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INTERRAD

International Association of Radiolarian Paleontologists

A Research Group of the International Paleontological Association

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INTERRAD is an international non-profit organization for researchers interested in all aspects of radiolarian taxonomy, palaeobiology, morphology, biostratigraphy, biology, ecology and paleoecology. INTERRAD is a Research Group of the International Paleontological Association (IPA). Since 1978 members of INTERRAD meet every three years to present papers and exchange ideas and materials.

INTERRAD MEMBERSHIP: The international Association of Radiolarian Paleontologists is open to any one interested on receipt of subscription. The actual fee is US $ 15 per year. Membership queries and subscription are sent to the Treasurer. Changes of address can be sent to the Secretary.

BIBLIOGRAPHIES: The bibliographies are produced by the Secretary. Any suggestion, reprints of articles and details of omission should be sent to him directly. Please send reprints of any radiolarian article to the Secretary this facilitate the edition of forthcoming bibliographies.

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VOLUME 22 **AUGUST 2004**

Editor: *Giuseppe Cortese*

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EDITORS' NOTE

Giuseppe Cortese

Welcome to a thick issue of Radiolaria (the main reason being: you are all in here... at least in the address list) ! Even if September 2003 already seems such a long time ago, I still want, on behalf of all radiolarian workers, to thank Peter Baumgartner and colleagues for the successful InterRad meeting they organized in Lausanne. With Chris Hollis new President of InterRad, we are now heading towards the first InterRad meeting taking place in the Southern Hemisphere.

Thanks are also due to those who provided abstracts and references to their publications, to the working group chairwomen/chairmen for their reports, and to all those who took his/her time to submit additional material to this issue.

A special tribute goes to Jonathan Aitchison, former Secretary of Interrad and Editor of quite a number of Radiolaria newsletters, for the solid service he granted to our community, and for all the help he provided during the preparation of the present issue. It is my pleasure to pick up the slack and ensure the distribution of our newsletter.

PRESIDENT'S LETTER

Chris Hollis

Dear InterRad colleagues,

You will see in this newsletter the first circular for InterRad XI to be held in Wellington, New Zealand, in March 2006.

There are three main deviations from the plans proposed at InterRad X in Lausanne. Firstly, we are combining with IGCP 467 and STS for part of the conference and two of the excursions. Those involved with IGCP 467 or "Circum-Panthalassa Triassic Faunas and Sequences" and the Subcommission of Triassic Stratigraphy were to hold a meeting in

New Zealand in 2005 but they have been talked into delaying a year so that those of you with an interest in the Triassic have double the reason to attend this meeting. My colleague Hamish Campbell was convening this Triassic meeting and so joins me as joint convenor of the InterRad XI conference and Triassic symposium. For those of you with little or no interest in the Triassic, rest assured that the full range of other radiolarian interests will be catered for in the programme.

Secondly, the conference will not be in an isolated retreat but instead is in downtown Wellington surrounded by shops, cafes, theatres, bars and clubs. In fact, it is in Wellington's premiere conference venue, *Te Papa Tongarewa*, the National Museum of New Zealand. It is going to be a challenge to keep you focused on radiolarians, but we aim to carefully manage the programme and accommodation options to foster the community spirit that is at the heart of InterRad. We've settled on Te Papa for two reasons: (1) we get most of the venue facilities for free under a sponsorship arrangement with my institute, and (2) it is hoped that the high profile location will attract a wider range of sponsors.

Thirdly, registration fees are probably going to be the highest you have ever paid to attend an InterRad conference, especially if you are American. Sponsorship deals have yet to be finalised but a hard look at the figures and comparison with similar conferences held locally indicates that we need to set a registration fee of $NZ450, which currently is €225 or $US250. If registrations exceed our conservative target, this fee will give us more flexibility in the range of discounts for students and other needy cases, or buy better quality beer.

So, there you go. Haere mai, haere mai, please come to Wellington for this meeting.

On another topic, I've just had quite a pleasant experience of having seven of my not that flash radiolarian photos selected for poster size reproduction in a science meets art exhibition of 40 photos that is touring New Zealand. It's amazing what passes as art these days. See: http://www.gns.cri.nz/news/release/art.html

INTERRAD XI, FIRST CIRCULAR

Chris Hollis

INTERRAD XI: RADIOLARIANS IN STRATIGRAPHY & PALEOCEANOGRAPHY

11th Meeting of the International Association of Radiolarian Paleontologists

&

CIRCUM-PACIFIC TRIASSIC STRATIGRAPHY & CORRELATION

A symposium hosted by IGCP 467 and STS

Wellington, New Zealand, March 2006

~ First Circular ~

This joint conference will be held at *Te Papa Tongarewa*, Museum of New Zealand, in Wellington, March 19-24. The conference is sponsored by InterRad, IGCP Project 467 (Triassic Time and Trans-Panthalassa Correlations), the Subcommission on Triassic Stratigraphy (STS) and the Institute of Geological and Nuclear Sciences (GNS).

Organising committee

Chris Hollis and Hamish Campbell (convenors), Janet Simes (organiser), Yoshiaki Aita, Jack Grant-Mackie, Rie Hori, Vanessa Lüer, Barry O'Connor, John Simes, Bernhard Spörli, Percy Strong and Atsushi Takemura.

Schedule

March 13-19: Pre-conference excursion 1. Northland and Auckland to Wellington via west coast Triassic localities (1A) or via central North Island volcanic and geothermal areas (1B)

March 19: Conference registration and ice-breaker

March 20-21, 23-24: Conference symposia and general sessions

March 22: Mid-conference Excursion 2. Wellington south coast

March 24-29: Post-conference Excursions 3, 4 and 5. Marlborough-Canterbury, Canterbury-Southland, Nelson

Registration

Discounted registration fees (prior to 30 September 2005) will be approximately $NZ450 (€225, $US250) for professionals and $NZ250 (€125, $US150) for students, retired/unwaged and accompanying persons.

Funding

Some funding for travel and conference expenses is available through InterRad, IGCP and other sponsors. If your attendance at the conference will depend on partial or complete funding, please contact convenors as soon as possible.

Provisional symposia

The conference will be arranged as a series of symposia, which will begin with plenary talks. Each day will finish with a general talk open to the wider scientific community. Suggestions for additions or changes to symposia are welcome and should be emailed to the convenors.

A. Triassic stratigraphy and biogeography

A1. Triassic catastrophes: P/T, T/J and intra-Triassic boundary events

A2. Paleobiogeography and terrane analysis

A3. Trans-Panthalassan correlation and radiolarian evolution

B. Paleontological and stratigraphic methods and results

B1. Quantitative stratigraphic methods (BIOGRAPH, CONOP, GRAPHCOR, etc.)

B2. Quantitative paleoecological analysis

B3. Advances in processing and examining microfossil samples

C. Correlation and interpretation of Cretaceous-Cenozoic biosiliceous facies

C1. Biostratigraphy of deep-water facies

C2. Paleoenvironmental interpretation of biosiliceous facies

D. Biological indicators of ocean productivity

D1. Climate and ocean productivity interactions in the modern ocean

D2. Interrelations between Quaternary climate cycles and ocean productivity

D3. Plankton response to aberrant climate events in a greenhouse world

E. Plankton biology and phylogenetics

E1. Phylogenetic methods

E2. Advances in plankton classification

E3. Advances in plankton ecology

Accommodation

Accommodation will be in a central Wellington hotel, five minute's walk from the conference venue. The hotel offers a wide range of reasonably-priced single, twin, double and family rooms as well as budget bunkrooms. Prices (including breakfast) will range from about $US60 to $US20 per night. It also has cooking, laundry and internet facilities, a restaurant and a large bar.

EXCURSIONS

<u>Pre-conference Excursion 1</u>: Northland, March 13-16 (4 days). Return flights: Kerikeri-Auckland. Permian-Triassic oceanic association of basalt, limestone, chert, and argillite (Waipapa Terrane), including fusuline/coral-, conodont- and radiolarian bearing lithologies and Arrow Rocks Permian-Triassic boundary succession. Late Cretaceous-Paleocene oceanic association of basalt and radiolarian bearing-limestone and chert (Tangihua Volcanics). Late Cretaceous-Oligocene allochthonous oceanic succession, including radiolarian-bearing organic shale and siliceous mudstone (Whangai and Waipawa Formations) and micritic limestone (Mahurangi Limestone); the latter formation containing exceptionally well-preserved Oligocene radiolarians. Leaders: Atsushi Takemura, Yoshiaki Aita and Bernhard Spörli. Indicative cost $NZ1000 (€500, $US600)

<u>Pre-conference Excursion 1A</u>: Auckland-Taupo-Wellington (North Island), March 17-19 (3 days). Minivans: Auckland-Wellington. Triassic-Jurassic oceanic association of pillow basalt, chert and argillite, Kawakawa Bay, followed by scenic tour through central North Island, overnighting in the Taupo. Maori cultural experience, thermal pools, geysers, and calc-alkaline volcanoes in central North Island volcanic area. Leaders: Chris Hollis and Yoshiaki Aita. Indicative cost $NZ600 (€300, $US360).

Pre-conference Excursion 1B: Auckland-Waitomo-Wellington, March 17-19 (3 days). Minivans: Auckland-Wellington. Triassic-Jurassic oceanic association of pillow basalt, chert and argillite, Kawakawa Bay, followed by a western North Island excursion to examine late Triassic-earliest Jurassic volcaniclastic sections in Marakopa and Awakino areas (Murihiku Terrane). Visits to a native bird park and Waitomo Caves may be included. Leaders: Hamish Campbell, Rie Hori and Jack Grant-Mackie. Indicative cost $NZ600 (€300, $US360).

Mid-conference Excursion 2: Wellington south coast, March 22. Late Triassic accretionary wedge and associated oceanic sediments (Torlesse Rakaia Terrane) exposed along the Cook Strait coast. Leader: Hamish Campbell. Indicative cost $NZ100 (€50, $US60).

Post-conference Excursion 3: Marlborough-south Canterbury (South Island), March 24-28. Ferry: Wellington to Picton, minivans Picton-Oamaru-Christchurch. Late Cretaceous-middle Eocene hemipelagic-pelagic succession of siliceous mudstone, chert, limestone and marl (Whangai, Mead Hill and Amuri Limestone Formations), including the only global records of radiolarian faunal turnover from Late Cretaceous to Eocene with intact Cretaceous-Tertiary and Paleocene-Eocene boundary intervals. Whale-watching, seal-colonies, radiolarian-bearing Mead Hill Formation in Kaikoura. Radiolarian-rich late Eocene diatomite, pillow basalts and penguins of Oamaru. Leader: Chris Hollis. 5 days. Indicative cost $NZ1000 (€500, $US600).

Post-conference Excursion 4: Southland (South Island), March 23-28. Return flights: Wellington-Dunedin. Early-Late Triassic neritic sequence in Southland Syncline along Otago coast (Kaka Point to Nugget Point) and inland in the Hokonui, Taringatura and Wairaki Hills (Murihiku Terrane). Leader: Hamish Campbell. 4 days. Indicative cost $NZ1200 (€600, $US720).

Post-conference Excursion 5: Nelson (South Island). Return flights: Wellington-Nelson, boat travel to D'Urville Island. Poorly fossiliferous Early Triassic Maitai Group exposed in river sections near Nelson city and on D'Urville Island. Leader: Yoshiaki Aita. 4 days. Indicative cost $NZ1200 (€600, $US720).

CONTACT DETAILS

Symposia, themes, funding and excursions

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Institute of GEOLOGICAL & NUCLEAR SCIENCES Limited

Registration and accommodation

Janet Simes (conference organiser), janet.simes@conferences.co.nz

Web site

This circular and conference updates will be posted at:

http://www.gns.cri.nz/interrad

MESOZOIC WORKING GROUP

Luis O'Dogherty

News from the Lower Jurassic Working Group

Leader: Spela Gorican

Participants: Anna Chiara Bartolini, Beth Carter, Patrick De Wever, Paulian Dumitrica, Jean Guex, Rie Hori, Luis O'Dogherty, Atsushi Matsuoka and Patricia Whalen

After two meetings at Ljubljana (August 2001 and September 2002), the Pliensbachian-Aalenian Radiolarian Catalogue advances well ! The catalogue is currently composed by 324 taxa. During this summer, the participants are checking the taxonomy and completing the new species (or species in open nomenclature).

