Eusauropterygian characters shared by A. multidentatus are, the elongated and broadened symphesis, and the contours of the lower jaw suggesting the presence of a constricted snout. Morphological details of the lower jaw symphysis show A. multidentatus to be close to *Cymatosaurus* among stem-group sauropterygians. *Cymatosaurus multidentatus* is the only representative of its genus known so far from the Alpine Triassic, and it represents the earliest known sauropterygian from the Alpine Triassic.

ROBERTS, A.M., YIELDING, G., KUSZNIR, N.J., WALKER, I.M. and DORN-LOPEZ, D., 1995. Quantitative analysis of Triassic extension in the northern Viking Graben. J. Geol. Soc. London, 152: 15-26.

It has been recognized for over a decade that large-displacement, pre-Jurassic faults are present in the Northern Viking Graben, part of the North Sea rift. These faults define a series of major fault-blocks below the more obvious Jurassic rift basin. The authors attempt here to quantify the amount of extension associated with this older rift event, which is probably of early Triassic age. Quantitative modelling of the Triassic rift and the succeeding period of thermal subsidence has been undertaken, using a combination of flexural backstripping and flexural-cantilever forward modelling. These techniques suggest that Triassic extension across the Horda Platform (Norwegian sector) reached c. 40% (β = 1.4). The consequences of this extension were deposition of a thick (>3 km) Triassic-Upper Jurassic syn-rift and post-rift sequence, prior to renewed, but minor, extension in the Late Jurassic-earliest Cretaceous. The thickness of the Viking Group reservoirs in the Troll area appears to have been almost entirely controlled by sediment loading during post-Triassic thermal subsidence. Jurassic extension on the Horda Platform was <5%, an order of magnitude less than the Triassic event. The Horda Platform is therefore principally an area of Triassic extension marginal to the main Jurassic rift further west. In the UK sector of the Viking Graben, Triassic structures are less obvious than those below the Horda Platform, because of Jurassic overprinting. They are, however, still present. Average Triassic extension across the East Shetland Basin was c. 15%, comparable with the magnitude of Jurassic extension in the same area. The authors believe that the Tern/Eider and Cormorant fault-blocks, with proven shallow basement, comprised a large eroded horst during the early Triassic, uplifted in the footwalls of major faults flanking the Magnus and Statfjord half-graben. During the Triassic, the Magnus half-graben was contiguous with the Unst Basin, now situated in the western footwall of the younger Jurassic basin. The presence of the Unst Basin suggests that Triassic extension occurred across the area that is now the northern Shetland Platform, continuing into the West Shetland area. Although the more obvious structures in the Viking Graben are Jurassic in age, the earlier Triassic event was equally as important in controlling the structural and stratigraphic history of the basin.

SANDY, M.R., 1994. Triassic-Jurassic articulate brachiopods from the Pucará Group, central Peru, and description of the brachidial net in the spiriferid *Spondylospira*. Palaeontographica, Abt. A, 233: 99-126.

Brachiopods collected from a number of localities in the Late Triassic (Norian) to Early Jurassic (Sinemurian-Pliensbachian) interval of the Pucará Group of central Peru are described. The following taxa are identified from the Late Triassic (Norian): the spiriferids *Spondylospira lewesensis* (Lees), *Spondylospira* sp.nov., *Zugmayerella koerneri* sp.nov.; the rhynchonellids *Fissirhynchia* cf. *F. fissicostata* (Suess), *Fissirhynchia* aff. *F. fissicostata* (Suess); the terebratulids *Loboidothyris* cf. *L. peruviensis* sp.nov., *?Lobothyris* triassicus sp.nov., *?Lobothyris* cf. *L. praepunctata* (Bittner), *?Pamirothyris* cf. *P. kushlini* (Dapys).

?Laevithyris cf. L. rossochae (Dagys); and the terebratellid Eodallina peruviana Elliot. From the Early Jurassic the terebratulid Loboidothyris peruviensis sp.nov. is described. The brachidial net is described from the spiriferid Spondylospira. It is a centrally located reticulate structure flanking the lateral and anterior sides of the base of the brachidium, and attached to the shell and brachidium of the brachial valve. The brachidial net consists of strands arranged in polygons which have long axes in the order of 0.2-0.7 mm. The brachidial net is believed to have been secreted by mantle tissue and may have acted either as a calcified mantle support/body wall or brachidium support. The genera represented in the Pucará Group are widespread forms, the exception being Spondylospira which characterises New World faunas. The presence of the spiriferids Spondylospira lewesensis (Lees), Spondylospira sp.nov., Zugmayerella koerneri sp.nov.; the rhynchonellids Fissirhynchia cf. F. fissicostata (Suess), Fissirhynchia aff. F. fissicostata (Suess); the terebratulids Loboidothyris cf. L. peruviensis sp.nov., ?Lobothyris triassicus sp.nov., ?Lobothyris cf. L. praepunctata (Bittner), ?Pamirothyris cf. P. kushlini (Dagys), ?Laevithyris cf. L. rossochae (Dagys); and the terebratellid Eodallina peruviana Elliot are supportive of a Late Triassic (Norian, or Norian-Rhaetian) age for a number of localities. Previous reports of a possible Early Jurassic age for Spondylospira from the Pucará Group have not been substantiated.

