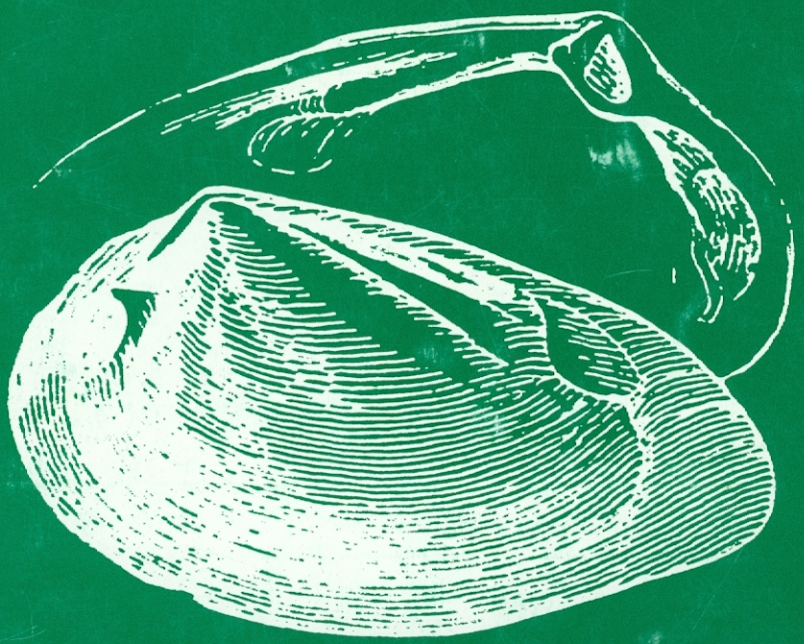
ALBERTIANA



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ALBERTIANA

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ALBERTIANA 22 was compiled and edited by Hans Kerp with the help of an editorial committee consisting of: Aymon Baud (Lausanne), Spencer G. Lucas (Albuquerque) Mike Orchard (Vancouver), Tim Tozer (Vancouver) and Henk Visscher (Utrecht).

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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IUGS/ICS SUBCOMMISSION ON TRIASSIC STRATIGRAPHY (STS)

Abbreviated Minutes of Business Meeting held on 23 September 1998 Martin-Luther-Universität, Halle/Saale, Germany

Meeting convened as part of the Epicontinental Triassic Symposium, Halle/Saale; 21-23 September 1998

Present: Bachtadse, Bachmann, Balini, Baud, Beutler, Courel, Dobruskina, Gaetani, Gaździcki, Gomez, Hagdorn, Grauvogel-Stamm, Heckert, Jacobshagen, Kent, Kerp, Kozur, Lepper, Lozovsky, Mertmann, Mørk, Posenato, Rieber, Schulz, Shishkin, Soffel, Szurleis, Torok, Warrington, Yin.

The Chairman (Gaetani) opened the meeting at 16.10. and proposed adoption of the Agenda circulated by the Secretary; this was agreed by the meeting.

1. Apologies

The following notified the Secretary that they would be unable to attend:

Carter, Cirilli, Dagys, Dickins, Eshet, Glenister, Gradinaru, Grant-Mackie, Haas, Hancox, Hirsch, Kolar-Jurkovsek, Kovács, Krystyn, Li Jinling, Marcoux, Michalik, Nakazawa, Newell, Odin, Orchard, Ramovš, Rubidge, Seyed-Emami, Siblík, Silberling, Steiner, Sudar, Sweet, Tatzreiter, Tiwari, Van Hinte, Visscher, Weitschat, Wendt, Yang Zunyi, Zakharov.

2. Chairman's announcements

ALBERTIANA 21 had been distributed in September; the Chairman welcomed the editor (Kerp) who had travelled from Münster specifically to attend the STS business meeting.

3. Working groups: progress towards GSSP selection

The Chairman noted that Triassic nomenclature used in literature appears to have stabilised since the STS meeting in Lausanne (October 1991) but no GSSPs have yet been selected for the Triassic. He stated that STS must deal with this situation, and introduced a review of the status, in relation to GSSP selection, of the stage boundaries which concern the STS.

3.1. Base of Triassic

Yin Hongfu (Chairman: Permo-Triassic Boundary Working Group, PTBWG) reported on his group's activity. A preliminary vote conducted in the PTBWG in 1995 had shown a large majority favoured *Hindeodus parvus* as the criterion for the base of the Triassic, and Meishan as the preferred candidate GSSP. A proposal on this basis will be submitted for a formal vote within the STS as soon as access to the site, and freedom to collect and remove samples, are guaranteed by the Chinese authorities; Yin hoped that this guarantee would be received soon.Yin summarised the biostratigraphic, magnetostratigraphic and other attributes of the

Meishan section, and demonstrated the potential for correlation to other Chinese sections which have comparable lithostratigraphy and biostratigraphic control. He also summarised the attributes and ancillary correlation methods available from the Meishan section, and demonstrated the worldwide potential for correlation on the criterion selected.The Chairman acknowledged the efforts made by the Chinese investigators to develop a GSSP proposal for the base of the Trias.

3.2. Induan/Olenekian boundary

No information had been received from the Olenekian Working Group (Chairman: Zakharov). Baud commented that work by the Russians on a section in Siberia was impeded by financial constraints, and suggested that better progress might be made with a section near Vladivostok. Kozur doubted whether the Siberian sections would satisfy the ICS criterion of "accessibility"; Mørk said that, though they contain the best Olenekian ammonites, the Siberian sections are effectively inaccessible at present. Yin suggested that a section in Nevada or British Columbia should be considered.

3.3. Olenekian/Anisian boundary

The Chairman compared magnetostratigraphic records from Chios and Kcira; a small break occurs in the former and ammonoids are absent around the boundary at Kcira. The Dobrugea section has some magnetostratigraphy, and has conodonts and ammonoids, the latter studied but not yet described; he had urged progress on the description of the ammonoids in connection with the GSSP selection and had received a proposal for a workshop in Bucurest and Dobrugea in 2000, with an excursion to the Anisian boundary section and description of the ammonites in a volume to accompany this meeting. Kent questioned whether ammonoid FADs from Dobrugea were necessary if there is good magnetostratigraphy. The Chairman said that, if the ammonoid studies are completed, it will be necessary to decide whether ammonites or conodonts (*Chiosella timorensis*) are to be used as the boundary criterion; he also referred to the Nevada succession, but noted that this has few attributes; Kozur spoke in favour of the use of *C. timorensis*. The Chairman proposed a ballot to determine which criterion should be adopted; while this is in progress the magnetostratigraphy and conodonts would be published, progress on Dobrugea would be monitored and then a decision made on a ballot to select a candidate section; this proposal was accepted by the meeting.

3.4. Anisian/Ladinian boundary

The Chairman displayed an overhead of a questionnaire he had sent out about this boundary and, in response to comments from Kent, said that work is in progress to improve aspects of the magnetostratigraphic cover.

3.5. Ladinian/Carnian boundary

The Chairman referred to the poster exhibited during the Halle Symposium, to a field meeting held on the section at Stuores in July 1998, and to a summary proposal published in ALBERTIANA 21; a fuller proposal has been submitted to *Rivista Italiana di Paleontologia e Stratigrafia*.

3.6. Carnian/Norian and Norian/Rhaetian boundaries

No information had been received.

3.7. Non-Marine Triassic Working Group

Lucas (Chairman: Non-Marine Triassic Working Group, NMTWG) reported on the activities of the NMTWG, which had met during the Halle Symposium. Elsevier has agreed to publish an account of non-marine Triassic stratigraphy in 2000. Publication of a special issue of *Palaeogeography, Palaeoclimatology, Palaeoecology*, devoted to the Permian-Triassic boundary, and edited by Yin and Lucas, is imminent.

4. Secretary's announcements

The Secretary (Warrington) referred to a request posted to members, asking them to indicate their likely attendance at the Halle meeting, their current interest and activity in relation to Triassic stage boundaries, and to confirm their contact details. Nearly 60% of the membership had responded, and the cooperation of these people was appreciated. Those unable to attend the meeting had been invited to send comments on agenda items; these are attached to the full minutes and are summarised below:

Item 3.

Glenister (Chairman: Carboniferous-Permian Boundary Working Group, Subcommission on Permian Stratigraphy) expressed the view that "the Meishan proposal for the base of the Triassic system is one of the strongest ever presented for a stage or system boundary", and hoped that a vote on that boundary would be held soon. Grant-Mackie hoped that the P/T boundary selection would be finalised soon, as the Meishan section "seems to have virtually everyone's support".

Orchard: conodonts from the *Otoceras woodwardi* beds in Spiti are not Changxingian in age (Orchard & Krystyn in press *Rivista Italiana di Paleontologia e Stratigrafia*, manuscript forwarded to the PTBWG Chairman). *Chiosella timorensis* is a suitable conodont datum for the base of the Anisian; *Neogondolella regalis* is not suitable. Documentation of the conodont succession around the Anisian-Ladinian boundary in Nevada is being prepared; the FAD of *Budurovignathus*, at the base of the subasperum ammonite zone, is an easily recognized datum. Discussions during the visit to the candidate Carnian GSSP at Stuores showed that the taxonomy of *Budurovignathus* required further work.

Item 4.

Grant-Mackie: the T/J boundary in New Zealand appears, on palynological evidence, to be within the upper Otapirian, rather than at the Otapirian-Aratauran local stage boundary. Orchard: in N. America, conodonts disappear within Carter's terminal Triassic radiolarian zone; some taxa range higher than in Europe.

Warrington is also Secretary of the Triassic-Jurassic Boundary Working Group (TJBWG) of the ICS International Subcommission on Jurassic Stratigraphy. He attended the Jurassic Congress in Vancouver in August, and participated in field excursions which included visits to proposed base Jurassic candidate GSSPs in Nevada and British Columbia. These events were very successful, and facilitated dialogue between workers from Europe and the Americas. Four candidate GSSPs (in British Columbia, England, Nevada and Peru) have been proposed; workers involved with each section have completed a questionnaire based on the ICS Guidelines for GSSPs. The responses provide a basis for objective comparison, and are an important step towards selection of a candidate GSSP for the base of the Jurassic.

5. STS membership

The Chairman noted that the STS membership is large and includes many corresponding members. ICS statutes require part of the voting membership of a subcommision to be changed every four years. Consideration of the current membership list and the dates people had served as Voting Members showed that Anderson, Chen Chuzhen, Demathieu, Jacobshagen, Kapoor, Nakazawa, Ramovš, Siblik, Virgili, Wendt and Yang Zunyi should retire as Voting Members and become Corresponding Members.

The new, slightly smaller, voting membership would comprise the members of the STS Executive (Baud, Gaetani, Orchard, Rieber, Warrington, Zakharov), four new voting members (Hancox, Lozovsky, Menning, Yin Hongfu) and the following existing voting members: Bucher, Dagys, Gazdzicki, Grant-Mackie, Haas, Hirsch, Koike, Kovacs, Kozur, Krystyn, Lepper, Lucas, Marcoux, Nicora, Seyed-Emami, Sheng Jin-zhang, Silberling, Stanley, Tozer, Vijaya, Visscher, Weitschat. The proposed changes were agreed by the meeting.