The time table is as follows:

Spela will be in Oregon with Beth during next September for editing the final version. In October the participants will receive the new version by e-mail for final corrections. The catalogue will be published by ZRC SAZU in Ljubljana. The policy to find money for printing in Slovenia requires that the manuscript (as a MS, not camera ready) is submitted to the Ministry of Science by December 1st. Technical editing is then provided by ZRC Publishing House for free. If we succeed to finish the MS in time and to get money, we can have the catalogue published by June 2005.

News from the Middle Jurassic-Lower Cretaceous Catalogue

Leader: Peter O. Baumgartner

As you well know, during the last InterRad Meeting a proposal was presented for the revision of the catalogue, as well as the Jurassic-Cretaceous Radiolarian zonations. We are working now on the addition of the Mid-Cretaceous genera and species together with numerous mid Jurassic species. Our intention is to have the update in digital support for inclusion in the InterRad X volume (Swiss Journal of Geosciences, old Eclogae), which will be published in winter 2005. For this reason, I will be in Lausanne next year during six months to help in the edition of this new version on CD-ROM.

Cheers,

Luis O'Dogherty

RECENT AND CENOZOIC WORKING GROUP

Annika Sanfilippo

As the majority of participants are engaged in Late Cretaceous-Paleogene, Quaternary or living radiolarian research there has been no specific working group project during the past year or need for meetings for either group. References with abstracts to the published papers resulting from this active group are compiled in the Bibliography herein. The published papers cover a wide range of subjects: observations of living radiolarians and their host-symbiont associations, radiolarians under the seasonally sea-ice covered conditions in the Okhotsk Sea, radiolarian flux and implications for paleoceanography, the presence of radiolarians in surface sediments in the Arctic Ocean, marginal seas, and northeastern East China Sea, biostratigraphic work on Early to Middle Miocene sediments in the Indian Ocean, magnetobiostratigraphic chronology and environmental history on Cenozoic sequences from Prydz Bay, Antarctica, a first record of a brackish radiolarian and an in depth study on the skeletal structure of *Prunopyle antarctica* Dreyer in sediment samples from the Antarctic.

The **Combined Late Cretaceous-early Paleogene, Cenozoic and Recent Working Group workshop, Lausanne, 2003,** covered a wide spectrum of interest as can be seen from the list of attendees below.

Attendees and interest

1. Bjørklund, Kjell. Quaternary radiolarians, Boreal.
2. Caulet, Jean-Pierre. On line generic database, RadSearch
3. Cortese, Giuseppe. Quaternary radiolarians, paleoceanography, paleoclimate, Southern Ocean; Messinian, Mediterranean Sea, Boreal.
4. Dahsimi, Salim. Paleogene radiolarians, Demerara Rise (ODP 207)
5. Danelian, Taniel. Late Cretaceous-Paleogene radiolarians, Demerara Rise (ODP 207)
6. Diserens, Marc-Olivier. Late Cretaceous radiolarians, low-latitude biostratigraphy (BIOGRAPH)
7. Dolven, Jane. Radiolaria.org; Holocene radiolarians, Boreal.

8. Hollis, Chris. Recent, Quaternary, Paleogene and Late Cretaceous radiolarians, SW Pacific and Pacific sector of Southern Ocean; global records of P-E transition; paleoceanography, paleoclimate, paleoproductivity, biostratigraphy (CONOP)
9. Itaki, Takuya. Quaternary and living radiolarians, paleoceanography, Japan Sea, Okhotsk Sea, NW Pacific, Arctic Ocean
10. Kruglikova, Svetlana. Taxonomy and biogeography of Arctic-boreal radiolarians
11. Jackett, Sarah-Jane. Paleogene radiolarians, low-latitude biostratigraphy (BIOGRAPH)
12. Jacot des Combes, Helene. Quaternary radiolarians, paleoenvironment
13. Lueer, Vanessa. Quaternary radiolarians, SW Pacific; paleoclimate, paleoproductivity
14. Matsuoka, Atsushi. Living radiolarians
15. Nigrini, Catherine. Comprehensive taxonomic database, RadWorld; low-latitude Eocene-Oligocene radiolarians.
16. Nishimura, Akiko. Paleocene-Eocene (North Atlantic, Southern Indian Ocean) and Recent radiolarians (Antarctic Ocean).
17. Ogane, Kaoru. Spongodiscid taxonomy
18. Teitler, Lora. Paleoceanography, paleoclimate
19. Whalen, Patricia. Antarctic radiolarians, Prydz Bay, Kerguelen Plateau

Summary of discussion

Workshop participants agreed to combine working groups in order to address themes of common interest, primarily the application of radiolarian distribution patterns in studies of past climate or past environmental change. It was agreed that the first step was to develop a consistent taxonomy through use of the web-based databases: RadWorld for genera and *Radiolaria.org* for species. *Radiolaria.org* also provides the facility for recording (paleo)biogeographic data for specified time slices.

RADWORLD UPDATE

Catherine Nigrini, Jean Pierre Caulet and Annika Sanfilippo

Installments of genera, taken from the relational database RadWorld, continue to grow on the web site of the Museum National d'Histoire Naturelle, Paris:

http://www.mnhn.fr/mnhn/geo/radworld/radworldsite/radsearch.html

The web site now includes the descriptions of about 700 genera, their type species (most with an illustration) and their subsequent emendations. We continue to concentrate on Mesozoic and Paleozoic and are nearing completion of that phase of the work. However, many Cenozoic genera are also included at this time.

RadWorld continues to grow and currently contains references to the original descriptions and type species of 2527 genera and the original descriptions of almost 7000 species of Radiolaria. We think that we have included almost all described genera and about 90% of all published papers. There are, of course, many more species that have been described in the literature. All taxonomic information prior to 1860 has been entered. Taxonomic data is partially complete up to 1930. However, all type species described both before and after 1930 have been entered. Complete references to 4700 papers pertaining to Radiolaria can also be found in the database.

As previously noted, we continue to translate much of the German, Russian and Italian literature into English. We would welcome any translations you may have made. In addition, we have scanned and cleaned a great deal of the older literature, including Haeckel, 1887. We hope to be able to make the electronic version of Haeckel 1887 available to the radiolarian community in the near future. We would welcome electronic copies of genera and/or species you have described. This would decrease our workload enormously and advance the building of the entire database.

RADIOLARIA.ORG UPDATE

Jane Dolven

Information is continuously added to *Radiolaria.org* – presently it contains 182 recent species within the areas of the Arctic Ocean, the Gulf of California, the Nordic Seas, the South Pacific and the Southern Ocean. Substantial contributions have been made by Richard Benson (species info) and Kjell Bjørklund (pictures). Completion of information for the Gulf of California and Nordic Seas is scheduled before the end of 2004.

The Archive section now includes scanned plates from approximately 30 taxonomic publications ranging from Cleve 1899 to van de Paverd 1995. Valuable help with the scanning has been given by David Lazarus, Ed Amon and Kjell Bjørklund.

RadRefs (an extensive computerized radiolarian reference library compiled by Sanfilippo, Nigrini, Caulet and Renz) has been added with the authors' permissions to the existing reference database in *radiolaria.org*. The RadRefs database will be an invaluable tool for species synonymies and bibliographic references.

The "radiolarian art" section has been extended to include (in addition to Eva Bjerke's radiolarian clay models) images from a radiolarian quilt made by the Canadian artist Barbara West.

Radpeople contains at present the contact information of 67 radiolarian researchers from all around the world. This page is password-protected. If you would like to get access to Radpeople, or contribute with species information, plates or MysteryRads, please contact Jane Dolven <jane@radiolaria.org>.

THE 300 SPECIMENS PROBLEM

Giuseppe Cortese

A discussion about this theme took place during October/November 2003 with some colleagues (Taniel Danelian, Chris Hollis, Annika Sanfilippo). It was then proposed that a wrap-up of the discussion would be of interest to the whole community, and could appear as a short note on this newsletter issue. Many thanks go to Demetrio Boltovskoy, David Lazarus, and Joe Morley for having revised and improved an earlier draft.

Background

Let's face it: even counting radiolarians may become boring. Particularly if, in order to get a statistically significant value for the abundance of a certain species, you need to count over 2000-3000 total specimens.

The rock/sediment samples we observe under our microscopes (even if possibly containing beautifully preserved radiolarians) are just that: a *sample* of a real population. It makes therefore sense to ask ourselves the question of how representative of the relative abundance of a certain species in a „real population" is what we determine as its abundance by counting a radiolarian slide/sample. Put it nicely, the question is: How many specimens one needs to count to get a representative distribution of a species' relative abundance?

Radiolarists were not the first to ask themselves these sort of questions.... Petrographers did already face the problem while counting mineral grains, and came up with the first solution to the problem (van der Plas and Tobi, 1965). In this paper, the authors defined the quite successful concept of „300 specimens ought to be enough for everybody".

Question & Answer

The baseline question was:

Is counting 300 specimens enough to provide statistical significance to the relative abundance estimate of the taxa encountered during a census/population study?

The problem of the number of specimens to count in order to estimate species proportions is a variation of the more general approach to the estimate of abundances, present in many contexts, with biological/paleontological studies being of particular interest to us.

Several works (see also reference list) deal with this general problem (Venrick, 1978; Frontier, 1981).

In answering the above mentioned question, one should not forget the error estimate attached to the abundance estimate. The former will be smaller, the higher the number of counted specimens. Fatela and Taborda (2002) put forward an example on this, and conclude that, by counting 100 specimens, a species having a „real“ abundance of 10% can be determined as 10% ± 3% (therefore anywhere between 7 and 13%), while by counting 300 specimens, the same species having a „real“ abundance of 10% becomes determined as 10% ± 1% (therefore between 9 and 11%).

As the adequacy of a method can only be judged against the question it is supposed to answer, it is the aim of our study which determines which estimate is useful or significant. In general, investigations of taxonomic diversity are the most affected by these problems, and should make an effort towards maximizing the number of counted specimens (in order to be able to document as many as possible, ideally all, taxa present, and therefore give a reliable estimate of the different diversity indices). Studies on the relative importance of taxa in a set of samples are also strongly affected, particularly so for those taxa which are less abundant than a few percent.

The baseline answer is:

The statistical significance of a species' relative abundance estimate depends directly (and strongly...) on the relative abundance of the species. The presence or absence in a sample of species having abundances higher than 3% are already determined at a 95% confidence level by counting only 100 specimens per sample (Fatela and Taborda, 2002).

While using a 95% confidence level is generally a desirable level of accuracy for replicate measurements (e.g. an engineer testing how well produced a steel bar of standard length is), it is, in my opinion, overly rigorous for micropaleontological studies and their attached problems, which are often more limited by other sources of error.

These include the practical feasibility of a study (i.e. the amount of time one wants/can afford to spend counting a sample), self-consistency through time in taxonomic identification, difference in taxonomic skills between experts, and non-uniformities in the sampling and sample preparation methods (Moore, 1973).

Due to these major limitations and to the „less strict“ statistical constraints they imply, it can sometimes be that a 90%, or even an 85%, confidence level is adequate, and meaningful counts can be obtained using a ca. one order of magnitude lower total number of specimens than formally requested (i.e. a few hundreds, instead of a few thousands specimens).

Example:

If we want to determine, with a 95% confidence level, the presence or absence of a 2% "real abundance" species, we will need to count at least a couple of thousands specimens (Patterson and Fishbein, 1989). On the other hand, we should be more than happy to determine the same 2% "real abundance species" only at the 80-85% confidence level, and count only a couple of hundred specimens (say 300-400) in order to do so.

