Ordovician NEWS

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NOTES FOR CONTRIBUTORS

The continued health and survival of *Ordovician News* depends on YOU to send in items of Ordovician interest such as lists and reviews of recent publications, brief summaries of current research, notices of relevant local, national and international metings, etc. As more geological software becomes available, details of this would also be welcomed by many of us. Also please ensure that I am notified of any changes in address, telephone or fax number and e-mail address. Submissions for inclusion in the next issue of *Ordovician News* should arrive before 1 March 1996; when providing lists of recent publications, please include only fully refereed articles and books (not abstracts) published during 1997.

Contributions should be in English, typed double space and sent to: S.H. Williams, Department of Earth Sciences, Memorial University of Newfoundland, St. John's, Newfoundland A1B 3X5, Canada, OR ideally via e-mail, as this saves a lot of retyping. For longer contributions, it would help if a copy was sent either on 3 1/2" diskette (either Macintosh or IBM, but please state operating system and software used) or via e-mail (preferably as encoded file).

EDITOR'S NOTE

I apologise for the delayed appearance of this issue or *Ordovician News*; time for research-related activities seems to be a precious commodity nowadays! A complete, revised listing of the Ordovician News mailing list is included, including postal addresses, telephone and fax numbers and e-mail addresses. Please let me know of any additions or corrections before next year's issue is published. I would like to thank Dianne Noseworthy and my wife, Kathleen Grebneff, for help with putting this issue together.

Henry Williams

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CHAIRMAN'S REPORT

It was with pleasure and honor that I assumed the chairmanship of the Ordovician Subcommission at the 30th IGC in Beijing. My initial trepidation upon learning that I was nominated has been relieved by the excellent and thorough preparation provided me by Barry Webby. Barry's tenure as Chair was remarkable in that he left the Subcommission poised for substantial progress on its primary objective - development of global series and stages and establishments of GSSPs for the boundaries that define them. On behalf of all members of the Subcommission, I thank Barry for his many years of valued service as Chair and earlier as Secretary. 1996 also saw the retirement of seven charter Titular Members of the Subcommission: Bruno Baldis, Bill Berry, Bill Dean, Valdar Jaanusson, Igor Nikitin, Rube Ross, and Barry Webby. Their service since 1975 has been critical to the success of the Subcommission. I hope that they will remain active as Corresponding Members.

The Huangnitang (China) GSSP for the base of the Darriwilian Stage, which received a 90% majority vote of the Titular Members of the Subcommission, was approved by the International Commission on Stratigraphy with a 65% majority vote. Subsequently, in January 1997, it was ratified unanimously by the Executive Committee of the International Union of Geological Sciences. An article on the Darriwilian GSSP is being prepared for publication in *Episodes*.

Ratification of the Darriwilian GSSP was a significant accomplishment. The Ordovician Subcommission lags far behind most other ICS subcommissions in establishing global series and stages. Global correlations are, of course, difficult for the Ordovician because of its strong faunal provincialism. Nevertheless, several biohorizons with the potential to serve as boundaries for global chronostratigraphic units have been identified and investigated to varying degrees, and one of them - the base of the Darriwilian - has been ratified. This latest action firmly sets the Subcommission's course for further progress as described in Barry Webby's contribution to this newsletter. It is essential that we proceed with documentation, discussion, and eventually votes on these remaining boundaries. Their present status is discussed in the minutes from business meetings held in Tarim and Beijing in the summer 1996 and included in this issue of *Ordovician News*. We can expect submissions for GSSPs at the base of the *approximatus* and *gracilis* graptolite zones to come before the Subcommission for voting within the next two years. I encourage all who are interested to join in the discussions immediately, rather than waiting to voice objections and concerns when formal ballots have been sent out. The mission of the Cambrian-Ordovician Boundary Working Group is particularly difficult given the nature of available candidate sections. As reported in this newsletter, the working group has made considerable progress, and I applaud the efforts of Roger Cooper, Godfrey Nowlan and the working group members in moving forward. I am optimistic that a single candidate section will receive a clear majority vote of the working group by late 1997 or early 1998. After which, of course, it will have to come before the Ordovician Subcommission for approval.

WOGOGOB-97, organized by Tanja Koren, provides an opportunity this summer to examine important Baltoscandian Ordovician successions in the vicinity of St. Petersburg. The program will include a business meeting of the Ordovician Subcommission and the inaugural meeting of the new IGCP Project No. 410 on Global Ordovician Biodiversity, Correlation and Resources. Planning is also well underway for the 8th ISOS to be held in Prague. These meetings together with those devoted to particular faunal groups (e.g. graptolites, trilobites) provide several opportunities for Ordovician workers to present and discuss their research over the next three years. Ordovician workers are very active indeed.

Stan Finney

ISOS ANNUAL REPORT FOR 1996

1. Name of subcommission

Subcommission on Ordovician Stratigraphy (SOS).

2. Summary table of Ordovician subdivisions

see attachment

3. Overall objectives

The Subcommission promotes international cooperation in Ordovician Stratigraphy. Specific objectives are:

a. To delimit and subdivide the Ordovician System (and Period) as a part of the overall ICS work to elaborate the standard global stratigraphic scale. This work aims to establish the boundaries (GSSPs), the correlation of the subdivisions (Stages and Series), and the nomenclature of the subdivisions.

b. To promote regular international meetings on aspects of Ordovician geology, especially those devoted to clarifying stratigraphic procedures, nomenclature and methods for use in establishing a unified global time scale, and to prepare correlation charts with explanatory notes (this latter task now completed).

c. To encourage, promote, and support research on all aspects of Ordovician geology worldwide and to provide outlets, *Ordovician News* and international meetings, for reporting results of this research.

4. Organization

a. Subcommission Executive

Chairperson, S.C. Finney (U.S.A.)
Vice-chairperson, Chen Xu (P.R. China)
Secretary, S.H. Williams (Canada)
17 other Voting Members (see attached list)
(with the change-over in Subcommission Chair at the 30th IGC, 7 voting members retired and 5 new voting members joined the Subcommission)
92 Corresponding Members

b. Cambrian/Ordovician Boundary Working Group:
Chairperson, R.A. Cooper (New Zealand)
Secretary, G.S. Nowlan (Canada)
11 other Voting Members
57 Corresponding Members

c. Informal intra-Ordovician Working Groups
Convenors of these groups are as follows:
(i) base of *approximatus* (base of "Arenig") - S.H. Williams, S.M. Bergström, C.R. Barnes
(ii) base of *laevis* (base of "Whiterock") - R.J. Ross, Jr., S.C. Finney, R. Ethington
(iii) base of *gracilis* (base of "Caradoc") - S.C. Finney, S.M. Bergström, Chen Xu, R.A. Fortey
(iv) base of *ordovicicus* (base of "Ashgill") - S.M. Bergström

5. Extent of national/regional/global support for projects

Independent support for projects comes mainly from individual Ordovician workers, through their employer organizations and through individual to multidisciplinary, cooperative, team activities supported by grants from national/regional government-funded bodies. SOS receives no formal support from international organizations outside IUGS/ICS.

6. Interface with other international projects

The membership of the Subcommission both geographically and in terms of research interests effectively reflects available expertise in aspects of Ordovician stratigraphy.

The Subcommission has no formal links with other global projects, though some individual Ordovician workers are members of IGCP projects, most notably the following:

Project 319: Global Palaeogeography of the Late Precambrian and Early Paleozoic
Project 321: Gondwana dispersion and Asian accretion
Project 328: Palaeozoic microvertebrate biochronology and marine/nonmarine correlation
Project 335: Biotic Recovery from Mass Extinction events - patterns, processes and implications
Project 351: Early Paleozoic Evolution from the nucleus to the margins in Africa and South America

A new IGCP proposal has been submitted to the Secretariat of IGCP by B.D. Webby (Australia), M. Droser (USA) and F. Paris (France), entitled "The Great Ordovician biotic radiation: implications for global correlation and resources".

7. Accomplishments and products generated in 1996

a. The GSSP proposal defining the base of the Darriwilian Stage was approved by a 94% majority of Titular members of the Subcommission. It was subsequently submitted to the ICS and is presently the subject of a postal ballot.

b. Roger Cooper and Godfrey Nowlan, Chair and Secretary, respectively, of the Cambrian-Ordovician Boundary Working Group reported the results of the first formal postal ballot to choose the GSSP from among three candidate sections. Green Point, Lawson Cove and Dayangcha received six, five, and two votes, respectively. The purpose of the first ballot was to reduce the three candidates to two. Ballots are now being prepared for the second vote, which will reduce two candidate sections (Green Point and Lawson Cove) to one.

c. Vice-Chairman Chen Xu led a Subcommission field excursion to the Tarim basin in July-August 1996. Those participating included Stig Bergström, Arthur Boucot, David Bruton, Stan Finney, and Barry Webby. An excursion highlight was the opportunity to visit and collect from the Dawangon section in the Kalpin uplift. It is a candidate section for the GSSP for the base of the *gracilis* Zone, which is favored as the base of the Middle Ordovician Series.

d. A Subcommission business meeting was held on August 7th at the 30th IGC Beijing. There, Barry Webby passed the Subcommission Chairmanship over to Stan Finney. Barry Webby and Chen Xu also convened an IGC Symposium session titled "Towards an integrated global Ordovician time scale: boundaries and subdivisions".

e. In 1996 a 95-page issue of *Ordovician News*, No. 13, was published. It was edited by Henry Williams.

f. A Friends of the Ordovician meeting was held on October 29, 1996 at the Annual Meeting of the Geological Society of America in Denver, Colorado. More than 40 Friends attended. Stan Finney reported on 1996 activities of the Subcommission. He also appointed an ad hoc committee to initiate the GOES Program (Global Ordovician Earth Systems). This program was proposed by Stan Finney and Bill Berry at the 7th International Symposium in Las Vegas in 1995. Its purpose is to promote and coordinate research on global earth systems during the Ordovician by integrating biotic events with oceanographic, atmospheric, and lithospheric events. Such research is multidisciplinary and integrates data from such disciplines as biostratigraphy, paleoecology, paleobiogeography, sedimentology, sequence stratigraphy, geochemistry, chemostratigraphy and magnetostratigraphy. Stan Finney appointed Bill Berry, Stig Bergström, and Chris Barnes to the ad hoc GOES Committee. Stan Finney will serve ex officio and requested that the Committee appoint two other membes from countries outside North America and, preferably, from disciplines other than biostratigraphy. Bill Berry was appointed Secretary and will prepare the Committee mission statement for distribution. The integration of the the GOES Program with the mission of the Ordovician Subcommission will be on the agenda of the Ordovician Subcommission business meeting in St. Petersburg. The GOES Program has no financial support and no bureaucracy. It is envisioned as a voice for Ordovician research, especially through the newsletter, international symposia, and publicity generated by the Subcommission executive. It serves the large number of scientists who study Ordovician geology, but not the boundary issues, and thus feel left out of the activities of the Subcommission.

8. Problems encountered in 1996

None

9. Work plan for 1997

a. *Ordovician News*, No. 14, will be assembled by Henry Williams and published in the Spring 1997.

b. A Subcommission business meeting will be held in St. Petersburg in August 1997 in conjunction with the WOGOGOB (Working Group on the Ordovician Geology of Baltoscandia) meeting being organized by Tanya Koren. A pre-meeting excursion in Sweden will be arranged by Stig Bergström and David Bruton for the purpose of examining candidate GSSPs for the intra-Ordovician boundaries to be defined at the bases of the *approximatus* and *ordovicicus* zones. The WOGOGOB meeting will include field excursions to examine Ordovician rocks in the St. Petersburg area; there is also the opportunity for a field excursion to the Ordovician of Estonia. Barry Webby has scheduled meetings and field excursions at WOGOGOB-St. Petersburg for work on the proposed IGCP project on "The Great Ordovician biotic radiation: Implications for global correlation and resources."

c. Substantial progress will be made on voting on candidate sections for the Cambrian-Ordovician Boundary.

d. Significant progress is expected in 1997 on intra-Ordovician boundaries.

(i) Two candidate sections have been proposed as the GSSP for the base of the *approximatus* Zone (the base of the second global subdivision of the Ordovician), the Ledge Section in Newfoundland and the Diabasbrottet Section in Sweden. The Diabasbrottet Section will be visited in the pre-WOGOGOB field excursion. It is expected that a postal ballots will be held in late 1997 to select the GSSP.

(ii) Stan Finney and Ray Ethington are will complete work in 1997 on the base of the North American Whiterock Series at the Red Canyon section in the Roberts Mountians, Nevada, USA. Once completed, they will prepare a proposal for defining the base of the Middle Ordovician Series at the base of the *laevis* Zone with the GSSP at Whiterock Canyon, Nevada.

(iii) In the Spring 1997, Chen Xu, Stan Finney, Stig Bergström, and Chuck Mitchell will visit the Calera, Alabama section that is a candidate section for the GSSP for the base of the Upper Ordovician Series that will be defined at the base of the *gracilis* Zone. In June 1997, they will also visit and study another candidate GSSP section at Pingliang, China. Together with the Dawangon section in Tarim, which was visited in 1996, these sections are the three best candidates for the GSSP for the boundary between the Middle and Upper Ordovician Series.

(iv) The pre-WOGOGOB excursion will visit Dalarna, Sweden to examine a section that appears to be the best candidate GSSP section for the base of the highest Ordovician subdivision, which may be defined at the base of the *ordovicicus* Zone.

e. The GOES Program will be a topic of discussion at the Subcommission business meeting in St. Petersburg. Its integration with the mission of the Ordovician Subcommission will be addressed at length.

f. The Corresponding Membership of the Subcommission will be reviewed.

g. Henry Williams has indicated a desire to step down as Subcommission Secretary in 1997. Accordingly, a new Secretary must be recruited.

Anticipated work plan for 1997-2000

a. The Executive will continue to focus on defining boundary stratotypes for all Stage and Series subdivisions of the Ordovician System. Considerable progress is planned for 1997 and will continue through 1998 and 1999. Goals for formal ballots by the Subcommission are late 1997 for the base of the *approximatus* Zone, 1998 for the bases of the *laevis* and *gracilis* zones, and 1999 for the base of the *ordovicicus* Zone.

b. The Eighth International Symposium on the Ordovician System will be held in Prague, Czech Republic in August or September 1999. There are plans for a post-sessional field trip to Spain and Morocco to study the cooler, peri-Gondwana successions.

c. There will be a WOGOGOB (Working Group on Ordovician Geology of Baltoscandia) meeting in St. Petersburg, Russia in August 1997 with four days of field trips to examine the Lower Ordovician of the East European (Russian) platform. There will be a pre-meeting excursion in Sweden by several Subcommission members to examine candidate sections for GSSPs.

d. There will be additional field meetings to examine prime candidate sections for stratotype boundaries.

10. Potential funding sources outside IUGS

The Subcommission has no regular funding sources outside IUGS. Individual members of the executive, Voting Members and Corresponding Members must find their own financial support to carry out their research activities on boundary stratotypes and to attend various meetings (WOGOGOB, 8th ISOS-Prague). The Chair, who is also Chair and Professor of the Department of Geological Sciences at California State University, Long Beach, is able to obtain travel support from his university and from his research grants; yet his travel expenses necessary to develop proposals for boundary stratotypes and to conduct meetings of the Subcommission far exceed available funds. Thus, he has requested partial supplementation in the 1997 budget request for his travel to attend the WOGOGOB meeting.

Stan Finney

MINUTES OF ISOS MEETINGS, 1996

Minutes of the ISOS Field Meeting during the excursion to Tarim (July 31, 1996) and Business Meeting of the Ordovician Subcommission at the 30th International Geological Congress in Beijing (August 7, 1996) are included here. Both meetings followed the same agenda and were virtually identical, including most of the members in attendance. Accordingly, the minutes are combined below.

Present (July 31; Tarim Field Meeting): Bergström, S.M., Boucot, A.J., Bruton, D.L., Chen Xu (Vice Chairman), Finney, S.C. (acting Secretary), Webby, B.D. (Chairman).
(August 7; Beijing Business Meeting): Barnes, C.R., Boucot, A.J., Bruton, D.L., Chen Xu, Erdtmann, B.D., Finney, S.C. (acting Secretary), Lane, R.H., (1st Vice Chairman, ICS), Remane, J. (Chairman, ICS), Wang, Xiaofeng, Webby, B.D. (Chairman)

1. Webby expressed gratitude to Chen Xu for arranging the Tarim field excursion and 30th IGC symposium "Towards an integrated global Ordovician time scale: boundaries and subdivisions."

2. Minutes of previous meetings of Ordovician Subcommission in Las Vegas, which were published in Ordovician News No. 13 (1996), were approved.

3. Webby reported on changes to membership following the 7th ISOS at Las Vegas. The Titular Members were reduced from 22 to 20. W.T. Dean resigned. B. Baldis, W. Berry, V. Jaanusson, I. Nikitin, R.J. Ross, Jr., and B.D. Webby completed their terms and have transferred to Corresponding Membership. Newly appointed Titular Members, approved by the ICS executive, are F.G. Acenolaza (Argentina), O. Fatka (Czech Republic), W. Huff (USA), C. Mitchell (USA), and Bob Nicoll (Australia). Also approved by the ICS executive is S. Finney's appointment as the new Chairman of the Subcommission, Chen Xu continuing as Vice Chairman, and S. H. Williams continuing for 1-2 more years as Secretary. Several Corresponding Members were also added.

4. Report on the C/O Boundary Working Group:
Webby reported that the COBWG-II is in the middle of a postal vote to decide on one of three sections as the Global Stratotype Sections. These sections are Green Point in Newfoundland, Dayangcha in China, and Lawson Cove in Utah. The purpose of the vote is to determine which of the three sections will be put forward for a formal ballot. Webby reviewed the history of COBWG-II and the fact that the WG was placed under the administrative supervision of the Ordovician Subcommission by the ICS. Webby then opened the floor to discussion as follows:
Bergström: Has precise level been decided for a formal vote.
Webby: No.
Bergström: Therefore, the WG is voting on a section before voting on a level.
Webby: There are three different levels. The most recent to be proposed is that of *Iapetognathus*. Species have now been studied and documented. The species present at Dayangcha is different from those at Lawson Cove and Green Point. It is restricted and is an offshoot of the main lineage. Roger Cooper is working on large collections of *Rhabdinopora* and has interesting new data.
Bergström: Cooper mentioned that he has made good progress in sorting out the 50+ subspecies of *R. flabelliforme*. Many are preservational and astogenetic variants.
Chen Xu: Last year all Dayangcha specimens were taken to Berlin to be studied by

Cooper, Erdtmann, and Chinese colleagues.
Erdtmann: Cooper spent 3.5 months at Berlin studying Erdtmann's collections. Erdtmann in turn reviewed Cooper's results and agrees that *R. flabelliforme* is cleaned up. The first occurrence is not changed and occurs in both Green Point and Dayangcha.
Webby: This work is of considerable importance for considering Dayangcha and Green Point.
Discussion followed on whether or not the Ordovician Subcommission must approve the GSSP once the WG has reached a majority vote.
Bruton: Is the COBWG-II advisory? Can the Subcommission reject their recommendation?
Webby: Subcommission oversees administration (budget), but not science. The WG will have to send the recommendation through the Ordovician Subcommission Chair to be passed on to the ICS.
Bruton: It is strange that the WG has more power than the Subcommission.
Webby: The Subcommission Chair is a voting member of the ICS and will have a chance to vote for or against the submission at that time. All Titular Members are allowed to write to Roger Cooper if unhappy with the vote and the late addition of Lawson Cove.
Bruton: Expressed concern regarding the small number of COBWG-II members making the decision.
Webby: Indicated present membership of WG includes three Titular Members of Ordovician Subcommission.
Remane: Once the COBWG-II attains a majority vote for a GSSP, it must then present it submission to the Ordovician Subcommission for a "yes" or "no" vote on the single candidate by postal ballot.
Webby: Once chosen, the C/O boundary would also be the base of the lowest Series and Stage, the names of which much be approved by the Subcommission.
Bruton: Is the Subcommission committed to approving the recommendation of COBWG-II?
Barnes: Hopes that WG will have clear majority and feels that it should not be tampered with by the Subcommission.
Webby: Asked Roger Cooper to also consider names of lowest Stage. When vote is taken by Subcommission on GSSP, names of Series and Stage should also be considered.
Remane: I recommend that votes on GSSP and names be keep separate
Webby: If majority vote for GSSP can be attained in one year, then formal votes can be completed by the Ordovician Subcommission and by the executives of the ICS and IUGS before the next IGC meeting in 2000.