6. Future meetings

31st IGC, Rio de Janeiro, Brazil: 6-17 August 2000
The Chairman felt that an STS general assembly should not be planned for the IGC because there was unlikely to be an adequate attendance by STS members. Few of those present at the Halle business meeting indicated that they were likely to go to the IGC and it was confirmed that the STS would not organise a general assembly at the IGC.

The Chairman suggested that future STS meetings should be on a 4-yearly basis, with the next being in 2002. Previous meetings had focused on the non-marine and on mixed marine/ non-marine Triassic; it would be appropriate for the next to be on marine Triassic. A proposal to organise a meeting in Oman had been received; this would form a suitable venue for a meeting with a marine focus, and would be investigated.

Workshop on the base of the Anisian, Romania: June 2000 (3.3, above).
Baud supported this suggestion and it was agreed to accept the proposal.

Other meetings:

- XIV International Congress on the Carboniferous and Permian; Calgary, Canada: 17-21 August, 1999
- V International Symposium, Cephalopods Past and Present; Vienna, Austria: 6-9 September, 1999
- VII International Symposium on Terrestrial Ecosystems; Buenos Aires, Argentina: September 1999
- Carpathian Geology 2000; Smolenice, Slovak Republic:11-12 October, 1999
- 10th International Palynological Conference, Nanjing, PRC: 24-30 June, 2000

7. Any other business

ALBERTIANA: Chairman thanked the editor, Hans Kerp, for maintaining the high standard of the STS newsletter and recognized the considerable effort involved in publishing the two issues per year which were necessary for the newsletter to be effective. He also acknowledged the valuable contribution of Utrecht University, where the newsletter is produced and distributed.

The Chairman referred to Kerp's request for a change of editor and noted the response outlined in ALBERTIANA 21. Kerp said his request reflected changes in his duties and a decline in his involvement with Triassic studies but, following offers from Orchard and Tozer to assist with

editing text, he is prepared to remain as editor; the Utrecht support will continue if the editor remains in the region.

The "Annotated Literature" section, which occupies many pages in each issue of ALBERTIANA, was discussed; this service is provided in other ways and several people felt that only the titles of relevant publications should be listed. Kerp said this would save much time, and the meeting agreed that this change should be implemented.

Mørk asked about putting the newsletter on-line. Kerp was not enthusiastic but agreed to look into the possibilities and report.

Kerp set 1 February and 1 August as deadlines for receipt of contributions; he asked for cover illustrations, and that titles for the publications list be sent to him by e-mail.

There was no other business.

The Chairman thanked Professor G. Bachmann, Halle, for the provision of facilities for the STS business meeting, and thanked delegates for their attendance and contributions. He declared the meeting closed at 18.00

G. Warrington
Secretary-General, Subcommission on Triassic Stratigraphy
7 November 1998

(Abbreviated, by the Secretary, from full minutes forwarded by him to the Chairman).

A REPRINT OF VON ALBERTI'S CLASSICAL MONOGRAPH

Everybody will, or at least should know the name Friedrich von ALBERTI, who is the founder of the Triassic System and after whom this newsletter has been named. Fewer will have read or maybe have even ever seen his classical work *"Beitrag zu einer Monographie des Bunten Sandsteins, Muschelkalks und Keuper, und die Verbindung dieser Gebilde zu einer Formation"* that appeared in 1834 and in which the Triassic was established. The original edition is very hard to find and the few libraries which hold a copy have it usually safely stored in their old book department. Therefore, the Friedrich von Alberti Stiftung (see also ALBERTIANA, 20: 64) took the laudable initiative to publish a facsimile edition of this classical monograph. The book contains the original monograph of 366 pages in which von Alberti gives a detailed description of the Triassic in its type area together with two enclusures. In addition, a 49 p. biographical note on the author with several illustrations is included. The book is very well produced and nicely bound in an old-style hard cover. For the price of DM 59,80 (= less than US $ 40.-) it is a real bargain that belongs on the bookshelf of every Triassic worker. The book can be ordered from:

Alberti-Stiftung
c/o Bürgermeisteramt Ingelfingen
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or Goldschneck Verlag W. K. Weidert
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ALBERTIANA is now also available on-line

Several readers and STS member experessed that they would like to see an electronic version of ALBERTIANA on the worldwide web. The editor/webmaster is pleased to inform you that an electronic version of ALBERTIANA is now available under the URL mentioned below.

Comments, suggestions for improvement and information to be posted on the website are most welcome!

http://www.uni-muenster.de/GeoPalaeontologie/Palaeo/Palbot/albomsl.htm

STS MEMBERSHIP RECORDS

A request for confirmation of contact details and other information was mailed to all Voting and Corresponding members of the STS in August 1998. An asterisk against a name in the above list indicates that no answer was received; in these cases the address given is the last one notified to the Secretary and is not necessarily correct. The members concerned are asked to contact the Secretary with confirmation of their contact details as soon as possible.

Distribution of *Albertiana* and items such as ballot papers, is based upon the information supplied to the Secretary. Incorrect records may result in these items being delayed, misdirected or lost; therefore it is in members' interest to ensure that the contact details held by STS are correct.

To assist in the maintenance of accurate membership records and contact details ALL Voting and Corresponding members of STS are asked to advise the Secretary immediately of any errors in their details as given in the above list, and to notify him promptly of any changes which occur. *PLEASE **TYPE** OR **PRINT** THE FOLLOWING INFORMATION **CLEARLY:***

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NAME:

TITLE:

FULL POSTAL ADDRESS:

TELEPHONE NUMBER*:

FAX NUMBER*:

E-MAIL ADDRESS:

ACTIVE IN TRIASSIC STUDIES ? YES / NO (delete as appropriate)

STAGE BOUNDARY(IES) WORKED ON ?

.....

* PLEASE INCLUDE FULL NATIONAL CODE(S)

Please post, FAX or e-mail any corrections or changes to your contact details to:

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THE EPICONTINENTAL TRIASSIC INTERNATIONAL SYMPOSIUM

Institut für Geologische Wissenschaften und Geiseltalmuseum, Martin-Luther-Universität, Halle-Wittenberg, Germany: 21-23 September, 1998

This meeting, held 120 years after the death of Friedrich August von Alberti (1795-1878), fully justified its title. It offered an intensive and varied programme of presentations on many aspects of the Trias, supported by an exhibition and a selection of excursions, and provided a forum for meetings of the German Subcommission on Permian and Triassic Stratigraphy and of the IUGS/ICS Subcommission on Triassic Stratigraphy and two of its component bodies, the Permian-Triassic Boundary and the Non-Marine Triassic working groups. It attracted some 200 registrants from more than 20 countries in Europe, Africa, Asia and the Americas; participants from the host nation were only slightly more numerous than those from other countries.

The Symposium began on 21 September with welcoming remarks, followed by a full morning plenary session with eight scientific contributions. Subsequent proceedings ran in two parallel sessions, accommodating 80 scheduled presentations, until the closing plenary session, with four scientific contributions and closing remarks, on the afternoon of 23 September. A large number of posters, many illustrating contributions to the lecture programme, were exhibited throughout the symposium. A 202-page Abstracts volume was published as *Hallesches Jahrbuch für Geowissenschaften*, Reihe B, Beiheft 5 (1998).

Pre-symposium excursions included a three-day visit to the Buntsandstein of the Hessian depression, and one-day visits to the Permian of the Saale Basin, the Buntsandstein and Muschelkalk in the central Germanic basin and the Jena region, and the Keuper of the Erfurt district. Post-symposium excursions included short visits to the Buntsandstein of the Jena region and the Buntsandstein and Muschelkalk around Halle, and longer excursions to the Triassic in the central Germanic basin (2 days) and the classic Germanic Triassic of the southern Germanic basin (4 days). A 250-page Excursions guide was published as *Hallesches Jahrbuch für Geowissenschaften*, Reihe B, Beiheft 6 (1998).

Even people who were not participants in the symposium could not have remained unaware of its subject because an exhibition, *'Trias. Eine ganz andere welt - Europa vor 250 Millionen Jahren'* was widely advertised in Halle. The exhibition was staged in six rooms in the Stadtmuseum and vividly conveyed many aspects of the biota and environments of the region during the Triassic. The timely publication, by the Friedrich von Alberti Stiftung, of a reprint of Alberti's seminal 1834 contribution *'Beitrag zu einer Monographie des Bunten Sandsteins, Muschelkalks und Keuper, und die Verbinderung dieser Gebilde zu einer Formation'* (see notice elsewhere in this issue) contributed further to the 'Triassic' atmosphere.

Participants had the opportunity to make or renew acquaintances at a welcoming party, with music, held in the courtyard of the Institut für Geologische Wissenschaften und Geiseltalmuseum on the evening before the start of the Symposium, and further hospitality was offered on subsequent evenings. On 21 September the Mayor of the City of Halle, Dr Rauen, welcomed participants to an evening reception in the Stadthaus, after which the exhibition *'Trias. Eine ganz andere welt'*, was visited in the nearby Stadtmuseum. On 22 September traditional music greeted participants to the Hallorenabend in the Salinemuseum, where a welcoming address was given by the senior member of the *Salzwirkerbrüderschaft im Thale zu Halle*, who appeared in

traditional dress. Silver items from the collection of the *brüderschaft* was displayed and demonstrations of the traditional method of preparation of salt from brine were given throughout the evening. The generous hospitality extended at these convivial events was greatly appreciated by all who attended.

Professor Dr Gerhard H. Bachmann and his colleagues on the symposium team planned and organised a very efficiently run and extremely stimulating event. A symposium volume will be published and this will be a 'must' for anyone professing an interest in the Trias.

G. Warrington
Secretary-General, Subcommission on Triassic Stratigraphy

Epicontinental Triassic International Symposium publications

About 70 papers have been submitted for publication in the symposium volume, and these are currently being edited. To register interest in this volume, please send your name and full postal address to:

Professor Dr I. Lerche
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Further information and order forms will be sent, in due course, to all who advise Professor Lerche of their interest.

Enquiries about the availability and price of the symposium Abstracts volume and the Excursion guide, which were published in *Hallesche Jahrbuch für Geowissenschaften* (see Halle Symposium report elsewhere in this issue), should be directed to:

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G. Warrington, Secretary-General,
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WORKSHOP ON THE LOWER-MIDDLE TRIASSIC (OLENEKIAN-ANISIAN) BOUNDARY

7-10 JUNE, 2000, TULCEA, ROMANIA

A four day workshop focusing on the Lower-Middle Triassic boundary will be held from June 7th to June 10th in North Dobrogea, Romania, an area where fossil-rich marine deposits spanning the Lower-Middle Triassic boundary are particularly well developed. The workshop, recommended and supported by the Subcomission of Triassic Stratigraphy of the IUGS, aims to present and evaluate the candidature of the Desli Caira section as GSSP for the Lower-Middle Triassic boundary and to give to the participants the opportunity to discuss multidisciplinary aspects concerning the considered time-interval (including bio and physical stratigraphy, paleogeography, paleoceanography and paleoclimatology).