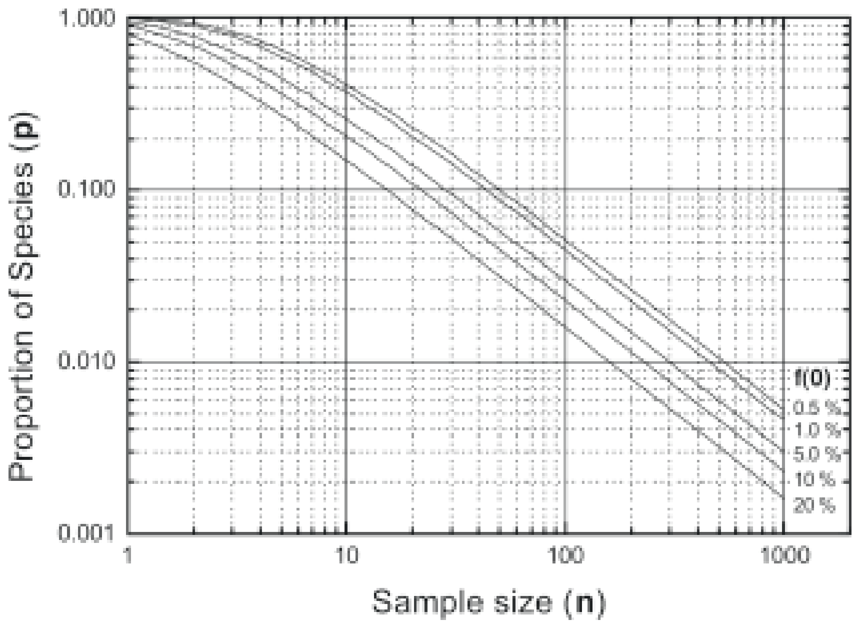

Figure legend: Counts (n), from a random sample, needed to detect a species occurring with a proportion (p) in the assemblage, and the probability of failure to detect its presence (f(0)). From Fatela and Taborda (2002). The null hypothesis being tested here is the presence or absence of a species in a sample, so a less hard task than estimating the true abundance to a specific relative error level.

The almost „esoteric" significance of the number „300" for paleontologists carrying out quantitative studies has, of course, a statistically-based explanation... In fact, if we routinely count ca. 300 specimens per sample, chances are quite meager (less than 1 time out of 100, see figure above) that we will miss (i.e. not count/find) a species whose "real abundance" is higher than 1.5%. Incidentally, this could be a good reason why people working with Principal Component („Factor") Analysis usually adopt either 1 or 2% as the lower screening level for relative abundances of species. In fact, species which are less abundant than 1.5% at any sample in a reference (coretop) dataset are actually not sufficiently determined (by counting a total of ca. 300 specimens per sample), and are therefore excluded from further analysis.

One way to improve the signal to noise ratio is to count 300 known specimens (which will bring the total number of counted specimens in the „400 or more" range). Another useful recommendation is to reach the same final number of specimens counted (say 300 or 400) in several (at least three) subsamples (slides, traverses, etc), counting 50, 80 or 100 in each, rather than in just one. Not only is the final error lower in this case, but one also gets an estimate of the error involved because it is possible to derive a variance value for the counts.

A trick and its howevers

One way to improve the statistics of counts is to carry out logarithmic estimates of species abundances. This method and its variations (e.g. the constant numerator technique), explained in detail in (Zachariasse et al., 1978), rely on an estimation of how many specimens are present in a given number of fields of view (or slide transverses/picking tray squares), and how many fields of view one needs to scan to count a given number of specimens belonging to a rare taxon. In this way, actual counts are multiplied by a factor, ending up with a total number of counted/estimated specimens of at least a few thousands.

The positive aspect of this method is the possibility to determine the abundance of very rare taxa, without requiring exhaustive counting. Its inherent flaw, though, is hidden in its assumptions, i.e. that the specimens are uniformly spread on the slide/tray. This is a very rough approximation, and the error induced by irregularly-spread microfossils (e.g. close to the slide edges, not accurate enough splitter, or not adequate slide-mounting method) may cause a serious mis-estimation of the average amount of specimens per unit area, which will in turn provide a wrong estimate of the total amount of specimens. Actually, in a report supposed to test different aspects of microfossil countings (Zachariasse et al., 1978), one of the most striking results was that, both for the foraminifera and nannofossil study included in that report, the assumption that the specimens were randomly distributed was demonstrated to be utterly wrong. This means that we end up in the paradoxical position of being able to determine quite reliably the relative abundance of a very rare species (by counting it), but we lose control on how many total specimens we presumably counted (as we estimate the total abundance by extrapolation of average density values) in order to do so.

We have basically moved the problem from being able to reliably determine the abundance of a rare species, to being able to accurately determine the density of the whole assemblage on a slide/tray. The main enemy here is the non-uniform distribution of the residue on the slide/tray. There have been of course improvements to the sample non-uniformity problem, and to the actual accuracy of splitters, following the introduction of the random settling techniques (Moore, 1973; Granlund, 1984), but other factors, mostly linked to the taxonomic bias, still limit the reliability of counting statistics .... These include the personal bias during the countings, and the constancy through time of a taxonomic concept (both for the same, and for different authors). In this respect, a nice (if pessimistic) conclusion to this discussion would be the statement at the end of IGCP Project n. 1 preface (Zachariasse et al., 1978):

„Another interesting result is that the theoretical maximum objectivity in species determination in terms of Linnean nomenclature, based on the subjectivity of a single investigator, is a less constant factor than expected, especially with increasing periods of time between successive counts. The disappointing results in comparing species determinations by different specialists may contain avoidable exaggeration, but these results do show that errors caused by subjective appreciation of the observations may widely overshadow the effects of all statistical errors and sampling irregularities. For a detailed quantitative analysis of fossil assemblages, the combination of the data from different observers seems to be a senseless effort“.

This subjectivity problem is nicely illustrated (Brolsma, 1978) in another chapter from the same report: four specialists reached considerably different results in terms of species and genera identifications when requested to identify the same 200 specimens. While this is an extreme example, partly biased by the very different background and expertise of the specialists participating in the exercise, it points to a real problem (taxonomic „synchronization“), which might overshadow any statistical error connected to the counting technique itself. It is not by accident that the closest results in Broelsma's experiments were obtained by two specialists from the same „school“ (i.e., with a relatively common taxonomic background). Therefore, just as mass spectrometers from different laboratories need to be intercalibrated in order to produce comparable isotopic results, at least within the measurement error, so technicians and faunal-counts producers can be „calibrated“ in order to achieve reproducible results. However, some species do have a wide range of morphological variability, and the general lumper/splitter attitude of the person carrying out the countings will affect the final result. A chronic optimist (like me) could therefore still be able to turn the above statement (from Zachariasse et al., 1978) into an appeal in favour of a more standard taxonomy (and therefore the necessity of funds, students and interest in taxonomy which is, erroneously, considered as a „low priority“ field).

Want to find out more?

A wide scale effort to evaluate and describe many counting techniques and associated problems (and quite an interesting reading if counting microfossils is your favourite pastime) is Zachariasse et al. (1978). Suggested further reading and/or cited literature:

Brolsma, M.J., 1978. Benthic Foraminifera. In: Zachariasse, W.J. et al. (Editors), Micropaleontological counting methods and techniques - An exercise on an eight metres section of the Lower Pliocene of Capo Rossello, Sicily. I.G.C.P. Project n. 1. Utrecht Micropaleontological Bullettins, 17: 47-80.

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RADIOLARISTS' ADDRESS LIST

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As proposed by several people at last InterRad, here is a first attempt at a semi-comprehensive list of radiolarists' (and their close relatives') addresses. Your feedback is requested in order to improve this list, complete it, and keep it actual: please send me a short note if you want to complete your entry, or whenever you change address. The complete list will be updated yearly, in coincidence with the publication of the Radiolaria newsletter.

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RADIOLARIAN BIBLIOGRAPHY 2002-2004

Giuseppe Cortese

The following list includes 109 references, mostly covering the 2002-2004 period. The featured papers had the word radiolarian either in the title, in the abstract, or in the keywords. This list does not include abstracts (at least as far as deduced from the given reference), but only publications (and their abstracts). Thanks to all of those who sent their references. If you notice papers which were published after the year 2000, and which are missing in this, as well as in the lists published on previous issues of the "Radiolaria newsletter", please inform me, and they will appear in next issue.

AFANASIEVA, M. S. & AMON, E. O. 2003. A new classification of the Radiolaria. *Paleontological Journal* **37** (6), 630-645.

New classification of higher radiolarian taxa is proposed. The phylum Radiolaria includes two superclasses, i.e., Pheodaria and Polycystina. The superclass Polycystina is composed of the following five classes: Sphaerellaria Haeckel, 1881; Spurnellaria Ehrenberg, 1875; Stauraxonaria Afanasieva, 2000; Aculearia Afanasieva, 1999, status nov.; and Nassellaria Ehrenberg, 1847. The class Aculearia combines three orders, i.e., Fasciculata ordo nov., Triangulata ordo nov., and Albaillellata Deflandre, 1953, emend. Afanasieva, 1999. The class Spumellaria consists of four orders, i.e., Collodariata Haeckel, 1881; Echidninata Kozur, Mostler et Repetski, 1996; Cancelliata ordo nov., and Spongiata ordo nov. A special attention was paid to the systems and evolution of spinaceous and spongy Paleozoic radiolarians.

AMON, E. O., AFANASIEVA, M. S., BOGDANOV, N. A., et al. 2002. A.I. Zhamoida and the establishment of radiolarian research in Russian paleontology. *Paleontologicheskii Zhurnal* (1), 118-119.

BARASH, M. S., KAZARINA, G. K., KRUGLIKOVA, S. B., et al. 2003. On the Neogene paleogeography of the North Yamato Rise (Sea of Japan) from biostratigraphic and seismostratigraphic data. *Oceanology* **43** (4), 542-550.

Results of a complex micropaleontological research of the samples obtained from a test area on the North Yamato Rise are presented. Radiolarians, diatoms, and palynocomplexes were examined. Neogene deposits from the beginning of the Middle Miocene to the end of the Late Miocene were identified. Coastal, shelf, and slope deposits were recognized with respect to the sediment composition. The existing conceptions about the gradual subsidence of the Yamato Rise under the sea level were refined. The positions of the coastline 14-13 and 6-5 My BP were localized. The results of continuous seismic profiling, namely, detailed maps of the acoustic basement topography and the overall thickness of the unconsolidated sedimentary cover, were also developed. Paleogeographic schematics were compiled for the beginning of the Middle Miocene, one of the initial stages of the subsidence of the rise under the sea level, and for end of the Late Miocene, when the rise was almost completely flooded. In the schematics, positions of the reconstructed coastlines and islands are shown together with their heights and hypothetical depth contours. At the end of the Miocene-beginning of the Pliocene, here, islands still existed and phosphorites were formed over a wide shelf.

BECCARO, P., BAUMGARTNER, P. O. & MARTIRE, L. 2002. Radiolarian biostratigraphy of the Fonzaso Formation, Middle-Upper Jurassic, Southern Alps, Italy. *Micropaleontology* **48** (Supplement 1), 43-60.

The studied section of the Fonzaso Formation is located in the Feltrine Alps, Dolomiti Bellunesi (Southern Alps, Italy). Paleogeographically the Feltrine Alps represents a Middle Jurassic slope that connected the Trento Plateau with the adjacent Belluno Trough, on the passive continental margin of the Southern Alps. The Fonzaso Formation is about 100m thick and consists of partially pelagic Middle to Upper Jurassic siliceous limestone and platform-derived calcareous turbidites also occur, particularly in the middle portion of the formation. Two units of red nodular limestone (Rosso Ammonitico Inferiore and Rosso Ammonitico Superiore: R.A.I. and R.A.S., respectively) bracket the Fonzaso Formation. Previously, the formation has been broadly dated on the ages of the under- and over-lying formations; we date it directly for the first time using radiolarian biochronology. The Fonzaso Formation contains a highly diverse and well-preserved radiolarian assemblage which allows for detailed biostratigraphic analysis. The formation ranges from UAZ 6 (middle Bathonian) to UAZ 10 (late Oxfordian-early Kimmeridgian), even though conclusive evidence for UAZ zones 6 and 9 was not found. A sharp facies change and the possible absence of at least the middle part of the Bathonian suggest a hiatus at the R.A.I.-Fonzaso Formation boundary. The transition between the Fonzaso Formation and the overlying R.A.S. appears to be gradational and continuous.