SANDY, M.R., 1994. Outstanding examples of color banding in the brachiopod *Coenothyris* - sitting pretty in the Triassic. (Abstract of lecture during the 1994 Annual Meeting of The Geological Society of America, Seattle, Washington.)

The presence of color banding in brachiopods now referred to species of the brachiopod genus Coenothyris was reported from the Muschelkalk (Middle Triassic) of Germany as early as 1845 (Alberti), and described in detail from southern France in 1925 (Fischer). Color banded specimens of Coenothyris are not rare, e.g., in the Upper 'Terebratula' Bed (Ladinian) a collection of 88% of 345 specimens of Coenothyris vulgaris from one locality show traces of color banding (probably all were color banded). Color banding is present throughout growth of the specimens, although is most commonly preserved at valve margins as a consequence of preservational history (e.g., Recent surficial weathering). It is possible that the relative abundance and strength of color banding in Coeno-thyris from the Upper 'Terebratula' Bed could be related to bathymetry. However. differ-entiating these variables from preservational/diagenetic influences is perhaps a subjective matter. Why so many specimens of this genus of terebratulid brachiopod should have traces of color patterns preserved in the Muschelkalk of Germany (e.g. Baden Württemburg) and France (Toulon region) is difficult to explain. The phenomenon is also known on specimens from the Lower Muschelkalk (Anisian, Pelsonian) of Upper Silesia, Poland. Presumably exceptional preservation of original or little altered shell material has been commonplace in these regions. The brachiopods are preserved in areas devoid of major tectonic disturbance in carbonates and calcareous shales of shallow-water origin.

SANDY, M.R. and STANLEY JR., G.D., 1993. Late Triassic brachiopods from the Luning Formation, Nevada, and their palaeobiogeographical significance. Palaeontology, 36: 439-480.

Brachiopods from the Late Triassic Luning Formation are described from localities in the Pilot and Shoshone Mountains, Nevada. The spiriferids *Balatonospira?* cf. *B. lipoldi, Zugmayerella unicata, ?Z.* sp., *Spondylospira lewesensis*, and the terebratulids *Plectoconcha aequiplicata, P. newbyi* sp.nov., *Rhaelina gregaria, R.* cf. *R. gregaria* and *Zeilleria* cf. *Z. elliptica* are described. This Luning fauna contains species known from western Europe (*Z. uncinata* and *R. gregaria*) and forms closely comparable to species known from western Europe are also present (*B.?* cf. *B. lipoldi* and *Z.* cf. *Z. elliptica*. Other species are

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only known from the Americas, *S. lewesensis* from displaced terranes in the cordilleran region of North America and from Peru, *P. aequiplicata* and *P. newbyi* sp.nov. from the displaced Paradise terrane of Nevada. Some of the brachiopods and associated corals, bivalves and foraminifers are conspecific with latest Triassic forms from central Europe. Ammonoids indicate the age of the fauna to be early Norian. The palaeobiogeographical distribution indicates existence of the Hispanic Corridor possibly as early as the Late Triassic which cannot be discounted as a possible migratory passage between Nevada and Tethys.

SATTERLEY, A.K., MARSHALL, J.D. and FAIRCHILD, I.J., 1994. Diagenesis of an Upper Triassic reef complex, Wilde Kirche, Northern Calcareous Alps, Austria. Sedimentology, 41: 935-950.