5. Report on Intra-Ordovician Boundaries
A. *T. approximatus* level:
Webby reviewed history of this level. On the basis of a straw vote in 1992, the Subcommission focused on the *approximatus* level and sought a stratotype section. At that time, the Ledge section in Newfoundland was the only fully documented candidate

section. Williams, Barnes and others prepared a report in 1993-94, on that basis of which a formal postal ballot was initiated. In the middle of the postal ballot, there was a response from some members that other candidate sections needed consideration. Accordingly, the vote was postponed with the request that other candidate sections be documented. This has been done by Bergström, Maletz, and Lofgren for the Hunneberg section in southern Sweden. The documentation will be published soon in *Newsletters in Stratigraphy*. A visit to the section in August 1997 is being planned by a group of Titular members. Following criticisms and responses on both sections that should be published in the next issue of *Ordovician News*, there should be two ballots: the first to choose the best section, and the second final yes or no vote on the GSSP as defined.
Discussion followed:
Erdtmann: There is still a problem location of stratotype in Newfoundland and whether or not the Ledge section is continuous below the FAD of *approximatus.*
Barnes: Erdtmann's interpretation of a gap in the Ledge section is based on his (Erdtmann's) interpretation of the graptolite succession. Henry Williams does not agree with Erdtmann's taxonomy and thus sees no basis for a gap at the Ledge. In fact, there may be a gap at Hunneberg.
Webby: Suggested that Tremadocian be used for the Stage between the C/O boundary and the *approximatus* biohorizon. Ordovician Subcommission should determine the name rather than the COBWG-II.
Bergström: This would require some redefinition of Tremadocian.
Chen: Would Tremadocian Stage be too long?
Webby: No, not when you carefully examine its duration on basis of graphic correlation as Walt Sweet did in his paper in *Ordovician Odyssey.*. Once the GSSP for the *approximatus* level is settled, the name of the overlying Stage should be chosen, probably a Swedish name if Hunneberg is chosen as the stratotype, or a Newfoundland name if the Ledge section is chosen.

B. *T. laevis* level:
Finney reported that work on a proposal for a candidate section is still in an early stage of development. Work is in progress on his Red Canyon section in the Roberts Mountains of Nevada, where he is trying to better correlate the bases of the *T. laevis* conodont Zone and the *I.v. lunatus* graptolite Zone in the Vinini Formation. A trench was excavated in June 1996. Extensive sampling is planned for late summer 1996 and early summer 1997, after which documentation should be adequate to prepare a GSSP candidate submission.
Bergström: Other sections where the relationship between *T. laevis* and *I.v. lunatus* can be seen are in the Marathon region of west Texas (Marathon Limestone) and in western Newfoundland (Cow Head Group). There is strong evidence that the base of the *T. laevis* Zone is within the *I.v. lunatus* Zone. The two may not coincide.
Webby: The two appear to not differ by much in time, and in correlations one might be able to consider them near isochronous.
Bergström: The *lunatus* Zone is probably only 200,000 years in duration and thus, in

itself, offers great precision in correlation.
Chen: This level has the potential for being recognized at a section south of the JCY area, but the section needs more detailed study.
Bergström: Believes that the *laevis/lunatus* level can be well correlated in China and that it is the best level in the Ordovician for global correlation because it is the level of major faunal turnover.
Webby: The level needs to be correlated through into the cool water province.
Finney/Webby: F. Paris and O. Fatka should be encouraged to attempt correlation into cool water province using organic-walled microfossils.

C. *U. austrodentatus* level:
Webby praised Chen Xu, Chuck Mitchell, and Stig Bergström, who along with Winston and Paris, provided outstanding documentation on GSSP at Huangnitang, China. Chen Xu reviewed the stratigraphic section, the faunas, and the *austrodentatus* biohorizon. Webby reported that the final vote was 94.7% in favor. This vote also approved the name Darriwilian Stage. During the vote, issue was raised by three people with regard to the Australian name. It was chosen because it is a well known name that is equivalent to the *austrodentatus-gracilis* interval. Webby congratulated the members who were responsible for the submission and indicated that it will be submitted soon to the ICS.

D. *N. gracilis* level:
Finney reviewed definition of base of *gracilis* Zone and emphasized that first appearance of *N. gracilis* retains consistent position relative to ranges of several other graptolite species and *Pygodus serra/P. anserinus* conodont zonal boundary between several carefully collected sections in southern Appalachians. He also pointed out that these same relationships hold in sections in Sweden and England, and that he recognized the same key species (e.g. *Dicellograptus geniculatus, D. gurleyi gurleyi,* and *D. gurleyi* n.ssp. A) in the same relative position to the *N. gracilis* FAD in the Dawango section visited during the pre-IGC excursion to Tarim.
Chen Xu reviewed the Tarim section and the potential of other Chinese sections. The Miaopo Shale in the Yangtze platform region is too thin, being only a few meters thick and ranging only from the uppermost *teretiusculus* Zone to the lowermost *gracilis* Zone. A section at Pingliang in the Ordos Basin is a potential candidate section but is in need of extensive study.
Wang Xiao-feng: There are other good sections in China as well.
Bergström: Dawango section should be seriously considered, but it needs more study.
Finney: An advantage of the Dawango section is that limestone beds with conodonts are common throughout the boundary interval. At Calera, Alabama, conodonts can only be found on shale surfaces and they are not abundant.
Bruton: I am concerned with low graptolite abundance at Dawango.
Chen: Diversity is high.
Bergström: There are several good potential candidate sections. The Calera, Alabama

section does have a problem, however, in that slumping of walls of the quarry in which the section is located can bury the boundary interval. Dawango, on the other hand, is very well exposed and will always remain well exposed because of nature of terrain and climate.
Finney: Calera section is also on private land, and at present we cannot guarantee that it will not be turned into a landfill in the future.
Webby: The base of the *gracilis* Zone is important because Lapworth used it as a division between his lower and upper Ordovician. Straw votes of Titular Members gave large majority to base of *gracilis* Zone as biohorizon for boundary between Middle and Upper Ordovician Series.

E. *complanatus/ordovicicus* level:
Webby: Chris Barnes has been working on section in Wales where he has a lineage from *Amorphognathus superbus* to *A. ordovicicus*. This level is close to the base of the traditional Ashgill.
Bergström: Base of *Dicellograptus complanatus* Zone - the traditional base of the Ashgill - is somewhat higher than this level. If the Ashgill was retained as a Stage with its base at the base of *ordovicicus* than the Ashgill would require some revision. The *superbus-ordovicicus* transition is rapid and can be recognized in North America and Europe. In North America the transition is in the *manitoulinensis* graptolite Zone which is equivalent to the upper *linearis* Zone. Barnes has it in the Whitland section in south Wales. It is likely to be isochronous worldwide.
Barnes: Recent work has shown that adequate graptolite control is lacking in the Whitland. There is no *D. complanatus.* Therefore, it is probably not a viable candidate GSSP section.
Bergström: In Sweden, the *A. superbus* to *A. ordovicicus* transition occurs in a section with *linearis* Zone graptolites.
Bruton: Where is the section.
Bergström: In Dalarna, by Rattvik. The Skalberget section is better than the Whitland section because *D. complanatus* occurs above the *superbus/ordovicicus* transition. This section will be studied more carefully next year.

6. Proposals for Future Meetings and Work Plans
A. WOGOGOB meeting in St. Petersburg, Russia in early August 1997. This meeting will include field trips to local Ordovician outcrops. The program includes a business meeting of the Ordovician Subcommission and depending on IGCP support, the initial meeting of a new global Ordovician Biodiversity Project. Bergström and Bruton are arranging a field excursion to Sweden and Norway before WOGOGOB in order to examine the Mt. Hunneberg and Dalarna sections.
B. Steve Westrop is organizing and international meeting on trilobites in Canada in 1997.
C. The project Pre-Variscan Terrane Analysis of "Gondwanan Europe" will hold a

Symposium on Neoproterozoic basements and Early Palaeozoic shelf complexes in Dresden, Germany, April 28-May 4, 1998. Organizers include B.-D. Erdtmann, R. Brocke, T. Heuse, U. Linnemann, O. Fatka, and P. Kraft.
D. In 1998, the Sixth International Conference of the Graptolite Working Group of the IPA will meet in Spain. Juan Carlos Gutierrez Marco is organizing the meeting, which will include field excursions to Ordovician sections (as well as Silurian).
E. The 8th International Symposium on the Ordovician System will be held in Prague in late summer 1999. It will include pre-meeting excursions in the Barrandian basin and post-meeting trips in Spain to look at cool water faunas and to Morocco to examine glacial deposits.
F. The next IGC meeting will be in 2000 in either South Africa or Brazil.

7. Other Business:
Barry Webby introduced Stan Finney as the new Ordovician Subcommission Chair. Finney acknowledged the outstanding leadership Webby has provided the Subcommission over his two terms of service as Chair and previous service as Subcommission Secretary.

Stan Finney

CAMBRIAN-ORDOVICIAN BOUNDARY - VOTING UNDERWAY

During 1996 the voting procedure for a second attempt at choosing the Cambrian-Ordovician boundary GSSP began. A large (84 page) circular which included summaries of the three candidate sections and other relevant papers, including a discussion of the conodont *Iapetognathus,* was sent to about 60 corresponding members in May and another circular with updates on the sections has been sent out in January 1997. True to form, lively discussion and debate has continued, and still continues, about the merits and disadvantages of the candidate sections and about the criteria on which a boundary should primarily be based. It has been clear for some time that there is no known ideal section and level for the base of the Ordovician System and the final choice will have to be a compromise. But our knowledge of the biostratigraphy and correlation of the boundary interval in sections around the world is now so vastly greater than when the Working Group (COBWG I) began its deliberations in 1974, that any one of the 3 candidate GSSP's (in my view) could have served as a workable standard. After this length of time a decision on the boundary is long overdue and the geological community at large have made it clear that one is expected soon. For this reason Secretary Godfrey Nowlan and I have propelled the proceedings (of COBWG II) along as quickly as possible without (we hope) sacrificing opportunity for discussion among the members.

The three finalists represented three different environments and each had its own mix of attributes. The deep water shale-carbonate Green Point section contains possibly the best early Ordovician sequence of graptolites in the world and a sequence of exquisitely preserved conodonts that, however, differs a little from those of carbonate platform regions. The shallow water carbonate Lawson Cove section (Wah Wah Mountains, Utah)

contains a diverse and abundant conodont succession, key trilobites including the olenid *Jujuaspis borealis*, and an excellent $\delta^{13}C$ curve. The Dayangcha section of northeast China, representing an outer shelf to upper slope environment, contains an excellent conodont succession up to the level of appearance of *Iapetognathus*, after which there is a barren zone, good graptolite faunas at five levels only but including *Rhabdinipora flabelliformis parabola*, together with a reasonably good $\delta^{13}C$ curve. All three sections contain other fossil groups.

The May circular was followed by distribution of the first ballot. Because there were 3 candidate sections the voting procedure has been complicated. In the first stage of the ballot Voting Members were asked to rank the 3 sections in order of their preference for GSSP. The first choice votes only were counted (the second and third choice votes were to be used only in the case of a tie). The three sections and first choice votes received by each were as follows:

Dayangcha 2 votes
Lawson cove 5 votes
Green Point 6 votes

This result indicated a clear preference for the Green Point and Lawson Cove sections which therefore proceeded to the second stage of the ballot. Although it was been eliminated as a contender for GSSP, the Dayangcha section has proved to be most valuable for relating graptolite and conodont biostratigraphy and will serve as a valuable regional standard and reference section for the outer shelf environment.

The result of the first stage of the ballot meant that the base of the Ordovician would be placed at the first appearance of the conodont *Iapetognathus* n.sp. 1 in either the Green Point or the Lawson Cove section. This level lies a short distance (4.8 m in the Green Point section) below the appearance of planktic graptolites, and thus just below the traditional base of the Tremadoc (to put this in context, the lower Tremadoc at Green Point is about 30 m thick). A paper describing the new species of *Iapetognathus* (by Nicoll, Nowlan, Miller, Repetsky and Ethington) is in a late stage of preparation and, it is hoped, will be submitted by mid year. Unlike the previous candidate conodont species, *Cordylodus lindstromi*, the taxonomy of the new species of *Iapetognathus* appears to be not under any dispute by the principal conodont workers.

During the second stage of the ballot, the following votes were cast:

Green Point 7 votes
Lawson Cove 5 votes.

The Green Point candidate GSSP was therefore the winner. This choice must now go back to the Voting Members of the Working Group for ratification and requires a 60% majority approval before it can be forwarded to the Ordovician Subcommission as a final recommendation.

Roger Cooper

IN MEMORIAM

Gunnar Henningsmoen

Gunnar Henningsmoen, Professor of Palaeontology and former director of the Palaeontological Museum, University of Oslo, died on 23. April 1996, aged 76. He had been sick for a long time but managed to follow what was being said and published almost up to the time of his death.

Gunnar Henningsmoen was well known for his work on trilobites and ostracods from the Cambrian and Ordovician but his interest were broad and his reputation beyond doubt. Apart from his palaeontology, which included an enormous contribution to the first Trilobite Treatise, he will be remembered for his work as Secretary of The International Commission on Stratigraphy (1960-1965) and his wise contributions to the Subcommission on Stratigraphical Terminology, Subcommission on the Stratigraphical Lexicon, Subcommission on Cambrian Stratigraphy, Committee on the Cambrian-Ordovician and Silurian-Devonian boundaries and Terminology of the Silurian and Ordovician Systems.

For generations of students he will be best remembered for his lecture notes, compendia and excursion guides, all well-written with a good sense of humour and likewise illustrated.

Gunnar Henningsmoen travelled extensively and the Palaeontological Museum, Oslo, collections contain many trilobite gems from his collecting in Spain, Sardinia, Great Britain, Canada and the U.S.A. His publication list contains over 70 well respected titles in international journals and a host of other important contributions to our science. His extensive book and reprint collection was left to the Palaeontological Museum.

All those who visited Oslo as Gunnar's guests will remember him for his boyish attitude to life and profession, his chain smoking, his ability to always find the best fossils and the warmth and hospitality he provided. He was kindness itself.

David Bruton

Bruno Baldis

I am sad to report that Dr. Bruno Baldis passed away on the 28 of May this year. He was very active in diverse matters of Ordovician paleontology and stratigraphy and was a Titular Member of the Ordovician Subcommission for many years. He was particularly dedicated to the study of Lower and Middle Ordovician trilobites and was working on the megafaults of the Precordillera basement at the time of his death. The record of his work can be found in the numerous papers he published on diverse subjects, many related to the Ordovician of South America and the Argentine Precordillera. His legacy also remains in the disciples he guided and formed, myself included. To us he was able to transmit his enthusiasm and love for geology, and in particular his devotion to paleontology. He was both a teacher and a good friend. His death is a great loss for both Argentina and South America as a whole [and to the work of the Ordovician Subcomission - Ed]. One feels that he still had a lot to give; he was only 60 when he died.

Matilde Beresi

Thomas Henry Clark

Thomas Henry Clark, Ordovician stratigrapher and paleontologist and a foremost teacher of geology in Canada, died after a brief illness in his 103rd year on April 28, 1996. He was born in London, England on December 3, 1893, and completed primary and private schools in London before coming to the United States in 1911 at the age of 18. After attending Normal School in Boston, he entered Harvard University, obtaining an A.B., *magna cum laude* in 1917, an A.M. in 1921 and a Ph.D. in 1923. His thesis work was a continuation of Percy Raymond's study of the graptolite assemblages and succession of the Lower Ordovician Levis Formation at Levis, Quebec with incursions in the trilobite faunas of the conglomerate boulders. During the First World War he served as a Lieutenant with the U.S. Medical Corps in France. In 1924 he went to McGill University in Montreal as an Assistant Professor where he would remain for the next 69 years until retiring on May 30, 1993 at the age of 99. In 1929 he was named Logan Professor of Paleontology, in 1932 Curator and in 1943 Director of the Redpath Museum and all University Museums; he resigned his curatorial charges in 1951 when he was named Director of the Department of Geological Sciences. For almost thirty years he taught all soft-rock courses at McGill, as well as General Geology to engineering students.

Professionally T.H. Clark spent all his life mapping Ordovician and Cambrian rocks in the Appalachians and the St. Lawrence Lowlands. In 1926 he began mapping three quadrangles in southern Quebec along the border with the U.S., extending from the Laurentian platform well into the Appalachian Allochton. To his regret this project brought him into conflict with U.S.G.S. geologists mapping in Vermont with the result that the Geological Survey of Canada chose to bury his final report, allowing only for the publication of a short paper on the stratigraphy and structure of the region. Wiser by this experience, Clark turned in 1938 to the mapping of the St. Lawrence Lowlands, a gigantic task that would take 35 years to complete. He mapped a total of 17 map-areas (quadrangles), the last six in cooperation with Yvon Globensky. The most oustanding areas are: the *Yamaska-Aston Area* (1964) with its magnificent Upper Ordovician stratigraphy and the *Portneuf Area* (1973) with the conformable Trenton-Utica contact. To him goes the great merit of having introduced the Ordovician stratigraphical terminology in use in the Lowlands today.

T.H. Clark co-authored with C.W. Stearn the classical text-book on *The Geological Evolution of North America,* first published in 1960. A second edition appeared in 1968 and a third one in 1979. He received the Logan Gold Medal and, as he was approaching his 100th birthday, the *Prix du grand mérite géoscientifique*. The *Thomas H. Clark Chair in Petroleum and Sedimentary Geology* is presently being established in his honor at McGill University.

John Riva

IGCP PROJECT NO. 410: THE GREAT ORDOVICIAN BIODIVERSIFICATION EVENT (GOBE)

Proposers: Barry D. WEBBY (Australia), Mary DROSER (USA), Florentin PARIS (France)

We have now been advised by the IGCP Secretariat that our proposal was one of eight new proposals accepted by the IGCP Scientific Board at its 25th session from 27-30 January 1997, as an ongoing IGCP Project for five years (1997-2001).

We are delighted with this outcome and thank the many individuals who wrote to us in support of the project after we first publicized our intention to apply last year (see details in *Ordovician News* No.13, p. 9-14).

We again **invite <u>all</u> Ordovician workers with interests in aspects of Ordovician biodiversity, correlation and resources to join us as active participants in Project 410.** Please contact one of the above-listed proposers if you have not previously done so, indicating your wish to be actively involved.

Aims

A brief review of the project has been appended to the Minutes of IGCP Scientific Board, 27-30 February 1997, as follows:-

"The project aims to involve the development of an improved, globally integrated zonation of graptolites, conodonts, organic-walled micro-fossils and shelly fossils using selected wide-ranging bio-events and graphic correlation methods, extend onshore-offshore community analyses to profiles in all latitudinal zones, identify patterns of biotic response to climatic change (greenhouse to icehouse), [establish, with] more precise time-scales, a better understanding of the response of the biota to global and regional environmental factors, and assessment of economically significant structural settings."

"The benefits to society are increasing the understanding of the factors controlling biotic diversity, as well as applying better time frames and facies analysis to oil shale deposits. The additions to biological understanding has application in managing marine communities. The project proposal builds on the already large database. It has canvassed support from an impressive list of individuals, across a broad range of scientific agencies. The spread of interest is global."

"The project is accepted for 5 years (1997-2001)."

Proposed Activities (1997-98)

We have already established **seven regional teams** with coordinators (listed below) to commence the first stages of our work program in various parts of the world, and our plans for an active program of work and meetings during 1997 are now well advanced.

The first official meeting of IGCP Project 410 will be held in association with the next meeting of the Working Group on Ordovician Geology of Baltoscandia (WOGOGOB), from 10-16 August 1997 in St. Petersburg, Russia, including a three day, post-meeting, field trip to examine the Lower Ordovician successions of the East

European (Russian) Platform. It will be an IGCP-sponsored meeting. A special trip to examine oil shales (kukersites) will also be available for a limited number of participants on 16 August. All correspondence should be to **Tania Koren** [Fax (812) 213 57 38; E-mail: tkoren@dronov.usr.pu.ru], with copies to **Barry Webby** for those specifically attending as a part of the IGCP 410 activities. Copies of Circular 2 for the WOGOGOB meeting are available from **David Bruton** [E-mail: d.l.bruton@toyen.uio.no].

The visit to the Baltic region is also expected to provide members of the IGCP project with an opportunity to study a representative onshore-offshore Ordovician profile of either in Sweden or Norway, i.e., across the confacies belts of JAANUSSON (1976), in the mainly temperately-disposed (intermediate latitude) platformal succession. Additionally, we hope to examine the intracratonic, oil shale (kukersite) deposits of Estonia. Details are still being finalized but this activity may be expected to follow directly on from the WOGOGOB field trip of 16 August (through some days in the last 2 weeks of August) - contact **Barry Webby** for further details.