BERNOULLI, D., MANATSCHAL, G., DESMURS, L. & MUENTENER, O. 2003. Where did Gustav Steinmann see the trinity? Back to the roots of an Alpine ophiolite concept. *Special Paper Geological Society of America* **373**, 93-110.

In 1905, Gustav Steinmann noted the close association of serpentinites, diabase and radiolarite and considered this "greenstone" or ophiolitic association as characteristic for the axial part of the "geosyncline" and the deep ocean floor. Although Steinmann considered diabase, spilite and "variolite" as intrusive rocks distinctly younger than the associated sediments, he stressed their association with deep-sea sediments, notably radiolarian cherts and pelagic limestones. In his view, the "consanguineous" association of ultramafic and mafic material was typical for suboceanic environments from where these magmas had ascended during folding of the oceanic sediments. Eventually, the importance of Steinmann's discovery was recognized, and the association of serpentinites, pillow lavas and radiolarites became known as the Steinmann trinity and, finally, a synonym for ophiolitic associations in general. Ironically, it appears that Steinmann never saw a completely developed ophiolite like those in Oman or Troodos. In the type-area of the trinity, in the Penninic zone of the Alps where Steinmann worked, the Jurassic ophiolites are dominated by serpentinites, pillow lavas, and oceanic sediments, whereas gabbros appear to play a subordinate role and no relics of a sheeted dike complex are found. Instead, oceanic sediments, radiolarian cherts, and pelagic limestones stratigraphically overlie serpentinized mantle rocks of subcontinental origin that were exhumed along concave-downward detachment faults and exposed on the sea floor. The gabbros intruded the partially serpentinized peridotites at a shallow depth. Undeformed basaltic dikes cut across gabbros deformed at high temperatures, and pillow lavas directly overlie the exhumed peridotites and gabbros. Both types of mafic rocks are characterized by epsilon Nd values typical for an asthenospheric mid-ocean ridge-type source. They may be the products of a steady process, which combined extensional deformation with magma generation and emplacement, and appear to record the onset of sea floor spreading across an exhumed subcontinental mantle during the earliest phases of the development of a slow spreading ridge. This situation is conspicuously similar to that of the early Cretaceous ocean-continent transition along the west-Iberian passive margin where subcontinental mantle was exhumed to the sea floor prior to the onset of sea floor spreading.

BJØRKLUND, K. R. & KRUGLIKOVA, S. B. 2003. Polycystine radiolarians in surface sediments in the Arctic Ocean basins and marginal seas. *Marine Micropaleontology* **49** (3), 231-273.

The polycystine radiolarian faunas in the Arctic Ocean, including the adjacent Arctic seas, have been studied in more than 377 surface samples. The deep basins in the Arctic Ocean have revealed 31 polycystine radiolarian species (11 spumellarians and 20 nassellarians). The polycystine radiolarian fauna in the southern Norwegian Sea was introduced from the north Atlantic Ocean ca. 13 400 yr BP. The shallow low Arctic marginal sea sediments (Iceland, Barents, and Chukchi Seas) have a strong dominance of Cannobotryidae (79%, 77% and 74%, respectively), while the deep Arctic Ocean basins (Nansen, Amundsen, and Makarov Basins) have a dominance of Actinommidae (90%, 70%, and 75%, respectively). The arctic polycystine radiolarian faunas have a strong affinity with the Norwegian Sea fauna, which supplies the Arctic Ocean with faunal elements that can live, thrive and reproduce there. In the Chukchi Sea the Pacific faunal influence is obvious (41 species), but none of the Pacific species are found in any abundance in the Amerasian Basin. No radiolarian species was found to be endemic to the Arctic Ocean except for a morphotype of *Actinomma l. leptoderma*, with a round inner sphere. This species is a possible endemic candidate for the Arctic Ocean. Eight species are to be found in all of the central Arctic basins, and can therefore be referred to as circumpolar species: *Actinomma leptoderma leptoderma*, *A. l. leptoderma* (with round middle sphere), *A. l. longispina*, *A. boreale*, *Spongotrochus glacialis*, *Pseudodictyophimus platycephalus*, *Cycladophora davisiana*, and *Tholospyris* (?) *gephyristes*, while *Amphimelissa setosa* probably is the only true arctic radiolarian species.

BLOME, C. D. & SANFILIPPO, A. 2003. Special issue - INTERRAD IX - International Association of Radiolarian Paleontologists - Preface. *Marine Micropaleontology* **49** (3), 185-186.

BOLTOVSKOY, D., CORREA, N. & BOLTOVSKOY, A. 2003a. Marine zooplanktonic diversity: a view from the South Atlantic. *Oceanologica Acta* **25**, 271-278.

Approximately 7000 marine zooplanktonic species have been described so far for the World Ocean; in the South Atlantic the presence of 40% of these has been confirmed, and an additional 20-30% are expected to be recorded in the future. The overall number of described species is very low when compared with other communities, and yet it may not be too far from the final, complete inventory. Very ample geographic distributional ranges, compositional similarity between the major oceanic basins, and declining species description rates suggest that the undescribed fraction of marine zooplankton is nowhere as large as those suggested for the biosphere as a whole. It is anticipated that the highest proportions of new species will be among the groups associated with the sea-floor (meroplanktonic and benthopelagic forms). However, the fact that a high proportion of the marine zooplanktonic species has already been described does not imply that the corresponding taxonomic systems are adequate and that our understanding of this community is better than that of others where undiscovered species are still the overwhelming majority. For most marine zooplanktonic species we have extremely scarce biological and ecological information. Furthermore, the taxonomy of several quite speciose groups is in such a state of disarray that synonyms by far outnumber “good species”.

BOLTOVSKOY, D., KOGAN, M., ALDER, V. & MIANZAN, M. 2003b. First record of a brackish radiolarian (Polycystina): *Lophophaena rioplatensis* n. sp. in the Río de la Plata estuary. *Journal of Plankton Research* **25**, 1551-1559.

Vertically stratified bottle plankton samples collected in the Río de La Plata estuary (Atlantic coast of South America at 35 deg. S) and in coastal waters off Mar del Plata (38 deg. S) in December 1999 and November 2001 yielded up to 394 live cells per l of a single new nassellarian species: *Lophophaena rioplatensis* n. sp. (family Plagoniidae). In estuarine waters, the species was recorded at salinities as low as 15.4 p.s.u.; densities in excess of 100 cells per l were found at salinities ranging from 16.9 p.s.u. These extremely high concentrations (the highest ever reported in the literature), as well as the fact that >90% of the individuals recorded contain cytoplasm, indicate that these are self-sustaining populations which thrive in the estuary (and in nearshore coastal waters), probably due to plentiful dissolved silica and an abundant food supply. Lophophaena rioplatensis is the first polycystine brackish-water species described. This finding shows that radiolarian fossils are not unequivocally associated with open-ocean conditions, but may also be useful indicators of coastal and brackish estuarine paleoenvironments.

BORTOLOTTI, V., CARRAS, N., CHIARI, M., et al. 2003. The Argolis peninsula in the palaeogeographic and geodynamic frame of the Hellenides. *Ofioliti* **28** (2), 79-94.

Geological and biochronological studies on the Argolis Peninsula (Pelagonian - Subpelagonian Domain) -also based on petrological data on the ophiolitic rocks- allowed us to propose a new tectonic unit succession; from the bottom upwards: a- the Trapezona Unit (Early-Middle Triassic - Late Jurassic; Pelagonian continental margin); b- the Dhimaina Ophiolitic Unit (Middle Triassic-Late Jurassic/Early Cretaceous oceanic realm, covered by an Early Cretaceous-Eocene “Mesautochthon; c- the Iliokastron Mélange Unit (Middle-Late Jurassic - Early Cretaceous) in the northern Argolis and the Adheres Melange Unit (Cretaceous-Paleocene) in the southern Argolis; d- the Faniskos Unit (Late Jurassic-Eocene). Based on a close examination of the paleogeography of the continental margin successions and of their possible relationships with the ocean floor successions, we propose a model for the evolution of the oceanic and continental domains of this section of the Hellenides during the Triassic-Eocene interval, and we try to frame it into the evolution of the whole Dinaric-Hellenic orogenic system. This model hypothesises the opening, during Middle-Late Triassic time, of a single ocean in the Dinaric-Hellenic realm (the Vardar Ocean), which continues its spreading phase until the Middle Jurassic when, an intra-oceanic subduction zone, testified by the presence of IAT volcanites and boninitic rocks developed contemporaneously with MOR basalts. During the Late Jurassic obduction of the ophiolitic units onto the continental margin began. During the Early Cretaceous, the complete thrusting of the Dhimaina Ophiolitic Unit onto the Trapezona Unit occurred. During Eocene, and particularly after the Ypresian, the different units reached their present tectonic setting.

BRAGIN, N. Y. & KRYLOV, K. A. 2002. Horizons of carbonaceous rocks in Triassic and Lower Jurassic cherty deposits of the Dal’negorsk reference section (Primor’e). *Stratigraphy and Geological Correlation* **10** (5), 503-509.

Three horizons of phthanites and black carbonaceous mudstones are distinguished in the key section of Triassic and Jurassic cherty deposits of the Gorbusha Sequence near the Settlement of Dal’negorsk (Sikhote Alin). The first horizon on the lower part of the section is pre-Olenekian, probably Induan in age, related in origin to events of the Paleozoic-Mesozoic boundary time. The second horizon of local distribution is dated back to the early Anisian. Its deposition was likely associated with local events. The third horizon in the lower Toarcian beds can be interpreted, with a high probability, as a record of the early Toarcian anoxic event.

BRAGIN, N. Y., TEKIN, U. K. & OZCELIK, Y. 2002. Middle Jurassic radiolarians from the Akgol Formation, central Pontids, northern Turkey. *N. Jb. Geol. Palaont. Mh.* **10**, 609-628.

Well preserved radiolarians were obtained from red silicified mudstone layers in basalts from Akgol Formation east of Azdaway Town, Kastamonu region. The assemblage is represented by *Archaeodictyomitra* (?) *amabilis*, *A. shengi*, *Cingulo-turris carpatica*, *Amphipyndax durisaeptum*, *Triversus ulivii*, *Tethysetta dhimenaensis*, *Ristola altissima* s.l., *Podobursa typica*, *Hiscocapsa robusta*, *Praezhamoidellum convexum*, *Eucyrtidiel-lum nodosum*, *E. ptyctum*, *E. takemurai*, *Dictyomitrella* (?) *kamoensis*, *Stichocapsa naradaniensis*. The approximate age of this assemblage is late Bathonian to early Callovian. Three species were described as new: *Stichomitra* (?) *angulata* n. sp., *Turbocapsula jurassica* n. sp., *Gongylothorax ponticus* n. sp.

BRAGINA, L. G. 2003a. Late Cretaceous representa-tives of the superorder Phaeodaria (Radiolaria). *Pale-ontologicheskii Zhurnal* **37** (1), 8-10.

In Russia Late Cretaceous Phaeodaria have been discovered for the first time. Two new species, *Protocystis naibiensis* sp. nov. and *Challengeria* (?) *sakhalinica* sp. nov., are described.

BRAGINA, L. G. 2003b. Morphology of cephalic structures in Late Cretaceous radiolarians of the Order Nassellaria. *Paleontologicheskii Zhurnal* **37** (4), 9-15.