The Wilde Kirche reef complex (Early-Late Rhaetian) grew as an isolated carbonate structure within the shallow Kössen Basin. At the Triassic/Jurassic boundary a single brief (c. 10-50 ka) period of subaerial exposure occurred. The preserved karst profile (70 m thick) displays a vadose zone, enhanced dissolution at a possible palaeo-watertable (5-15 m below the exposure surface), and a freshwater phreatic zone. Karst porosity was predominantly biomouldic. Primary cavities and biomoulds were enlarged and interconnected in the freshwater phreatic zone; cavity networks developed preferentially in patch reef facies. Resubmergence of the reef complex allowed minor modification of the palaeokarst surface by sea floor dissolution and Fe-Mn crust deposition on a sedimentstarved passive margin. Fibrous calcite (FC), radiaxial fibrous calcite (RFC) and fascicular optic calcite (FOC) cements preserved as low Mg calcite (LMC) are abundant in primary and karst dissolution cavities. FC cement is restricted to primary porosity, particularly as a synsedimentary cement at the windward reef margin. FC, RFC and FOC contain microdolomite inclusions and show patchy non-/bright cathodoluminescence. $\delta^{10}O$ values of nonluminescent portions (interpreted as near original) are -1.16 to - 1.82‰ (close to the inferred δ^{16} O of calcite precipitated from Late Triassic sea water). δ^{16} O values are constant (+3 to +2.2%). These observations suggest FC, RFC and FOC were originally marine high Mg calcite (HMC) precipitates, and that the bulk of porosity occlusion occurred not in the karst environment but in the marine environment during and after marine transgression. The HMC to LMC transition may have occurred in contact with meteoric water only in the case of FC cement. The most altered (brightly luminescent) portions of RFC/FOC cements yield $\delta^{18}O = -2.44$ to 5.8%, suggesting HMC to LMC alteration at up to 34°C, in the shallow burial environment at depths of 180-250 m. Abundant equant cements with δ^{*} O = -4.1 to 7.1‰ show crisp, uniform or zoned dull luminescence. They are interpreted as unaltered cements precipitated at 33-36°C at 200-290 m burial depth, from marinederived fluids under a slightly enhanced geothermal gradient. Fluids carrying the equant cements may have induced the HMC to LMC transition in the fibrous cements.

SCHWARTZ, H.L. and GILLETTE, D.D., 1994. Geology and taphonomy of the *Coelophysis* quarry, Upper Triassic Chinle Formation, Ghost Ranch, New Mexico. J. Paleont., 68: 1118-1130.

The *Coelophysis* dinosaur quarry at Ghost Ranch, near Abiquiu, New Mexico, is unique among Triassic fossil sites for its yield of numerous complete and partial skeletons of a single species of theropod dinosaur *(Coelophysis bauri)*. Since its discovery in 1947 by E.H. Colbert in the red siltstone beds of the Upper Triassic Chinle Formation, the quarry has yielded the remains of at least 1,000 individuals from approximately 30 cubic meters of excavated material. The main bone-bearing strata are abandoned channel deposits that are part of a siltstone overbank sequence. The *Coelophysis* remains found at the quarry are remarkably whole and well preserved, though they range in degree of articulation from complete skeletons to isolated limbs and bones. Skeletons, partial skeletons, and bones are

crudely aligned and show little evidence of predator or scavenger disturbance or surface weathering. Geologic and taphonomic evidence suggests that the dinosaurs preserved in the Ghost Ranch quarry were transported to the site as carcasses by fluvial currents. The carcasses blocked a small channel and were subsequently buried by silts. Petrographic study and neutron activation analysis reveal no evidence of volcanic ash, paleopathologic osteology, or unusual chemistry in the quarry bone and sediments. The virtual monospecificity, taphonomy, and ecology of the assemblage suggest that the dinosaurs perished due to a regional environmental crisis, such as drought.

SCHMIDT, T.M., 1992. Tontüten: Sedimentstrukturen im Buntsandstein des nördlichen Saarlandes, Deutschland. Jber. Mitt. oberrhein. geol. Ver., N.F., 74: 117-126.

Near Britten in Buntsandstein of the northern Saarland (Germany) curious sedimentary structures have been found. They are named 'Tontüten' (mud cones). The genesis of fossil Tontüten is deduced from the observation of recent Tontüten-genesis, and is interpreted in sedimentological terms. According to this model, Tontüten were formed in areas that had been submerged by a muddy suspension, covered by an algal-film, and then desiccated. Parallel orientation of the Tontüten was generated by a second, brief flooding episode. Rapid sedimentation was necessary to preserve these fragile structures. Such processes occur, for example, also in Wadi environments.

SCHUMANN, I. and SCHUMANN, D., 1995. Ein Ceratiten-Pflaster aus dem Oberen Muschelkalk von Götzingen (SW-Deutschland). N. Jb. Geol. Paläont. Abh., 195: 109116; Stuttgart.

The fossilisation of numerous shells of a *Ceratites* coquina is investigated. There are significant differences in preservation depending on the filling processes of the simultaneously embedded shells. Early shell dissolution leads to drastic deformations of the probably still plastic sediment filling.

SEEGIS, D.B. and GOERIGK, M., 1992. Lakustrine und pedogene Sedimente im Knollenmergel (Mittlerer Keuper, Obertrias) des Mainhardter Waldes (Nordwürttemberg). Jber. Mitt. oberrh. geol. Ver., N.F., 74: 251-302.

SENFF, M., 1994. Eine Foraminiferenvergesellschaftung aus den Raibler Schichten (Karn) der östlichen Lienzer Dolomiten (Kärnten, Österreich). Giessener Geol. Schr., 51: 241-253.

The Raibl beds (Carnian) of the Lienz Dolomites (Austria) consist, like in the entire Upper Austroalpine of an alternation of three siliciclastic and three carbonatic units, which reflect changing conditions of sedimentation and water depth. The foraminiferal fauna found in these series is related to the lithological facies. The authors could differentiate two different associations, which can be related to specific sedimentary environments.