We plan also to schedule a number of other meetings during 1997, as follows:

1. First IGCP 410 North American Regional Meeting at the Geological Society of America Annual Meeting in Salt Lake City (October 20-23, 1997) - contact **Mary Droser**.
2. First IGCP 410 meeting in Western Europe will be associated with the APF/SGF (Association of French Paleontologists/Geological Society of France) meeting on "Biostratigraphy and Palaeogeography", in Lyon, France from 27-28 November 1997 - contact **Florentin Paris**.
3. First IGCP 410 meeting in Australasia will be held in conjuction with the AAP conference on the "Palaeobiogeography of Australasian faunas and floras" to be held at University of Wollongong, Australia from 8-11 December 1997 - contact **Barry Webby**.

In 1998, the major field meeting will be held in China, and will probably involve two field trips with an intervening workshop session. The field trips will focus on the biotas and community profiles of two contrasting regions: (1) the low paleolatitude, Lower-Middle Ordovician slope to basin, and Upper Ordovician platform to slope successions of the Zhejiang-Jiangxi border region of East China; and (2) the mainly intermediate palaeolatitude Yangtze Platform successions of the entire Ordovician column in the Yichang area of South China. Details will be advised later. Our colleagues Profs. **Rong Jia-yu, Chen Xu, Zhou Zhi-yi** and **Wang Xiao-feng** have kindly agreed to coordinate this activity. We are also attempting to coordinate these travel arrangements to China with a short visit, arranged by Prof. **Duck Choi** and colleagues (Seoul National University), to examine Ordovician successions and faunas in South Korea.

Seven regional teams and coordinators:

In establishing this large-scale global project, it seemed essential that we have a well defined management structure, at least for the first two years of the project. Consequently in addition to the co-proposers' responsibilities in overall direction and leadership of the project, we felt it necessary to invite a few persons in each regional area to act as coordinators of the work program. In a few cases, details of the final list of coordinators (see below) for a particular region currently remain incomplete, but will be finalized in the next month or so. We encourage you to actively participate in the project through the proposers and/or the coordinators, in whichever way you think your relevant research can best be reported as a part of the project topic.

North America: Ray Ethington (Chair), Mary Droser, Chris Barnes, Peter Sheehan, Bill Berry

South America: Gilberto Acenolaza (Chair), Juan Benedetto, Ramiro Suarez-Soruco

Europe - North Africa: Florentin Paris (Chair), Alan Owen, Naima Hamoumi, Juan-Carlos Gutierrez-Marco, Bernie Erdtmann, Olda Fatka

Baltic - Russian Platform: David Bruton (Chair), Lars Holmer, Dim Kaljo, Leonid Popov, Sven Stouge

Kazakhstan - Middle Asia - Siberia: Mischa Apollonov (Chair), Igor Nikitin, Alexei Kim, Alexandr Kanygin

China - Eastern Asia: Rong Jia-yu (Chair), Chen Xu, Wang Xiao-feng, Zhou Zhi-yi, Duck Choi

Australasia: Barry Webby (Chair), Bob Nicoll, Roger Cooper, Fons VandenBerg, Ian Percival

Networking

First, we will maintain close contact with participants in project 410 through the annually published pages of this most important Subcommission newsletter, *Ordovician News*.

Secondly, we will provide at intervening times, between the annual newsletter, regular updates of information to most participants in the project through electronic mail links, given that more than 140 Ordovician specialists were listed with e-mail addresses in the last issue of *Ordovician News*. Within the limits of available finances those without e-mail will receive information by fax or post, but IGCP funding support for "secretarial expenses" (including postage, fax, stationery costs, etc.) is limited. If you do not have access to e-mail please contact one of your regional coordinators, or a proposer, so that we can ensure that you receive all pertinent information

Thirdly, we plan to establish in the next few months, with the help of colleagues in the Centre for Ecostratigraphy and Paleobiology at Macquarie University, a World Wide Web site with relevant, regularly updated, information about IGCP project 410 accessible to all on the Internet.

Linkages

This new globally directed project, the first IGCP project to exclusively highlight Ordovician rocks and fossils, aims to be fully collaborative with the work of the Ordovician Subcommission, especially aspects relating to the establishment of a more refined time scale.

It has limited overlap relationships with existing IGCP projects, in areas of: 1) aspects of end-Ordovician extinction, with IGCP project 335, but this project terminates in 1997; 2) studies of Arctic Canadian, Russian and Baltic Ordovician microvertebrates, with IGCP project 406; and 3) the specific work on Late Ordovician bio-events and biodiversity shifts of another new IGCP project (no.421) that will focus on "North Gondwanan Mid-Palaeozoic biodynamics".

Finances

A limited amount of financial support will be available to cover travel and subsistence costs for some participants from developing countries in order to attend the IGCP-sponsored meeting in St Petersburg this August. In order to be considered for support, you will be expected to present one or more papers relevant to the aims of the IGCP project at the meeting, and provide a reasonable guarantee that the papers will be published subsequently with due acknowledgement to the IGCP project.

We hope that financial support will continue in future years, despite the present funding crisis in IGCP owing to the substantial reduction of support from the United Kingdom and the United States (in 1997 and future years with support reduced by $US90,000 per annum). Currently IGCP projects are supported on the basis that the allocation covers part of the costs of organizing and managing the project, and it mainly provides support to scientists from developing countries allowing them to participate in, and attend, the meetings. It provides no more than "seed" money. Most of the remaining costs of conducting the research for IGCP Project 410 must be covered by participants gaining support directly from their own National, and other international, funding agencies. We encourage you to seek such funding, so establishing linkages to this major, cooperative, global research project on Ordovician biodiversity, correlation and resources.

We encourage ALL participants to enquire from their respective National IGCP Committees about funding support to attend IGCP-sponsored meetings. We note that, for example, in Australia, grant-in-aid monies are provided by the Australian Government through the Australian Geological Survey Organisation to assist Australian geoscientists (especially younger ones) to actively participate in IGCP research projects. Specifically, travel assistance and subsistence costs may be provided to allow researchers to participate in IGCP-sponsored conferences, workshops or seminars.

Publications

A full bibliography of relevant publications resulting from the project work must be provided each year in the annual reports (see below). We ask all participants in Project 410 to advise co-proposers at regular intervals of their relevant publications, if possible send copies to ensure that titles are listed correctly for the full bibliography of the Project. Also, please acknowledge IGCP Project 410 in your relevant research publications, and use the IGCP logo in the heading of the publications, if possible.

Assessment

An annual report focusing clearly on scientific achievements of Project 410 must be submitted each year by 15 October to the IGCP Secretariat. First major assessment of progress of the IGCP Project 410 will take place at the end of 1998, and by this time we should be able to fully document the major achievements of the various programs of work of the seven regional teams through 1997 and 1998.

Concluding Remarks

We look forward to you joining with us in actively participating in the work of IGCP project no.410. Please contact one of us if you require any further information.

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Mary Droser, Department of Earth Sciences, University of California - Riverside, Riverside, CA 92521. U.S.A.; Fax: + 1 (909) 787 4324; e-mail: mary.droser@ucr.edu
Florentin Paris, UPR du CNRS "Géosciences", Université de Rennes I, 35042 Rennes-cedex. France; Fax:+ 33 (2) 99286100; e-mail: florentin.paris@univ-rennes1.fr

IAPETUS OCEAN, ITS BIRTH LIFE AND DEATH: THE WILSON CYCLE

A symposium will be held at the Geological Society of America Meeting in Salt Lake City, October 20-23, 1997, covering all aspects of Iapetus. We also anticipate an additional theme session and poster sessions if enough abstracts are submitted. This is co-sponsored by GSA International, the Paleontological Society, the Structural Geology and Tectonics Division and the Geophysics Division of GSA. For additional information contact Ian Dalziel, Mary Droser, or Ben Van der Pluijm.

Mary Droser

8th INTERNATIONAL SYMPOSIUM ON THE ORDOVICIAN SYSTEM

The 8th ISOS will be organised coincident with the 200th Jubilee of Joachim Barrande. Charles University has agreed to publish the conference proceedings. These will include a Guidebook for all the field trips and a volume of Short Papers. As for the 7th ISOS in Las Vegas, the organizing committee has decided that all contributors will submit short papers that will be published in time for the distribution at the meeting. The papers in this Short Papers volume will be refereed, edited and returned to the authors for necessary revisions and resubmission. Maximum length will be specified in the Preliminary Circular (to be mailed in November 1997).

Volunteers are being recruited to serve as theme session convenors. Those wishing to develop specific theme sessions are encouraged to contact Oldrich Fatka.

Present plans of the organizing committee are following:
2 days of Barrande Symposium (in the National Museum in Praha)
5 days of pre-ISOS excursions (Ordovician of the Barrandian area)
5 days of ISOS
Post-ISOS excursions
- *First version:*
Transportation Prague - Madrid (plane)
2 days of field excursion in Spain
6 days of field excursion to the Anti-Atlas (Morocco)
The excursions in Spain and Morocco organized by J. C. Gutierrez Marco in cooperation with N. Hamoumi.
- *Second version:*
Transportation Prague - Madrid (bus)
2 days excursion to Thuringia (Germany) - this excursion is promised by Bernie Erdtmann
2 days of field excursion in Spain
6 days of field excursion to the Anti-Atlas (Morocco)
The excursions in Spain and Morocco organized by J. C. Gutierrez Marco in cooperation with N. Hamoumi.

Oldrich Fatka and Petr Kraft

PRE-VARISCAN TERRANE ANALYSIS OF "GONDWANAN EUROPE"

We are now in the middle of organizing this meeting, to be held in Dresden, Germany on 28 April - 4 May 1998. More than 60 people from 12 countries have already responded to the first circular and have pre-registered. The conference is being co-sponsored by the Society of Geological Sciences in Germany (GGW) and by EUROPROBE. Anybody wishing to obtain details or copies of the circulars should contact me at the address, etc., given in the "Names and Addresses" section of *Ordovician News*.

Bernd Erdtmann

REPORT: THIRD BALTIC STRATIGRAPHICAL CONFERENCE

The 3rd Baltic Stratigraphical Conference was held in Tallinn, Estonia 8-12 October 1996, including an early Palaeozoic excursion into Ordovician and Silurian outcrops. The main topics were East Baltic regional stratigraphy and high resolution biostratigraphy. 92 specialists from 12 countries participated in the conference and 66 papers were given. The Abstracts and Field Guide were published: *The Third Baltic Stratigraphical Conference. Abstracts. Field Guide*. Editors T. Meidla, I. Puura, J. Nemliher, A. Raukas and L. Saarse. 1996, Tartu, 156 p.

Jaak Nolvak

PALAEONTOGRAPHICA CANADIANA No. 13

Palaeontographica Canadiana is a monograph series of major contributions to Canadian paleontology that is dominantly, but not exclusively, systematic in content. The series is sponsored jointly by the Canadian Society of Petroleum Geologists (CSPG) and the Geological Association of Canada (GAC).

Palaeontographica Canadiana No. 13 - Latest Ordovician-Silurian articulate brachiopods and biostratigraphy of the Avalanche Lake area, southwestern District of Mackenzie, Canada by Jisuo Jin and Brian D. E Chatterton has just been released. ISSN 0821-7556, ISBN 0-920230-59-8. 167 pp. (incl. 50 plates, 32 text-figs.).

Due to different methods of calculating postage and handling costs, prices from the two distributors vary depending on destination.
For Canadian orders: from GAC $51.50 CAN (incl. taxes, postage); from CSPG $42.00 CAN + $2.75 CAN postage + appropriate CAN taxes.
For US orders: from GAC $51.50 US (incl. postage); from CSPG $42.00 CAN + $5.50 CAN postage.
For International orders: from GAC $$51.50 US (incl. postage); from CSPG - contact CSPG by internet home page (http://www.cspg.org) for exact costs for international post.
Addresses: *Geological Association of Canada,* Publications, Department G222, Department of Earth Sciences, Memorial University of Newfoundland, St. John's, Newfoundland A1B 3X5; Phone (709) 737-7660; Fax (709) 737-2532; E-mail gac@sparky2.esd.mun.ca; Home Page http://www.esd.mun.ca/~gac
Canadian Society of Petroleum Geologists, #505, 206-Seventh Ave. S.W., Calgary, Alberta T2P 0W7 ; Phone (403) 264-5610; Fax (403) 264-5898; Home Page http://www.cspg.org

And coming later in 1997...
Palaeontographica Canadiana No. 14 - S. Pinard et B. Mamet. Taxonomie des petits foraminifères du Carbonifère Supérieur-Permien inférieur du bassin de Sverdrup, Arctique canadien. 43 pls.
Palaeontographica Canadiana No. 15 - J.M. Adrain and G.D. Edgecombe. Silurian encrinurine trilobites from the central Canadian Arctic. 35 pls.

Sandy McCracken

GEOLOGY AND PALEONTOLOGY OF THE PORT AU PORT PENINSULA, WESTERN NEWFOUNDLAND - A FIELD GUIDE

Canadian Paleontology Conference Field Trip Guidebook No. 5
by S.H. Williams, E.T. Burden, L. Quinn, P.H. von Bitter and A.R. Bashforth

Beginning with the systematic coastal surveys of Captain James Cook in 1765, geological research in western Newfoundland continued through episodes of French gunboat diplomacy in the nineteenth century into the twentieth century, and with the advent of new technologies, western Newfoundland has taken on new significance as one

of the best exposed examples of the global processes involved in the opening and closing of oceans and the formation of vast mountain ranges. The Port au Port Peninsula has been the site of active frontier hydrocarbon exploration over the past two years, with a number of companies involved in both seimic surveys and subsurface drilling. By travelling the highway circling the Port au Port Peninsula, tourists and professionals alike can achieve an appreciation for the scale of events in both space and time which have shaped not only this region, but the entire Atlantic seaboard from Newfoundland to Florida.

The guide was produced as part of the Sixth Canadian Paleontological Conference (CPC-VI), the annual technical meeting of the Paleontological Division of GAC, held in Corner Brook, western Newfoundland, during September, 1996 with the theme "Economic and Applied Paleontology". The seventy-four pages of text are divided into three main sections: an introduction to some of the basic principles of the earth sciences, followed by a full description of the geology and history of hydrocarbon exploration of the Port au Port region, and locality descriptions. A full colour geological map of the Port au Port Peninsula is included in addition to a number of monochrome figures illustrating aspects from plate tectonic setting and regional stratigraphy to fossil communities.

Copies of the text may be order from the GAC Publications office (see above).

Henry Williams

ACRITARCHA IN PRAHA 1996 - THE PROCEEDINGS VOLUME OF THE ACRITARCH SUBCOMMISSION MEETING

A meeting and workshop of the Acritarch Subcommission of the Commission Internationale de Microflore du Paleozoique (CIMP) was organised at the Charles University in Prague (Czech Republic) by Olda Fatka and Thomas Servais from 10-13 April 1996. The meeting attracted nearly 60 acritarch workers from 26 countries. Meetings were held on three days with 25 oral contributions and 20 poster presentations. Three technical sessions were organized, on Wednesday morning (general topics of acritarch research), Thursday morning (Precambrian to Ordovician acritarchs) and Friday morning (Ordovician to Carboniferous acritarchs). The afternoon sessions served for the workshop, microscope and poster sessions. Thursday afternoon was reserved for a guided tour of the historical centre of Prague. A one day field excursion to important localities in the Lower Palaeozoic of the Barrandian area closed the Meeting on Saturday. All papers presented at the meeting were included as extended abstracts or short papers in a special issue of *Acta Universitatis Carolinae Geologica*. The full reference is: FATKA, O. and SERVAIS, T. 1997. Acritarcha in Praha 1996. *Acta Universitatis Carolinae, Geologica* **40** (3-4).

Olda Fatka and Thomas Servais

ELECTRONIC BIBLIOGRAPHY OF NEWFOUNDLAND AND LABRADOR FOSSILS

Version 1.0.1 (December 05, 1996) of this publication (Boyce, W.D. and Williams, S.H. 1995. One and a half centuries of paleontological research: a selective bibliography of Newfoundland and Labrador fossils. *Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report* **95-1**, pages 299-321) is now available on the internet by ftp from zeppo.geosurv.gov.nf.ca; it is located in the pub/paleontology directory as PAL-B101.ZIP. The bibliography, PAL-B101.RTF, is in Rich Text Format.

The file is also accessible on the World Wide Web using the URL ftp://zeppo.geosurv.gov.nf.ca/pub/paleontology/PAL-B101.ZIP

Input on additions or omissions is welcome.

Doug Boyce

THE IBEXIAN, LOWERMOST SERIES IN THE NORTH AMERICAN ORDOVICIAN

USGS Professional Paper 1579 is presently being printed. It is expected to be ready for examination and ordering at the GSA meeting in Salt Lake City, and will be a 1997 publication. There are three parts - A, B and C:

1579-A "The Ibexian, Lowermost Series in the North American Ordovician", by Reuben J. Ross Jr., Lehi F. Hintze, Raymond L. Ethington, James F. Miller, Michael E. Taylor and John E. Repetski, with a section on Echinoderm Biostratigraphy, by James Sprinkle and Thomas E. Guensberg. This includes 50 pages, 10 figures (including detailed maps of localities) and Plate 1 (a "bedsheet" showing the 3000 ft [1090m] lithologic section with ranges of trilobites, conodonts and brachiopods and echinoderms). Graptolite correlations are discussed on p. 28-29.

1579-B is by Walter Sweet and others sets up a reference standard for graphic correlation based on the Ibexian section in the southern Egan Range.

1579-C is by Pete Sheehan and others is about Late Ordovician and Early Silurian of the Great Basin.

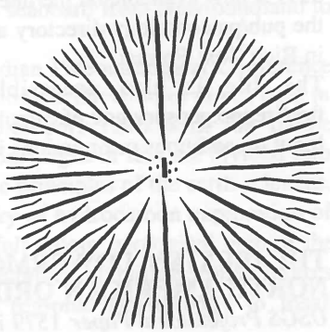
Rube Ross

KILBUCHOPHYLLID CORALS FROM THE CARADOC

Colin Scrutton

I am anxious to trace further records of kilbuchophyllid corals from the mid Caradoc, or indeed any level in the Ordovician. The kilbuchophyllids are discoidal or shallowly conical to conical solitary corals with well developed septa which are inserted as in scleractinian rather than rugose corals (Scrutton & Clarkson 1991; Scrutton 1993). Characteristically, the septa are arranged in a series of nested triads between the first six

protosepta (see the idealised diagram below). There are no horizontal elements present (dissepiments or tabulae) but there may be a blade-like columella or domed axial structure. The discoidal forms reach a diameter of about 30 mm, whilst the conical forms are usually about 10 to 15 mm, but may reach 22 mm diameter. All the material recovered so far has been mouldic and it is now possible to show that the original skeletal material was aragonite (Scrutton *et al.* in press).



So far about 50-60 specimens have been found, but all in the British Isles. It is possible that these unusual corals were very restricted in their distribution. I made an attempt when the material was first discovered to determine if they occurred further afield. However, ***Ordovician News*** offers a much better opportunity to uncover records from elsewhere in the world. If you have seen anything or know of any material that might fit the bill, please e-mail me or write (see "Names and Addresses" in this issue of *Ordovician News*.), preferably with a photograph, or an actual specimen. I would be most grateful!

References

Scrutton, C.T. 1993. New Kilbuchophyllid corals from the Ordovician of the Southern Uplands, Scotland. *Cour. Forsch.-Inst. Senckenb.* **164**, 153-158, 6 figs.

Scrutton, C.T. and Clarkson, E.N.K. 1991. A new scleractinian-like coral from the Ordovician of the Southern Uplands, Scotland. *Palaeontology* **34**, 179-194.

Scrutton, C.T., Jeram, A.J. and Armstrong, H.A. (in press). Kilbuchophyllid corals from the Ordovician (Caradoc) of Pomeroy, Co. Tyrone: implications for coral phylogeny and for movement on the Southern Uplands Fault. *Trans. Roy. Soc. Edinburgh: Earth Sci.*

THE LOWER PALEOZOIC IAPETUS K-BENTONITE PROJECT

Stig Bergström

During the last few years, Warren Huff, Stig Bergström and Dennis Kolata, along with Carlos Cingolani, Ricardo Astini and several students, have been involved in a large project on the distribution, geochemistry, age, and stratigraphic, tectonomagmatic, biologic and paleogeographic significance of Ordovician and Silurian K-bentonites. We have examined hundreds of localities in North America, Northwest Europe and the Precordillera of Argentina and quite a few papers have been published, or are in press or submitted. The most important publication during the past year was a summary monograph on the Ordovician K-bentonites of eastern North America, which was

published as *Geological Society of America, Special Paper* 313. As far as Ordovician K-bentonites are concerned, we plan another period of fieldwork in the Precordillera this spring, as well as examination of the K-bentonite succession in a drill core to be drilled in the next few months through the Ordovician in the classical Röstånga area in southern Sweden. Several K-bentonite beds have proved to be quite useful as stratigraphic markers in both Europe and North America, and the paleogeographic significance of some ash beds in terms of the evolution of Iapetus is being examined.