Eight morphological types of the initial chamber (cephalis) of Late Cretaceous radiolarians of the order Nassellaria are described; seven of them, i.e., *Perseus*, *Napora*, *Arcanicapsa*, *Cornutella*, *Theocoronium*, *Sciadiocapsa*, and *Squinabollum*, are established for the first time. These types are distinguished by the structure of the cephalic spicule (presence or absence of various spines, incorporation of elements into the cephalic wall, etc.) and the subdivision of the cephalis into upper and lower parts. These data allow one to introduce clarity into the taxonomic position of species of the Late Cretaceous Nassellaria.

BRAGINA, L. G. 2003c. New radiolarian species from the upper Cretaceous Naiba reference section (Southern Sakhalin). *Paleontologicheskii Zhurnal* **37** (3), 244-251.

A new study of the Late Cretaceous radiolarian assemblages of southern Sakhalin has revealed a large number of new taxa. The species *Cenosphaera robusta* sp. nov., Hexapyramis (?) *perforatum* sp. nov., *Patellula sakhalinica* sp. nov., *Spongodiscus sakhalinensis* sp. nov., *S. quasipersenex* sp. nov., *S. concentricus* sp. nov., *Spongurus cylindricus* sp. nov., *Stylodruppa ornata* sp. nov., and *Patulibracchium* (?) *quadroastrum* sp. nov. are described.

BRAUN, A. & CHEN, J. Y. 2003. Plankton from Early Cambrian black shale series on the Yangtze Platform, and its influences on lithologies. *Progress in Natural Science* **13** (10), 777-782.

Black shales, cherts, and associated lithologies in the Early Cambrian of the Yangtze Platform yielded abundant phyto-plankton, the earliest well preserved skeletons of zooplankton (radiolarians) and abundant phosphatic ovoid bodies, probably representing fecal pellets, produced by Mesozooplankton grazing on phytoplankton. The oceanic food chain in surface waters is therefore considered to be more complete than known up to now with respect to primary and secondary consumers in the Early Cambrian plankton ecosystem. On the basis of primary sedimentary compositions preserved in phosphorite concretions and chert layers it is shown that biosiliceous sedimentation mixed with organic substance played a significant role within the black shale sequence of the Hetang and Niutitang formations. The resulting lithology corresponds closely in character to the bituminous Alum-shale and Lydite-sequences of Lower Silurian (Llandoverian) age along northern Gondwana (e. g. Thuringia, Bohemia).

BRAUN, A., SPRECHMANN, P. & GAUCHER, C. 2003. Stratigraphic age of phosphorite-nodules from the San Gregorio formation of Uruguay. *Neues Jahrbuch für Geologie und Paläontologie-Monatshefte* (12), 739-748.

Radiolarian taxa (*Albaillella spinosa* CHENG 1986, multishelled and apophysate entactinids, advanced morphotypes of stauraxon radiolarians) indicate Late Carboniferous (Early to Middle Pennsylvanian) age of phosphorite concretions occurring in the San Gregorio Formation (ex Itarare Fm.) of Uruguay. Similar concretions are occurring in Africa (Namibia and South Africa) and possibly represent a flooding event, as well as in Kansas, USA indicating a polarward migration of equatorial faunas during the Upper Carboniferous.

CENTENO-GARCIA, E., OLVERA-CARRANZA, K., CORONA-ESQUIVEL, R., et al. 2003. Depositional environment and paleogeographic distribution of the Jurassic-Cretaceous arc in the western and northern Guerrero Terrane, Mexico. *Abstracts with Programs Geological Society of America* **35** (4), 76.

The Guerrero terrane of western Mexico contains large volumes of Upper Jurassic-Lower Cretaceous volcanic-sedimentary rocks of arc affinity. The basement of the arc is heterogeneous in composition, formed by previously accreted terranes. Detailed stratigraphic studies in the coastal (Arteaga-Zihuatanejo and Colima) and northern (Zacatecas-Guanajuato) areas indicate that the arc had a complex paleogeography. The stratigraphy of the Arteaga-Zihuatanejo area is made up of basaltic to andesitic lava flows with geochemical compositions similar to present island arcs. They show brecciated and pillowed textures that suggest submarine magmatism. They are interbedded with rudist reefal limestone, volcanic conglomerates (submarine lahars), and other epiclastics. Dinosaur footprints and redbeds indicate periods of subaerial exposure. The abundance of clasts derived from pre-Cretaceous units suggests that its basement was partially exposed during the arc activity. The succession in Arteaga-Zihuatanejo is Late Aptian to Lower Albian in age. The stratigraphy in Colima is Berriasian to Albian in age. It is made up of basaltic to rhyolitic submarine lava flows with arc chemical signatures, ignimbrites and epiclastics, interbedded at the top with thick successions of evaporites, reefal and restricted platform limestone, and some redbeds. The stratigraphy of the arc in Zacatecas-Guanajuato region is made up of basaltic pillowed flows with MORB-IAB and OIB geochemical signatures. They are interbedded with distal volcaniclastic turbidites, black shales, green and black chert that contains radiolarian, few volcanic conglomerates, tuffs and detrital limestone. These lithofacies suggest a deeper marine environment, where fissural basaltic lava flows were interbedded with sediments derived from the volcanic edifices of intermediate composition. Rapid changes in thickness (from up to 4,000 m in Colima to 800 m in Arteaga), differences in lithofacies, and the changes in the geochemical composition of the arc magmas suggest that the arc was under an extensional setting, with associated normal faults that exposed the basement. We interpret this to mean the axis of the arc volcanism was in the Arteaga-Zihuatanejo region. The Colima region might represent an intra-arc basin and the Zacatecas-Guanajuato area a deep marine back-arc basin.

CHANG, F., ZHUANG, L., LI, T., et al. 2003. Radiolarian fauna in surface sediments of the northeastern East China Sea. *Marine Micropaleontology* **48**, 169-204.

Radiolarian abundance and species composition have been determined in 72 surface sediment samples from the northeastern East China Sea. The results are compared with chemical and physical properties of the overlying water masses, and with sediment conditions. In the study area, radiolarian abundance and species number increase markedly from northwest to southeast, and their distributions can be divided into three provinces: the low-density zone corresponding to the shelf, the middle-density zone corresponding to the western slope of the Okinawa Trough and the high-density zone corresponding to the central part of the Okinawa Trough. The distribution of radiolarians correlates well with modern sea surface temperature and sea surface salinity, but shows a negative relation with nutrients and primary productivity of the overlying water. This distribution pattern is also strongly affected by the sediment type and terrigenous material input. Also, the Kuroshio Current has an important effect on controlling the distribution and species composition of radiolarian fauna in this area. Based on three Q-mode factors (accounting for 90.2% of the variance), three radiolarian assemblages have been distinguished, and their distributions are clearly correlated with oceanographic current patterns in the region. The mixed water assemblage dominated by *Tetrapyle circularis*, *Tetrapyle quadriloba* and *Ommatartus tetrathalamus tetrathalamus* is restricted to the area of the Mixed Water, but mainly influenced by the Shelf Water. The Kuroshio Water assemblage, which is dominated by *Lithelius minor*, *Dictyocoryne profunda*, *Stylodictya multispina*, *Acrosphaera spinosa*, *Dictyocoryne truncatum*, *Spongaster tetras*, *Stylodictya arachnia* and *Ommatartus tetrathalamus tetrathalamus*, is basically controlled by the Kuroshio Surface Water. And the transition assemblage dominated by *Tetrapyle quadriloba* and *Monozonium pachystylum* is associated with the Tsushima Warm Current Water. The boundaries among these assemblages approximately coincide with the oceanographic front. And the changes in the distribution of these assemblages could be regarded as not only modifications of the water masses, but also indicators of the possible movements of the oceanic front.

CHEN, M., WANG, R., YANG, L., et al. 2003. Development of East Asian summer monsoon environments in the late Miocene; radiolarian evidence from Site 1143 of ODP Leg 184. *Marine Geology* **201**, 169-177.

Abundant radiolarians are preserved in the relatively complete upper Miocene section of ODP Site 1143. Three radiolarian zones, RN6, RN7 and RN8, are recognized on the basis of *Diartus petterssoni* (total range in RN6, <11.9-8.77 Ma), *Diartus hughesi* (last appearance at RN7/RN8, 7.7 Ma) and *Stichocorys delmontensis* (RN6 to RN8, >6.7 Ma). Variations in the abundance of radiolarians, especially Pyloniid forms, radiolarian flux and species diversity are good proxies of upwelling which, similar to today's, was likely driven by summer monsoons. These radiolarian paleomonsoon proxies indicate that the east Asian summer monsoon first initiated close to the middle/late Miocene boundary at approximately 12-11 Ma and reached a maximum strength at approximately 8.24 Ma. Therefore, the initiation of the east Asian summer monsoon was likely earlier than the first Indian monsoon, which appeared approximately 8 myr ago.

CHIARI, M., BORTOLOTTI, V., MARCUCCI, M., et al. 2003. The middle Jurassic siliceous sedimentary cover at the top of the Vourinos ophiolite (Greece). *Ofioliti* **28** (2), 95-103.

The age of the Vourinos ophiolitic massif, pertaining to the Jurassic Tethys Ocean, is not yet exactly known. Four sections in the cherts at the top of the basalts yielded well preserved radiolarian assemblages according to which the age of the end of the "ophiolitic activity" (= the end of ocean spreading) was immediately before or within the latest Bajocian interval. A radiometric (Ar/Ar) age of the metamorphic sole at the base of the ophiolite gave 171+/-4 Ma (late Bajocian), this is, an age slightly older than that of the cherts: this can mean that the metamorphic soles pertain to an intraoceanic hot thrust, doubling the oceanic crust/lithosphere.

CORTESE, G., ABELMANN, A. & GERSONDE, R. 2004a. A glacial warm water anomaly in the subantarctic Atlantic Ocean, near the Agulhas Retroflection. *Earth and Planetary Science Letters* **222** (3-4), 767-778.

ODP Site 1089 is optimally located in order to monitor the occurrence of maxima in Agulhas heat and salt spillage from the Indian to the Atlantic Ocean. Radiolarian-based paleotemperature transfer functions allowed to reconstruct the climatic history for the last 450 kyr at this location. A warm sea surface temperature anomaly during Marine Isotope Stage 10 was recognized and traced to other oceanic records along the surface branch of the global thermohaline circulation system, and is particularly marked at locations where a strong interaction between oceanic and atmospheric overturning cells and fronts occurs. This anomaly is absent in the Vostok ice core deuterium, and in oceanic records from the Antarctic Zone. However, it is present in the deuterium excess record from the Vostok ice core, interpreted as reflecting the temperature at the moisture source site for the snow precipitated at Vostok Station. As atmospheric models predict a subtropical Indian source for such moisture, this provides the necessary teleconnection between East Antarctica and ODP Site 1089, as the subtropical Indian is also the source area of the Agulhas Current, the main climate agent at our study location. The presence of the MIS 10 anomaly in the $\delta^{13}C$ foraminiferal records from the same core supports its connection to oceanic mechanisms, linking stronger Agulhas spillover intensity to increased productivity in the study area. We suggest, in analogy to modern oceanographic observations, this to be a consequence of a shallow nutricline, induced by eddy mixing and baroclinic tide generation, which are in turn connected to the flow geometry, and intensity, of the Agulhas Current as it flows past the Agulhas Bank. We interpret the intensified inflow of Agulhas Current to the South Atlantic as responding to the switch between lower and higher amplitude in the insolation forcing in the Agulhas Current source area. This would result in higher SSTs in the Cape Basin during the glacial MIS 10, due to the release into the South Atlantic of the heat previously accumulating in the subtropical and equatorial Indian and Pacific Ocean. If our explanation for the MIS 10 anomaly in terms of an insolation variability switch is correct, we might expect that a future Agulhas SSST anomaly event will further delay the onset of next glacial age. In fact, the insolation forcing conditions for the Holocene (the current interglacial), are very similar to those present during MIS 11 (the interglacial preceding MIS 10), as both periods are characterized by a low insolation variability for the Agulhas Current source area. Natural climatic variability will force the Earth system in the same direction as the anthropogenic global warming trend, and will thus lead to even warmer than expected global temperatures in the near future.