SENOWBARDI-DARYAN, B., 1994. Alpinotubus lamellatus n.gen., n.sp., ein Wurm aus der Mittelund Ober-Trias (Ladin-Karn) des alpin-mediterranen Raumes: Fazies- und Leitfossil. Giessener Geol. Schr., 51: 255-265.

Alpinotubus lamellatus n.gen., n.sp., an U- or V-shaped worm tube, primarily composed of High-Mg-Calcite, is described from Ladinian reef boulders embedded within siliciclastic slope sediments respectively basinal deposits of the Southern Alps (Dolomites, Italy) and from Carnian reef limestones respectively reef boulders of Slovenia, Hungary and Sicily. Representing a facies fossil of central reef area, *Alpinotubus lamellatus* is also an index fossil of Ladinian and Carnian age.

SENOWBARI-DARYAN, B., 1994. Mesozoic sponges of the Pucará Group, Peru. Palaeontographica, Abt. A, 233: 57-74.

The Pucará Group of central Peru represents nearly 3,000 m of shallow-water carbonate deposition spanning from the Late Triassic to Middle Jurassic in time. The Upper Triassic carbonate rocks, the Chambara Formation, and the Jurassic units, the Aramachay and Condorsinga Formations, exhibit distinctive associations of sponges, which are described in this paper. From the Triassic succession of Huanincocha near the Lake Junin in central Peru three genera of inozoan sponges, including Eusiphonella, Corynella and Peronidella and two genera of sphinctozoan sponges, Amblysiphonella and Colospongia have been found. Amblysiphonella tubifera is described as a new species. A specimen of Colospongia was observed in the field but not collected. Jurassic sponges were collected from several localities southeast of the town of Cerro de Pasco in central Peru. The Carhuazcocha locality south of the town of Junin contains the most diverse sponge fauna including the following described taxa: Stellispongiella ? juninensis n.sp., Stellispongiella ? ramosa n.sp., Stellispongiella ? minor n.sp., Trammeria dendroida n.gen., n.sp., Cornuaspongia longidepressa n.gen., n.sp., Cornuaspongia reticulata n.gen., n.sp. Neither the Triassic nor the Jurassic sponge associations of Peru, are known from other Triassic or Jurassic localities of the world.

SHANGYOU NIE, AN YIN, ROWLEY, D.B. and YUGAN JIN, 1994. Exhumation of the Dabie Shan ultrahigh-pressure rocks and accumulation of the Songpan-Ganzi flysch sequence, central China. Geology, 22: 999-1002.

The presence of coesite- and diamond-bearing ultra-high-pressure (UHP) metamorphic rocks in the Dabie and Sulu regions, central China, suggests that a >100-km-thick crustal section (4 x 106 km³ in volume) has been denuded. This volume is comparable to that represented by the 10-15-km-thick Middle to Upper Triassic flysch rocks in the Songpan-Ganzi region. Regional geology and radiometric dates are compatible with an interpretation that the majority of these sedimentary rocks were derived from denudation of the orogenic belt between North and South China blocks following their latest Paleozoic to Triassic collision. This correlation implies a high denudation rate of ~ 4 mm/yr that may have been in part promoted by tropical precipitation and extreme topographic relief for as long as 25 m.y.

SHEN SHUZHONG and HE XILIN, 1994. Brachiopod assemblages from the Changxingian to lowermost Triassic of Southwest China and Correlations over the Tethys. Newsl. Stratigr., 31: 151-165.

A comprehensive study on the brachiopod assemblages of the Permian-Triassic strata in Southwest China is presented. The detailed brachiopod stratigraphy from six sections suggests that the Changxingian can be subdivided into three assemblage zones, in ascending order the *Derbyia guangdongensis-Oldhamina squamosa-Orthothutina eusarkos* Assemblage, the *Peltichia traversa-Perigeyerella costellata* Assemblage and the *Waagenites pigmaea-Neochonetes substrophomenoides-Nototbyris crassa* Assemblage. The lowermost Triassic (Transitional bed) is represented by the *Lingula fuyuanensis-Crurithyris flabelliformis* Assemblage. Correlations of brachiopod faunas of Southwest China and others in the Tethys are also discussed.

SIMMS, M.J., 1994. Crinoids from the Chambara Formation, Pucará Group, central Peru. Palaeontographica, Abt. A, 233: 169-175.

Silicified crinoid columnals, cirrals and brachials have been recovered in some abundance from the Chambara Formation, of supposed Late Triassic age, at several localities in central

Peru. Three taxa are represented. Two species of isocrinid are recognised and described, as *lsocrinus* sp. A and *lsocrinus* sp. B. They differ from known species but the material is insufficiently diagnostic to erect new species. The third taxon, represented by a single pluricolumnal, is an eocomatulid. It is sufficiently distinct from the only other known eocomatulid for it to be assigned to a new species, *Eocomatula decagonalis*. Its presence in the Chambara Formation is further evidence for the rapid diversification of the pentacrinitid/comatulid clade during the Late Triassic and Early Jurassic.