ORDOVICIAN STUDIES IN MOROCCO

Naima Hamoumi

Paleontology and stratigraphy

Ordovician strata were first recognised in Morocco by H. Termier (1927) in Central Morocco and Bigot and Dubois (1931) in the Anti-Atlas. Following this period of pioneer investigations many studies focused on paleontology and stratigraphy. The first synthesis of the Ordovician rocks was made by Choubert (1942), while some Ordovician fossils, especially from the Anti-Atlas, were illustrated by H. Termier (1950). Since 1959 there has been a large amount of research done on Ordovician by J. Destombes, particularly in the Anti-Atlas and Coastal Meseta and his results have been published in numerous syntheses. Paleontological material from the Anti-Atlas has been studied by many specialists from a number of countries, including Destombes (Trilobita -Phacopina), Deunff (microplancton), H. and G. Termier (Bryozoa), Spjeldnaes (Bryozoa), Havlicek (Brachiopoda), Horny (Gastropoda), Marek (Bivalvia and Hyolithida), Bruton (Trilobita-Odontopleuridae, Illaenidae), Henry (Trilobita-Calymenina), Ingham (Trilobita-Trinucleidae), Grekof (Ostracoda), Ubaghs and Chauvel (Echinodermata), Willfert (Graptolithina), Barnes (Conodonts), Boucek (Conulariida) and Bockelie (Crinoids). Studies on Chitinozoan and Acritarchs have been made by Rahmani, Marhoumi and El Aouad Debbaj.

More recently, since 1992 J. C. Guttierrez Marco and his group from Spain (Madrid, Oviedo and Zaragoza) have been involved with paleontological studies on the Ordovician of Coastal Meseta and Anti-Atlas (including graptolites, conodonts, trilobites brachiopods and echinoderms) within the framework of project CNR/CSIG with N. Hamoumi. J. C. Guttierrez Marco also supervised two Moroccan doctoral students, while Muriel Vidal (Rennes University) began working in the Anti-Atlas on Asaphid trilobites with J.L. Henry and J. Destombes.

Sedimentology

A program of sedimentological study on Ordovician strata, combining facies reconstruction and interpretation with petrological, mineralogical and geochemical analysis and sequence stratigraphy was launched in 1982 by N. Hamoumi. The objectives of these studies are to recognise sedimentary sources, to reconstruct sedimentary

environments and paleogeography, to link the sedimentary record with tectonic, eustatic and climatic controls and to attempt correlation with other north-Gondwanan regions. Particular emphasis has been placed on:

1. Nature and origin, sedimentary dynamics and processes and sequence stratigraphy
2. Mode of formation, environmental setting, depositional processes, and geodynamic and eustatic significance of oolitic ironstones.
3. Dynamics and record of the upper Ordovician glaciation.

Many of these studies have been carried out by doctoral students supervised by N. Hamoumi in the Meseta and the Anti-Atlas. Their results have been presented in unpublished theses, scientific reports, guide books and by numerous lectures at national and international meeting. The working group has also been actively involved in many national and international projects, including IGCP Project 260 "Earth's Glacial Record"; IGCP Project 277 "Phanerozoic Oolitic Ironstones"; IGCP Project 351 "Lower Paleozoic in NW Gondwana"; RCP 080705 Géodynamique du Massif Armoricain; Projet CNR/CNRS TOAE "L'Ordovicien du Maroc"; Projet CNR/ CSIG " Comparaison de l'Ordovicien marocain et de l'Ordovicien bérique"; Action Intégrée 362 " Les structures paléozoïques du Maroc"; Projet pétrolier " Grand Tadla "; and EUROPROBE - IBERIA Project "Early Paleozoic paleogeography of SW European Variscides ".

SOME COMMENTS ON ORDOVICIAN SUBDIVISIONS AND USAGE

Barry Webby

I. Current status of global subdivisions

In the last issue of *Ordovician News* (No.13, 1996, p.40-41) I reported the results of two formal Subcommission ballots held in October-December 1995, relating to the global Series divisions of the Ordovician System. To reiterate, the results declared on 7 February 1996 were as follows:

Postal Ballot 1. **That the Ordovician System be subdivided into three formal Series, named Lower, Middle and Upper.**

Voting result: 18 For; 2 No; 1 Abstain (90% majority).

Postal Ballot 2. **That a tripartite division of the Ordovician System be adopted using the base of the *Tripodus laevis* conodont Biozone for the base of the Middle Ordovician Series, and the base of the *Nemagraptus gracilis* graptolite Biozone for the base of the Upper Ordovician.**

Voting result: 14 For; 3 No; 4 Abstain (82% majority).

The results represented an overwhelming majority support from Titular Members for a primary subdivision of the Ordovician System into three global Series, named LOWER, MIDDLE and UPPER. The results were conveyed to the Chairman of the International Commission on Stratigraphy, but the nomenclature cannot yet be ratified formally until the definitions are linked to GSSP proposals for specific levels at the bases (FADs) of

Iapetognathus n.sp.1 (for the LOWER), *T. laevis* (for the MIDDLE) and *N. gracilis* (for the UPPER ORDOVICIAN). The Cambrian-Ordovician Boundary Working Group is responsible for establishing the GSSP based on *Iapetognathus* n.sp.1.

The Subcommission earlier (1992) adopted the base of the *Tetragraptus approximatus* graptolite Zone as another significant boundary level (now representing the level that will subdivide the LOWER ORDOVICIAN SERIES into two), and established its first intra-Ordovician GSSP defining the base of the Darriwilian Stage, based on the first appearance of graptolite *Undulagraptus austrodentatus* in the Huangnitang section, near Changshan County Town, Zhejiang Province, China, recently ratified by ICS and IUGS. This now represents the upper subdivision of the MIDDLE ORDOVICIAN SERIES. So, the general framework of global Series and Stages of the Ordovician System has now very clearly emerged (Fig. 1). The decision to adopt a primary, tripartite Series subdivision of the Ordovician System was endorsed overwhelmingly by the Subcommission.

What remains is a lot of hard work by Subcommission members to document the best possible sections for the other four or five GSSPs, to establish most precise global correlation of their associated strata, and to get these proposals ratified by ICS and IUGS.

II. The need for a set of guidelines for future global Series and regional series usages

The high level of biogeographic differentiation of Ordovician biotas has made the development of a precise, unified global standard a slow and difficult process. In many areas of the world where provincially based, regional series and stages are still actively used, there will be a need for many more years to maintain a dual nomenclature of global AND regional usages - the former gradually taking over from the latter as higher levels of resolution of global correlation is achieved.

The practical value of using formalized global Series (and Epoch) names, LOWER (Early), MIDDLE (Middle) and UPPER (Late) derived from their positions within the respective global System (and Period), like the Devonian usage, should be apparent to all - for these names to have any real meaning in terms of geologic time (as a global concept) they must be based on ONE set of subdivisions, NOT a different set of lower, middle and upper Ordovician usages for every distinct major palaeogeographical province of the world! Jaanusson stressed long ago (1960 - see *Report 21st Int. Geol.Congr. v.*7, p.70-81) that, because of the wide and confusing range of past regional usages of lower, middle and upper Ordovician, we should abandon such usages altogether, in favour of only geographically based regional series names (e.g., N. American Mohawkian, Baltoscandian Harjuan, etc.). However, despite Jaanusson's plea, these informal regional usages of lower, middle and upper Ordovician have continued to be much used.

So, for example, middle Ordovician has an entirely different meaning in North American, Australian, and Baltoscandian concepts of time. Some authors have clearly related their usage to regional geographical synonyns, and used the names interchangably in their specific regional contexts; for example, N. American middle Ordovician representing the Whiterockian-Mohawkian interval, and Baltoscandian middle Ordovician

meaning Viruan (Fig.1). But then, in other areas of the world where geographically based regional names have not been established, there are even more problematical usages of lower, middle and upper Ordovician, not clearly related to a local geographic usage.

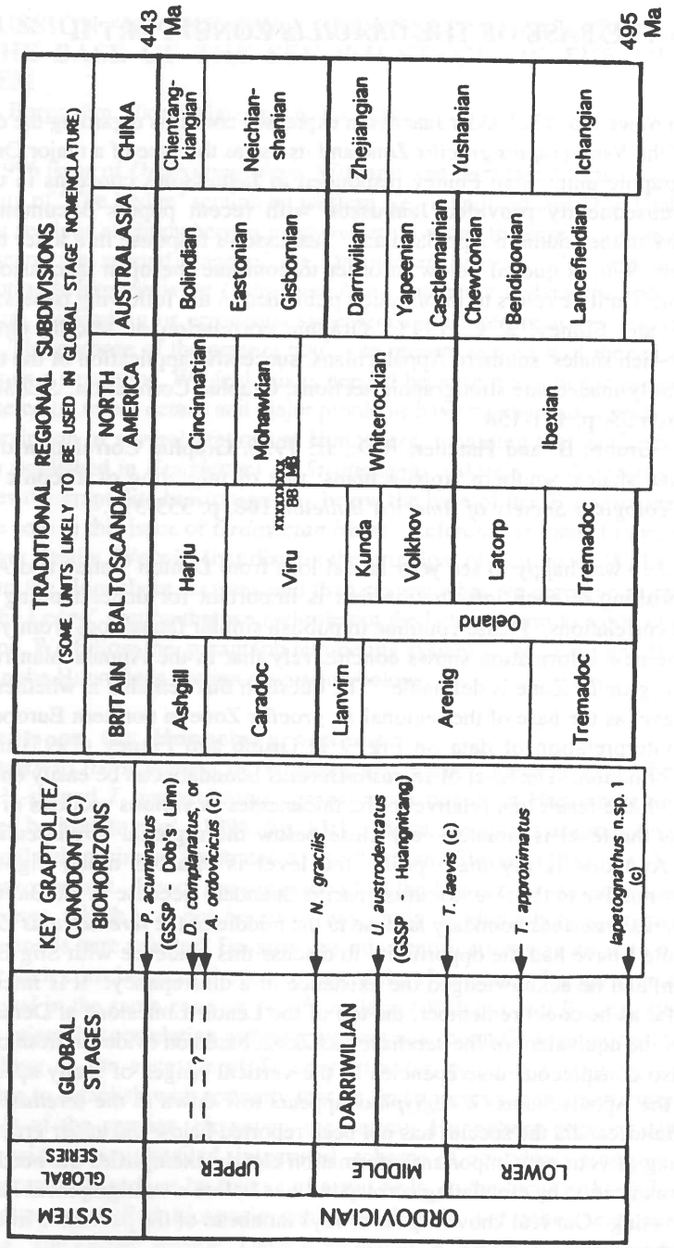
For presentations of worldwide reviews on aspects of geological and biological events (e.g., aspects of event stratigraphy, biogeography, evolutionary history of specific animal groups), authors have commonly adopted one (or sometimes more than one) set of regional subdivisions (and usages of lower, middle and upper Ordovician) dependent on their own regional usages (and prejudices), sometimes presented even without an introductory comment (or diagram) to clearly explain which local "time scale" has been employed. It is essential that in future we adopt the new global nomenclature for such surveys, using the formalized global Series, and the outline of as yet mainly unnamed global Stage divisions (Fig. 1).

I recommend that the Subcommission endeavour to establish a set of guidelines for future Series usage. First, that the formal global names - LOWER (Early), MIDDLE (middle) and UPPER (Late) ORDOVICIAN SERIES (Epochs), should be clearly distinguished from current, informal, regionally based, usages. The global names should always be capitalized, and perhaps for further emphasis spelt out entirely in capitals (or small capitals), e.g., MIDDLE ORDOVICIAN, LATE ORDOVICIAN. I see no need for the introduction of another set of geographic names (or adaptation from existing regional usages) for these global units. The Devonian Subcommission has already adopted formal names derived from their positions within the global System (Period), and these have proved to provide a simple and most practical global Series nomenclature.

Secondly that, while the various regional, geographically based, series names will continue to be used for the foreseeable future, the informal subdivisions of "lower" ("early"), "middle" and "upper" ("late") Ordovician should only be maintained: (a), provided the terms are used with regional qualifiers, e.g., N. American middle Ordovician, or Baltoscandian upper Ordovician; or (b), provided they are clearly linked to regional, geographically based, series names, e.g., Oelandian (lower Ordovician), Cincinnatian (upper Ordovician).

I hope that the Subcommission can, as a part of the next stage of its work program, establish a simple, practical set of guidelines (similar to or modified from the above-suggested proposals) that will enhance our ability to communicate in a clear and unambiguous fashion. Furthermore, this will allow issues such as the relative ordering of geological and biological events in Ordovician time to be understood in more meaningful terms of a global, rather than regional, context.

Fig. 1. Chart showing stratigraphic relationships between global Series, Stages, key faunal markers (two with ratified GSSPs) and some regional subdivisions. Note also the volcanic ash event marker (the Baltoscandian Big (=Kinnekulle) Bentonite, BB, and correlative North American Millbrig Bentonite, MB). Radiometric ages from Tucker R.D. & McKerrow W.S. 1995 (Canadian Journal of Earth Sciences 32, 368-379).



WHERE IS THE BASE OF THE *GRACILIS* ZONE? PART II

Stan Finney

In *Ordovician News* No. 13, Valdar Jaanusson expressed concerns regarding the definition of the base of the *Nemagraptus gracilis* Zone and its use as the base of a major Ordovician chronostratigraphic unit. Stan Finney responded to Jaanusson's concerns in the same issue, and subsequently provided Jaanusson with recent papers documenting the biostratigraphy in the southern Appalachians. Jaanusson's response in a letter to Finney dated 19 May 1996, is quoted below in order to continue the open discussion of this important topic. In it he refers to information published in the following papers:

Grubb, B. J. and Finney, S. C. 1995. Graphic correlation of Middle Ordovician graptolite-rich shales, southern Appalachians: successful application of the technique to apparently inadequate stratigraphic sections, Graphic Correlation. *SEPM Special Publication* **53**, p. 151-158.

Finney, S.C., Grubb, B. and Hatcher, R.D., Jr. 1996. Graphic Correlation of Middle Ordovician shales, southern Appalachians: rate of migration of Taconic foreland basin. *Geological Society of America Bulletin*, **108**, p. 355-371.

"Dear Stan, ...I was happy to see your faunal logs from Denton Valley and Abington. It is the publishing of such information that is important for understanding regional zonation and correlations. Please continue to publish similar faunal logs from your other sections. The new information shows conclusively that in the Appalachian region the base of the *N. gracilis* Zone is definable. The question that remains is whether or not it is the same level as the base of the regional *N. gracilis* Zone in northern Europe. In this respect the interpretation of data on Fig. 7 in Grubb and Finney (1995) may yield important information. The level of *serrus/anserinus* boundary can be easily entered into that figure with the result that relative to the thicknesses in various sections of southern Appalachians the level is situated very close below the regional *teretiusculus/gracilis* boundary. And this is my main point: the level is situated much higher in the Appalachians relative to the *teretiusculus/gracilis* boundary because in the Baltoscandian region the *serrus/anserinus* boundary is close to the middle of the *teretiusculus* Zone.

Meanwhile I have had the opportunity to discuss this evidence with Stig Bergström in Stockholm, and he acknowledged the existence of a discrepancy. It is interesting to note that as far as he could remember, the top of the Lenoir Limestone at Denton Valley is still within the equivalent of the *teretiusculus* Zone, based on evidence from conodonts. There are also conspicuous discrepencies in the vertical ranges of many species. For example, in the Appalachians *G. euglyphus* appears low down in the *teretiusculus* Zone whereas in Baltoscandia the species has not been reported below the upper *gracilis* Zone. The publishing of your new important information clearly exemplifies the need for some kind of communication by circulating correspondance before a stratigraphical issue is ripe for decisive voting. Our real knowledge is always far ahead of the published information.

With all best wishes, Valdar"

DISCUSSION OF THE TWO PROPOSED STRATOTYPE SECTIONS OF THE BASE OF THE SECOND STAGE OF THE ORDOVICIAN SYSTEM

Stig M. Bergström, Jörg Maletz and Anita Löfgren

In the 1996 issue of *Ordovician News*, Williams and Barnes published a discussion of the suitability of "The Ledge" section on western Newfoundland and "The Diabasbrottet" and adjacent sections at Hunneberg in southwestern Sweden to serve as a global stratotype for the base of the second stage of the Ordovician System. We were unaware of this contribution before receiving *Ordovician News* and hence had not the opportunity to reply to several misleading or erroneous statements and interpretations regarding the latter section. The purpose of the present note is to present our view of the suitability of these sections as a stratotype. We feel this is needed because much of the previous discussion has centered on minor details and major problems have not been adequately documented. A full description of several sections at Hunneberg, including that at "Diabasbrottet", was recently published in *Newsletters on Stratigraphy* (Maletz *et al.*, 1996), while Maletz discusses the graptolite biostratigraphy below the base of the *T. approximatus* Zone in a separate note in this issue of *Ordovician News*. Reference is made to these contributions for further details. We will first discuss the principal objections of Williams and Barnes (1996) to the Hunneberg sections and then review what we perceive as major problems with "The Ledge" section that we feel rule out the latter section as a potential global stage stratotype. We follow the paragraph numbering system of Williams and Barnes (1996, p. 49-50) in the Hunneberg section discussion below.

Comments on the Hunneberg sections

1. Contrary to the statement by Williams and Barnes, there is no doubt at all that the typical, H-shaped *T. approximatus approximatus* occurs at Hunneberg and that form is illustrated by Maletz *et al.* (1996, fig. 13:1). These specimens are indistinguishable from Newfoundland specimens illustrated by Williams and Stevens (1988, text-fig. 20X-GG) as *T. a. approximatus.* Hence the suggestion that the Hunneberg specimens rather represent *T. acclinans,* which was not based on any study of Hunneberg specimens, is clearly erroneus and is here rejected. Because this misidentification was the only biostratigraphic basis for their correlation of the lower part of the Hunneberg *T. approximatus* Zone with a high level in the same zone on Newfoundland (Williams and Barnes, 1996, fig. 2), we likewise reject this correlation as being without any scientific foundation.

As long as the ancestor of *T. approximatus* remains unknown, it is obviously impossible to establish with certainty that its first appearance in a particular section is the true FAD of the species. However, the various Hunneberg sections studied are tied together with a very detailed, integrated, scheme of conodont, graptolite and trilobite biostratigraphy, as well as by tracing of event beds, so the local FAD of *T. approximatus* is far better controlled biostratigraphically than in any other section in the world, including "The Ledge" section. There is no evidence that the FAD of *T. approximatus* at

Hunneberg is younger than that in any other section elsewhere.

2. It must be stressed that the Hunneberg sections represent a relatively deep water environment, probably on the outer shelf, and there is no lithologic evidence of any break at the base of the *T. approximatus* Zone in the succession of dark shales with thin limestone interbeds.

The Hunneberg sections belong to the Scanian-Oslo Confacies Belt of Jaanussson (1976) which has a very complete siliciclastic succession. The platform sections in central and eastern Baltoscandia represent other confacies belts characterized by shallower-water deposition dominated by carbonate units with some stratigraphic gaps. Hence, it is irrelevant that some sections in the latter region, hundreds of km from Hunneberg, show evidence of condensation or even gaps at the base of the *P. elegans* Zone; to question the completeness of the Hunneberg based on such evidence is even more irrelevant in view of the fact that we are concerned about the base of the *T. approximatus* Zone, not the base of the *P. elegans* Zone, which the Hunneberg sections show to be at a substantially higher stratigraphic level. Furthermore, the statement that Löfgren's four subzones of the *P. proteus* Zone "have only local application" is misleading and not supported by any evidence; in fact, in several recent papers, Löfgren herself has shown that these units can be recognized in sections over tens of thousands of square km in Sweden, and recently, Viira (1996) recognized these subzones in Estonia, more than 750 km from Hunneberg.

3. Williams and Barnes are clearly handicapped by the fact that they have not visited the Hunneberg sections because if that was the case they would not state that "the Diabasbrottet section is in reality four sections." Diabasbrottet is a very large quarry, or a series of quarries, extending along the base of the mountain side for a kilometre or more, and there are numerous outcrops of the Lower Ordovician along the quarry wall, some of these many tens of metres wide, others just a few metres. In some of these, the rock wall is too steep for easy collecting but others, including those collected by Löfgren (1993), are easily accessible. Individual beds can indeed be traced for considerable distances (Maletz *et al.*, 1996, fig. 9).