The workshop will begin on Wednesday 7 June, 2000 at Tulcea, with one day of oral presentations and will continue with three days of field trips to representative Lower to Middle Triassic sections within the North Dobrogea area.

Further information concerning the program, accommodations, and costs (costs will be kept to a minimum) will be included in a first circular, and on the Internet, which will be released in April, 1999.

If you are interested in participating, please contact one of the organizers,

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FORTHCOMING MEETINGS

1999

15-18 July - European Palaeontological Association Workshop, Lisboa, Portugal
Contact: CEPUNL - Rogerio Bordalo da Rocha, Quinta da Torre, P-2825 Monte de Caparica, Portugal. E-mail: cepunl@mail.fct.unl.pt

17-21 August - XIV International Congress on the Carboniferous and Permian - Calgary, Canada
Contact: XIV ICCP, Department of Geology and Geophysics, University of Calgary, Calgary, Alberta, Canada, T2N 1N4. FAX: 403 284 0074 *or* e-mail: henderson@geo.ucalgary.ca

6-9 September - V International Symposium: Cephalods present and past - Vienna, Austria
Contact: Herbert Summesberger, Museum of Natural History, Vienna.
FAX:(0043) 1/52 177/459 *or* e-mail: herbert.summesberger@nhm.wien.ac.at

14-17 September - The biology and evolution of bivalves - University of Cambridge, UK
Contact: E. M. Harper, Department of Earth Sciences, Downing Street, Cambridge CB2 3EQ.
FAX: +44 (0)1223 333450 *or* e-mail: emh21@cus.cam.ac.uk

15-25 September - The continental Permian of the southern Alps and Sardinia (Italy): regional reports and general correlations - Brescia, Italy, with field trips (Sardinia and southern Alps)
Contact: Professor G. Cassinis, Dipartimento di Scienze della Terra, Università degli Studi, Via Ferrata 1, 27100 Pavia, Italy. FAX: +39 0382 505890 *or* e-mail: cassinis@unipv.it

26 September-2 October - VII International Symposium on Mesozoic Terrestrial Ecosystems - Buenos Aires, Argentina
Contact: The Secretary, VII International Symposium on Mesozoic Terrestrial Ecosystems, Museo Argentino de Ciencias Naturales "B. Rivadavia", Avda. Angel Gallardo 470, 1405 Buenos Aires, Argentina. FAX: 54 1 983 4151

13-17 October 1999 - Seventh International Symposium on Fossil Algae - Nanjing, China
Contact: Dr. Yuan Xunlai *or* Ms. Zhao Meiping, Institute of Geology and Palaeontology, Academia Sinica, 39 East Beijing Rd., Nanjing 210008, China, FAX: 025-335-7026 or e-mail: algae@pub.nj.jsinfo.net

11-14 October - Carpathian Geology - Smolenice, Slovak Republic
Contact: RNDr. Igor Broska, CSc., Geological Institute of the Slovak Academy of Sciences, Dúbravská cesta 9, 842 26 Bratislava, Slovak Republic.
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2000

24-30 June - 10th International Palynological Congress, Nanjing, People's Republic of China
Contact: Secretary of the Organizing Committee for the 10th International Palynological Congress, Nanjing Institute of Geology & Palaeontology, Academia Sinica, 39 East Beijing Road, Nanjing, 210008, People's Republic of China

30 July - 3 August 2000 - Sixth Quadrennial Conference of the International Organisation of Palaeobotany (IOPC-VI) - Qinhuangdao City, Hebei Province, China
Contact: Prof. Lujun Liu, Secretary-General of IOPC-VI Organising Committee, Nanjing Institute of Geology and Palaentology, Academia Sinica , 39 East Beijing Road, Nanjing 210008, China, FAX: +86-25-3357 026 *or* e-mail: paleobot@publicl.ptt.js.cn *or*
http://www.geocities.com/CollegePark/Gym/7213/contents.htm

6-17 August - 31st International Geological Congress - Rio de Janiero, Brazil
Contact: Secretariat Bureau, 31st International Geological Congress, Av. Pasteur, 404 - Casa Brazil 2000 - Urca - Rio de Janiero - RJ - Brazil.
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NEW DATA ON INDUAN/OLENEKIAN BOUNDARY IN SOUTH PRIMORYE

Annual Report 1998 of IOBWG

Yuri D. Zakharov and Alexander M. Popov

In the summer of 1997-98, we have investigated the Lower-Middle Triassic section at the Abrek Bay in South Primorye, between Vladivostok and Nakhodka. The first information on the Abrek Bay outcrops was published by Kiparisova (1972), who investigated some fossils (Kiparisova, 1961) collected by other geologists in 1936-56. Brachiopods collected by them at the Abrek locality were described by Dagys (1974) as a new genus of rhynchonellid brachiopods (*Abrekia*). Some years ago, the section that lies in ravine about 1.6 km NE of Tri Kamnya Cape (Ussuri Gulf) in South Primorye was proposed as a stratotype for the Induan/Olenekian boundary by Zakharov (1996).

The second section (Abrek Bay) can be also recommended as a GSSP candidate for the I/O boundary because a lot of ammonoids and brachiopods are present in the Lower Olenekian here. It is interesting that the all brachiopod representatives of *Abrekia sulcata* Dagys (more than 180 specimens) were found by us only within the single level of the *Hedenstroemia bosphorensis* Zone at the type locality, 2.6-3.1 m above the Induan/Olenekian boundary, associating with Lower Olenekian ammonoids - *Meekoceras boreale* Diener and *Ambites* sp. They were considered to be Induan in age till now (Dagys, 1974). *Abrekia sulcata* seems to be a good index for the lowermost Olenekian in Far East. As for inarticulate brachiopods, Lingula borealis Bittner and *Orbiculoidea* sp. are presented in both uppermost Induan and lowermost Olenekian in the Abrek section, with a dominance of *Orbiculoidea* in the Upper Induan *Gyronites subdharmus* Zone.

The Induan -Middle Olenekian shelf facies in the Abrek section substitute very quickly by uppermost Olenekian-Lower Anisian slope facies with radiolarians (not good preserved spherical *Spumellaria*). They are currently being investigated by Dr. E. Panasenko.

Acknowledgments

Thanks are due to Dr. E.S. Panasenko for information on radiolarians from Olenekian-Anisian transition. The work was made under the financial support of RFBR grant 97-05-65832.

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ABOUT THE TOP OF THE TRIAS

G. Warrington

Though of obvious interest to STS members, the upper limit of the Trias is the responsibility of the Triassic/Jurassic Boundary Working Group (TJBWG) of the International Subcommission on Jurassic Stratigraphy (ISJS). The STS Secretary, who is also Secretary of the TJBWG, briefly reviewed recent TJBWG activity during the STS business meeting in Halle (see Abbreviated Minutes of that meeting elsewhere in this issue of *Albertiana*). The work of the TJBWG will be reported in more detail as progress is made towards the selection of a GSSP for the base of the Hettangian Stage, marking the base of the Jurassic and, *inter alia*, the top of the Trias.

Some recent advances are noted here, for the benefit of STS members interested in the upper boundary of the System. Important discoveries, which are very relevant to discussions on the definition of the Triassic/Jurassic (T/J) boundary, have recently been made during the study of the lowest ammonite faunas in the Lias Group in the UK (Bloos & Page 1997; Page & Bloos 1998). These faunas include *Neophyllites* and *Psiloceras erugatum* (Phillips), found below the level of the appearance of *Psiloceras planorbis*, the index fossil for the lowest zone of the Hettangian; *P. erugatum* has been found *in* situ for the first time. Occurrences of *Neophyllites* have been discussed further by Bloos (1999). Further information on the ammonoid succession in the base-Jurassic candidate GSSP area of New York Canyon, in the Gabbs Valley Range, Nevada, USA, has been published by Guex et al. (1998), and further studies of the candidate GSSP on Kunga Island, Queen Charlotte Islands, British Columbia, Canada, have been published by Carter et al. (1998). The programme of the 5th International Symposium on the Jurassic System, held in Vancouver, Canada, in August 1998, included the following talks and poster presentations relevant to the T/J boundary:

- Bloos & Page - The ammonite sequence in the early Hettangian of north-west Europe.
- Carter - Extinction and recovery of radiolarians at the Triassic-Jurassic boundary in Queen Charlotte Islands.
- Cohen & Coe - Re-Os dating of organic-rich mudrocks and the Os isotope composition of seawater.
- Copestake & Partington - Stratigraphic sequences in the Jurassic-lowermost Cretaceous (Hettangian to Ryazanian) of the North Sea Basin and adjacent areas of north west Europe.
- Damboranea - Hispanic corridor: its evolution and the biogeography of bivalve molluscs.
- Embry - Large-scale sequence boundaries in the Jurassic succession of the Sverdrup Basin, Arctic Canada.
- Erlström & Guy-Ohlson - Distribution and evolution of the Triassic-Jurassic boundary sedimentation in Scania, southern Sweden.
- Haggart - Fossils and faults: unravelling the history of Queen Charlotte Islands, British Columbia.
- Hirsch & Katz - Mesozoic radiation and Tr/J extinction events.
- Iglesia Llanos & Riccardi - Bio-magnetostratigraphic scale of the Lower Jurassic of the Neuquen Basin, Argentina.
- Keisuke - Microfaunas in Triasso-Jurassic pelagic successions of the Chichibu Super Belt in East Shikoku, SW Japan.
- McRoberts - The Triassic-Jurassic boundary and end-Triassic mass extinction.

- Orchard - Decline and fall of conodonts at the Triassic-Jurassic boundary
- Pálfry & Dosztály - A new marine Triassic-Jurassic boundary section in Hungary: preliminary results.
- Pálfry & Smith - Timing of Early Jurassic recoveries and spacing of mass extinctions.
- Pálfry, Smith & Mortensen - A U-Pb and ^{40}Ar-^{39}Ar time scale for the Jurassic.
- Posen, Hounslow & Warrington - Magnetostratigraphy of the Hettangian/Rhaetian boundary section, St Audries Bay, UK
- Taylor - The Triassic/Jurassic system boundary in the Gabbs Formation, Nevada
- Tripathi - Palynological characteristics during Late Triassic-Early Jurassic time slot in India.
- Warrington - St Audrie's Bay, Somerset, England: a candidate Global Stratotype Section and Point for the base of the Jurassic System.
- Whalen, Carter & Orchard - Rhaetian radiolarians and conodonts near the Triassic-Jurassic boundary in Baja California Sur.

Of particular interest for the geochronology of the Triassic was the report of a U-Pb zircon dating of 199.6±0.7Ma from a tuff bed close below the proposed level of the base of the Jurassic (Pálfry et al. 1998). The publication of the proceedings of this conference will, therefore, be of interest to STS members.