SIMON, V. and STEUBER, T., 1993. Stratigraphie und stabile Isotope ($\delta^{r_3}C$, $\delta^{r_6}O$, $\delta^{r_3}C_{w_6}$) der Domvrena-Schichtengruppe (Trias-Jura) im Helikon-Gebirge, Böotien/Griechenland. Sonderveröff. Geol. Inst. Univ. Köln, 70: 259-276.

The Domvrena Formation is a Triassic-Jurassic limestone sequence with interbedded radiolarites and mafic volcanics. Sedimentation started in Middle Triassic with algal reefs and pelagic limestones. Upper Triassic limestones and dolomites were deposited in subtidal or intertidal environments. The Liassic is marked by lagoonal 'Conchodus' limestones. Sedimentation was interrupted in Middle Jurassic by a period of emersion, however, reefal deposits reoccurred in Upper Jurassic times. Regional subsidence initiated the sedimentation of pelagic limestones, radiolarites and mafic volcanics during the Tithonian. An 'isotope log' of the Domvrena Formation is based upon more than 800 samples. The original isotopic composition of the Triassic limestones has been altered in the course of meteoric cementation and dolomitization, yielding relatively negative values (-5‰ to -3‰ δ^{n} O and O‰ to 1‰ δ^{13} C). From Late Liassic to Tithonian isotopically heavier limestones prevail in the section ($\delta^{13}C_{ag}$) shifts gradually from -28‰ in the Anisian to -21‰ in the Late Triassic.

SMITH, A.B., 1994. Triassic echinoids from Peru. Palaeontographica, Abt. A, 233: 177-202. Six genera and eight species of late Triassic (Norian) to early Jurassic (Sinemurian) echinoids are described from the Pucar Group of central Peru on the basis of test material, though only one of these is represented by a complete test. Two of the genera and all six of the species that can be positively identified are new. In addition there are at least three distinct spine morphologies, presumably corresponding to some of the described tests. Three of the genera and five of the species are triadocidarids, otherwise known only from the Anisian through to Carnian of south eastern Europe. One genus and species is a true cidarid, while two others are definite euechinoids, providing amongst the earliest records of this group. Finally, there is one taxon known from isolated plates, of uncertain affinity, that may possibly represent the earliest echinothurioid. The phylogenetic position of the Peruvian taxa is investigated through a numerical cladistic analysis of all well-preserved Triassic echinoids and two new families are erected, Triadocidaridae, for a clade of cidaroid-like forms that have only rudimentary perignathic girdle structures, and Lenticidaridae, for a clade of imbricate-plated taxa with well-developed apophyses and broad interradial granulation.

STANLEY, G.D., 1994. Early Mesozoic carbonate rocks of the Pucara Group in northern and central Peru. Palaeontographica, Abt. A, 233: 1-32.

From northern and central Peru 19 Triassic and Jurassic localities were investigated. Measured sections and collection sites yielded abundant and diverse groups of silicified fossils and carbonate microfacies from the Pucará Group, a carbonate rock unit exceeding 2,000 m in thickness which is well-exposed in the Peruvian Andes. Over eighty years of geologic investigation on the stratigraphy, ore deposits, and paleontology of the Pucará

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have resulted in biostratigraphic classifications, recognition of depositional environments, correlations, age and stratigraphic framework, but study of many fossil groups has lagged behind. Fossils from previous investigations have not been precisely located and agediagnostic fossils are usually scarce in the carbonate rock sequence of the Pucará. New fossils described from the 19 localities have helped in refining dating and correlations. The thick Pucará succession in Peru is important because relative to many other regions of the world, it records a fairly complete history of Late Triassic to Early Jurassic rocks and fossils, including the Triassic-Jurassic systematic boundary. It also includes an extensive record of marine sedimentation along the Pacific Cordillera of South America. Abundant and diverse marine fossils of the Pucará Group include Upper Triassic (Norian) and Lower Jurassic (Hettangian-Sinemurian) tropical, shallow-water sponges, corals, spongiomorphs, calcareous sponges, gastropods, bivalves, ammonites, crinoids and echinoderms. Conodonts also occur in the Late Triassic portion of the sequence. Abundant shallow-water depositional environments, including small-scale coral, sponge and oyster biostromes characterize the sequence. The 19 localities and the measured sections described in this paper are utilized by most authors in this volume to designate their fossil material.

STANLEY JR., G.D., 1994. Upper Triassic corals from Peru. Palaeontographica, Abt. A, 233: 75-98.