4. As pointed out by Maletz *et al.* (1995), the heating of the Hunneberg rocks is likely to make them unsuitable for paleomagnetic work. However, we have been informed that such heating will not prevent work on some stable isotopes and chemostratigraphy.

Problems with "The Ledge" section

The succession at "The Ledge" is clearly one of the biostratigraphically and sedimentologically most interesting sequences through that interval anywhere in the world. It has been subjected to intense study by several prominent geologists in recent years, and must be considered as well known in most respects. However, as noted by some previous authors, there are several serious problems with this section that make it unsuitable as a global stratotype. We have recently discussed these problems (Maletz *et al.*, 1996) but summarize the key ones as follows:

1. The section was deposited in a slope environment and contains numerous debris flows, some of which are quite magnificent. As illustrated by Williams *et al.* (1994, fig. 3) and

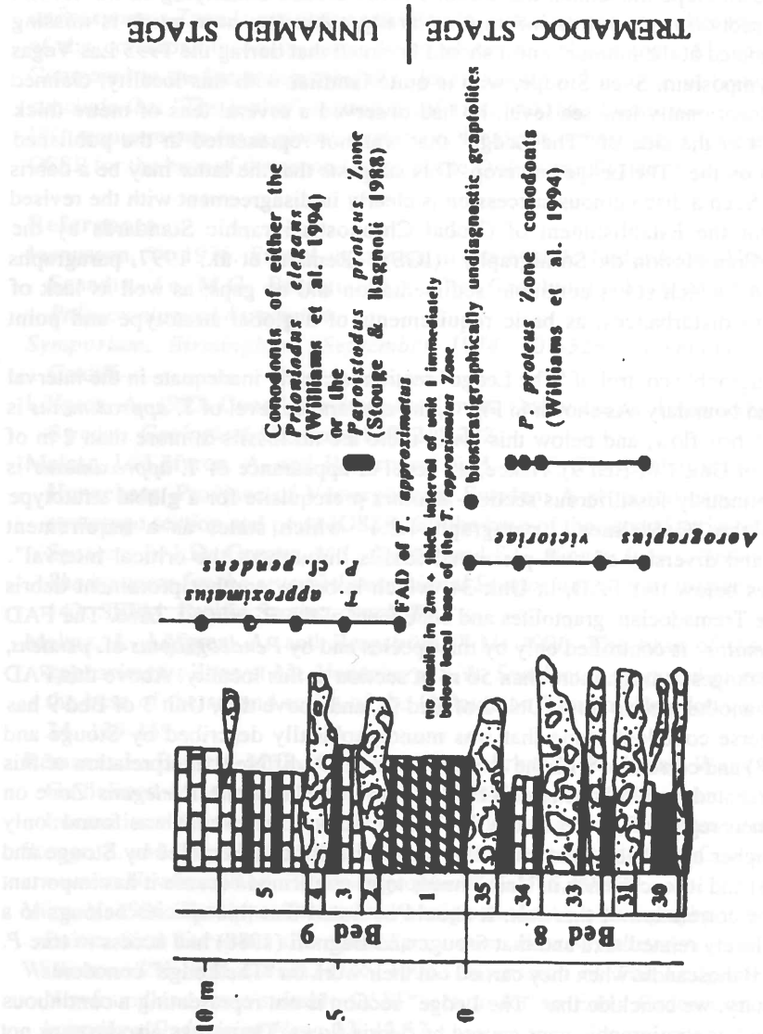


Fig. 1. Columnar section at "The Ledge", western Newfoundland, proposed by Williams et al. (1994) as the stratotype base of the second series of the Ordovician System. Note the occurrence of large debris flows and incomplete biostratigraphic control near the base of the T. approximatus Zone. The figure is based on Williams et al. (1994, fig. 3).

easily seen in the field, these clearly cut across the succession and it is obvious that during their down-slope movement these debris flows eroded underlying strata. Hence, "The Ledge" section is doubtless incomplete stratigraphically; how much is missing cannot be estimated at the moment but it should be noted that during the 1995 Las Vegas Ordovician Symposium, Sven Stouge, who is quite familiar with this locality, claimed that during exceptionally low sea level, he had observed a several tens of metre thick succession just at the side of "The Ledge" that was not represented in the published sections based on the "The Ledge" outcrop. This suggests that the latter may be a debris flow channel. Such a discontinous succession is clearly in disagreement with the revised "Guidelines for the Establishment of Global Chronostratigraphic Standards by the International Commission on Stratigraphy (IGS)" (Remane et al., 1997, paragraphs 4.1.2 and 4.1.4.) which stress continous sedimentation and no gaps, as well as lack of synsedimentary disturbances, as basic requirements of a global stratotype and point (GSSP).

2. The biostratigraphic control of "The Ledge" section is clearly inadequate in the interval of the proposed boundary. As shown in Fig. 1, the appearance level of *T. approximatus* is just below a debris flow, and below this level, there are no fossils in more than 2 m of section (most of Unit 1 of Bed 9). Hence, the level of appearance of *T. approximatus* is NOT in a continously fossiliferous section- another prerequisite for a global stratotype according to the "Guidelines..., paragraph 4.2.1" which states as a requirement "Abundance and diversity of well preserved fossils throughout the critical interval". Several metres below this FAD, in Unit 34, which is below another prominent debris flow, there are Tremadocian graptolites and conodonts of the *P. proteus* Zone. The FAD of *T. approximatus* is controlled only by this species and by *Pendeograptus* cf. *pendens,* a species that ranges through more than 50 m of section at this locality. Above this FAD level, there is another debris flow (Unit 2 of Bed 9), and above this, Unit 3 of Bed 9 has yielded a diverse conodont fauna that was monographically described by Stouge and Bagnoli (1988) and correlated with the *P. proteus* Zone. A different interpretation of this fauna was presented by Williams *et al.* (1994) who referred it to the *P. elegans* Zone on the basis of their report of *P. elegans* in the Unit 3 fauna. This species was found only some 40 m higher up in the sequence in the large collections assembled by Stouge and Bagnoli (1988) and its occurrence in Unit 3 needs to be confirmed because it has important bearing on the correlation of this unit. It should be noted that this species belongs to a complex of closely related taxa and that Stouge and Bagnoli (1988) had access to true *P. elegans* from Baltoscandia when they carried out their work on "The Ledge" conodonts.

In summary, we conclude that "The Ledge" section is not representing a continuous succession but has stratigraphic gaps caused by debris flows. There may also be gaps not associated with debris flows, as suggested by the sudden appearance of a diverse conodont fauna in Unit 3 that is strikingly different from the next older one in Unit 34. The FAD of *T. approximatus* is not in a continously fossiliferous succession because fossil control is entirely lacking in a more than 2 m thick interval just below, and also in the debris flow just above, this level. The graptolite biostratigraphy is poor in the lower 15 m of

the *T. approximatus* Zone, being based only on the zonal index and a conditionally identified long-ranging species of *Pendeograptus.* Likewise, the base of the *T. approximatus* Zone is not well-controlled by conodonts or any other fossils, and the age of the conodont fauna in some 40 m of section above the FAD level is in doubt. Compared to the biostratigraphically closely controlled sections at Hunneberg, we must conclude that "The Ledge" section is inferior, and that it does not fulfill the very basic ISC requirements for a global stratotype. Hence it is unsuitable for consideration as a GSSP for the base of the second stage of the Ordovician System.

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THE LEDGE SECTION, COW HEAD PENINSULA, WESTERN NEWFOUNDLAND: A CANDIDATE AS SUITABLE GSSP SECTION: DISCUSSION

Svend Stouge and Gabriella Bagnoli

Introduction

The second stratigraphic subdivision of the Ordovician System was proposed to be marked by the FAD of *Tetragraptus approximatus approximatus* Nicholson, 1873. This has been modified since the Ordovician Meeting in Las Vegas, June 1995 and the FAD of *Tetragraptus approximatus approximatus* may instead be applied for another level in the subdivision (Subseries or Stage) of the Ordovician System (e.g., Williams and Barnes, 1996).

Williams *et al.* (1994) proposed the Ledge Section on the Cow Head Peninsula, western Newfoundland, Canada as a possible global boundary stratotype section for this potential subdivision. Maletz *et al.* (1995) subsequently introduced the Diabasbrottet Section, Hunneberg, Sweden as an other candidate for the stratotype section. Both sections were described as excellent with respect to fossil content including abundant graptolites, conodonts and, in addition, trilobites in the Diabasbrottet Section. It is therefore surprising how little agreement there is in the correlation between the two candidate sections (e.g. Maletz *et al.*, 1995; Erdtmann and Maletz, 1995; Williams and Barnes, 1996). As these sections are recognized to be among the best in the world one wonders therefore how it will be possible to recognize the base of the Subseries/Stage in sections of poorer quality, let alone correlate between such sections. After having looked into the debate, we are convinced that the correlation problems originate not from any deficiency in the two sections, but from different interpretations and errors introduced by the authors.

Disagreements

The disagreements that evolved after the publication by Williams *et al.* (1994) include: 1) taxonomical differences from earlier work (e.g. Stouge and Bagnoli, 1988); 2) different interpretation of the correlation of the Ledge Section to other sections outside Newfoundland (Erdtmann and Maletz, 1995; Maletz *et al.*, 1995 *versus* Williams and Barnes, 1996); 3) whether or not a hiatus is present in the Ledge Section (Erdtmann and Maletz, 1995) or in the Diabasbrottet Section (Williams and Barnes, 1996), or in both sections (Williams and Barnes, 1996), and finally 4) whether this possible hiatus at the Ledge on Cow Head Peninsula was caused by the so-called Ceratopyge Regressive Event (CRE) of Erdtmann (1986; see Erdtmann and Maletz, 1995).

1) Taxonomic differences

It is clear that an appropriate taxonomic approach must be adopted in the comparison and correlation of stratotype sections (see discussion concerning graptolites in Williams and Barnes, 1996). In the specific case Baltoscandic conodont names have been erroneously

applied to conodont taxa in the Cow Head Group by Williams *et al.* (1994) (repeated in Williams and Barnes, 1996) and hence many of the listed taxa become out of place. The most important and wrongly placed taxa in this context have been listed without any photographic documentation, synonymy list, or comments on previous work.

The major taxonomic controversy is the identification of *Prioniodus elegans* Pander, 1856. It came as a great surprise to us when Williams *et al.* (1994) first claimed that the FAD of *Prioniodus elegans* lies near the base of Bed 9, coinciding with the FAD of *Tetragraptus approximatus*. We were surprised because this is not what we had documented earlier (Stouge and Bagnoli, 1988); in contrast, our data indicated that the FAD of *Prioniodus elegans* is near the top of Bed 9, close to the FAD of *Tetragraptus akzharensis* Tzaj, 1968 in the Ledge Section (see Williams and Stevens, 1988), whereas the FAD of *Tetragraptus approximatus* coincided with the FAD of *Prioniodus oepiki* (McTavish, 1973).

At first, we ascribed this to a *lapsus calami* and and we did not make further comment. However, to our growing consternation, Williams and Barnes (1996) repeated the initial error. This is even more astonishing when it is noticed that the authors had apparently not investigated the interval within which *Prioniodus elegans* occurs in the Ledge Section (e.g. Williams *et al.*, 1994, fig.3, *versus* Stouge and Bagnoli, 1988). We can only conclude that the *Prioniodus* present at the base of Bed 9 and supported by our new collections is not *Prioniodus elegans*. Williams *et al.* (1994, 1996) must have identified *Prioniodus oepiki* (McTavish, 1973) *sensu* Stouge and Bagnoli, 1988 as *Prioniodus elegans*.

Therefore, *Prioniodus elegans* is wholly irrelevant to the discussion of the position of the boundary of this stratigraphic subdivision of the Ordovician System, based on the FAD of *Tetragraptus approximatus*. The misidentification has obviously created difficulties for Williams *et al.* (1994) in their correlation with the Baltoscandic sections and, in addition, gives unnecessary support to the argument for the presence of an extensive hiatus at the Ledge Section (e.g., Erdtmann and Maletz, 1995). Furthermore, in contrast to Williams and Barnes (1996), we consider the FAD of *Prioniodus elegans* to be an excellent marker enabling very precise ties to be made not only with Baltoscandia but also with several other regions in the world.

However, the *elegans* identification problem goes further: *Prioniodus gilberti* Stouge and Bagnoli, 1988 - which is a very characteristic zonal index conodont species - has not been identified from Bed 8 at the Ledge Section by Williams *et al.* (1994, fig. 3). Instead, it has been identified and listed as *Prioniodus elegans* in the Martin Point Section (see Williams *et al.* 1994, fig. 6) where *Prioniodus elegans* has been marked from unit 42e; this *Prioniodus* species is, in fact, *Prioniodus gilberti*. This information is derived from our own collections and the statement by Williams *et al.* (1994, p. 225) that "The initial species, *P. gilberti* Stouge and Bagnoli is not recognized in any other section" thus becomes invalid. Given such misidentifications, we can understand why Williams *et al.* (1994) found correlation difficult and why conodont zones are considered "local" (see Williams and Barnes, 1996).

Another important taxon that probably has been misidentified by Williams *et al.* (1994) is *Acodus deltatus* Lindström, 1955. We strongly suspect that Williams *et al.* (1994) have misidentified this taxon as we have not recorded one single specimen of *Acodus deltatus* in the upper strata of Bed 8, whereas *Prioniodus gilberti* is quite common and *Diaphorodus* sp. (=*Acodus deltatus sensu* Ethington and Clark, 1981) is present. The application of the name *Acodus deltatus* will muddy the water further because *Acodus deltatus* in North America is only superficially similar to the Baltoscandian taxon. The north American specimens referred to *Acodus* Pander, 1856 represent different genera that are not closely related with *Acodus deltatus* Lindström, 1955. The noncritical application of the *Acodus deltatus* name gives a false impression of faunal similarity between the North American platform-slope and the northwest European platform.

2) Conodont correlation between North America and Northwest Europe

For biostratigraphic correlations between the two regions, the following FAD's can be used with confidence: *Paracordylodus gracilis* Lindström, 1955, *Periodon primus* Stouge and Bagnoli, 1988, *Oelandodus elongatus* (Lindström, 1955) and *Prioniodus elegans*. If these taxa are applied, correlation becomes straightforward. The *Paracordylodus gracilis* Subzone of the *Paroistodus proteus* Zone (Löfgren, 1993, 1994) correlates with the upper part of Bed 8 at the Ledge Section, where *Paracordylodus gracilis* (see Williams *et al.*, 1994) and *Prioniodus gilberti* (see Stouge and Bagnoli, 1988) occur. This interval is directly connected with the *Aorograptus victoriae* graptolite fauna (La2) also from Bed 8 (see Williams and Stevens, 1991).

The *Oelandodus elongatus-Acodus deltatus* Subzone of the *Paroistodus proteus* Zone (Löfgren, 1993, 1994) correlates with the *Prioniodus oepiki* and *Prioniodus adami* zones (Stouge and Bagnoli, 1988; Löfgren, 1993, 1994). This subzone corresponds with the *Tetragraptus approximatus* Zone (La3) from the lower and middle part of Bed 9 at the Ledge Section (e.g., Williams and Stevens, 1988).

Lastly, the *Prioniodus elegans* Zone of the Baltoscandic region correlates with the upper part of Bed 9 with *Prioniodus elegans*. *Prioniodus elegans* occurs together with the *Tetragraptus akzharensis* graptolite fauna.

The results of the proposed biostratigraphic correlation of the "local" conodont biozones are:

1) The *Aorograptus victoriae* (La2) graptolite fauna from the Ledge Section is contemporaneous with the *Hunnegraptus copiosus* graptolite Zone from the Hunnebergian Substage. This conclusion is in accordance with the correlation promoted by Williams and Barnes (1996) and based on graptolites, but certainly not with the Erdtmann and Maletz (1995) correlation.

2) The FAD of *Tetragraptus approximatus* at the Ledge on Cow Head Peninsula becomes equivalent with the base of the *Oelandodus elongatus-Acodus deltatus* Subzone at the Diabasbrottet Section. Now the conodont data are in accordance with the data presented by Maletz *et al.* (1995) in the sense that *Tetragraptus approximatus* appears before *Prioniodus elegans*. In addition, the Williams and Barnes (1996) idea that *Tetragraptus approximatus* (or "*Tetragraptus approximatus*") should appear later in the Swedish sections than it does at the Ledge Section, which was also pointed out already by Lindholm (1991), is supported by the conodont correlation.

3) Hiatus problems

For outsiders, the dialogue between Erdtmann (1995), Erdtmann and Maletz (1995) and Williams and Barnes (1996, figs. 1, 2) becomes intriguing because each group claims that there is an impressive hiatus on the other side or "across the pond", without mention of the kind of hiatus under discussion (faunal hiatus, unconformities, etc.). The reader who is not familiar with the interval under discussion may be unable to understand why such incomplete sections were suggested as candidate subseries/stage boundary stratotypes.

Fortunately, it is not as bad as it looks, because both sections are indeed without important breaks at the level under consideration. In the Diabasbrottet Section, the hiatus postulated by William and Barnes (1996) is not present, but there is a graptolite faunal hiatus in the sediments below the local FAD of *Tetragraptus approximatus* (or "*Tetragraptus approximatus*"), whereas other fossils occur.

Within the succession at the Ledge Section we (Stouge and Bagnoli, 1988) did point out the presence of some beds without fossils ("Barren Interzone") separating the La2 from the La3 graptolite-conodont faunal associations. The faunal hiatus is represented by interbedded silty and dolomitic sediments and it is characterized by separating the *Macerodus dianae-Paracordylodus gracilis-Prioniodus gilberti* conodont fauna and *Aorograptus victoriae* (La2) graptolite fauna from the succeeding *Tropodus comptus-Periodon primus-Oelandodus elongatus-Prioniodus oepiki-Prioniodus adami* conodont fauna and the *Tetragraptus approximatus* (La3) graptolite fauna. The "Barren Interzone" is an extensive and important regression that can be recognized both from the succession on the platform (="Pebble-Bed" of Boyce, 1989) and from the proximal slope deposits of the Cow Head Group (Stouge and Bagnoli, 1988) at the Ledge Section. At this point, Erdtmann and Maletz (1995) are correct when they suggest that a hiatus is present at the Ledge Section. In contrast with their ideas, however, we find that the hiatus is 1) situated below the FAD of *Tetragraptus approximatus* and 2) it is not the same regression as the CRE.

4) Position of CRE

An unnecessary hiatus problem is the application of the Ceratopyge Regressive Event (or CRE) (Erdtmann 1986). Erdtmann (1995) and Erdtmann and Maletz (1995) have stated correctly however, that the *Hunnegraptus copiosus* graptolite fauna (Lindholm, 1991) is within the Hunnebergian Substage. They also propose that the *Aorograptus victoriae* graptolite fauna from the Ledge Section is older than the Hunnebergian Substage; we are not in agreement on this point. Following the reasoning of Erdtmann and Maletz (1995), the *Aorograptus victoriae* (La2) fauna should be separated from the *Tetragraptus approximatus* fauna by an extensive hiatus that was caused by the Ceratopyge Regressive Event (CRE). In contrast, the *Hunnegraptus copiosus* fauna from Baltoscandia occupied

the interval that is missing at the Ledge. A consequence of this model is that the CRE (corresponding to the Tremadoc-Arenig boundary in Scandinavian tradition, Tjernvik (1956)) should be equivalent to the "Barren Interzone" regression.

We interprete the CRE to be the regression at the top of the Ceratopyge Series which in turn is the same as the top of the Tremadoc in Scandinavian usage (Tjernvik, 1956). Thus the CRE regression is situated at the base of the trangressive-regressive cycle that includes the FAD of *Paracordylodus gracilis* rather than at the top. Consequently and in contrast with Erdtmann and Maletz (1995) the unnamed regression (i.e. "Barren Interzone" regression) which is developed between the *Aorograptus victoriae* (La2) fauna below and succeeded by the FAD of *Tetragraptus approximatus* is not the same regression as the CRE. The CRE is clearly older and, together with the base of Hunnebergian Substage, is to be found below the FAD's of *Macerodus dianae, Paracordylodus gracilis, Prioniodus gilberti* and *Aorograptus victoriae* in the Cow Head Group. Thus the CRE should not be used for precise correlation of the potential subseries/stage boundary unless one uses a very large and wide brush while drawing the correlation line, thus obscuring the *Paracordylodus gracilis* transgressive-regressive cycle.