CORTESE, G., GERSONDE, R., HILLENBRAND, C.-D. & KUHN, G. 2004b. Opal sedimentation shifts in the World Ocean over last 15 Myr. *Earth and Planetary Science Letters* **224** (3-4): 509-527.

Biogenic silica (opal) accumulation records were used to trace mechanisms, consequence and geographic pattern of shifts in the main locus of opal deposition of the World Ocean over last 15 Myr. Over this time interval, the main opal „sink" seems to have moved from the North Atlantic, to the Pacific, equatorial Pacific, eastern equatorial Pacific, eastern boundary current upwelling systems (California, Namibia, Peru), and finally to the Southern Ocean. The interplay between opal deposition and a series of climatic, tectonic, oceanographic and biologic events have been analysed and discussed.These events include: Cenozoic global cooling trend, intensified glaciation in Antarctica, Late Miocene-Early Pliocene biogenic bloom, development of Northern Hemisphere glaciation, closing of the Panama Seaway, transition of the climate system from a „greenhouse" to a „icehouse" world, Mid-Pleistocene Revolution, nutrient availability, evolution of diatoms and C4 plants, changes in continental weathering rates. While the observed shifts are mostly traceable to oceanic reorganizations and global climatic evolution, conditions favorable to opal deposition involve the above mentioned complex mix of processes. For this reason, the interpretation of opal deposition records might not always be straightforward. We however believe it can still provide clear indications of large-scale oceanographic reorganizations in the geological past.

DANELIAN, T. & MORREIRA, D. 2004. Palaeontological and molecular arguments for the origin of silica secreting marine organisms. *C.R. Pal.Evol.* **3**, 229-236.

The morphological resemblance of some primitive Early Palaeozoic Radiolaria with siliceous sponges has raised the intriguing question of their possible phylogenetic affinity. Here, we address this question through the analysis of available molecular evidence for a number of silica-secreting marine organisms. The obtained phylogenetic tree does not support the above hypothesis, but it suggests the monophyly of Acantharian and Polycystine Radiolaria. The record of the oldest known siliceous fossils provides a time calibration of the molecular dendrograms and allows to suggest likely ages for the origin of several non-fossilizable groups.

DANELIAN, T., TSIKOS, H., GARDIN, S., et al. 2004. Global and regional palaeoceanographic changes as recorded in the mid-Cretaceous (Aptian-Albian) sequence of the Ionian zone (northwestern Greece). *Journal of the Geological Society, London* **161**, 703-709.

Micropalaeontological and chemostratigraphic results from the mid-Cretaceous "upper siliceous zone" of the Ionian zone, studied in two localities of NW Greece (Paliambela and Panaya), provide new insights into the palaeoceanographic evolution of Tethys and better correlation with well-studied Italian successions. d13C carbonate and organic-carbon isotope stratigraphy allows an improved correlation of the early Aptian Fourcade Level with OAE1a. Calcareous nannofossils point to intervals of reduced sedimentation within the late Aptian part of the limestones overlying the Fourcade Level. Combined calcareous nannofossil, radiolarian and planktonic foraminiferal biostratigraphy suggests that the overlying radiolarites (named herein "Dercourt member") are essentially middle Albian in age. Radiolarites of this age and thickness have not been identified in the well-explored Italian sections or in southern Albania. It is therefore likely that the Dercourt radiolarites reflect a high productivity event localised in the Greek area of the Ionian zone, possibly due to a bathymetrically-induced upwelling of intermediate/deep waters which entered into the Ionian trough following the opening of new oceanic gateways in the Eastern Mediterranean Tethys.

DE PORTA, J. 2003. La formacion del istmo de Panama; su incidencia en Colombia. *Revista de la Academia Colombiana de Ciencias Exactas, Fisicas y Naturales* **27** (103), 191-216.

The first outlines of the Isthmus of Panama began in the middle Miocene. Its formation had impacts on paleography. The elevation of the Cordillera Oriental, which began between 12.9 and 11.8 million years ago, had its maximum intensity between 5 and 2.5 million years ago, causing changes in the hydrographic networks of the Amazon, Orinoco and Magdalena rivers. The record of a cold epoch in the Sabana de Bogota, dated at 2.7 million years ago, may correspond to a glacial stage of the upper Pliocene. The formation of the Itsthmus led to the great faunal exchange between North and South America. During the Pleistocene, along the Caribbean coasts of Colombia, a series of coral reefs, dated between 300,000 and 124,000 years, formed.

DE WEVER, P., O'DOGHERTY, L., CARIDROIT, M., et al. 2003. Diversity of radiolarian families through time. *Bulletin de la Societe Geologique de France* **174** (5), 453-469.

The examination of radiolarian biodiversity at the family level through Phanerozoic time reveals some general trends known in other groups of organisms, especially among plankton, while some other trends seem to be quite peculiar. The Permian/Triassic crisis that is one of the most important in the evolution of marine organisms, is marked in radiolarian assemblages by the extinction of two orders (Albaillellaria and Latentifistularia) towards the end of the Permian, and mostly by the tremendous diversification of Spumellaria and Nassellaria in the early-mid Triassic. Radiolarian diversity increased from Cambrian to Jurassic, remained quite stable during the Cretaceous and has decreased slightly since then.

DENNETT, M. R., CARON, D. A., MICHAELS, A. F., et al. 2002. Video plankton recorder reveals high abundances of colonial Radiolaria in surface waters of the central North Pacific. *Journal of Plankton Research* **24** (8), 797-805.

Colonial spumellarian Radiolaria are heterotrophic protists that form large (up to several meters in length), gelationous structures in the surface waters of all tropical and subtropical oceanic ecosystems. These species are morphologically and trophically complex and some, but not all, produce silica skeletal structures of considerable paleontological significance. Skeletonless species of Radiolaria are poorly sampled by plankton nets, which can severely damage these delicate organisms. Therefore, abundances of colonial Radiolaria typically have been underestimated in quantitative studies of zooplankton abundance and biomass. Here we document the abundances of colonial Radiolaria in the central North Pacific based on analysis of video images from a miniaturized video plankton recorder. We observed abundances of radiolarian cell in colonies that exceeded that exceeded previous reports of total Radiolaria by more than ten-fold, and counts of skeleton-bearing Radiolaria by more than two to three orders of magnitude. Biomass (carbon) within these colonies was similar to or greater than the total radiolarian biomass (i.e. including all solitary species) previously reported for the Pacific. Symbiont productivity within colonial Radiolaria was estimated to constitute a modest but significant fraction of total primary productivity (up to ≈9%)in the upper 150 m. These fundings indicate an important contribution of skeletonless spumellaria to food webs and biogeochemical cycles of these communities.

DUMITRICA, P. & ZUGEL, P. 2003. Lower Tithonian mono- and dicyrtid Nassellaria (Radiolaria) from the Solnhofen area (southern Germany). *Geodiversitas* **25** (1), 5-72.

A highly diverse association of monocyrtid and dicyrtid nassellarians is described from the lower Tithonian Muhlheim Member of the Solnhofen area. Nine genera and 52 species are described as new, and a new family is defined. Spicular nassellarians are first reported from the Jurassic, bridging the pre-existing long stratigraphic gap between the Middle Triassic and the Paleogene. The first occurrence of Sethoperidae Haeckel, 1881 is dated back from the Eocene to the Pliensbachian and the range of the Cuniculiformidae De Wever, 1982 is extended up to the Cenomanian by the inclusion in it of the genus *Cassideus* Pessagno, 1969, the definition of which is emended. The range of the family Foremanellinidae Dumitrica, 1982 is also extended up to the lower Tithonian where it is represented by the genus *Sanniopileus* n. gen. Among the new genera described herein it is interesting to mention *Poculinapora* n. gen., very close to *Napora* Pessagno, 1977 but bearing an apical tube. Beside the lower Tithonian species, one species is described from the Bajocian of Japan.

EGGER, H., FENNER, J., HEILMANN-CLAUSEN, C., et al. 2003. Paleoproductivity of the northwestern Tethyan margin (Anthering section, Austria) across the Paleocene-Eocene transition. *Special Paper Geological Society of America* **369**, 133-146.

Sediments in the expanded Anthering Section at the northwestern Tethyan margin were deposited in an abyssal environment, at the continental rise to the south of the European plate. The section contains deposits from calcareous nannoplankton Zones NP9 and NP10 and displays the global negative carbon isotope excursion (CIE) in the upper part of Zone NP9. Associated with the CIE is a strong three-fold increase in the rate of hemipelagic sedimentation. This suggests an increased input of siliciclastic suspended material into the basin, which is indicative of enhanced continental run-off at that stratigraphic level. Concurrent acmes of siliceous plankton and dinoflagellate cysts indicate that a high input of dissolved nutrients affected even open marine settings and caused eutrophication of surface waters. The associated high flux of organic carbon to the seafloor resulted in oxygen-depleted conditions and caused the total extinction of benthic faunas. However, impoverished foraminifera faunas indicate that a change of ecological conditions started shortly before the CIE.

ERBA, E., BARTOLINI, A. & LARSON, R. L. 2004. Valanginian Weissert oceanic anoxic event. *Geology* **32** (2), 149-152.

Biotic changes in nannofossils and radiolarians associated with the Valanginian $\delta^{13}C$ anomaly are documented at Ocean Drilling Program Hole 1149B in the Pacific Ocean: they are coeval and similar to those previously documented in the Tethys, suggesting a global perturbation of marine ecosystems. A marked increase in abundance of *Diazomatolithus*, absence of nannoconids, and a *Pantanellium* peak characterize the Valanginian $\delta^{13}C$ excursion. Such changes are interpreted as being due to global enhanced fertility and a biocalcification crisis under conditions of excess CO_2. The occurrence of organic C-rich black shales in the Southern Alps and in the Pacific in the interval corresponding to the $\delta^{13}C$ excursion suggests a Valanginian oceanic anoxic event (OAE). Volcanism of the Parana-Etendeka large igneous province (ca. 132 Ma) was presumably responsible for an increase of CO_2, triggering a climate change and accelerated hydrological cycling, possibly causing an indirect fertilization of the oceans. Widespread nutrification via introduction of biolimiting metals at spreading ridges could have significantly increased during the Gondwana breakup and simultaneous tectonic events in three separate oceans. There is no paleontological or $\delta^{18}O$ evidence of warming during the Valanginian OAE. On the contrary, both nannofossils and oxygen isotopes record a cooling event at the climax of the $\delta^{13}C$ excursion. Weathering of basalts and burial of organic C-rich black shales were presumably responsible for CO_2 drawdown and establishment of reversed greenhouse conditions.

FENG, Q. L., HELMCKE, D., CHONGLAKMANI, C., et al. 2004. Early Carboniferous radiolarians from north-west Thailand: Palaeogeographical implications. *Palaeontology* **47**, 377-393.

Moderately well-preserved radiolarian assemblages are described from bedded cherts south of Mae Hong Son, north-west Thailand. Twenty species and subspecies are identified, including one new species (*Archocyrtium sashidai* Feng sp. nov.). The assemblages belong to the middle Early Carboniferous *Albaillella indensis* and *Eostylodictya rota* zones. The new data suggest that there was a pelagic basin between the Shan-Thai terrane and Gondwana during the Early Carboniferous. This implies, contrary to previous interpretations, that the Shan-Thai terrane had already rifted apart from Gondwana during the Early Carboniferous.

FLORINDO, F., BOHATY, S. M., ERWIN, P. S., et al. 2003. Magnetobiostratigraphic chronology and palaeoenvironmental history of Cenozoic sequences from ODP sites 1165 and 1166, Prydz Bay, Antarctica. *Palaeogeography, Palaeoclimatology, Palaeoecology* **198**, 69-100.