Seventeen coral and one spongiomorph taxa are described from the Upper Triassic silicified specimens of the Pucará Group in central Peru. Among these, three new species are distinguished: *Stylopbyllopsis gracilis* n.sp., *Pinacophyllum peruvianum* n.sp., and *Retiophyllia pascoensis* n.sp. In situ paleoecological associations of biostromes 1-10 m thick occurring within bedded carbonate rocks of the Chambara Formation, reveal no evidence of reef development. The growth types of the corals and the fine-grained lithofacies of the enclosing rock types suggest shallow-water, low-energy settings on an extensive carbonate ramp. The composition of the fauna reveals some links to Cordilleran terranes of North America. Similarities exist with northeastern Oregon and western Idaho, Nevada, and northern California. Despite a degree of endemism, Tethyan relationships are indicated for 11 of the taxa. Of these, six coral species are restricted to the western Tethys. It is the first occurrence of the Alpine corals, *Margarosmilia charlyana* (Frech) and *Retiophyllia frechi* (Roniewicz) in the Americas.

SUAREZ, M., BELL, C.M. and HUTTER, T., 1995. Lower Triassic lacustrine sediments in La Coipa area, Atacama, Chile. J. South Am. Earth Sci., 8: 9-15.

Lower Triassic lacustrine sediments in an area of at least 300 km² at the La Coipa Mine area (26°50' S, 69°15' W), in northern Chile, indicate a large, actively subsiding lake, which was at one time evaporitic. This lake was surrounded by highlands dominated by outcrops of Late Paleozoic volcanic rocks and granitoids. An open lacustrine environment includes black hemipelagic shales with intercalated thin and medium-grained turbidites probably representing a channel-levee complex. The coarse-grained, lake margin sediments are dominated by debris-flow deposits and turbidites with intercalated black shales. These represent either the subaqueous part of a fan delta (formed during low-stand) or subaqueous talus (formed in a high stand). The Early Triassic age, given by palynomorphs, represents the first documentation of strata of this age in Chile and apparently in the Andes. It indicates that basins of probable extensional origin were forming prior to the previously accepted Middle-Late Triassic age. TAYLOR, T.N. and GRAUVOGEL-STAMM, L., 1995. The ultrastructure of voltzialean pollen. Rev. Palaeobot. Palynol., 84: 281-303.

The ultrastructure of several in-situ bisaccate pollen grains produced by Triassic members of the Voltziales is described and illustrated. These include five species of *Willsiostrobus (W. willsii, W. ligulatus, W. rhomboidalis, W. cordiformis, W. denticulatus)*, in addition to *Darneya dentata* and *Sertostrobus laxus*. All of the grains are protosaccate with ektexine elements extending from the inner surface of the saccus wall to the nexine. White line nexine lamellae show some uniformity in thickness among species suggesting a basic substructure to the exine. Sporoderm ontogeny in these grains is compared with that of modern bisaccate conifer pollen, and the development and function of the protosaccus are discussed.

VACHARD, D., MARTINI, R., RETTORI, R. and ZANINETTI, L., 1994. Nouvelle classification des foraminifères endothyroïdes du Trias. Geobios, 27: 543-557.

A systematic revision of the Triassic endothyroid Foraminifera allows to describe the following taxa: Endotebidae, n.fam., Endotriadidae, n.fam., Endotebanella, n.gen., type-species Endothyranella kocaeliensis Dager, 1978a, Endotriada, n.gen., type-species Endotriada tyrrhenica, n.gen. n.sp., Endotriadella, n.gen., type-species Ammobaculites wirzi Koehn-Zaninetti, 1968. The species Endoteba bithynica, n.sp., and Endotriada tyrrhenica, n.gen. n.sp., are described. The genus Endoteba and various species are emended. Biostratigraphic, paleogeographic and phylogenetic values of the taxa are discussed.

WATERHOUSE, J.B., 1994. The Early and Middle Triassic ammonoid succession of the Himalayas in western and central Nepal. Part 1. Stratigraphy, classification and early Scythian ammonoid systematics. Palaeontographica, Abt. A, 232: 1-83.