Conclusions

This letter concludes our participation in the discussion on the position of the FAD of *Tetragraptus approximatus* and the FAD of *Prioniodus elegans* and correlation of the same. From this discussion we conclude that FAD of *Prioniodus elegans* and FAD of *Tetragraptus approximatus* do not coincide, whereas FAD's of *Prioniodus oepiki* and *Tetragraptus approximatus* do.

Our final conclusions including the transatlantic correlation based on our own collections from the Cow Head Group, will be presented and documented in coming publications, which currently are in preparation.

Finally we may add that we are in favor of the Ledge Section as a boundary stratotype using the FAD of *Tetragraptus approximatus*, because the boundary in question can be defined on the basis of graptolites in the section and the boundary can be precisely recognized using conodonts. The second proposed candidate section (Diasbasbrottet) does not have graptolites at the boundary horizon, but the boundary can be fixed by using - local or not - conodonts (and trilobites).

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ORDOVICIAN GRAPTOLITES BELOW THE BASE OF THE *TETRAGRAPTUS APPROXIMATUS* ZONE

Jörg Maletz

In 1991, the Subcommission on Ordovician Stratigraphy (I.C.S.) accepted the base of the *Tetragraptus approximatus* Zone as the base of the second series of the Ordovician Series. Two sections have subsequently been proposed for a global stratotype (GSSP) for this level (Williams *et al.* 1994, Maletz *et al.* 1995, 1996). Nevertheless severe discrepancies still exist concerning the graptolite taxonomy and biostratigraphy of the late Tremadoc graptolite faunas from the interval directly below this level (Williams and Barnes 1996). These faunas are important in order to understand the completeness of the successions discussed as the proposed GSSP's. Graptolites from the late Tremadoc have been commonly neglected and few adequate descriptions exist. Also biostratigraphic data are

difficult to get from most areas. The aim of this note is to compare the different taxonomic and biostratigraphic interpretations and correlate the biostratigraphically important faunas.

The Tremadoc represents a very long time interval; according to Cooper (1992, table 1) it represents 22.5 Ma of Earth history. The La 2 alone is probably about 14.5 My, almost as long as the whole of the Arenig. An unexpectedly low number of graptolite zones are described from the Tremadoc. For the Arenig, 14 graptolite zones (La 3, *T. approximatus* Zone, to the Da 1, *Undulograptus austrodentatus* Zone) are documented from Australia (VandenBerg and Cooper 1992). The Australian succession in the Late Tremadoc contains only two zones (La 1.5, La 2), although it may be possible to differentiate the La 2 into a lower subzone without *Araneograptus* and an upper subzone with *Araneograptus* (Cooper, pers. com.).

The most complete record of late Tremadoc graptolite faunas known is probably that in Scandinavia, as is shown by this overview. This fact seems curious, as the Scandinavian Lower Ordovician successions are condensed and therefore thought to be incomplete by some workers. However, the faunas are well preserved and important data for a taxonomic and biostratigrapic interpretations are available from this area. Here, the Scandinavian succession (Fig. 1) is taken as a provisional standard, and all successions from other areas are compared with it.

Faunal succession

In the earlier part of the Late Tremadoc, starting with the *Kiaerograptus kiaeri* Zone, kiaerograptids are common. The proximal end development of the kiaerograptids, including *Psigraptus*, shows a long free pending metasicula (Spjeldnaes 1963, Williams and Stevens 1991). Most graptolite species from the *K. kiaeri* to *K. stoermeri* zones of Scandinavia (Fig. 1) show this characteristic feature that distinguish the interval. The genus *Kiaerograptus* includes species with two or more stipes. The larger multiramous species resemble typical clonograptids. The proximal structure in these specimens is rarely seen.

Reinvestigation of material of *Kiaerograptus lauzonensis* Erdtmann (1966) (= *K. undulatus* of Williams and Stevens 1991) from the *Aorograptus victoriae* Zone of western Newfoundland shows that the species is more variable than described by Williams and Stevens (1991). Many specimens bear long first order stipes and show the first branching only at some distance from the proximal end. Proximal ends of *K. lauzonensis* are nearly indistinguishable from those of *K. kiaeri*.

The free pending metasicula is also found in *Psigraptus*, and in the associated faunas from the Austalian La 1.5 (Cooper and Stewart 1979). *Psigraptus* is here included tentatively in the kiaerograptids (see also Maletz 1992), and it constitutes the only genus with reclined stipes in this group. The exact integration of the *Psigraptus* horizon or zone, however, is still uncertain. The Chinese succession indicates the probable inclusion of the *Psigraptus* Zone into the lower part of the interval with kiaerograptids. Information from other areas is not yet available.

In the younger faunas from the *Kiaerograptus supremus* Zone on, the kiaerograptids are gone. These faunas have a different aspect. Large adelograptids appear, but are often misidentified as *Clonograptus*, followed by the characteristic *Araneograptus* slightly higher up in the *A. murrayi* Zone or the upper La 2. *Paradelograptus*, a genus that appears first in the *Aorograptus victoriae* Zone of eastern Newfoundland, is common, but reaches far into the Arenig (Erdtmann *et al.* 1987). Structural details are not available from most elements of the *A. victoriae* zone. Probably around the La 2, or even higher up, the specimens lose their bithecae in the fashion indicated by Lindholm (1991a). In the *Hunnegraptus copiosus* Zone most bithecae are gone, as is seen from relief material present in Scandinavia and North America (Texas). A single bitheca, the sicular bitheca is still present, however. At the moment only in Scandinavia (Maletz *et al.* 1995, 1997) and in Bolivia (Erdtmann, Maletz, unpublished) is the succession from the *H. copiosus* to the *T. phyllograptoides* (= *T. approximatus*) Zone documented.

There are no indications for a faunal differentiation in the Late Tremadoc that could be related to a faunal provincialism. The main problem is that faunas of Late Tremadoc age seem to be undescribed from most areas.

Scandinavia. The early Tremadoc succession with the *Rhabdinopora flabelliformis* faunas has been revised recently (Cooper *et al.* in press). It is followed by a poorly defined fauna of the *Adelograptus tenellus* Zone. Only in Norway more complete faunal successions are known from the interval overlying the *A. tenellus* Zone. In the Oslo region, Monsen (1925) described the faunas of the *Ceratopyge* Shale (now uppermost part of Alum Shale Formation), and devided them into the lower subzone of *Bryograptus ramosus, Bryograptus broeggeri,* and *Triograptus osloensis* (*Bryograptus ramosus* Zone herein), and the upper subzone with *Didymograptus*? *kiaeri, Clonograptus tenellus* and *Bryograptus hunnebergensis* (*Kiaerograptus kiaeri* Zone herein). *Kiaerograptus stoermeri*, a species closely related to *K. kiaeri*, was discovered from the upper part of the overlying *Ceratopyge* Limestone (now Bjørkåsholmen Formation) by Erdtmann (1965a), and a *K. stoermeri* Zone was differentiated (Erdtmann 1965b, fig. 5). The usefullness of this zone is not yet proven, as the species has never been discovered in any other section.

Younger Tremadoc graptolite faunal successions from Scania were described by Lindholm (1991a,b). The *Kiaerograptus supremus, Araneograptus murrayi* and *Hunnegraptus copiosus* zones can be differentiated below the basal Arenig *Tetragraptus phyllograptoides* Zone. The succession is described from the Krapperup core in Scania, that may reach a level slightly above the Bjørkåsholmen Formation. A short gap in the known faunal record may still exist in the Scandinavian successions at this level, as faunas with *K. stoermeri* or *K. kiaeri* are not reached in the core. The presence of bithecae and a dendroid plaited overlap of the thecae are demonstrated for *K. supremus* (Lindholm 1991a), but structural details are not available for other faunal elements of the zone.

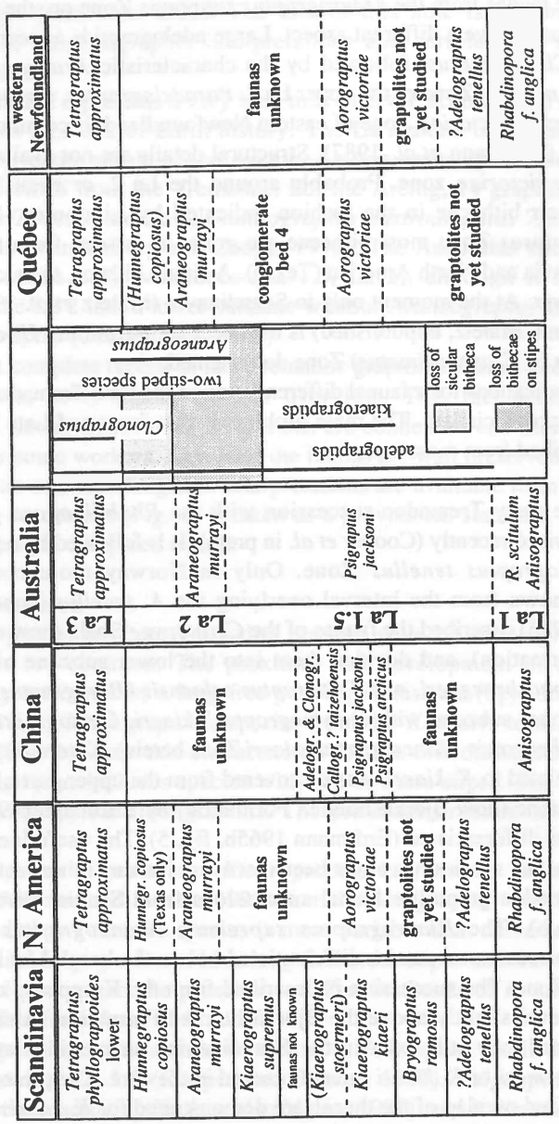

Fig. 1. Comparison of Early Ordovician Scandinavian succession with others in the world.

H. copiosus shows a sicular bitheca, but clearly has dichograptid stipes. The "dendroid" plaited overlap structure is still present in certain dichograptids from the *T. phyllograptoides* Zone (Lindholm and Maletz 1989), but they do not bear bithecae.

Eastern Canada (Québec, western Newfoundland). Tremadoc faunas from above the *Rhabdinopora flabelliformis anglica* level are practically undescribed from western Newfoundland (see Williams and Stevens 1991), except for the fauna of the *Aorograptus victoriae* Zone. It is followed by the *T. approximatus* Zone fauna.

The *A. victoriae* Zone has a fauna of clear kiaerograptid appearance. *Adelograptus altus* and *Kiaerograptus undulatus* have the free pending metasicula, but *Kiaerograptus*(?) *magnus* bears a simple adelograptid proximal end development. *K. undulatus* is closely related to or even identical with *K. kiaeri* from Scandinavia, even though the Scandinavian material has never produced any specimens with distal branchings. The Scandinavian material, however, is mostly fragmentary and large specimens are unknown. *Adelograptus altus* is present in the *K. kiaeri* Zone in Norway (Maletz, unpublished).

A taxonomic problem is seen in the species *Aorograptus victoriae*. Different concepts exist here. The type material of *Bryograptus victoriae* T.H. Hall comes from the La 2 of Australia. Morris (1988) discussed the La 2 faunas in detail and concluded that *B. victoriae* represents the juveniles of the large "clonograptids" *Clonograptus flexilis rigidus* and *C. flexilis flexilis*, as described from the La 2. Williams and Stevens (1991) described *Aorograptus victoriae* as a biradiate declined to pendent adelograptid, that is not related to *Clonograptus*. The specimens of this species from western Newfoundland are completely bithecate (Williams and Stevens 1991, p. 26). The biostratigraphic framework here presented (Fig. 1) indicates, that these occurrences are of different age, and that the Victorian and Newfoundland forms are not conspecific.

In Québec, the faunal succession is slightly more complete. Faunas of late Tremadoc age from below conglomerate bed 4 of Logan (1865) were noted by Berry and Osborne (1966), but not described. Faunas from an undefined level below the *A. victoriae* Zone include a variety of adelograptids (*Clonograptus sarmentosus, Stellatograptus stellatus* in Erdtmann 1967).

From the N-section at Lévis, Erdtmann (1966) described a few specimens of *Kiaerograptus lauzonensis* (= *Kiaerograptus undulatus* Williams and Stevens 1991), that show a long free pending metasicula. The material comes from several metres below conglomerate bed 4 (Maletz 1997, in press). The exact level, however, is unknown. *K. lauzonensis* clearly belongs in the eastern North American *A. victoriae* Zone. Additional faunal elements such as *Kiaerograptus*(?) *bulmani* (Thomas) and *Paradelograptus* sp. cf. *P. filiformis* (Williams and Stevens) are present.

Higher up, directly above conglomerate bed 4, the *A. murrayi* Zone can be documented (Maletz 1997), based on the common occurrence of *A. murrayi* in the G- and N- sections (Maletz, 1992, 1997). The G-locality is also the type locality of *A. murrayi*. The presence of the *H. copiosus* Zone is not proven in this area. A species, which is probably identical, or at least closely related to, *H. copiosus*, is *Didymograptus novus*

(Berry 1960) from Texas. The type material of this form shows dichograptid stipes, but a prominent sicular bitheca is present (Riva, pers. com.). The material represents the only record of the *H. copiosus* Zone faunas from North America.

In the Québec area, above the *A. murrayi* Zone appear faunas of the *T. approximatus* Zone in the G-locality (Maletz 1997).

Australia. The Australian succession is highly incomplete biostratigraphically. Only three levels with graptolites can be differentiated in the Tremadoc. The La 1 certainly belongs to the early Tremadoc, and is not discussed here. The La 1.5 bears the conspicuous fauna with *Psigraptus*, that can be correlated with a level somewhere in the long time interval of the kiaerograptids. It is known from two localities only, and represents not more than a single bedding plane assemblage in a thick unfossiliferous succession (Cooper and Stewart 1979). The next younger fauna, the La 2 fauna, again is known from a thin interval only, but is much better documented by a variety of different species (Morris 1988). The faunal elements clearly indicate the *A. murrayi* Zone. The *H. copiosus* Zone is not found in Australia yet. Faunal ranges are generally not documented from the Australian faunas. The next younger interval contains the La 3 fauna, that can be correlated with the *T. approximatus* Zone. This fauna was indicated to include a variety of different elements by VandenBerg and Cooper (1992), but Morris (1988) quoted only very few elements in his (unpublished) reinvestigation.

China. The Chinese faunal succession is poorly known. The data are taken from Wang and Erdtmann (1986) for the Hunjiang area (Jilin). The *Anisograptus* Zone, which includes a large number of *Anisograptus* together with *Rhabdinopora*, is followed by the *Psigraptus* Zone. A faunal gap of at least 45 m is seen between the *Anisograptus* Zone and the *Psigraptus* Zone. The two species of *Psigraptus, P. arcticus* and *P. jacksoni,* are present. The psigraptids are accompanied by specimens of multiramous species, generally included in *Clonograptus* (author). The *Psigraptus* Zone is followed by the *Callograptus*? *taizehoensis* Zone, in which only benthic, dendroid graptolites occur together with a few indeterminate *Adelograptus* specimens.

The *Adelograptus - Clonograptus* Zone includes a variety of different "adelograptids". Mostly these elements are poorly described and are in need of reevaluation. Lin (1981) described and figured material from the Yehli Formation of Shaanxi and Hebei. Especially the material of *Adelograptus asiaticus, A. horizontalis, A. taihangshanensis* and *Kiaerograptus hengshanensis* show the conspicuous free pending metasicula, typical for the kiaerograptids. Good faunal successions are not documented yet.

South America (Bolivia). The South American faunas of the Tarija region in Bolivia are currently under investigation by Erdtmann (TU Berlin). They show the transition from the *Hunnegraptus copiosus* Zone (first unequivocal record outside of Scandinavia) to the *T. phyllograptoides* Zone (= *T. approximatus* Zone).

The Yunchará segment has a faunal succession with the *Araneograptus murray* and

Hunnegraptus copiosus Zones in the Obispo Formation followed by strata with *T. phyllograptoides*. *K. supremus* is common, but is invariably associated with *A. murrayi*. Thus, it may not be possible to distinguish the *K. supremus* Zone.

T. approximatus starts higher up in the section, thus appears later in relation to the Scandinavian succession. Earlier Tremadoc faunas are poorly represented in the succession, but the early Tremadoc *Rhabdinopora flabelliformis* is present at several levels.

Results.

1) The Late Tremadoc graptolite succession needs more attention, as it can be more finely subdivided and a detailed biozonation is available.

2) The beds directly below the *T. approximatus* Zone belong to the *Hunnegraptus copiosus* Zone in Scandinavia and Bolivia (Erdtmann, Maletz,, unpublished). Coeval strata may possibly be documented in Texas (Berry 1960: *Didymograptus novus* = *Hunnegraptus* sp.).

3) The *Aorograptus victoriae* Zone of western Newfoundland most likely belongs to an interval in the lower part of the Late Tremadoc and is not equivalent to the *Hunnegraptus copiosus* Zone as was proposed by Williams *et al.* (1994) and Williams and Barnes (1996).

4) The Australian La 2 faunas represent only a small fraction of the Late Tremadoc.

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NEW DISCOVERIES IN THE EARLY ORDOVICIAN OF SOUTH AMERICA AND RUSSIA

Bernd-D. Erdtmann

Our research team has been recently engaged in two Ordovician projects in different parts of the globe: first, the Eastern Cordillera of northern Argentina (with Cristina Moya, Julio Montero and Guillermo Lopez, Salta) and in adjacent southern Bolivia (with Sven Egenhoff, TU Berlin, new PhD student on Ordovician basin analysis, Eastern Cordillera); and second pre-Variscan stratigraphy of the southern Urals, Russia (with Kirill Ivanov, Andrei Maslov, Misha Krupenin of Ekaterinburg and Ivo Paalits, TU Berlin). Here the most important preliminary results from the 1996 field campaigns are summarized.

a) Stratigraphic ranges of important Tremadoc and early Arenig graptolites were measured at Cerro San Bernardo and nearby localities near Salta, Argentina and at Sella (near Tarija, Bolivia) as well as at Cieneguillas and Culpina in southern Bolivia. Several shallowing-upwards events were established for the Tremadoc to early Arenig interval in the characteristic inner clastic shelf to nearshore environments of the Salta to Sella depositional strike encompassing a very distinctive but zonally non-specific graptolite facies for this particular tempestite-dominated facies region. Investigation of this graptolite facies is in progress by Erdtmann and Montero.

The shelf marginal or deep shelf depositional environments are best represented by the extremely thick (several kms!) Tremadoc to early Arenig sections of Cieneguillas and Culpina, NW of Tarija in southern Bolivia. Here a virtually "classic" succession of Tremadoc, "Hunnebergian" and early Arenig graptolites was encountered which over an extended section documents the ranges of La 2 type and Scandinavian type (Mt. Hunneberg and Oslo) graptolite ranges relevant to the definition of the boundary between the first and second Series of the Ordovician System currently being discussed. Most critical to this discussion may be the potential evolutionary lineages of *Aorograptus* (pre-CRE) to the post-CRE "burst" of *Araneograptus murrayi* and its continued evolution into intermediate forms between *Araneograptus murrayi* and *Pendeograptus crassus* (VandenBerg & Cooper, 1992). Furthermore, evolutionary lineages for *Hunnegraptus copiosus*, *Clonograptus-Temnograptus* (probably deriving from CRE-related occurrences of *Stellatograptus stellatus*) and for *Tetragraptus phyllograptoides* is unfolding during this ca. 700 m thick black shale interval between the CRE low stand quartzites and the FAD of *Paratetragraptus approximatus*. In contrast to the critically condensed Mt. Hunneberg and Oslo sections for this interval (Maletz, Lofgren and Bergström, 1996) *Tetragraptus phyllograptoides* appears much earlier at Cieneguillas and Culpina than *Paratetragraptus approximatus*. A publication relevant to a discrete range chart of all graptolites of this

important stratigraphic interval is currently in preparation.

b) In Russia it was long known (but not brought to international attention) that a spectacular angular unconformity as well as a distinct metamorphic break exists in the Bashkirian Urals over stratigraphic intervals spanning a minimum hiatus between Late Vendian to "somewhere" in the Ordovician. This hiatus was investigated at three of the most prominent localities with special emphasis on determining the stratigraphic ages of the Ordovician onlaps. This is made difficult by the presence of unfossiliferous basal conglomerates with subsequent fossil shell hash-bearing calcareous gritstones. At two locations also an intermediate sandstone bed has been found which carries large trace fossils of *Cruziana* type. These may indicate a late Tremadoc to Arenig age, but may also be as young as Llanvirn. The subsequent gritstone contains shell-debris including trochospiral gastropods, articulate brachiopods and crinoid columnals. Currently Ivo Paalits and Erdtmann are investigating both potential micro- and macrofaunas from these beds to better pin down the exact ages.