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NEW PUBLICATION EDITED BY STS MEMBERS

The special publication announced by Spencer Lucas in his report to the STS business meeting in Halle (see Abbreviated Minutes of that meeting elsewhere in this issue of Albertiana) has appeared as part four of volume 143 of the Elsevier journal Palaeogeography, Palaeoclimatology, Palaeoecology (November 1998). This issue, entitled The Permian-Triassic boundary and global Triassic correlations, was edited by Spencer Lucas and Yin Hongfu. The articles, which include four (by Kozur, Lozovsky, Mei et al. and Yin & Tong) on Permian/Triassic boundary topics, and four (by Dobruskina, Khuc & Huyen, Lucas and Tong) on Triassic topics, comprise some 185 pages and are listed in the "New Triassic literature" section of this issue of ALBERTIANA.

STS Meeting in Rio de Janeiro

A meeting of the Triassic Subcommission is planned during the 31st International Geological Congress (IGC) in Rio de Janeiro, Brazil, 6-17th August 2000. This will provide an opportunity to meet Triassic colleagues in a South American venue and review STS activities.

Friedrich von Alberti Prize 1998

Dr. Jens Lorenz Franzen from the Senckenberg Research Institute in Frankfurt am Main is the first recipient of the Friedrich von Alberti Prize. This prize has been established by the Friedrich von Alberti Foundation, in which 20 quarry companies are involved (see ALBERTIANA 20: 64). Dr. Franzen received the prize of DM 20,000.- for his scientific work on the famous Messel *Fossillagerstätte* and it preservation as well as for his work on the evolution of man. In addition he also received a facsimile edition of von Alberti's famous monograph in which he established the Triassic System. The Friedrich von Alberti Prize will be given yearly, alternatingly to professional and "amateur" palaeontologists. In addition the Friedrich von Alberti Foundation supports young scientists, particularly from Baden-Württemberg. A young Ph.D. student received financial support to present his results at an international congress in Prague.

ALBERTIANA

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A DEBATE ON THE LADINIAN-CARNIAN BOUNDARY

Paolo Mietto and Stefano Manfrin

Introduction

Research on the ammonoid distribution in the Ladinian-Carnian boundary interval in the Southern Alps (Italy) allowed Mietto & Manfrin (1995a, b) to define a stratigraphical interval - characterized by *Daxatina, Clionitites* and by some species of *Trachyceras* different from *T. aon* - below the traditional base of the Carnian (= base of the Aon Zone/Subzone). The interval, defined in the Prati di Stuores section (Pralongià, Dolomites), was named the Daxatina cf. canadensis Subzone. As a consequence of the new biostratigraphical data, it was suggested that the base of the Carnian be placed in a lower stratigraphical level. Therefore the upper part of the Frankites regoledanus Zone (*sensu* Krystyn in Zapfe, 1983), usually considered Ladinian and correlated with the upper Frankites sutherlandi Zone in North America, should be included in the Carnian.

The proposal aroused interest in a group of Italian researchers (Loriga Broglio & Neri, 1995) who studied other groups of fossils, as well as the magnetostratigraphy and the sequence stratigraphy of the Prati di Stuores section, surely the most interesting and complete in the Dolomites among those including the L/C boundary.

The suggestions, one of lowering the base of the Carnian Stage using the first appearance of the cosmopolitan genus *Daxatina* as a criterion for recognizing it (Mietto & Manfrin, 1995a,b), and the other of considering the Prati di Stuores section as the Global Stratotype Section and Point (GSSP) for the base of the Carnian Stage, were made in Broglio Loriga et al. (1998b) and formally proposed in Broglio Loriga et al. (in press). In a meeting at Pralongià, 2-3 July 1998, the stratigraphic section of Prati di Stuores was visited by the members of the S.T.S. and the research was presented and discussed. An internal report (Broglio Loriga et al., 1998a) was also prepared.

Later Balini and others (1998) reported the results of their research at Spiti (Himalaya) on the same interval, with interesting data on conodonts and pelagic bivalves, not well documented at Stuores. The writers doubt some conclusions of Balini and et al. (1998), and will discuss them.

Remarks

Balini et al. (1998) present two kinds of problems that will be discussed and analysed. The first kind is formal - in Balini et al.'s opinion as well - and is related to taxonomy. The second one is more significant and concern methodological and philosophical concepts.

Taxonomy

When the suture line is not visible, *Daxatina* is not easily distinguished from *Trachyceras*; this is well illustrated in Tozer (1994), for example. The criticism about the *Trachyceras muensteri* illustrated in Mietto & Manfrin (1995a: pl. 5, fig. 5; 1995b: pl. 2, fig. 16) and related as *Daxatina* cf. *canadensis* in the internal report (Broglio Loriga et al., 1998a) is clearly a mistake, from which Balini et al. (1998) conclude that at Stuores "...the ammonoid taxonomy does not seem to be stable". No experienced specialist in ammonoid taxonomy can mistake *T. muensteri*

with *D. canadensis*, because of their great morphological differences, and therefore the statement of Balini et al. is clearly unfair.

The specimen in discussion has traces of a clearly *Trachyceras*-like suture line; many other cospecific specimens were found in beds both over and underlying level PSR3, the probable origin stratum of the above mentioned specimen of *T. muensteri*, within a 40 cm thick set of layers particularly rich in ammonoids. This is the meaning of PSR3.dt.1 of the quoted specimen. Very good specimens of the same species were found with *T. bipunctatum* in other coeval stratigraphic sections in the Dolomites, for example in the sections of Campolongo Pass (Sella group).

Another problem is the taxonomical separation between *Frankites regoledanus* and *F. apertus*. According to Mietto & Manfrin (1995a, b) the turnover of these taxa is correlatable with the bioevents documented (Tozer, 1994) in Canada:

1. appearance of *Frankites,* with *F. glaber,* at the base of the Sutherlandi Zone (Subzone 1);
2. replacement of *F. glaber* by *F. sutherlandi* at the base of Subzone 2;
3. coexistence of *F. sutherlandi* and *Daxatina canadensis* in the middle/upper part of Subzone 2.

The recognition of the same trend among the representatives of *Frankites* documented in the Southern Alps makes the discrimination between *F. regoledanus* and *F. apertus*, doubted in Balini et al. (1998), particularly important. The problem was discussed at the S.T.S. meeting at Pralogià. A first conclusion was that the species named *F. apertus* by Mietto & Manfrin (1995a, b) can be discriminated from *F. regoledanus*, first of all for the frequency of the ribs. There was no conclusion as to the name of the species that, according to L. Krystyn (personal communication) should be probably considered *nova species*. From this point of view the *F. regoledanus-F. apertus* problem is just a nomenclature problem, with no influence on the meaning of the bioevents of the interval and on the possible correlations with the successions in other paleobiogeographical provinces. Surely this is an open problem, but it will never ".... lead to serious confusion in the future stratigraphic scale" as concluded by Balini et al. (1998: p. 31).

Another problem posed by Balini et al. (1998) is that the *Daxatina* "...forerunner is unknown". In our opinion, the forerunner is in the *Asklepioceras-Muensterites* lineage (cf. Mietto & Manfrin, 1995b: pl. 2, fig. 9). These genera are well known both in low-intermediate latitude domains.

Methodology and "philosophy"

If the suture line is not visible, it is difficult to discriminate *Daxatina* from *Trachyceras*, so that the former genus "... does not completely fulfil the requirements of a guide fossil" in Balini et al. (1998: p. 30) opinion. If the transitive law is applied, also *Trachyceras* "... does not completely fulfil the requirements of a guide fossil". If the statement of Balini et al. (1998) is accepted, many taxa should be eliminated as biostratigraphical markers. The problem will occur for example with *Schreyerites-Paraceratites* or with *Eoprotrachyceras-Protrachyceras,* involving in the discussion the Pelsonian-Illyrian and the Fassanian-Longobardian boundaries.

In a case similar to that in discussion, *Metapolygnathus* vel *Gondolella polygnathiformis* is considered the possible conodont marker for the Ladinian-Carnian boundary. As reported in Broglio Loriga et al. (1998b: p. 9), the species was identified in the FŸred Limestone in the Balaton Highlands by Kovacs et al. (1991), but in an upper Ladinian context, and later denied by one of the authors. In this case, should the problem of the "taxonomical stability" prevent the use of this taxon for biostratigraphical purposes? Of course this has no real meaning. Any taxon, when its distinctive characters are not well preserved, can be valued subjectively; this is a problem of palaeontology and it must be taken into account when the data are used for

biostratigraphical purposes, so that the objective and the subjective data are distinguishable. Surely, it is not scientifically correct to refer to non-illustrated taxa to support one's ideas or to discuss others'. Most of the researchers of ammonoid Triassic biostratigraphy, the writers included, have incurred in this mistake. But it is unfair to attribute the mistake to other, without seeing one's own. Balini et al. (1998), for example, point out - as for the ammonoids at Stuores - "... at present the features of these species are unknown ...". The most significant species were at least illustrated in Mietto & Manfrin (1995a, b) and now in Broglio Loriga et al. (in press), although surely the complete taxonomy of the ammonoids found at Stuores must be given in a near future. That being stated, Balini et al. (1998) write "As regard the appearance of *Clionitites*, in Epidaurus section this genus occurs already at the base of the Regoledanus Zone (sample A16 in Krystyn 1983, fig.3 p. 244) then Mietto & Manfrin's sections record a F.O., not the F.A.D. of the genus". But the "Krystyn 1983, fig.3 p. 244" is only a stratigraphic column of Epidaurus, with no reference to *Clionitites*. Possibly Balini et al. (1998) referred to Krystyn & Mariolakos (1975), where this genus is reported at Epidaurus associated with *F. regoledanus.* Anyway, there are no descriptions and/or pictures of these presumed *Clionitites.* Therefore, at the moment the statement that *Clionitites* appears before *Daxatina* and/or *Trachyceras* is a still undemonstrated opinion. On the basis of the data found in the Southern Alps and of those in the literature, the presumed pre-Carnian *Clionitites* should be carefully compared to the very similar taxa *"Anolcites"* cf. *laricus* and *Zestoceras.* The latter genus, originally defined in Canada (Tozer, 1994), is now well documented in the Southern Alps, with a set of species comparable - at least as a trend - with what observed in Canada in the Upper Ladinian-Lower Carnian interval (Maclearni to Sutherlandi Zones), as reported in Broglio Loriga et al. (1998a, in press).

Balini et al. (1998) report a possible specimen of *Daxatina* at level 97/176 of Muth (Spiti). During the S.T.S. meeting at Pralongi', L. Krystyn illustrated the composite Spiti section; the report of *Daxatina* in Himalaya and his statement about the sure occurrence of the genus in the Tethys domain as well as in the Southern Alps were considered very interesting. The doubt later expressed in Balini and others (1998) about the occurrence of *Daxatina* at Spiti is very surprising. Clearly there were the same problems of "taxonomical stability" that disturb Balini et al. when they value other researchers' works.