The Early and Middle Triassic of the Manang district in the central Nepal Himalayas is represented by a fine succession of ammonoid zones. Further west, in Dolpo, the early and middle Triassic succession is more compressed, but contains a number of ammonoids. These Manang and Dolpo ammonoids will be described in a seven-part series. In the first part the stratigraphy is outlined. A basal Manang Group of dense carbonates is subdivided into five formations, with five members in the basal Pangjang and Khangsar Formations and eight members in the topmost Gungdang Formation. Ammonoids occur in twelve major zones and additional minor zones of Scythian and Early Anisian age, with 17 levels recognised for the Scythian Series. The overlying Mukut Group has Anisian ammonoid faunules at the base and Ladinian and younger faunules in higher beds. In Dolpo, the Kalkya Group, with three formations, has Scythian and early Anisian ammonoids. Above the Mukut Group yields Anisian and younger ammonoids. In the introductory review of Early Triassic ammonoids it is considered that several suborders were developed somewhat as proposed by German and Soviet authorities, rather than the more nomenclaturally conservative classification favoured by American and British experts. Triassic ammonoids are rearranged into several orders: Medlicottiida, Sageceratida and Lobitidina are recognised as survivors from Permian, together with Otoceratida, and Xenodiscida. Meekoceratida are discriminated for a major early Triassic group of two major associations, Meekoceratidina and Flemingitidina. The most abundant group Ceratitida incorporates a number of suborders, including Noritidina as new. Phylloceratida commenced in the basal Anisian. The associations form coherent groups, based primarily on the morphology and mode of development of the suture, with significance also attached to shell shape, ornament, details of body chamber, and siphon. Thirty two ammonoid species are recorded from the lower part of the sequence in Manang, found in two major zones named alter

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Otoceras woodwardi and Ophiceras tibeticum. These are separates by faunally depauperate levels characterised by Metotoceras dieneri, Lytophiceras ptychodes and Lytophiceras-Ophiceras. All are classed in the Gangetian Stage of Waagen and Diener. Newly named genera are Shevyrevoceras, type species Celtites fallax Frech 1905 (Superfamily Xenodiscoidea), Zakharovites, type species Glyptophiceras pascoei Spath 1930 (Superfamily Dinaritoidea), Altoconchella, type species A. delinguens Waterhouse and Tilichonia, type species T. typus Waterhouse (Superfamily Otoceratoidea), Himophiceras, type species H. spathi Waterhouse and Shalshalia, type species Ophiceras himalayanus Griesbach 1880 (Superfamily Gyronitoidea), Mesokantoa, type species M. alta Waterhouse and Hubeitoceras, type species Koninckites yangjianensis Xu 1988 (Superfamily Nordophiceratoidea) and Zhaojinkeoceras, type species Z. nepalensis Waterhouse (Superfamily Meekoceratoidea). New groups of family rank Zakharovitinae, Dzhulfoceratidae, Anotoceratidae, Tilichoniidae, and Khangsariidae are proposed. Some sixteen new species are named. It is shown that Gyronitid and Meekoceratid ammonoids entered the Triassic succession earlier than previously realised in the Himalayas (as well as Greenland and China), overlapping with Ophiceras and Otoceratidae. The Permian-Triassic life crisis is discussed, and analysed as a multiphased event with life-destructive episodes at the start of and within the Gangetian Stage.

WEBER, H., 1992. Frühe Stratigraphie im Lettenkeuper des hohenloher Landes (nördliches Baden-Württemberg) im 19. Jahrhundert (Alberti und Kurr). Jber. Mitt. oberrh. geol. Ver., N.F., 74: 173-190.

WEBER, H., 1994. Revision eines Profils im Lettenkeuper bei Wackershofen, NW Schwäbisch Hall. Jber. Mitt. oberrh. geol. Ver., N.F., 76: 253-260.

WENZEL, B., 1994. Zur Lithostratigraphie und Sedimentologie des Röt und zu den Massenverlagerungen and der Röt-/Muschelkalkgrenze in Nordosthessen. Giessener geol. Schr., 53.

A sedimentological study of the evaporitic-clayey deposits of the 100-105 m thick Röt sequence in the area around Eschwege (NE Hessia, Germany). The sequence represents a transgressive-regressive-transgressive development. Small cycli are related to waterlevel changes. The second part of this study discusses the soil mechanics of these deposits.

WERNEBURG, R., 1994. Eine Triopside aus dem Buntsandstein Thüringens. Rudolstädter nat.hist. Schr., 6: 21-23.

A description of an ichnocoenosis with a 2 cm long triopsid (Notostraca, Crustacea) and other fossil remains from the Chirotheriensandstein (Bunter) of Bad Berka (Thuringia, Germany).

WRIGHT, V.P. and SANDLER, A., 1994. A hydrogeological model for the early diagenesis of Late Triassic alluvial sediments. J. Geol. Soc., London, 151: 897-900.

The late Triassic Mercia Mudstone Group of southwest Britain, problematic, complex arid playa-floodplain-aeolian deposit, contains a variety of Mg clays and carbonates. Recent interpretations have invoked marine waters as a source of Mg in clays. However, both the Mg-rich clays and other early diagenetic features seen in the late Triassic in Europe are directly analogous to those found in the inland drainage basins of Australia. A simple hydrogeological model is offered based on these basins where shallow groundwater evolution takes place within the basin producing a range of early diagenetic products including groundwater dolocretes and Mg clays. Such a model, as developed in Australia, is probably widely applicable to ancient arid alluvial systems.