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CURRENT RESEARCH

GILBERTO AÇENOLAZA (Argentina) is continuing work on lower Ordovician stratigraphy and biostratigraphy. He is also involved with IGCP projects as co-leader of Project 351 - Early Paleozoic Evolution of NW Gondwana, and is co-editor of a book on the meeting held in Morocco and of a recently published book (in Germany) on the geology of the Famatina System.

GUILLERMO AÇENOLAZA (Argentina) defended his Doctoral thesis last December, which dealt with the biostratigraphy of the Cambrian-Ordovician boundary and lower Ordovician in the Quebrada of Humahuaca of Jujuy Province (Northern Argentina). This focused on trilobites, conodonts and trace fossils, and dealt also with large specimens of *Rhabdinopora* (25 cm. long). He is now writing papers presenting some of these new findings and is working with colleagues from Spain and Bolivia on a number of different topics on Lower Ordovician biostratigraphy.

AICHA ACHAB (Canada) is working with **Azzedine Soufiane** on chitinozoans as part of a multidisciplinary project on the Ordovician-Silurian boundary interval in east-central Nevada (coordinated by **Stan Finney**). The boundary has been recognised by Stan and **Bill Berry** in the Vinini Formation of the Vinini Creek section on the basis of graptolites, and suspected in the Hansen Creek Formation of Copenhagen Canyon. Other participants of this multidisciplinary project are **Steven Jacobson** (acritarchs), **Walter Sweet** and **Ray Ethington** (conodonts) and **John Cooper** (stratigraphy and sedimentology).

DICK ALDRIDGE (UK) continues work with **Sarah Gabbott** and **Hannes Theron** on the Soom Shale of South Africa; some spectacular new finds were made during fieldwork in 1996, and papers are in the final stages of preparation on the chitinozoans, a naked agnathan and the taphonomy of the biota. Conodont work in the Ordovician of Estonia with **Viive Viira** has been advanced by the recruitment of a research student, **Stephanie Barrett**. **Kim Freedman** has also joined the team to work on the taphonomy of conodonts and other agnathans.

HOWARD ARMSTRONG (UK) has been busy working with **Alan Owen** over the last couple of years on an investigation into the biostratigraphy and REE patterns of Southern Uplands cherts (funded by the BGS). The results are now coming onstream and papers should start appearing in the next few months. He continues to work mainly with graduate students on Upper Ordovician conodonts. **Gail Radcliffe** is finishing her Ph.D. on extinction and recovery at the O-S boundary. **Caroline Smith** (with **Alan Owen**) is looking at deep water conodont and trilobite faunas from the Upper Ordovician. Howard and Alan Owen are about to embark on a study of limestone clasts within southerly derived Devonian conglomerates from the Midland Valley, Scotland. Interest was stimulated by finding Ordovician limestones in conglomerates from the Pentland Hills.

ESTHER ASSELIN (Canada) has now finished a study of chitinozoans from Ordovician outliers of the Lac Saint-Jean and Chicoutimi area with **Denis Lavoie** and **Aicha Achab** and a paper is being prepared for publication. Variations were observed between chitinozoan microfaunas from this more internal part of the Laurentian craton and those known in the St Lawrence Lowlands of southern Quebec. Results were presented during the Ninth International Palynological Congress at Houston in June 1996. A study of chitinozoans from the allochthonous Cambro-Ordovician succession of the Humber Zone of the Quebec reentrant (with Denis Lavoie) will be undertaken early in 1997. The objective of this project is to define precisely the age of different lithostratigraphic units and contribute to the recognition of marine eustatic fluctuations that can be used to establish comparisons with the Humber Zone of western Newfoundland.

RICARDO ASTINI (Argentina) continues his studies employing different sedimentologic, stratigraphic, sequence stratigraphic and tectonostratigraphic approaches to the Ordovician rocks in the main Lower Paleozoic basins of Argentina. He is currently

focusing on the Middle Ordovician paleogeographic rearrangements in the Precordillera during and after its accretion to Gondwana. He is also working on the volcaniclastic successions of the Famatina Ranges in trying to unravel the environments and paleogeographic settings of these successions and plans to extend his studies on the Hirnantian glacial rocks in the Subandean Ranges and Cordillera Oriental. He is also actively involved in the Precordilleran K-bentonite project together with **Warren Huff, Dennis Kolata, Stig Bergström, Carlos Cingolani, Edsel Brussa** and **Chuck Mitchell**.

HUGH BARRON (UK) has recently joined the BGS Southern Uplands mapping team and has been mapping in the Northern Belt with **Jim Floyd, Elizabeth Pickett** and **Richard Smith**. He is also trying to find time to write up some acritarch biostratigraphy from the Silurian of the Pentland Hills (Midland Valley, Scotland) with **Stewart Molyneux**.

RICHARD BATCHELOR (UK) is still working on bentonites from Scandinavia and Scotland, in collaboration with **Tony Weir**. The chemical composition of apatite is being used as a fingerprinting tool, and some preliminary work on Sr isotopic signatures is being carried out in collaboration with **Scott Samson**.

DENIS BATES (UK) and **David Harper** are writing up the Arenig Tagoat fauna from SE Ireland. Other Paleozoic studies include Silurian retiolites and TEM work on Silurian dendroids from Gotland; he has a preliminary paper coming out shortly in *Geobios*.

JUAN BENEDETTO (Argentina) is working on Ordovician articulate brachiopods from Bolivia and Argentina. A revision of the Arenig brachiopod fauna from NW Argentina is in press. Currently he is working on the systematic description of a rich Arenig brachiopod fauna from the volcaniclastic Suri Formation of the Famatina Range. In 1996, a new project was started on Caradoc faunas from the Cordillera del Tunari (Cochabamba, Bolivia) in conjunction with colleague **Ramiro Suarez Soruco**. Juan is also continuing his studies on the biogeography and paleogeography of Western Gondwana, paying particular atention to the accretion of exotic terranes.

STIG BERGSTRÖM (USA) spent last spring, summer and fall doing fieldwork in Sweden, Argentina, the Appalachians in Tennessee-Virginia, Xinjiang Province of westernmost China, the upper Mississippi Valley, West Texas and the Ohio Valley in Ohio and Kentucky. Most of his research at home in Columbus dealt with conodonts and graptolites and their use in solving a variety of geological problems. Together with **Dan Goldman**, Stig completed a comprehensive paper on North American Midcontinent Upper Ordovician graptolites, which has been accepted for publication in *Palaeontology*. Several K-bentonite papers were finished and are in review or press, as is a paper on

Laurentian Middle Ordovician conodonts from the Trondheim region, central Norway. Stig is also involved with Ordovician global stratotype work in Sweden, eastern North America and China.

TOM BOLTON (Canada) is completing a study of the Middle and Upper Ordovician megafauna of southern Baffin Island, to accompany papers prepared by **Sandy McCracken** (conodonts), **Murray Copeland** (ostracodes), **John Riva** (graptolites), **Esther Asselin** and **Aicha Achab** (chitinozoans), **Rick Wickander** (palynomorphs), and **Bruce Sanford** and **Al Grant** (geology). In addition, the trilobites *Bathyurus angelini* Billings fom the Whiterockian Carillon Formation of Montreal, and *B. perplexus* Billings from western Newfoundland are under study with **Hans Hoffman**, and a crinoid fauna from the Table Point Formation (Whiterockian) of the Port au Port Peninsula, western Newfoundland, is being described with **Bill Aussich**. Description of a serpulid worm biostrome recognized in several sections of Blackriveran strata throughout the Ottawa Valley with Merriam Steele-Petrovich has been completed.

DOUG BOYCE (Canada) is continuing work on a memoir dealing with Early to Middle Ordovician trilobite systematics, biostratigraphy and biofacies of the St. George and Table Head groups of western Newfoundland.

PAT BRENCHLEY (UK) reports that research at Liverpool continues to centre around obtaining a very high resolution Hirnantian isotope stratigraphy for global correlation of of late Ordovician environmental and extinction events. There is now an isotope curve for the Dob's Linn succession (Underwood *et al*., in press) that allows correlation between shelly and graptolitic sequences.

EDSEL BRUSSA (Argentina) has been continuing his studies on the Ordovician graptolites of the Argentine Precordillera and Famatina. He is planning to check the *Undulograptus austrodentatus* Zone in the Precordillera and to study the relationships between graptolite-bearing strata and sedimentary environments in the eastern and western tectofacies. He is also collaborating on the K- bentonite project with **Stig Bergström, Warren Huff, Dennis Kolata, Carlos Cingolani, Ricardo Astini** and **Chuck Mitchell**. With Chuck he is also studying late Caradoc graptolites from the Western Precordillera trying to get information about their paleogeographic relationships.

DAVID BRUTON (Norway) has just completed (with help of **Ole Hoel** and an assistant) a *Catalogue of the trilobites figured in Fr. Schmidt's Revision der Østbaltischen Silurischen Trilobiten (1881-1907)* (n.b., for "Silurian" read mainly "Ordovician"). Original figured material amounted to 1408 specimens of which they have traced 990 or approximately 70%. The object of the work has been to examine collections in Moscow and St. Petersburg, photograph important specimens and publish a computer-based

catalogue.

PETR BUDIL (Czech Republic) is continuing his study of Bohemian Ordovician dalmanitid trilobites. A revision of the representatives of genera *Mucronaspis* and *Songxites* from the Bohemian Upper Ordovician has been published, while a revision of the Bohemian representatives of the genus *Ormathops* has been prepared. A short paper about some interesting temporary outcrops of Ordovician sediments in NE part of Prague (Bohemia) has also been published.

ROBIN COCKS (UK) has been working with **Stuart McKerrow** on Avalonia and its boundaries through time and they have a *Geological Magazine* paper in press and a further paper (with **Cees van Staal**) in preparation. He has also finished work on an Ashgill fauna from Taimyr (with **Tanya Modzalevskaya**) which has been accepted for *Palaeontology* and on a small paper (with **Richard Fortey**) on the Late Ordovician sequences and shelly faunas in Thailand. Current work is with **Zhan Ren-bin**, who is at the Natural History Museum for a year, on the middle Ashgill brachiopods of the eastern part of the South China plate.

ROGER COOPER (New Zealand) reports that a one year period of study leave at Lund University and TU Berlin enabled him to return to graptolite research for a while. Much of the time was spent on matters related to the Cambrian-Ordovician Boundary (see report in this issue). A full revision of the *Rhabdinopora* and *Anisograptus* groups of species jointly with **Jörg Maletz, Bernd Erdtmann** and **Wang Haifeng** is complete and in press (*Norsk Geologisk Tiddskrift*). An ecostratigraphic and biostratigraphic analysis of Tremadoc graptolites provides the basis for a revised set of global graptolite chronozones in a paper that should be submitted shortly. Rates of origination and extinction of Ordovician graptolite species have been analysed, using the Australasian sequence and the results presented at the North American Paleontological Congress in Washington. Average species duration (288 species) is 3.12my and ranges from 1.53my for Sigmagraptidae to 5.08my in Anisograptidae. Attempts to relate the standing diversity curve to the eustatic curve for the Ordovician revealed two major difficulties; one is which eustatic curve to use, the other is how to define standing diversity. The second can be resolved but the first still appears to be an open question. On the home front Roger has completed a revision of New Zealand's early Paleozoic for the new 1:250 000 (Nelson) map, including a revision of the terrane history and development.

JOHN COPE (UK) is continuing work on new Ordovician bivalve faunas, and a phylogenetic classification of bivalves should appear this year. A new student has now started work on Anglo-Welsh Silurian bivalves.

JACQUES DESTOMBES (France) is conducting studies on Morroccan Ordovician trilobites (with **Drs. Vidal, Henry** and **Hammann**) and Gastropods (with **Dr. Horny**).

MARY DROSER (US) is continuing her work with **Peter Sheehan** studying the paleoecological signature of the Ordovician radiation through examination of the Ordovician strata of the Great Basin. Her student, **Xing Li**, is finishing up his dissertation examining the development of Ordovician shell beds. Other students are working on aspects of the Ibexian and Whiterockian faunas of the Great Basin. She is also looking at the trace fossils and ichnofabrics of the type Cincinnatian.

JAN OVE EBBESTAD (Norway) is presently occupied with fieldwork in Norway and Sweden, as he continues his Ph.D. on Baltic Upper Ordovician gastropods. In addition, his Masters' thesis from Oslo on the Ceratopyge fauna has now progressed well towards publication.

SVEN EGENHOFF (Germany) has just started a Ph.D. thesis on the sedimentology of clastic coastal to basin successions in southern Bolivia. He will try to reconstruct the still poorly understood evolution of a probable back-arc basin from uppermost Cambrian to late Ordovician times. His work is supported by the German NSF (DFG)-Special Research Program 267 dealing with deformational processes in the Andes.

BOB ELIAS (Canada) is studying various aspects of corals during the Ordovician radiation, mass extinction, and early Silurian recovery. Research with **Graham Young** focuses on the diversity, distribution, and organizational complexity of latest Ordovician to earliest Silurian coral faunas. A postdoctoral fellow, **Xu Shaochun**, is working on latest Ordovician corals of south China.

BERND ERDTMANN (Germany) has been mostly engaged in two Ordovician projects at two quite different locations of the globe: a) The Eastern Cordillera of northern Argentina (with **Cristina Moya, Julio Montero** and **Guillermo Lopez**) and in adjacent southern Bolivia (with **Sven Egenhoff**, a new Ph.D. student at TU Berlin, on Ordovician basin analysis in the Eastern Cordillera), and b) Pre-Variscan stratigraphy of the southern Urals, Russia (with **Kirill Ivanov, Andrei Maslov, Misha Krupenin** and **Ivo Paalits**). Results are summarized elsewhere in this issue.

OLDRICH FATKA (Czech Republic) is continuing studies on Lower and Middle Ordovician acritarchs and chitinozoans of Bohemia. He organized a conference of the Acritarch Subcommission of the C.I.M.P. in April 1996 in Prague in cooperation with **Thomas Servais** and both have edited a special issue based on the meeting (see "Acritarcha in Praha 1996" elsewhere in this issue). A revision of selected acritarch taxa is continuing together with **Rainer Brocke** and Thomas Servais.

ANNALISA FERRETTI (Italy) continues her work on Upper Ordovician

conodonts. Two papers, one with **Chris Barnes** on the conodont fauna from Kalkbank limestone of Thuringia, and one on Upper Ordovician conodont fauna from Wales will be soon completed. In preparation for the ECOS VII which will be held in Italy in 1998, a revision with **Enrico Serpagli** of the Upper Ordovician conodonts from the Carnic Alps and Sardinia has just been started, involving both new sampling and analysis of classical collections.

STAN FINNEY (US) is leading a multi-disciplinary study of late Ordovician basin and platform sections in central Nevada. The research team includes **Bill Berry, Walt Sweet, John Cooper, Steve Jacobson, Rob Ripperdan** and **Azzedine Soufiane**. The sections were sampled extensively and systematically last summer for sedimentology, graptolites, conodonts and organic-walled microfossils, carbon-isotope stratigraphy, and organic geochemistry. They provide a unique opportunity to closely compare and integrate varied data sets that record the Late Ordovician extinction and associated eustatic, oceanographic, and biotic events. Preliminary results will be presented in a Symposium, sponsored by the Geological Society of America and the Paleontological Society, at the Annual Meeting of the GSA in Salt Lake City in October 1997. Stan has also organized a pre-meeting field excursion to examine the Nevada sections.

RICHARD FORTEY (UK) reports that there are now two postdoctoral research fellows working with him at the Natural History Museum in London, making a welcome addition to the devotees of the Ordovician in Britain. **Jonathan Adrain** (financed by Natural Environment Research Council) is studying the basal mid-Ordovician faunal 'revolution'. This work involves both the description of new faunas, and the phylogenetic and biogeographic assessment of older ones at the base of the Middle Ordovician (*sensu* Ross and others). The trilobites of the Tourmakeady Limestone, an interesting 'mound'-style fauna in western Ireland, has been the first leg of this project, which now goes on to examine patterns of evolution and origination, and to deal with a major new silicified fauna from Newfoundland. **Tim McCormick** (financed by Leverhulme Trust) is working on the fine scale evolution of the pelagic trilobite *Carolinites*, based upon quantitative work on large collections of silicified material (e.g., from the classic Utah sections). The optics of this interesting and stratigraphically important animal are an interesting diversion. Meanwhile Richard and **Robin Cocks** have obtained another NERC grant to look at faunal evidence for Gondwanan peripheral terrane positions - another postdoc opportunity for somebody. This is partly based on work in Thailand. It is encouraging to see that it is still possible to get grant support for Ordovician work, even if the process of doing it inevitably distracts from primary research by the applicant.

GERALD FRIEDMAN (US) continues his research with students on the Lower Ordovician Tribes Hill Formation in the Mohawk Valley, New York. High-frequency peritidal stacking patterns characterize the facies of this passive margin. The cycles reflect

small amplitude sea-level changes consisting of upward-shoaling parasequences that ultimately became emergent. Microbial reef mounds occupy the basal part of some of these cycles. Aggrading hummocks and channels occupy inter-reef mound areas resulting from storm events in a subtidal setting. A project with **Baiying Guo, Jonathan P. Bass** and **Golam Sarwar** studied the Cambro-Ordovician Wappinger Group in southeastern New York. Two deep wells drilled into the Cambro-Ordovician formations reported gas shows which, combined with studies into lithofacies, diagenesis, petrophysics, and the structural configuration of the Taconic fold- and thrust belt, suggests there may be economic gas-bearing reservoirs, or reservoirs suitable for gas storage, elsewhere in this poorly studied part of New York.

ROBERT GANIS (US) has discovered a number of new graptolite and conodont localites in the allochthonous sediments of the Harrisburg region in Pennsylvania which show the Hamburg Klippe to contain a far greater range of exotic Early and Middle Ordovician material than previously recognized. Graptolites are being worked on together with **Henry Williams**, while **John Repetski** is looking at the conodonts. Preliminary results have been summarized in a recently produced field guide (see "References"). A number of early Arenig ash beds found in association with conodont-bearing limestones have been sampled and are to be studied by **Warren Huff**.

YNGVE GRAHN (Sweden) has worked mainly with Silurian and Devonian stratigraphy over the last two years. Together with **Jaak Nolvak** he is also studying the effects of asteroid impacts on Ordovician faunas and sedimentology.

NAIMA HAMOUMI (Morocco) is currently continuing her studies on the Ordovician of Morocco and Upper Ordovician of the Crozon Peninsula. She is also working in collaboration with **J.M. Piçarra** and **T. Oliveira** on the Upper Ordovician of Santa Justa.

THOMAS HEUSE (Germany) is continuing biostratigraphic work on Ordovician palynomorphs (acritarchs and chitinozoans) in the East Cordillera of southern Bolivia and northern Argentina.

NORTON HILLER (New Zealand) reports that after several short term contracts, he is now permanently employed at the Canterbury Museum in Christchurch and is thus unlikely to do any further work on Ordovician rocks, He wishes the Subcommission all best wishes for its future deliberations and will have to satisfy his interest in matters Ordovician in the future by reading published papers by the membership.

LINDA HINTS (Estonia) is continuing her studies on the Upper Ordovician sequences and brachiopod faunas of the East Baltic. Some manuscripts (in cooperation with **Dimitri Kaljo, Pat Brenchley** and **Jaak Nolvak**) have been presented for

publication. Last year her research was focused on the boundary beds between two topmost Ordovician, Pirgu and Porkuni, stages. The gaps at this level and faunal differentiation complicate the correlation of sequences. Isotopic study of sediments from North Estonia yield useful additional information which will be analysed together with data on facies and fauna. Some new data on the topmost Ordovician sequences from Estonia and Poland were presented at the Third Baltic Stratigraphical Conference (reports with Brenchley, Bednarczyk and others; abstracts and some descriptions of outcrops visited during the excursion in Meidla, T. , *et al.* (eds), 1996).

OLLE HINTS (Estonia) is currently working on the taxonomy, distribution and palaeoecology of Ashgill scolecodonts from Estonia. He also continues his research of Caradoc material from the same region. Together with **Tarmo Kiipli** he is involved in the study of Caradoc K- bentonites, particularly with respect to microfaunas.

OLE HOEL (Norway) completed his Masters Degree in November 1996 and is now waiting for a scholarship towards a Dr.- degree study. The Masters thesis (Lowermost Arenig trilobites from the Oslo Region) is in the process of being prepared as an article for the *Norsk Geologisk Tidsskrift*, where it will hopefully be published in the not too distant future. The thesis described 23 trilobite species (three of them new) from limestones in the normally graptolitic Tøyen Formation. The trilobites belong to the *Megistaspis planilimbata* Zone (=3D, *Tetragraptus approximatus* Zone,=3D, *Paroistodus proteus* Zone) of Norway, and shows that the fauna is much poorer in species than in coeval beds in Sweden.