A transect of three sites was drilled during Leg 188 of the Ocean Drilling Program (ODP), proximal to the East Antarctic Ice Sheet (EAIS) across the Prydz Bay continental shelf (Site 1166), slope (Site 1167), and rise (Site 1165). We present results of a palaeomagnetic and rock magnetic study of sediments recovered at sites 1165 and 1166. Magnetostratigraphic interpretations are presented for both holes and are mainly constrained by diatom and radiolarian biostratigraphies, interpreted in the light of recent refinements to Southern Ocean zonal schemes and datum calibrations for these microfossil groups. Site 1165 records a history of sedimentation on the continental rise extending back to earliest Miocene times (about 22 Ma). Several long-term changes characterise this record, including an overall trend of decreasing sedimentation rates from the bottom to the top of the hole. There is a progressive decrease in the sedimentation rate above about 308 mbsf (meters below sea floor), which is marked by a transition from dark-grey fissile claystones to greenish-grey diatom-bearing clays. At this transition, ice-rafted debris, sand grains, and total clay content also increase. The chronology presented here indicates a middle Miocene age (approximately 14.3 Ma) for the lithological transition. Correlation to ODP Hole 747A from the Kerguelen Plateau suggests that this lithological transition coincides with the base of the Mi-3/3a δ^{18}O event, which suggests palaeoclimatic control on middle Miocene sedimentation changes at Site 1165. Core recovery was poor at Site 1166. Consequently, the magnetostratigraphic data are of limited value. The deepest cores recovered at Site 1166 record brief intervals in the early history of the EAIS for the Prydz Bay region, extending back through the early stage of glaciation to pre-glacial times. An Early Cretaceous fluvio-lacustrine unit, lagoonal deposits and sandy fluvio-deltaic units of mid-late Eocene age contain a sporadic record of the transition from humid and mild conditions to cool temperate conditions.

GAWLICK, H. J. & FRISCH, W. 2003. The Middle to Late Jurassic carbonate clastic radiolaritic flysch sediments in the Northern Calcareous Alps: sedimentology, basin evolution, and tectonics - an overview. *Neues Jahrbuch für Geologie und Paläontologie-Abhandlungen* **230** (2-3), 163-213.

The sedimentation pattern in the Northern Calcareous Alps dramatically changed around the Bathonian/Callovian boundary. Significant sedimentation resumed with the deposition of radiolarian chert (Ruhpolding Radiolarite Group), which documents the change from condensed carbonates to almost purely siliceous sediments.From the Bathonian/Callovian boundary on, the sedimentary evolution in the southern part of the Northern Calcareous Alps (Lammer Basin with mass-flow deposits and large slides originated from the Hallstatt Zone) clearly differed from that in the northern part (later Trattberg Rise and Tauglboden Basin - Oxfordian to Early Tithonian). The main difference of Lammer and Tauglboden Basin is the earlier onset and different composition of huge mass-flows in the Lammer Basin, which suggests generation of a substantial local relief. Another type of radiolarite basins is formed in the Kimmeridgian in the southern Northern Calcareus Alps south of the Lammer Basin, called Sillenkopf Basin (Kimmeridgian to Tithonian). These different carbonate clastic radiolaritic flysch basins are formed in sequence due to the closure of the Tethys Ocean.The following Basins and Formations are defined: 1) Lammer Basin with Strubberg Formation; Callovian to Oxfordian; containing the Hallstatt Melange (mass-flow deposits and slides). 2) Tauglboden Basin with Tauglboden Formation; Oxfordian to Tithonian; containing mass-flow deposits and slides from a nearby topographic rise (Trattberg Rise). 3) Sillenkopf Basin with Sillenkopf Formation; Kimmeridgian to Tithonian; mass-flow deposits with mixed allochthonous origin.

GHAZI, A. M., PESSAGNO, E. A., HASSANIPAK, A. A., et al. 2003. Biostratigraphic zonation and ^{40}Ar- ^{39}Ar ages for the Neotethyan Khoy Ophiolite of NW Iran. *Palaeogeography, Palaeoclimatology, Palaeoecology* **193** (2), 311-323.

The Khoy ophiolite in northwestern Iran represents a piece of oceanic lithosphere formed in the Mesozoic Neotethys. This ophiolite consists from bottom to top of well-defined basal metamorphic rocks, peridotites, gabbros and a variety of upper to lower Cretaceous deep-marine rocks. These include pelagic fossiliferous carbonates and basalts as interlayers or exotic blocks. Four hornblende separates from gabbros and amphibolites give values from 108 to 111 Ma. The results from microfossil studies show the presence of late Cretaceous (e.g. *Marginotruncana*, *Globotruncana*) and middle to late Eocene (e.g. *Globorotalia*, *Orbulonoides*) planktonic foraminifera. The data suggest that although the initial rifting and crystallization of the oceanic crust of the Khoy ophiolite began in the late Albian, the volcanic activities continued through to the late Eocene time. Another possibility for such variation of lithofacies and biofacies and disturbances in the fossil record may be the result of bioturbation and transportation and rapid changes of depositional conditions during eruption of the basaltic lava flows. Pelagic sediments alone have been listed and of the foraminiferas the first three are planktonic, as would be expected. Only Orbulonoides is a benthic form and aberrant. The third possibility is that the Khoy ophiolite may represent a classic supra-subduction-type ophiolite where volcanic members of the different parts of oceanic environment (e.g. MORB, volcanic arc, ocean island) are now juxtaposed.

GORICAN, S., SMUC, A. & BAUMGARTNER, P. O. 2003. Toarcian Radiolaria from Mt. Mangart (Slovenian-Italian border) and their paleoecological implications. *Marine Micropaleontology* **49** (3), 275-301.

Diverse and well-preserved Toarcian radiolarians have been recovered from a succession of organic-rich shale with intercalations of siliceous limestone. The succession is located at the Slovenian-Italian border in the Julian Alps and was deposited on a subsided block pertaining to the south Tethyan passive continental margin. Twenty spumellarian and 17 nassellarian genera were found in total. Thirty-six taxa were identified to species level and one new species, *Bistarkum mangartense* n. sp., is described. The assemblages show a high predominance of spumellarians over nassellarians. Spongy spumellarians, especially *Orbiculiforma* ?, are markedly abundant. Pantanelliidae are generally rare but reach a pronounced peak of 13% in one stratigraphic level. Among nassellarians, *Parahsuum* is the most abundant but members belonging to Syringocapsidae are scarce to absent. In addition to paleolatitude and water column depth, ecological conditions accompanying the early Toarcian global anoxic event may have to a considerable extent determined the specific taxonomic composition of these radiolarian faunas.

GOWING, M. M. & GARRISON, D. L. 2003. Larger microplankton in the Ross Sea: Abundance, biomass and flux in the austral summer. *In:* (DITULLIO, G. R. & DUNBAR, R. B. eds). *Biogeochemistry of the Ross Sea. Antarctic Research Series, 78.* 243-260.

Microplankton (20-200 µm organisms) are integral and important parts of Antarctic microbial food webs and influence carbon flux from the euphotic zone. Most studies have focused on the abundant smaller forms that can be adequately sampled in a few hundred milliliters of water. Abundance and biomass of the larger forms are less well known, even though these organisms can comprise significant carbon flux from the euphotic zone. We sampled larger microplankton using 60-liter water samples in the upper 200 m at 5 sites along 76.5 °S in the south central Ross Sea during December 1995-January 1996. Abundances of discoid centric diatoms > 132 µm diameter, thecate heterotrophic dinoflagellates > 50 µm, athecate heterotrophic dinoflagellates > 100 µm in longest dimension, aloricate aplastidic ciliates > 65 µm, three genera of loricate ciliates, sarcodines, and nauplii ranged from < 1 to several hundred cells L^{-1}. Standing stocks of the individual groups integrated over 200 m ranged from 3.4 to 959 mgC m^{-2}. Carbon fluxes of the same groups measured in sediment traps deployed for ca. 2 days were generally < 1% of the total organic carbon flux, except for the large athecate heterotrophic dinoflagellates that comprised 23% of the total carbon flux at one site. Over all the sites the larger microheterotrophs comprised an average of 11% of the total organic carbon flux. This is a pathway of carbon flux that has not been considered in conceptual or quantitative models. A comparison of fluxes to standing stocks showed that, while all of the groups had the potential to contribute significant carbon flux if they had sunk en masse, only the large athe-cate heterotrophic dinoflagellates were important at one site at the time of sampling. Fifty percent of that population was sinking, indicating that this was an episodic event. Larger microplankton therefore warrant inclusion in Ross Sea carbon budgets and probably also consideration in budgets for other oceans.

GOWING, M. M., GARRISON, D. L., WISHNER, K. F. & GELFMAN, C. 2003. Mesopelagic microplankton of the Arabian Sea. *Deep-Sea Research I* **50**, 1205-1234.

The Arabian Sea is notable for its dramatic monsoonal effects on euphotic zone biogeochemical processes and the large spatial extent of its mesopelagic oxygen minimum zone. As part of the US Joint Global Ocean Flux Study (USJGOFS) Arabian Sea project, we sampled microplankton (organisms 20-200 μm including diatoms, dinoflagellates, ciliates, sarcodines and nauplii) at 5 depths from 250 –1000 or 1100 m at 6 stations during 4 seasonal cruises in 1995. Abundances of groups of organisms at discrete depths averaged 1 - 2 liter^{-1} seasonally. Mean seasonal integrated biomass of the assemblage was 29 mgC m^{-2} during the late Northeast Monsoon, 37 mgC m^{-2} during the Spring Intermonsoon, 47 mgC m^{-2} during the late Southwest Monsoon and 49 mgC m^{-2} during the early Northeast Monsoon. Overall, protozoans dominated the mesopelagic microplankton assemblage. Integrated biomass peaked during the late SW Monsoon at two stations as expected if microplankton responded to surface productivity and mesopelagic organic carbon fluxes. At three stations, microplankton biomass peaked during the early NE Monsoon; this may reflect a continuing response to SW Monsoon productivity signals by these larger, slow-growing organisms. Protozooplankton abundance did not appear to be negatively affected by low (<0.1 ml dissolved O_2 l^{-1}) oxygen, whereas naupliar abundance and biomass were higher where oxygen concentration was higher. Total microplankton biomass was highest where oxygen concentrations and also mesozooplankton biomass were lowest, suggesting that predation also played a role in microplankton distributions. Calculations based on allometric relationships indicated that the mesopelagic-heterotrophic microplankton assemblage could, on average, respire 9–38% of the particulate carbon flux that entered the system at 100m and possibly 18–76% of the flux remaining at 250 m. Microplankton may therefore be significant carbon cyclers in the ocean’s vast ‘‘twilight zone’’.

GUEX, J. 2003. A generalization of Cope's rule. *Bulletin de la Societe Geologique de France* **174** (5), 449-452.

For numerous shelly invertebrates, Cope's rule is shown in this paper to merely describe the particular case where volume increase is strictly coupled with diameter or length. Allometries, which are frequently observed in the evolution of the shells' geometry, mean that their size, volume and surface can vary independently. The consequences of this can be summarized as follows: 1) volume increase not coupled with an increase of diameter or length of the organisms generates increasing involution and/or lateral width in the shell of cephalopods, foraminifera and radiolarians; 2) an increase of the biomineralizing surface, not coupled with volume increase, generates increasing apparent complexity in the sutures and growth lines in ammonites, and an increase in the complexity and number of chambers in foraminifera.

GUPTA, S. M. 2003. Orbital frequencies in radiolarian assemblages of the central Indian Ocean; implications on the Indian summer monsoon. *Palaeogeography, Palaeoclimatology, Palaeoecology* **197**, 97-112.