YIN FENG-JUAN, 1994. Late Triassic palynofloras from the Huangshanjie and Haojiagou formations in the Turpan-Hami basin, Xinjiang and their significance. Acta Micropalaeont. Sinica, 11: 239-248. (in Chinese with English summary)

Two Late Triassic palynologocal assemblages, both dominated by pteridophyte spores, with 60 genera and 63 species are described from boreholes in the Turpan-Hami Basin.

YIN HONGFU and LIN QUUXIAN, 1994. Triassic. In: Yin Hongfu (editor), The Palaeobiogeography of China, Clarendon Press, Oxford, pp. 189-218.

This contributions consists of three sub-chapters, one on the the Triassic palaeobiogeographical provincialization of the world, one on provoncialization in China and the a concluding part with remarks on Triassic palaeobiogeography. This latter part discusses the relations between climate zonation, plate tectonics and biogeography as well as the significance of distributution patterns of biofacies.

YIN HONGFU, TONG JINNAN, DING MEIHUA, ZHANG KEXIN and LAI XULONG, 1994. Late Permian -Middle Triassic Sea Level Changes of Yangtze Platform. Earth Science - J. China Univ. Geosci., 19: 627-632. (in Chinese with English summary)

This paper first introduces procedures leading to the establishment of a Late Permian -Middle Triassic sea level change curve of the Yangtze Platform. Bathymetric curves extracted from curves of habitat types are first transformed to sea level curves in the order of stages. The comparison between curves of Yangtze and the world reveals that since the Late Permian marine sequences are lacking in most parts of the world, the Late Permian to Griesbachian curve of Yangtze may serve as an important parameter for further revision of the world curve. The Early - Middle Triassic short-term changes of Yangtze are briefly concordant with those of Haq's world curve, whereas its long-term changes are discordant. The latter, however, is representative of the East Asian regions affected by the Indosinian Orogeny. Basically the third cycles of Yangtze and the world are only partly concordant, and even in concordant cases their detailed boundaries are not coincident. This indicates that sea level changes are not strictly synchronous over the world. It seems that the 1st and 2nd cycles (supercycles and megacycles) may be world-wide, but not the 3rd cycles.

ZÁGORŠEK, K., 1994. Comparison between Triassic *Trepostomata*, recent *Cyclostomata* and Paleozoic *Trepostomata* (Bryozoa); and one question in addition. Acta Universitatis Carolinae - Geologica, 1-2: 145-149.

Triassic bryozoans from two localities in the Vysoká Formation (Malé Karpathy Mountains) have been studied. In both localities bryozoans are concentrated in almost monospecific accumulations.

ZANINETTI, L., RETTORI, R. and MARTINI, R., 1994. Paulbronnimanninae RETTORI & ZANINETTI, 1993 (Foraminiferida, Ammodiscidae) and other Anisian foraminifers from the Piz da Peres section (Valdaora-Olang, Pusteria valley, Dolomites, NE Italy). Riv. It. Paleont. Strat., 100(3): 339-350.

The Anisian succession exposed in the Piz da Peres area, studied by De Zanche et al. (1992) using sequence stratigraphy, is here examined from a micropaleontological point of view. The Recoaro Limestone, deposited during highstand time, contains the most diversified microfauna of the stratigraphic succession; it is Pelsonian in age, with the typical association *Meandrospira dinarica-Pilammina densa*; the coeval Pelsonian foraminifers *Paulbronnimannelia judicariensis* (Premoli Silva, 1971) and *Paulbronnimannella whittakeri* Rettori gen. n., sp. n., are also present.

ZASLAVSKAYA, A., ESHET, Y., HIRSCH, F., WEISSBROD, T. and GVIRTZMAN, G., 1995. Recycled Lower Paleozoic Microfossils (Chitinozoa) in the Carboniferous of Sinai (Egypt) and Permo-Triassic of the Negev (Israel): Paleogeographic considerations. Newsl. Stratigr., 32: 57-72.

Ordovician-Silurian microfossils (chitinozoans, scolecodonts, acritarchs) and graptolite fragments are found within continental Carboniferous strata of Central Sinai (Egypt) and Marine Permian and Triassic strata in the subsurface of southern Israel. Palaeocurrent measurements indicate that these Lower Paleozoic organic fragments must have been redeposited, since marine Ordovician-Silurian sediments are not found between the Gulf of Suez and the Dead Sea Rift. They were redeposited either as the result of the primary recycling, during Carboniferous-Triassic times, from Paleozoic rocks exposed along a semicircular belt from Syria, through jordan and Saudi Arabia to Egypt, or as the result of the secondary recycling of a Ordovician-Silurian deposition in Israel and Sinai prior to its Late Paleozoic uplift and removal to an eastward depocenter.

Triassic workers are kindly requested to send reprints or xerox copies of the titles and abstracts (including journal, volume and page numbers) of their recently published pagers to the editor for the 'Annotated Triassic Literature'

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