Synchroneity

A very important problem is stressed in Balini et al. (1998) when they doubt the synchroneity of the F.O. of *Daxatina* in the different paleobioprovinces, and therefore the possibility of recognizing its F.A.D. The occurrence of the cosmopolitan genus *Daxatina* (the only one in this critical interval) would not be appropriate as the marker of the base of the Carnian Stage. The doubts on the real pre-dating of *Trachyceras* would make the use of the F.O. di *Trachyceras,* that in North America is at the base of the Desatoyense Zone, inappropriate as well. In other words, Balini and others seem to support the maintenance of the present criterion, that is the base of the Aon Zone (correlated with the base of the Desatoyense Zone) as the L/C boundary.

As they are the main problem in the correlations among different paleobiogeographic provinces, surely these doubts can be shared on philosophical basis. In the case in exam both the historical correlations and the new proposal can only be based on biostratigraphy, since no comparable data of physical stratigraphy are available at the moment. This stated, at present (cf. Dagys & Tozer, 1989; Dagys & Weitschat, 1993) the base of the Carnian Stage is correlated through the F.O. of *Trachyceras* (= *T. aon*) in the Aon Suzone (low latitude: Tethys), the F.O. of *Trachyceras* (= *T. desatoyense*) and the occurrence of *Stolleyites* in the Desatoyense Zone (middle latitude: Canada), and the F.O. of *Stolleyites* in the Tenuis Zone (high latitude: Arctic Ocean). None of them can be considered a FAD. In the Southern Alps the genus *Trachyceras* occurs a

long time before *T. aon*; in Canada, *Stolleyites* occurs in the Desatoyense Zone but seems to be already present in the Ladinian (Tozer, 1994); *Trachyceras* is not documented in the Boreal domain.

Daxatina appears below the base of the Aon Subzone (Southern Alps, ?Spiti), of the Desatoyense (British Columbia, Nevada) and the Tenuis Zones (Svalbard). The comparison between the ammonoid successions in the Southern Alps and in British Columbia shows an exceptional analogy on taxonomical basis and proves that the bioevents in this interval are basically in homotaxis. On the basis of these valuation elements, the problem of the synchroneity of the F.O. of *Daxatina* as proposed in Balini et al. (1998) is merely academic.

Now the scientific community has to answer the question, whether it is preferable to refer to an asynchronous and non-cosmopolite event, like the F.Os of species of *Trachyceras*, non-cospecific in the different domains, or to the F.O. (but why not the F.A.D.?) of the synchronous and sure cosmopolitan genus *Daxatina*, probably represented by the same species in the various paleobioprovinces.

A basic issue

Up to now, assuming that the F.O. of *Trachyceras* coincide with those of *T. aon* and *T. desatoyense,* every association including *Trachyceras* was considered lower Carnian (lower Julian) in age. Even if the proposal of lowering the L/C boundary is accepted, the assumption is still basically correct, since *Trachyceras* is pre-dated. On the basis of the new statement, the associations should be divided into pre- or post-Aon vel Desatoyense biozones.

The precise analysis of the Canadian fossiliferous localities reported in Tozer (1994) allows the identification of a stock of specimens (characterized in particular by *Trachyceras*? sp., *Clionitites callazonensis*, *C. reesidei*, *Daxatina limpida* and *Stolleyites* sp. indet.) always found below the first occurrence of *T. desatoyense*. They are attributed to the Desatoyense Zone, but we think that this is not the only possible interpretation. Moreover, in the Southern Alps the L.O. of *Daxatina* is older than the base of the Aon Subzone.

As for *Trachyceras* ? sp. reported by Tozer (1994: pl. 88, fig. 14) in the Callazon Creek (British Columbia, GSC loc. 84268), the specimen, the suture line of which is not visible, was found 17 m below the first *T. desatoyense* (GSC loc. 84269). For the features of the venter it may be a real *Trachyceras*. The stratigraphic position of the specimen is no guaranty of its sure belonging to the Desatoyense Zone and consequently it cannot be surely stated that in Canada the genus *Trachyceras* first appears at the base of the Desatoyense Zone. This is true also if Tozer's doubts on the identification of the specimen are accepted.

In this case, taxonomic doubts and different stratigraphic considerations justify subjective interpretations; of course the different interpretations should stimulate further researches.

As a conclusion, it must be stressed once again that the lack of a clear discrimination between objective and subjective data, that is between checkable data (key data) and interpretations, were, are and will always be detrimental for further discussion.

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DORASHAMIAN, INDUAN, OLENEKIAN, ANISIAN, LADINIAN, CARNIAN, NORIAN AND RHAETIAN CARBONATES OF RUSSIA: STABLE ISOTOPES, Ca-Mg RATIO, AND CORRELATION

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The $\delta^{13}C$ anomalies at different levels of Permian-Triassic carbonates in the Primorye region, North Caucasus, Transcaucasia and the Alps, which are usually characterized by high Mg contents, seem to be related to high biological productivity of the Tethyan marine basins caused by conditions of transgressions and warm climate during the following epochs: (1) early

Dorashamian (*Paratirolites kittli* Zone), (2) middle Olenekian (*Tirolites-Amphistephanites* Zone), (3) early Anisian, (4) late Ladinian-?earliest Carnian, (5) late Carnian, (6) early Norian, and (7) early Rhaetian. The highest bioproductivity during Triassic took apparently place during the middle Olenekian (Fig. 1).

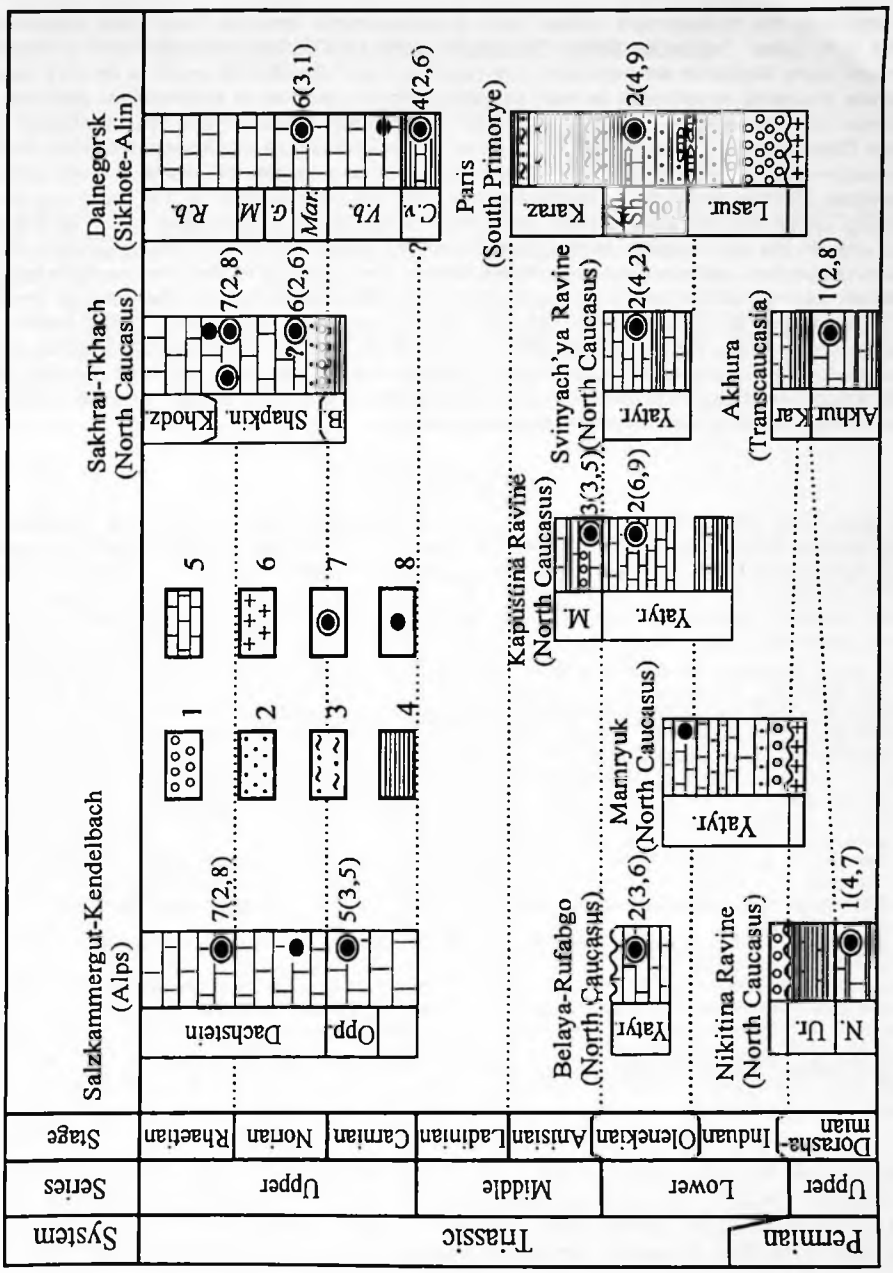
The existence of thermal maxima in the Tethys during early Dorashamian, middle Olenekian, early Anisian, and early Norian times seems to be in agreement with some radiolarian diversification events. Abundance and high taxonomic diversity of the *Albaillellaria* from lower Dorashamian cherts of the Pantovyj and Skalistyj Creek basins and Amba Mount area (Sikhote-Alin) and from conteporaneous flyschoid strata of the Orel Mount area (South Primorye) seem to be caused by optimal temperature conditions. Accumulation of significant masses of radiolarian cherts in Sikhote-Alin during the Olenekian is probably related to similar conditions. It is possible that appearance of the polysegmental *Nassellaria* was related to the Anisian warmth and transgression, although the spherical *Spumellaria*, as was recently recognized in North Caucasus (Kapustina and Svinyach'ya Ravine, Mamryuk, Rufabgo) and South Primorye (Abrek Bay), was a dominant group among the microfossils in both Induan-Olenekian strata and during the Olenekian-Anisian transition. The sharp changes in taxonomic diversity of both *Nassellaria* and the *Spumellaria* in cherts of Sikhote-Alin (Skalistayj Creek, Dalnegorsk and Breevka village areas) and the development of planktonic limestone in the Dzhaurskaya Suite and its equivalents in Sikhote-Alin appear to have been related to the Carnian and Norian warm periods.

Judging from the isotopic data, the calculated palaeotemperature for the early Dorashamian shallow-water carbonate facies of Transcaucasia (Zakharov et al., 1997) and North Caucasus reaches 23.8°C. In the beginning of Urushtenian (late Dorashamian) time temperature of near bottom waters of the shallow sea in North Caucasus (23.8-24.2°C) was similar to those for the early Dorashamian. The same temperature conditions of tropic and subtropic seas are suspected to be at least in middle Olenekian time proceeded from some isotopic and Ca-Mg ratio data for the Tethys.