STEVEN HOLLAND (USA) is finishing a study with **Mark Patzkowsky** on the sequence stratigraphy and brachiopod biofacies of the entire exposed Middle and Upper Ordovician of the Nashville Dome of central Tennessee. They are beginning similar studies on the post-Knox through Moccasin/Eggleston interval of southwestern Virginia and extreme northeastern Tennessee.

LARS HOLMER (Sweden) and **Leonid Popov** are working now on the Cambrian and Early Ordovician brachiopods of south Kazakhstan and Kirgizia (jointly with **Svetlana Koneva**), and on the Lower Ordovician stratigraphy and brachiopods of the East Baltic (together with **Eva Egerquis**). They are also planning to complete a study of the Arenig and Llanvirn biostratigraphy and brachiopods of Chu-Ili Range and Sarytum which will be carried out in cooperation with **Robert Neuman** and **Olga Nikitina**.

JAROSLAV KRAFT (Czech Republic), as a head coordinator of the project "Bohemian Ordovician as a stratigraphical standard for the Mediterranean Area" (duration 1994-1996), has completed the final field studies and data collecting for the final report. This research will be the basis for presentations, including excursions, at the 8th ISOS in Prague. In cooperation with **Petr Kraft** he has also continued a systematic study of

Bohemian Lower Ordovician graptolites and stratigraphy.

PETR KRAFT (Czech Republic) participated in the project "Bohemian Ordovician as a stratigraphical standard for Mediterranean Area" with responsibility for Arenigian-Dobrotivian stages. In cooperation with **Jaroslav Kraft** he has continued a systematic study of Bohemian Lower Ordovician graptolites, stratigraphy and some problematic fossils.

ED LANDING's (US) current projects include: 1) Establishing a precise, sequence- and conodont-trilobite based correlation of Lower Ordovician carbonates from central into eastern New York; 2) Reevaluating late Tremadoc graptolites from the Levis Formation in Quebec with **Jörg Maletz**. A report with **Bowring, Fortey, Westrop** and **Davidek** in the *Canadian Journal of Earth Sciences* establishes a 484 +/- 1 Ma U-Pb age on a bentonite in the upper Tremadoc of Cape Breton Island and suggests a much younger age for the Tremadoc-Arenig boundary. A report almost completed with these authors plus **Adrian Rushton** and **Jonathan Adrain** on an uppermost Cambrian ash in North Wales supports a 490 Ma or significantly younger age for the Cambrian- Ordovician boundary.

OLIVER LEHNERT (Germany) continues work on the biostratigraphy and paleobiogeography of Cambrian and Ordovician conodonts from western Argentina (Precordillera, "Bloque de San Rafael"/Mendoza Province and Famatina Range). He is also investigating Cambro-Ordovician conodont faunas from the Pogonip Group in the Southern Great Basin. Within the dolomitic successions in this region, conodonts are the only useful tool to correlate different units in terms of zonal biostratigraphy and to test the sequence stratigraphic framework worked out by his friends **John Cooper** and **Martin Keller**.

ALFRED LENZ (Canada) reports that the M.Sc. thesis by **Eugene MacDonald** on early and middle Llandovery radiolarians of the Cape Phillips Formation, Cornwallis Island, Arctic Islands, and the Ph.D. thesis by **Mark Obermajer** on thermal maturity of Ordovician to Devonian rocks of southern Ontario, are now completed.

DARREL LONG (Canada) is currently working on carbonate/siliciclastic mixing models in the Paleozoic of the Hudson Platform, at first in the SW (Moose River Basin), then in the west as far north as Churchill. The abundance of new drilling (for kimberlite pipes) in the past few years means that it should be possible to make some major advances in the understanding of this basin.

JÖRG MALETZ (Germany) has started work on Silurian graptolites from Dalarne in addition to his Ordovician graptolite studies. A longer paper on the Llanvirn graptolites of Norway will be out this year.

TIM MCCORMICK (UK) is now working on a 3-year postdoc with **Richard Fortey** sponsored by the Leverhulme Trust.

TONU MEIDLA (Estonia) is continuing work on the Ordovician ostracodes and stratigraphy of Baltoscandia (in cooperation with **Linda Hints** and **Jaak Nolvak**). Other fields of interest are Ordovician sea-level changes, biodiversity and the late Ordovician event.

MICHAEL MELCHIN (Canada) is working mainly on graptolites (especially late Ashgill and early Silurian) from Arctic and eastern Canada. His research is focusing on morphology, systematics, biostratigraphy, autecology (especially hydrodynamics), biodiversity and extinction patterns, and new study methods such as infrared video microscopy.

MICHAL MERGL (Czech Republic) continues his study of phosphatic-shelled brachiopods from the Bohemian Lower Ordovician; two papers (about *Thysanotos* and a new lingulate genus) are in print. Extensive field work during the summer of 1996 made it possible to improve knowledge of Bohemian trilobites within the critical late Tremadoc-Hunneberg interval (Mílina Formation), as this trilobite fauna shows Gondwanan as well as Baltic affinity. Over the next three years, Michal will direct his brachiopod work mainly towards Siluro-Devonian lingulates.

JÜRI NEMLIHER (Estonia) is back working actively on trilobites of Lower Ordovician age from the Baltic basin. This year he plans to finish his M.Sc. thesis on cheiruaceans of Billingen Stage.

JAAK NOLVAK (Estonia) continues work on Ordovician chitinozoans and biostratigraphy from the East Baltic, together with colleagues **Linda Hints, Olle Hints** and **Tonu Meidla** and in cooperation with **Yngve Grahn** and **Florentin Paris** on chitinozoan dating of some Ordovician events.

ASTA ORASPOLD (Estonia) is participating in the project on early Paleozoic geoevents in the Baltic Basin (project leader **Dimitri Kaljo**). Since the 1970's she has been studying the Upper Ordovician sequences in the East Baltic. Last year her work was concentrated on the composition and distribution of a distinct lithostratigraphical unit (mainly dolomites and dolomitic limestones) on the Pirgu-Porkuni boundary (=roughly the Rawtheyan-Hirnantian boundary beds).

MATTHEW PARKES (Ireland) is getting back to Ordovician biostratigraphical projects throughout Ireland, in South Mayo and Tramore; also the revised Ordovician correlation chart with **David Harper**, SE Ireland trilobites with **Alan Owen**, and at Portrane/Lambay Island amongst others.

IAN PERCIVAL (Australia) continues to pick conodont-dominated residues from central New South Wales. The highlight of the past year has been the recognition of a new carbonate succession of late Middle Ordovician age on the northern Molong High. A co-operative project involving **Barry Webby** (stromatoporoids and corals), **Yongyi Zhen** (conodonts), and **John Pickett** (sponges and receptaculitids) is exploring this richly fossiliferous limestone, with Ian describing the brachiopods and gastropods. Other current Ordovician studies involve systematics of Late Ordovician lingulid and acrotretid brachiopods with colleagues from Macquarie University.

TERESA PODHALANSKA (Poland) is continuing her work on the stratigraphy and sedimentology of the Ordovician in the Polish part of the Baltic Basin. New investigations on Late Ordovician and Early Silurian graptolite biostratigraphy in Poland are also being carried out.

SUSANNE POHLER (Germany) is still working with **Nikolay Sennikov** on Tremadoc sediments and biostratigraphy in the Altai Mountains, southern Siberia.

LEONID POPOV (Russia) has started a study in cooperation with **Igor Nikitin** of a diverse brachiopod fauna from the Late Ordovician carbonate mud mounds of north-central Kazakhstan. Their study of the Middle Ordovician (Llandeilo-Caradoc) brachiopods and biostratigraphy of south Kazakhstan is also in progress.

BRIAN PRATT (Canada) continues his activities on Early Ordovician trilobites from the Mackenzie Mountains, Early Ordovician corals (Lichenaria) from western Newfoundland, and Ordovician reefs.

IVAR PUURA (Estonia) finished his doctoral thesis on "Lingulate brachiopods and biostratigraphy of the Cambrian-Ordovician boundary beds in Baltoscandia" in November, 1996 at the Department of Historical Geology and Palaeontology, Uppsala University (supervised by **John Peel** and **Lars Holmer**). Current research in Estonia is focusing mostly on Cambrian-Ordovician biostratigraphy and biodiversity, and aspects of taphonomy, in particular, comparative mineralogy of Recent and fossil apatite skeletons (with **Jüri Nemliher**). Ivar would appreciate further contacts and co-operation in the field of biogenic apatite studies.

RONG JIA-YU (China) has been studying: 1) Synecology and biogeography of Ordovican and Silurian brachiopods of China; this work will be finished in early 1998; 2) Biotic recovery from the Late Ordovician mass extinction based on data from South China (with a global comparison). This work started two years ago and will be completed in 1998; 3) Comparison of biotic recovery from three mass extinctions (late Ordovician, late Devonian and late Permian) based on the data from South China (searching for common and different characters for each recovery).

RUBE ROSS (US) reports that the Ibexian stratotype *Professional Paper* by **Ross, Hintze, Ethington, Taylor, Repetski** and **Sprinkle** is at the stage of negotiating printing costs, along with companion papers by **Walt Sweet** and **Pete Sheehan**.

ADRIAN RUSHTON (UK) retired from the British Geological Survey in January 1997, but hopes to find the energy to pursue some of those unfinished and long-neglected projects that tend to be the legacy of any Survey palaeontologist. These projects may include work on Ordovician graptolites as well as Cambrian trilobites and stratigraphy, and will be from a base at the Natural History Museum in London.

TERESA SANCHEZ (Argentina) is continuing her studies on taxonomy and biogeography of Ordovician pelecypods from Argentina and Bolivia. Currently investigations are focused on a new and highly diversified Caradoc fauna from the Argentine Precordillera. In collaboration with **Beatriz Waisfeld**, she is analysing the nature of the Ordovician radiations, extintion events and faunal recoveries in Gondwana.

NORMAN SAVAGE (US) still has an interest in things Ordovician, particularly brachiopods, conodonts, and biostratigraphy. He is, however, currently working on Devonian conodonts in Alaska and Russia, plus some additional work on his contribution to the rhynchonellid part of the brachiopod Treatise.

NIKOLAI SENNIKOV (Russia) is presently studying the biostratigraphy of the volcanic-jasper-terrigeneous formations (conodonts, radiolarians, sponges) of the Upper Cambrian - Lower Ordovician of the Gorny Altay (South Siberia).

THOMAS SERVAIS (Belgium) is currently working as an Alexander von Humboldt-Foundation Research Fellow at the Technische Universität Berlin in **Bernd Erdtmann**'s department. While a publication on Upper Ordovician graptolites of Belgium is in press (with **Jörg Maletz**), new investigations concern the Silurian graptolites of the Brabant Massif (in collaboration with **David Loydell, Mark Williams** and **Jan Zalasiewicz**). Several acritarch studies include a comparison of the British "*trifidum* flora" at the Tremadoc-Arenig boundary with German material (with **Stewart Molyneux**), the investigation of assemblages from Pomerania (NW-Poland, in collaboration with **Wieslaw Bednarcyk**) and the revision of selected Ordovician acritarch taxa (with **Rainer Brocke** and **Olda Fatka**).

XU SHAOCHUN (Canada) has begun a postdoctoral fellowship at the University of Manitoba. Research is on latest Ordovician corals of south China.

LAWRENCE SHERWIN (Australia) is working on Ordovician volcanic sequences extending from Lancefieldian to Bolindian as a part of regional mapping of the Forbes 1:250 000 geological sheet. His work on the (mostly unfossiliferous) Ordovician rocks of the Narromine 1:250 000 have been published at last.

PAUL SMITH (UK) reports that work continues on Greenland stratigraphy, conodont palaeontology and basin development in collaboration with **Maxine Huselbee** and **Jan Audun Rasmussen**. Research on Ordovician fish faunas with **Ivan Sansom** and **Moya Smith** continues to uncover new taxa from the Harding Sandstone of Colorado and its equivalents and new evidence points to a vertebrate affinity for *Anatolepis*, now known from a large number of peri-Laurentian localities.

JIM SPRINKLE (US) and **Tom Guensburg** received a medium-sized grant in December from the CRDF (Civilian Research and Development Foundation) to work with Paleozoic echinoderms at the Russian Paleontological Institute in Moscow on a joint project comparing Early and Middle Ordovician echinoderm faunas from the western U.S. and Baltic Russia. This will result in an exchange of visits in 1997 by the two of them and **Sergei Rozhnov** to look at collections and field areas and joint work on some aspects of the faunal composition and occurrence of these radiating echinoderms. They published a joint abstract on new reef occurrences of cyathocystid edrioasteroids for GSA last October. Jim and Tom are now trying to complete joint papers on new Early Ordovician camerate crinoids and rhombiferans from the Fillmore and Wah Wah formations in the Great Basin. In Texas, **Colin Sumrall** finished his Ph.D. dissertation in April, 1996, proposing a new phylogeny of fossil echinoderms using a number of new Cambrian and Ordovician occurrences. Parts of this dissertation are now in press, and Colin is teaching this spring at Tulane University.

JIM STITT (US) continues to work on projects involving lower Ordovician trilobites and biostratigraphy.

HUBERT SZANIAWSKI (Poland) notes that it may be of interest for *Ordovician News* readers to know that during the Sixth European Conodont Symposium ECOS VI, held in Poland from June 30 to July 6, 1996, several talks on Ordovician conodonts and conodont biostratigraphy were given. A field guide and abstracts were published and are still available from the Institute of Paleobiology of the Polish Academy of Sciences. A proceedings volume is under preparation and will be published as a special issue of *Palaeontologia Polonica.*

JOHN TAYLOR (US) continues work on Lower Ordovician (Ibexian) trilobite faunas from the central Appalachians (Pennsylvania, Maryland, and Virginia) and a few areas in western North America (Bliss Sandstone in New Mexico, Manitou Limestone in Colorado, and Goodwin? Limestone in Nevada).

MICHAEL TAYLOR (US) reports that since retiring from the USGS in October 1995, he has acquired a home in Springer, New Mexico and completed construction of a

private paleontological laboratory, where among other projects, he will continue to work on Upper Cambrian and Lower Ordovician trilobites. His immediate attention is directed to a project dealing with *Symphysurina* and related trilobites from the Ibex area, western Utah. In addition, he is assembling material for a biographical article on Frank Springer, namesake of his newly adopted town. Paleontologists will recognize Frank for his turn of the century work on crinoids; lawyers will recognized him for his precedent-setting Land Rights work before the U.S. Supreme Court; and horse fanciers will recognize him for work at his CS Ranch, New Mexico, on development of the American Quarter Horse. Any information readers may offer about Frank Springer would be greatly appreciated.

SIMON TULL's (UK) main area of interest these days is the petroleum geology of the former Soviet Union. In particular, he is looking at the Timan-Pechora Basin, where source rocks include Ordovician mudrocks. Ordovician carbonates are (generally minor) reservoirs in the NE of the basin. This year, he is starting a project on the geological evolution of Central Asia, from the Cambrian to present. The area includes the whole of the southern republics of the former Soviet Union from the Caspian Sea to Tarim and Junggar in NW China.

BEATRIZ WAISFELD (Argentina) continues to work on Ordovician trilobite-dominated associations from northwestern Argentina and Famatina Ranges. Main research fields include trilobite taxonomy, paleoecology and paleobiogeography, as well as the Ordovician radiations.

WANG XIAOFENG (China) is continuing work with **Chen Xiaohong** on the Ordovician graptolites and chitinozoans, sequence stratigraphy and palaebiogeography in South China. The Ordovician stratigraphical lexicon of China in Chinese and English editions with **Chen Xu, Chen Xiaohong** and **Zhu Ciying** and a guidebook on geology of the Yangtze Gorges areas for the 30th IGC in Beijing with **Bernd-D. Erdtmann** and **Mao Xiaodong** were published in 1996, as well as four joint papers concerning *Psigraptus*, chitinozoans and sea level change. Two new projects dealing with zooclast reflectances and the *Nemagraptus gracilis* Zone at the Longmendong section, Shanxi Province are planned for 1997.

HENRY WILLIAMS (Canada) is preparing the first batch of paleontological data recovered during hydrocarbon exploration in western Newfoundland for publication, together with **Elliott Burden, Felicity O'Brien, Grace Parsons** and **Helen Gillespie**. Palynological work on the Green Point section, summarized as a report to the C.O.B. Working Group, is also being put together; this study revealed, among others, that scolecodonts range down into the late Cambrian (previous first occurrence was documented as latest Tremadoc). Other ongoing projects include graptolites from the Hamburg Klippe of Pennsylvania (with **Bob Ganis**) and dating of "Hirnantia Fauna" brachiopods from northern England (with **Dave Harper**).

MARK WILLIAMS (UK) has recently succeeded Adrian Rushton as the Lower Palaeozoic palaeontologist at the British Geological Survey. Before joining BGS last year, he had studied Ordovician ostracodes and Cambrian arthropods but is now working intensively with Ordovician and Silurian graptolites.

BRIAN WITZKE (US) reports that various Midcontinent Ordovician projects are plodding along. His editing job (along with **Ludvigson** and **Day**) of the "Paleozoic Sequence Stratigraphy" volume is now over, with the publication of *GSA Special Paper* 306. Several articles in the volume will be of interest to Ordovician researchers.

ELLIS YOCHELSON (US) has signed a contract with Kent State University (Ohio) to publish his biography of Charles Doolittle Walcott. This covers birth (1850) to the time he left the US Geological Survey (1907) for the Smithsonian. Although Walcott is best known for his efforts on Cambrian trilobites, at about age 10 he was collecting from the Utica Shale. He spent five years at Trenton Falls and (outside of Wales) one cannot get more Ordovician than that! The biography is scheduled for the spring, 1998 list. More details should be available by late fall. Check the history of geology website at *http://geolclio0.stusm.edu* or with Ellis in November at *yochelson.ellis@simnh.si.edu*. Ellis has also submitted a paper on the rise of the Ordovician and the decline of the Lower Silurian in the United States, which covers the period from about 1885-1902.

EUGENY YOLKIN (Russia) is working on several projects, including: the Silurian and Devonian event-stratigraphy of the Altai-Sayan Folded Area (**Yolkin, Sennikov, Bakharev, Klets** and **Yazikov**); subsurface Paleozoic of the Western Siberian Plain (the same team); and a new project on an information-research database complex "BIOCHRON" (with support from the Russian Foundation for the Basic Researches for the team, which includes **Sennikov** (leader, graptolites), **Yolkin** (curator on paleontology, conodonts), **Betekhtina** (non-marine bivalves), **Gratsianova, Klets** and **Yazikov** (brachiopods), **Izokh** and **Moskalenko** (conodonts), **Yolkina** (curator on computer programming), **Kipriyanova, Semyonova** and **Shemyakina** (programming).

GRAHAM YOUNG (Canada) is examining Late Ordovician and Silurian colonial corals, with a focus on faunas from the Red River and Stony Mountain formations of Manitoba. Work in press and submitted deals with variation and functional morphology. Ongoing collaborative studies with **Bob Elias** are on diversity an distribution of latest Ordovician to earliest Silurian coral faunas.

YUAN-DONG ZHANG (China) has finished his study with Alf Lenz on Silurian and Devonian graptolites and biostratigraphy, and returned to Nanjing. There he will continue his studies on Ordovician graptolites, especially those from the Darriwilian and Gisbornian intervals in China.

ZHAN REN-BIN (China) has been studying in the British Natural History Museum with **Robin Cocks** since December 1996. He will work there for one year and complete his Ph.D thesis on Late Ordovician brachiopods and their synecology in the Zhejiang-Jiangxi border region, East China. He will also study the Foliomena Fauna from the early to late Caradoc rocks in South and North China; he will cooperate with Robin Cocks in the Museum for most time while in London and also with **Dave Harper** while in Galway, Ireland for several weeks. He is also involved with the following projects: 1) Synecology and biogeography of Ordovican and Silurian brachiopods of China; 2) Biotic recovery from the Late Ordovician mass extinction based on the data from South China (with a global comparison).

ZHANG YUAN-DONG (China) reports that following completion of cooperative work with **Alf Lenz** on Silurian graptolites from SW China, he will recommence his studies on Ordovician graptolites and biostratigraphy. Yuan-dong's main interest is now on quantitative biostratigraphy of the Ordovician graptolitic strata in South China and an application has been made to NSF for funding. Yuan-dong is also working on the Arenig-Caradoc graptolites from SE China, and the Late Silurian-Early Devonian graptolites from Yunnan, SW China.

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