Conditions for the middle Olenekian seem to be compared also with the early Aptian climatic optimum (with palaeotemperature for shallow water terrigenous facies in North Caucasus about 13.7-23.9°C). Morante & Hallam (1996) have reconstructed tropical conditions for the Eastern Alps in early Rhaetian from oxygen-isotopic investigation of the Kössen Limestone ($\delta^{18}O$ = -1.76‰ to -2.89‰; T = 19-24°C). Similar result for the Upper Triassic of the Alps (values of $\delta^{18}O$ range from -0.05‰ to -2.83‰) from ammonoid aragonitic material was obtained early by Fabricius et al. (1970).

The range of $\delta^{18}O$ values in aragonitic ammonoid shells from the Lower and Middle Triassic in Arctic Siberia suggests the average temperature values for early Olenekian, late Olenekian and late Anisian of 8.8?°, 16.2?° and 15.4?°C correspondingly (Zakharov et al., in prep.), which is consistent with palaeotemperatures obtained from Olenekian bivalves probably living in some fully saline basins of Arctic Siberia (Kurushin & Zakharov, 1995).

Fig. 1. Correlation of the uppermost Permian and Triassic of the Tethys from geochemical data: 1 - conglomerate, 2 - sandstone, 3 - striped sandy siltstone, 4 - mudstone, 5 - limestone, 6 - granite, 7 - carbon-isotopic anomaly and its number (values in per milles are shown in bracketes), 8 - $\delta^{13}C$ value about 2.2‰. Suites: N. - Nikitinskaya, Ur. - Urushtenskaya, Akhur. - Akhurinskaya, Kar. - Karabaglyarskaya; Yatyr. - Yatyrgvartinskaya, M. - Malotkhachskaya, B. - Babukskaya, Shapk. - Shapkinskaya, Khodz. - Khodzinskaya, Lazurn. - Lazurninskaya, Tob. - Tobizinskaya, S. - Shmidtskaya, Zh. - Zhitkovskaya, Karaz. - Karazinskaya. Formation: Opp. - Opponitz.


System
Series
Stage
Permian
Triassic
Upper
Lower
Middle
Upper
Dorasha-mian
Induan
Olenekian
Anisian
Ladinian
Carnian
Norian
Rhaetian
Salzkammergut-Kendelbach (Alps)
Dachstein
Opp.
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5(3,5)
Sakhrai-Tkhach (North Caucasus)
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Nikitina Ravine (North Caucasus)
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We indicate the temperature values with question-marks because they were obtained using using R.V. Teiss' "water correction" (Zakharov et al., 1975). For reconstruction of late Palaeozoic and early Mesozoic environments the data from reef distribution seem to be very important, because the reefs consider to be very sensible indicator for marine environment changes. As an example of a prospering reef is that of the end-Permian strata of the Urushtenskaya Suite in North Caucasus. It is known that at the start of the Triassic, reefs disappeared from the face of the earth and a reef formation was not renew in any region of world in both the middle Olenekian climatic optimum (transgression) and the similar condition of the beginning of Middle Triassic. After the Permian-Triassic boundary ecological crisis they have arisen in the tropical zone only in the Late Triassic (although scleractinian corals made their first appearance in Middle Triassic). Lack of reefs in the low latitudes during the beginning of the Triassic more logically to connect with O_2 deficit both in the atmosphere and the hydrosphere of that time as consequence of the anoxic event across the Permian Triassic boundary (Baud et al., 1989; Berner, 1989; Gruszczynski et al., 1989; Hallam, 1994; Holser et al., 1989). The absence of visible sighns of organic SiO_2 - accumulation just in the Permian-Triassic transition time and the low rates in reconstruction of the radiolarian taxonomic diversity through the Induan and Olenekian to the early Anisian seem to be caused by the same reason.

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A TETRAPOD-BASED TRIASSIC TIMESCALE

Spencer G. Lucas

Eight, temporally successive assemblage zones of tetrapod (amphibian and reptile) fossils provide the basis for dividing Triassic time into eight land-vertebrate faunachrons (LVF). The beginning of each LVF is defined by the first appearance datum (FAD) of a widespread tetrapod genus. These LVFs, the taxa whose FADs define their beginnings, and their approximate correlation to the standard global chronostratigraphic scale (SGCS) are (ascending order): 1. Lootsbergian, FAD *Lystrosaurus* = late Dorashamian-Induan; 2. Nonesian, FAD *Cynognathus* = Olenekian; 3. Perovkan, FAD *Shansiodon* = Anisian; 4. Berdyankian, FAD *Mastodonsaurus* = Ladinian-early Carnian; 5. Otischalkian, FAD *Paleorhinus* = late early-early late Carnian; 6. Adamanian, FAD *Rutiodon* = latest Carnian; 7. Revueltian, FAD *Pseudopalatus* = Norian; 8. Apachean, FAD *Redondasaurus* = Rhaetian. These Triassic LVFs provide a framework for the correlation of Triassic nonmarine deposits with a temporal resolution comparable to the seven Triassic Stages/Ages of the SGCS.

Introduction

Triassic biochronology is dominated by the ammonoid paleontologist and marine micropalentologist. The fossils they study provide the basis upon which most of the Triassic SGCS has been built. However, ammonoids and marine microfossils are largely irrelevant to the correlation of the nonmarine strata deposited across the vast expanse of Triassic Pangaea. Tetrapod fossils are key to these correlations, and their organization into a global biochronology provides a timescale applicable to the nonmarine Triassic.

Fossil tetrapods are widespread (Fig. 1) and have long been used to correlate nonmarine Triassic strata (e.g., Ochev & Shishkin, 1989; Lucas, 1990, 1997, 1998). Lucas (1998) presented a comprehensive tetrapod biostratigraphy and biochronology for the Triassic strata of Pangaea by defining, or redefining, Triassic LVFs, which are eight time intervals identified by Triassic tetrapod fossils. Here, I present a concise summary of this work.

Previous vertebrate-based subdivisions of Triassic time

Although tetrapods have long been used to correlate nonmarine Triassic strata, relatively few efforts have been made to establish a formal tetrapod biostratigraphy or biochronology of the global Triassic (Fig. 2). Broom (1906, 1907, 1909) introduced the earliest, and perhaps most influential, Triassic tetrapod biostratigraphy for the Lower Triassic of the Karoo basin in South Africa. He identified three successive biostratigraphic intervals, the *Lystrosaurus*, *Procolophon* and *Cynognathus* "beds." Watson (1914a, b) later termed these "zones," and, since Kitching (1970), the *Lystrosaurus* and *Procolophon* zones have been combined into a single, *Lystrosaurus* zone. Identification of the *Lystrosaurus* and/or *Cynognathus* "beds" or "zones" has long been possible in Antarctica, South America, India, China and Russia because of the cosmopolitanism of Early Triassic tetrapods, especially the genera *Lystrosaurus* and *Cynognathus*.

Romer (1975; also see Cox, 1973) presented the first global Triassic tetrapod biochronology when he identified three successive types of land-vertebrate "faunas:" A (Early Triassic), B (Middle Triassic) and C (Late Triassic) (Fig. 2). Cosgriff (1984) divided Romer's division A into A1 (= *Lystrosaurus* biochron) and A2 (*Cynognathus* biochron). Ochev & Shishkin (1989; also

see Anderson & Cruickshank, 1978) recognized the same intervals as Romer, but chose to name them the proterosuchian epoch (= A), kannemeyerioidean epoch (= B) and dinosaurian epoch (= C).

Cooper (1982) proposed a more detailed global tetrapod biostratigraphy of the Triassic than did Romer (Fig. 2). He recognized a succession of six Triassic zones based largely on a perceived stratigraphic succession of dicynodonts (see Lucas & Wild, 1995 for a revised dicynodont biozonation; also, note that Cooper [1982] considered the *Lystrosaurus* zone to be Permian). However, Cooper's zonation has not been used by subsequent workers. The status of global Triassic tetrapod biostratigraphy and biochronology thus has not progressed much beyond that of Romer (1975), as a recently published synthesis (Ochev & Shishkin, 1989) indicates.

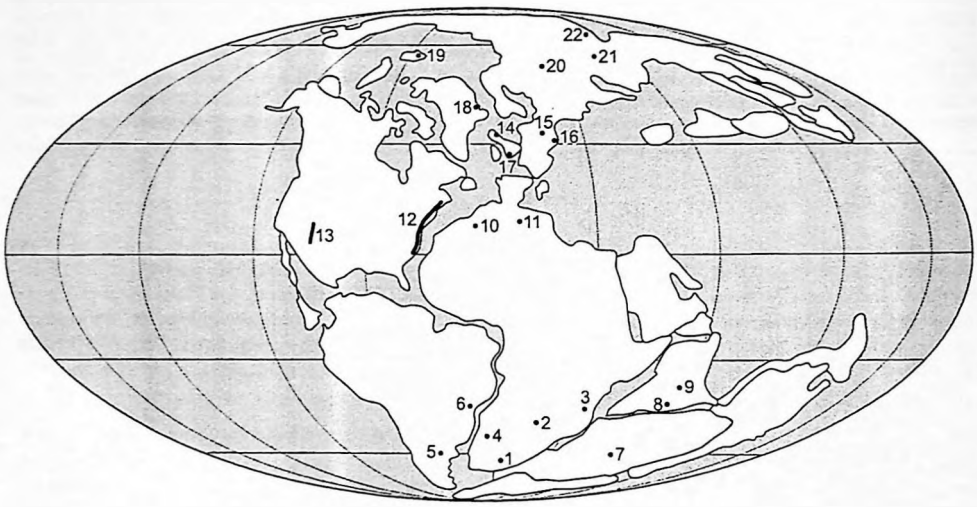

Fig. 1. Map of Triassic Pangaea showing locations of principal vertebrate fossil assemblages. Locations are: 1, Karoo basin, South Africa. 2, Zambia. 3, Tanzania. 4, Namibia. 5, Argentina. 6, Brazil. 7, Transantarctic Mountains, Antarctica. 8, Pranhita-Godavari Valley, India. 9, Damodar, India. 10, Essaouira basin, Morocco. 11, Ilizi basin, Algeria. 12, Newark Supergroup basins, eastern USA-Canada. 13, Moenkopi and Chinle basins, western USA. 14, Scotland. 15, Germanic basins. 16, Northern Italy. 17, Devon, United Kingdom. 18, Eastern Greenland. 19, Svalbard. 20, Russian Urals. 21, Junggur basin, China. 22, Ordos basin, China.

More detailed subdivision of Triassic time has been made in provincial biochronologies proposed for Argentina, North America and China. Bonaparte (1966, 1967, 1982) introduced a set of "provincial ages" for the Triassic of Argentina, but he never defined these terms (Fig. 2). (Lucas & Harris [1996] did define the Chanarian as a LVF). Lucas (1993) proposed a succession of LVFs for the Chinese Early-Middle Triassic tetrapod record. Lucas & Hunt (1993) proposed Late Triassic LVFs based on the Chinle Group tetrapod record from the western United States, and Huber et al. (1993; Lucas and Huber, 1998) proposed Middle-Late Triassic LVFs based on the Newark Supergroup record of eastern North America (Fig. 2).

Lucas & Huber (1998) reviewed global Late Triassic tetrapod biochronology and demonstrated the broad utility of the Chinle Group tetrapod biochronology proposed by Lucas & Hunt (1993; also see Lucas, 1997). The status of "provincial" tetrapod biochronology of the Triassic is that schemes exist for the Argentinian and Chinese record and for the Middle-Late Triassic record from North America. Although I advocate a global tetrapod biochronology, this does not obviate the need for some provincial biochronologies, whose utility as a secondary standard (Cope, 1996) is noted below.

Lootsbergian LVF

Lootsbergian time begins with the FAD of the dicynodont *Lystrosaurus*. The end of the Lootsbergian is equivalent to the beginning of the Nonesian, which is defined by the FAD of the cynodont *Cynognathus*. The Lootsbergian LVF is characterized by the *Lystrosaurus* Assemblage Zone in the Balfour (Palingkloof Member), Katberg and Burgersdorp (lower part) formations of the Karoo basin of South Africa (Groenewald and Kitching, 1995). The following tetrapod genera are restricted to Lootsbergian time and are widespread and/or common enough to be useful as index fossils: *Wetlugasaurus*, *Tupilakosaurus*, *Luzocephalus*, *Lydekkerina*, *Procolophon*, *Lystrosaurus*, *Scaloposaurus*, *Thrinaxodon*, *Proterosuchus* (= *Chasmatosaurus*) and *Prolacerta*.

The terms *Lystrosaurus* zone, beds or fauna have been applied to a wide geographic range of strata/fossils of Lootsbergian age. The most significant vertebrate fossil assemblages of Lootsbergian age are from the upper Guodikeng and lower Jiucaiyuan formations, Junggur basin, China; Heshanggou Formation, Ordos basin, China; lower part of Fremouw Formation, Antarctica; Panchet Formation, India; Vokhmian horizon of Vetluga Series, Russian Urals; and Wordy Creek Formation, eastern Greenland.

Direct cross-correlation of the Lootsbergian to part of the Induan is provided by the occurrence of characteristic Lootsbergian temnospondyls in ammonite-bearing Induan strata of the Wordy Creek Formation in eastern Greenland (Trümpy, 1961). Apparently, the beginning of the Lootsbergian does not correspond to the beginning of the Triassic. Indeed, the FAD of *Lystrosaurus* has long been assumed to equate to the beginning of the Triassic, but a close correlation has not been documented. Whether or not the end of the Lootsbergian correlates to the end of the Induan also is uncertain.

Nonesian LVF

Nonesian time begins with the FAD of the cynodont *Cynognathus*. The end of the Nonesian is the beginning of the Perovkan LVF, which is defined by the FAD of the dicynodont *Shansiodon*. The Nonesian LVF is characterized by the *Cynognathus* Assemblage Zone from the upper two-thirds of the Burgersdorp Formation in the Karoo basin of South Africa (Kitching, 1995). The following tetrapod taxa are restricted to Nonesian time and are widespread and/or common enough to be considered index fossils: *Parotosuchus*, *Trematosuchus*, *Erythrosuchus*, *Cynognathus*, *Diademodon*, *Trirachodon*, *Kannemeyeria cristarhynchus*

Kitching (1977) reviewed the *Cynognathus* Assemblage Zone localities, and Kitching (1995) provided a recent synopsis of the stratigraphic ranges of the genera. Watson (1942) and Kitching (1977) subdivided the *Cynognathus* Assemblage Zone into two subzones. Hancox and Rubidge (1994), Hancox et al. (1995) and Shishkin et al. (1995a) divided the *Cynognathus* Assemblage Zone into three successive zones: (1) *Kestrosaurus* acme zone; (2) "*Parotosuchus*" *africanus* acme zone; and (3) advanced capitosauroid zone. Kitching (1995), however, made no

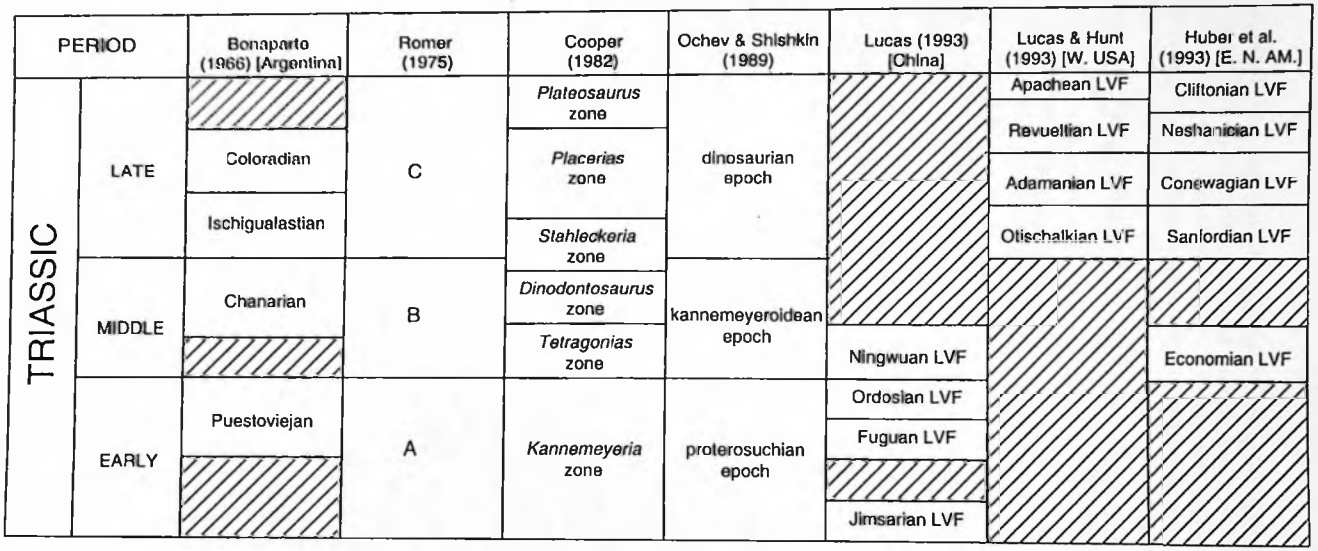

Fig. 2. Previously proposed Triassic tetrapod biochronologies and biostratigraphies.

attempt at subdivision, and no formal subdivisions are advocated here, pending publication of research in progress by P.J. Hancox and his co-workers.

Principal vertebrate fossil assemblages of Nonesian age come from the upper Fremouw Formation, Antarctica; Petropavlovsk Formation ("Yarenskiy horizon") in the Russian Urals; Wupatki and Torrey formations of the Moenkopi Group, Arizona-Utah, USA; Puesto Viejo andRio Mendoza formations, Argentina; lower part of Ermaying Formation, Ordos basin, China; Omingonde Formation, Namibia; lower N'tawere Formation, Zambia; K7 horizon of the Kingori Sandstone, Tanzania; and Sticky Keep Formation of Svalbard.

The occurrence of *Parotosuchus* in marine Olenekian strata of the Mangyshlak Peninsula in western Kazakstan (Lozovsky & Shishkin, 1974) is the most direct cross-correlation of the Nonesian to the SGCS. *Aphanerama* or *Parotosuchus* records in Svalbard, Germany and/or North America also support correlation of the Nonesian with at least part of the Olenekian.

Perovkan LVF

The beginning of the Perovkan is defined by the FAD of the dicynodont *Shansiodon*. The end of the Perovkan is the beginning of the Berdyankian, which is defined by the FAD of the temnospondyl *Mastodonsaurus*. The Perovkan LVF is characterized by the vertebrate fossil assemblage of the Donguz "svita" (= Formation) in the Russian Urals (Shishkin et al., 1995b). The following tetrapod taxa are common and/or widespread enough to be useful index taxa of the Perovkan: *Eryosuchus*, *Eocyclotosaurus*, *Shansiodon*, *Scalenodon*, *Parakannemeyeria*, *Sinokannemeyeria*, *Kannemeyeria simocephalus*. Principal vertebrate assemblages of Perovkan age are from the upper Ermaying Formation, Ordos Basin, China; lower Kelamayi Formation, Junggur basin, Xinjiang, China; Holbrook and Anton Chico members of the Moenkopi Formation, western USA; Upper Buntsandstein (Röt), Germany; Lower Zarzaitine Formation, Algeria; lower Manda Formation, Tanzania; and the Otter Sandstone of the United Kingdom.

Direct correlation can be made of the Perovkan to the SGCS because marine facies of the lower RŠt contain early Anisian conodonts, which justifies assigning the Perovkan age tetrapods from the RŠt an early Anisian age (Wild, 1980). Perovkan tetrapod assemblages are best known in Russia and China where they contain numerous dicynodonts. Correlatives are either dicynodont dominated (Manda, Omingonde) or amphibian dominated (Moenkopi, Upper Buntsandstein). It seems likely that no Perovkan vertebrate assemblage is younger than early Anisian. Although Perovkan time is the interval up to the beginning of the Berdyankian, the latter part of the Perovkan may lack vertebrate representation. This indicates the possibility that there is a need for another LVF between the Berdyankian and Perovkan, though I cannot define and characterize one at present because of inadequate data.

Berdyankian LVF

The beginning of the Berdyankian is defined by the FAD of the temnospondyl *Mastodonsaurus*, whereas the end of the Berdyankian is the beginning of the Otischalkian, which is defined by the FAD of the phytosaur *Paleorhinus*. The Berdyankian LVF is characterized by the vertebrate fossil assemblage of the Bukobay Formation ("svita") in the Russian Urals. The type Berdyankian vertebrate assemblage is directly superposed on the type Perovkan assemblage. The following tetrapod genera are common and/or widespread enough to be index fossils of the Berdyankian: *Dinodontosaurus*, *Mastodonsaurus*, *Exaeretodon*, *Massetognathus*, *Stahleckeria*. The vertebrate fauna of the Lettenkeuper in Germany and the Chanarian LVF localities in Argentina and Brazil are the principal correlatives of the Berdyankian type assemblage.

Berdyankian is correlated to the Ladinian based mostly on the age of the Lettenkeuper. The Chanarian tetrapods from Argentina are older than late Carnian, which is the age of the overlying tetrapod assemblage from the Ischigualasto Formation. The Chanarian has long been considered Ladinian (e.g., Bonaparte, 1966), but without a strong basis.

Berdyankian is difficult to correlate globally, mostly because of a paucity of tetrapod assemblages of this age. Two clusters of localities (European and South American) are equated, largely on the basis of the Lettenkeuper dicynodont and the conclusion that "*Elephantosaurus*" is a stahleckeriid, possibly a synonym of *Stahleckeria* (Lucas and Wild, 1995). The South American Chanarian LVF thus is the provincial secondary standard correlative to the Berdyankian. Like the Perovkan, the Berdyankian is relatively long, at least as long as the Ladinian and part of the early Carnian. Nevertheless, Berdyankian vertebrate fossil assemblages probably only represent the earlier part of this time interval. Therefore, the potential exists to recognize another LVF between the Berdyankian and Otischalkian, although data to do this are insufficient at present.

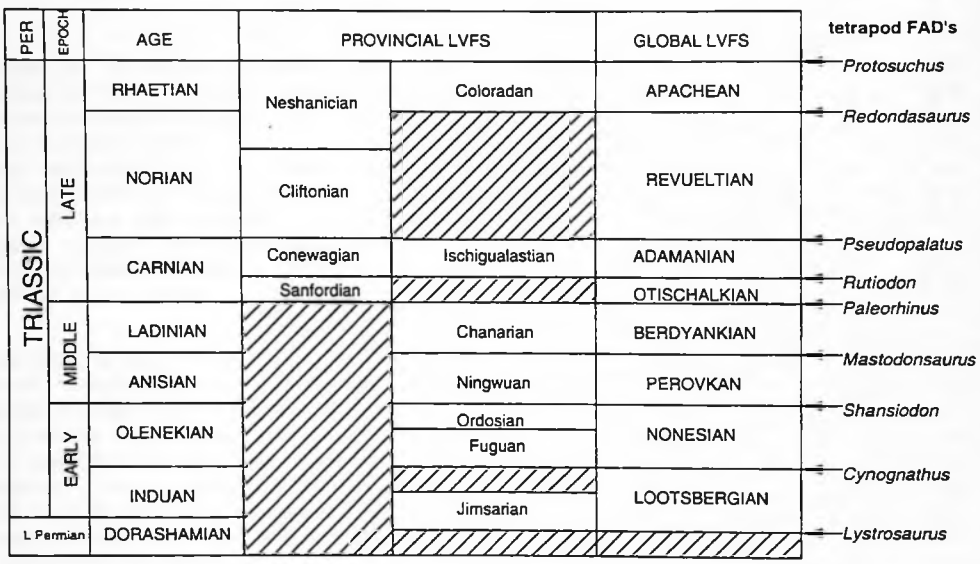

Fig. 3. Triassic provincial and global LVFs, their correlation to the SGCS and the tetrapod FADs that define their boundaries.

Otischalkian LVF

The beginning of the Otischalkian is the FAD of the phytosaur *Paleorhinus*. The end of the Otischalkian is the beginning of the Adamanian, which is defined by the FAD of the phytosaur *Rutiodon*. The vertebrate fossil assemblage of the Colorado City Member of the Dockum Formation, Chinle Group near the defunct town of Otis Chalk, Howard County, Texas, USA characterizes the Otischalkian.

The following tetrapod genera are restricted to Otischalkian time and are widespread and/or common enough to be useful as index fossils: *Paleorhinus*, *Angistorhinus*, *Longosuchus* (=

Lucasuchus), *Metoposaurus, Doswellia*. Besides Chinle Group correlatives, principal Otischalkian-age vertebrate assemblages are from the Sanfordian interval of the Newark Supergroup basins of eastern North America; Schilfsandstein, Kieselsandstein, Lehrbergschichten and Blasensandstein of the German Keuper; Irohalene Member (T4) of the Timesgadiouine Formation, Argana Group, Morocco; and basal part of Maleri Formation, Pranhita-Godavari Valley, India. The Otischalkian is of Carnian (late Julian-early Tuvalian) age on the SGCS based on *Paleorhinus* and *Metoposaurus* records in marine strata in Austria (Hunt and Lucas, 1991), palynostratigraphy (Litwin et al., 1991, 1993; Cornet, 1993) and magnetostratigraphy (Kent et al., 1995; Molina-Garza et al., 1996).

Adamanian LVF

The beginning of the Adamanian is defined as the FAD of the phytosaur *Rutiodon*. The end of the Adamanian is the beginning of the Revueltian, which is defined by the FAD of the phytosaur *Pseudopalatus*. The Adamanian LVF is characterized by the vertebrate fauna of the Blue Mesa Member of the Petrified Forest Formation in the Petrified Forest National Park, Arizona, USA. The following tetrapod taxa are restricted to Adamanian time and are widespread and/or common enough to be useful as index fossils: *Scaphonyx*, *Stagonolepis* and *Rutiodon*-grade phytosaurs, including *Leptosuchus* and *Smilosuchus*.

Besides the Chinle Group correlatives, major Adamanian-age vertebrate faunas are those of the Conewagian interval of the Newark Supergroup basins of eastern North America; Lossiemouth Sandstone Formation, Scotland; Ischigualasto Formation, Argentina; and upper Santa Maria Formation, Brazil.

The Adamanian is of latest Carnian age based mostly on palynostratigraphy and magneto-stratigraphy (see references cited above under marine cross-correlation of the Otischalkian). In West Texas, Otischalkian and Adamanian tetrapod assemblages are stratigraphically superposed. Therefore, Adamanian time is a younger portion of the Tuvalian than the Otischalkian. Norian (Revueltian LVF) vertebrates are stratigraphically above Adamanian vertebrates in Arizona, New Mexico and Texas. Therefore, Adamanian vertebrates are the youngest Carnian vertebrates known. Like the Otischalkian, the Adamanian is relatively short, easily recognized over a broad area and relatively precisely correlated to the SGCS.

Revueltian LVF

Revueltian time begins with the FAD of the phytosaur *Pseudopalatus*. The end of the Revueltian is the beginning of the Apachean, which is defined by the FAD of the phytosaur *Rendondasaurus* The Revueltian LVF is characterized by the vertebrate fossil assemblage of the Bull Canyon Formation in east-central, New Mexico, USA. I term this the *Pseudopalatus* Assemblage Zone.The following tetrapod taxa are restricted to Revueltian time and are widespread and/or common enough to be useful as index fossils: *Typothorax*, *Aetosaurus* and *Pseudopalatus*-grade phytosaurs, including *Nicrosaurus* and *Mystriosuchus*.

Besides Chinle Group correlatives, the principal Revueltian-age tetrapod assemblages are those of the Newark Supergroup of eastern North America of Neshanician and Cliftonian (part) age; Ørsted Dal Member of the Fleming Fjord Formation, Greenland; Lower and Middle Stubensandstein of the German Keuper; Zorzino Limestone and Forni Dolomite, northern Italy; and lower part of Dharmaran Formation, India.

Palynostratigraphy, magnetostratigraphy and sequence stratigraphy suggests the type Revueltian assemblage is of Norian age (Lucas, 1997). Based on stratigraphic position, magneto-

stratigraphy, and palynomorphs, the Neshanician LVF is of early to middle Norian age. Stratigraphic position, magnetostratigraphy, and palynomorphs indicate the Cliftonian LVF is of late Norian-Rhaetian age. The Italian records of *Aetosaurus* provide direct evidence that at least part of the Revueltian = middle Norian (Alaunian). Revueltian correlates approximately with the entire Norian, which is consistent with the evidence cited above (Lucas, 1997). However, whether or not the beginning and end of the Revueltian and Norian are exact equivalents is unclear.

By any recent Triassic numerical timescale (e.g., Harland et al., 1990; Gradstein et al., 1995; Kent et al., 1995; Gradstein and Ogg, 1996), the duration of the Norian is at least 10 million years. This means the Revueltian is one of the longest Triassic LVFs recognized here. It merits subdivision, as Hunt and Lucas (1993) suggested, perhaps along the lines of the Cliftonian-Neshanician subdivision used in the Newark Supergroup, but no subdivision is attempted here.

Apachean LVF

Apachean time begins with the FAD of the phytosaur *Redondasaurus*. The end of Apachean time is the FAD of the crocodylomorph *Protosuchus*. The Apachean LVF is characterized by the vertebrate fossil assemblage of the Redonda Formation (Chinle Group) in east-central New Mexico, USA. The following tetrapod genera are restricted to Apachean time and are widespread and/or common enough to be useful as index fossils: *Redondasaurus*, *Redondasuchus*, *Riojasaurus*.

Principal vertebrate fossil assemblages of Apachean age are the Whitaker quarry in the Rock Point Formation of the Chinle Group at Ghost Ranch, New Mexico, the Cliftonian LVF assemblages, in part, of the Newark Supergroup and that of the Coloradan LVF of Argentina. Some of the fissure fill assemblages in the uppermost Mercia Mudstone Group and/or lowermost Penarth Group of the United Kingdom (Benton & Spencer, 1995) may be Apachean correlatives. However, their ages are problematic, in part, because they lack identifiable phytosaurs, aetosaurs or metoposaurs. Some of the so-called Rhaetian vertebrate sites in France, such as Saint-Nicolas-de-Port, may be Apachean correlatives as well (Lucas & Huber, 1998).

Correlation of the Apachean to the SGCS must be based on indirect lines of evidence. Apachean time is post-Revueltian (~ Norian) and pre-Jurassic, so I tentatively correlate it to the Rhaetian. However, whether or not it is in part of late Norian age is uncertain. Magnetostratigraphy of the uppermost Chinle Group in eastern New Mexico (Molina et al., 1996), correlated to the Newark Supergroup magnetostratigraphy (Kent et al., 1995), also suggests the Apachean is latest Triassic ("Norian-Rhaetian").

The Apachean is the most difficult Triassic LVF to correlate globally. This almost certainly reflects a provincialization of the global tetrapod fauna. Some of the apparent endemism of Apachean land vertebrate assemblages may also be due to facies, sampling and taphonomic biases. Rather than recognize a global Apachean LVF, it may be necessary to recognize two or more provincial LVFs during this time interval.

There is no evidence that the Apachean is in part of Jurassic age. The FAD of the crocodylomorph *Protosuchus* appears to correspond closely to the beginning of the Jurassic. *Protosuchus* occurs in the McCoy Brook Formation (Newark Supergroup), the upper Stormberg Group of South Africa and the Dinosaur Canyon Member of the Moenave Formation in Arizona (Colbert & Mook, 1951; Sues et al., 1996). The Moenave record of *Protosuchus* is stratigraphically superposed above Apachean-age body fossil assemblages of the uppermost Chinle Group (Lucas et al., 1997).

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BRITISH TRIASSIC PALAEONTOLOGY: SUPPLEMENT 22

G. Warrington

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

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A book with 12 contributions on the palynolgy and organic petrology of Permian, Triassic and Tertiary coals and lignites form India has been published by R.S. Tiwari, former director of the Birbal Sahni Institute in Lucknow. The 273 page book is entitled: "Coaliferous fuel resources of India: parameters of studies in palynology and biopetrology". It can be ordered for US $ 30.- from:

The Director of the Birbal Sahni Institute
53, University Road
Lucknow - 226 007, India

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[1] The continuous Help of Mrs. Gaby Schwenzien (Münster) and Dr. Zwier Smeenk (Utrecht) in tracing relevant Triassic literature is gratefully acknowledged. Thanks are also due to all authors who sent information on their recent publications. Some references have been traced from secondary sources. Therefore, diacritical signs may sometimes be missing. Titles of congress abstracts are not included.

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Special attention should be paid to grammar and syntax. Because the editor's administrative assistance has been reduced to virtually zero, linguistic corrections will be minimal. In case of doubt, send your manuscript to a colleague for proof reading. References should be in the format used in the 'Annotated Triassic Literature'. The use 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.*

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