Radiolarian distribution in surface sediments and its relationships with overlying surface oceanography provided impetus for down-core faunal variation related to changes in monsoon intensity due to the Earth's orbital eccentricity in the geologic past. In present study, a high resolution (delta t = 4.75 ka) radiolarian distribution for the last 485 ka in a core (AAS 2/3) from the central Indian Ocean Basin revealed orbital and sub-orbital cycles. Relationships between temporal distribution of: (1) high-salinity Pyloniids and *Didymocyrtis*; (2) low-salinity Spongodiscids and *Spongaster*; (3) transitional Euchitoniids; and (4) southern *Anthocyrtidium* assemblages, and the orbital forcing (ETP, i.e. the normalized sum of the Earth's eccentricity, tilt and precession), and the May-July insolation were analyzed. Spectral analyses revealed significant cycles of Pyloniids (400-, 126-, 95-, 54-, 41-, 31-, 23-, 19-, 17-, and 15-ka), *Spongaster* (95-, 41-, 29-, 23-, 19-, 17-, and 15-ka), Euchitoniids (126-, 95-, 51-, 31-, 21-, 18-, and 17-ka), and *Anthocyrtidium* (400-, 69-, 41-, 31-, 23-, 19-, and 15-ka). Cross-spectral analysis between Pyloniids and ETP suggested coherent Pyloniid cycles lagging ETP by 9 ka at 100-ka eccentricity, while both were in-phase (<2 ka) at 41-ka tilt and 23-ka precession cycles. Coherent *Spongaster* cycles led ETP by 38 ka at 100-ka eccentricity, 15 ka at 41-ka tilt, 5 ka at 23-ka precession cycles. Coherent *Anthocyrtidium* cycles led ETP by 14 ka at 100-ka eccentricity, 10 ka at 31-ka tilt, and were in-phase at 41-ka tilt as well as 23- and 19-ka precession cycles. Similarly, a radiolarian monsoon index defined as the normalized sum of Pyloniids, *Didymocyrtis*, Spongodiscids, *Spongaster*, Euchitoniids, and *Anthocyrtidium* (PDSSEA) led ETP at 54- and 23-ka cycles, while both were nearly in-phase at 41-, 31- and 15-ka cycles. Coherent PDSSEA cycles led insolation during May-July at 8 degrees S (core-site) at 23-ka precession, lagged 100-, 54- and 29-ka cycles and were in-phase at 41-ka tilt and 15-ka sub-orbital cycles. The results suggest that radiolarian assemblages exhibit proxy-monsoon cycles due to the Earth's orbital eccentricity at 400-, 126- and 95-ka, tilt at 54-, 41- and 31-ka, next to precession at 23-, 19- and 17-ka as well as insolation forcings at the core-site during the Late Quaternary.

HARA, H. & KASHIWAGI, K. 2004. Jurassic accretionary complex of the Ashio Terrane in the Kuromatagawa region, Niigata Prefecture, central Japan. *The Journal of the Geological Society of Japan* **110** (6).

The Jurassic accretionary complex of the Ashio Terrane, distributed in the Kuromatagawa region of Niigata Prefecture, central Japan, is divided into two tectonostratigraphic units; the Kuromatagawa and the Oshirakawa Complexes, based on lithology and geologic age. The Kuromatagawa Complex is composed mainly of coherent sequences of interbedded sandstone and shale, and slabs of basaltic rocks and chert ranging from 300 to 500 m and over in thickness. The Oshirakawa Complex consists of melange-type rocks and slabs of basaltic rocks, limestone, chert and sandstone ranging from 50 to 300 m in thickness. It is characterized by melange-type rocks including basaltic rocks and sandstone less than 50m in thickness within pelitic matrix. According to radiolarian fossils obtained from shale, the accretionary age of the Kuromatagawa Complex ranges from middle Middle to early Late Jurassic (late Bathonian - Oxfordian), and the Oshirakawa Complex was accreted in middle Early Jurassic (late Sinemurian - early Pliensbachian). Considering the lithology and geologic age, the Kuromatagawa and the Oshirakawa Complexes are correlated with tectonostratigraphic units of the Tamba-Mino Terrane in the Inner Zone of Southwest Japan. The Oshirakawa Complex is one of the early Jurassic complexes which is the oldest in the Tamba-Mino-Ashio Terrane, and occupies the structurally uppermost unit in the Tamba-Mino-Ashio accretionary wedge.

HASLETT, S. K. 2003. Upwelling-related distribution patterns of radiolarians in Holocene surface sediments of the eastern equatorial Pacific. *Revista Española de Micropalaeontologia* **35** (3), 365-381.

Temporal studies have identified a radiolarian assemblage characteristic of upwelling that has been used to construct an Upwelling Radiolarian Index (URI) and which appears to correlate with the spatial upwelling pattern (thermocline depth) in the present day eastern equatorial Pacific (EEP). In the present study, 92 radiolarian taxa were counted in surface sediment samples from the EEP and the distribution of 14 species interpreted as upwelling-related have been individually mapped (rather than compiled into a URI) and described. Some of the species have previously been considered upwelling-related (*Acrosphaera murrayana*, *Eucyrtidium erythromystax*, *Lamprocyrtis nigriniae* and *Pterocorys minythorax*), but others have not (*Amphirhopalum ypsilon*, *Anthocyrtidium zanguebaricum*, *Botryostrobus auritus*, *Carpocanarium papillosum*, *Eucyrtidium octocolum*, *Lamprocyclas maritalis*, *Phormospyris scaphipes*, *Pterocorys clausus* and *Cycladophora davisiana*), and correlation analysis confirms the upwelling relationship of these species.

HAYS, J. D. & MORLEY, J. J. 2004. Erratum - The Sea of Okhotsk: a window on the Ice Age ocean. *Deep-Sea Research Part I* **51**, 593–618.

The modern Sea of Okhotsk and the high-latitude glacial ocean share similar radiolarian faunas suggesting they also share environmental similarities. This sea favors deep- (>200 m) over shallow-living species as evidenced by collections of sediment traps set at 258 and 1061m in the central part of the Sea. Of the twelve dominant polycystine radiolarian species, four live above and eight below 258 m. The shallow-living species' productivity maxima coincide with spring and fall phytoplankton blooms while deep-living species' annual production, nearly twice that of the shallow-living species, is concentrated in fall. Previous workers have shown that summer plankton tows collect higher concentrations of polycystine Radiolaria below than above 200m and that Radiolaria, fish and zooplankton have unusual concentration maxima between 200 and 500 m. The paucity of Radiolaria and other consumers above 200m coincides with an upper (0–150 m) cold (1.5 °C to 1.5 °C), low salinity layer while higher concentrations below 200m occur within warmer saltier water. This unusual biological structure must produce a lower ratio of shallow (<200 m) to deep carbon remineralization than elsewhere in the world ocean. Deep-living radiolarian species, similar to those of the modern Sea of Okhotsk, dominate glacial high-latitude deepsea sediments. If the hydrographic and biological structures that produced these glacial faunas were like those of the modern Sea of Okhotsk, then glacial high-latitude oceans would have differed from today's in at least two respects. Surface waters were less saline and more stable enhancing the spread of winter sea ice. This stability, combined with a deepening of nutrient regeneration would have reduced surface water nutrients contributing to a reduction of atmospheric carbon dioxide.

HOLLIS, C. J. 2003. The Cretaceous-Tertiary boundary event in New Zealand: profiling mass extinction. *New Zealand Journal of Geology and Geophysics* **46**, 307-321.

Of over 20 known Cretaceous/Tertiary (K/T) boundary sections in the New Zealand region, 6 in the northern South Island were selected for detailed biostratigraphic and paleoenvironmental study because of their apparent stratigraphic completeness and the range of depositional environments represented. These sections represent the only known southern high-latitude (55–60°S) transect of the K/T boundary transition from continental slope to terrestrial mire. The K/T boundary is marked by deposition of an impact fallout layer in four of these sections, and a disconformity representing a hiatus of <100 000 yr in the remaining two sections (Mead and Branch Streams). In the terrestrial Moody Creek Mine and shallow marine mid-Waipara sections, rapid and widespread destruction of forests is shown by abrupt replacement of mixed forest pollen and spore assemblages by assemblages dominated by few species of ground ferns. Foraminiferal and radiolarian biostratigraphy indicates that within 100 000 yr these ferns were replaced by a cool-temperate conifer-dominated assemblage that persisted until c. 63.5 Ma. In the marine sections, an abrupt decrease in carbonate content reflects a major decline in carbonate production associated with mass extinction of calcareous plankton, although several smaller species of planktic foraminifera persist for c. 100 000 yr into the Paleocene. In four sections in Marlborough (Flaxbourne, Woodside, Mead, and Branch), which represent a transect across a coastal upwelling zone, paleoproductivity proxies (excess SiO_2, excess Ba, Ba/Al, $d^{13}C$) indicate that the decline in calcareous plankton was partly offset by sustained siliceous plankton productivity. Extinctions of thermophilic foraminifera, survival of cosmopolitan foraminifera, and expansion of diatoms and spumellarian radiolarians indicate that pronounced cooling occurred across the K/T boundary. A subsequent decline in planktic foraminifera and in carbonate content, associated with a progressive increase in siliceous plankton productivity, indicates that further cooling resulted in dominantly biosiliceous sediment being deposited in the core of the Marlborough upwelling zone from c. 64.9 to 63.5 Ma. The onset of this biosiliceous event at c. 64.9 Ma and a later major increase in biogenic silica in the deepwater sections (Flaxbourne, Woodside) at c. 64.6 Ma are correlated with sea-level falls in the shelf section (Branch) and are also linked to eustatic events recorded in Europe and North and Central America. These early Paleocene regressive events within a cool climatic regime are the probable cause of incomplete K/Tboundary records in most of New Zealand. It remains uncertain if they are directly related to the K/T bolide impact, the short-term effects of which may have disrupted the global climate system for millions of years, or are related to other factors such as tectonism or fluctuating CO_2 emissions from Deccan volcanism.

HOLLIS, C. J., RODGERS, K. A., STRONG, C. P., et al. 2003a. Paleoenvironmental changes across the Cretaceous/Tertiary boundary in the northern Clarence Valley, southeastern Marlborough, New Zealand. *New Zealand Journal of Geology and Geophysics* **46**, 209-234.

Strata outcropping in Mead and Branch Streams, northern Clarence valley, provide important records of pelagic-hemipelagic sedimentation through the Cretaceous-Paleocene transition in a southern high-latitude, upwelling system flanking a carbonate platform. The two stream sections, <10 km apart along-strike, comprise similar stratigraphic successions with differences mainly due to Branch Stream being situated closer to land (outer shelf-upper bathyal) than the mid-bathyal Mead Stream section. Age control is based on foraminiferal and radiolarian biostratigraphy. A Cretaceous/Tertiary (K/T) boundary clay is not preserved in either section. The siliceous microfossil record indicates that basal Paleocene sediments at Branch Stream, although slightly enriched in Ni and Cr, were deposited after a significant sea-level fall. A basal Paleocene claystone at Mead Stream is not enriched in K/T impact-derived elements and was probably deposited after sea-level fall. Earliest Paleocene sediment may be preserved as burrow fill in an uppermost Cretaceous bioturbated zone, which is enriched in Ni and Cr and contains a foraminiferal assemblage indicative of Paleocene Zone P0. Zone P0-Pa foraminiferal assemblages within the basal Paleocene sediments in both sections indicate that sea level fell within 100 000 yr of the K/T boundary event. The K/T boundary at both sites coincides with an abrupt change in lithofacies from calcareous to siliceous ooze. Biosiliceous sediment dominates the sedimentary record over the first 1.5 m.y. of the Paleocene, which corresponds to 45 m of strata at Branch Stream and 20 m in the more condensed Mead Stream section. A trend from diatom-poor to diatom-rich and finally radiolarian-rich microfossil assemblages over the lower 5 m of Paleocene strata at Branch Stream is consistent with progressive deepening at the landward margin of an upwelling zone. A second regressive pulse at c. 64.5 Ma, followed by prolonged transgression from 5-50 m above the K/T boundary, is inferred from an initial increase in the frequency of mudstone beds, followed by a similar trend from diatom-poor to radiolarian-rich microfossil assemblages. Within the upper part of this interval, an increase in carbonate marks a return to lithofacies, and probably also paleodepth, equivalent to the underlying Cretaceous. In the deeper Mead Stream section, variation in diatom and radiolarian assemblages is mainly due to variable preservation in highly recrystallised lithologies. High overall abundance and little change in paleoproductivity indicators (Ba, $d^{13}C$) indicate that high biological productivity continued across the K/T boundary and through the biosiliceous episode. Siliceous plankton thrived in the Marlborough upwelling zone during the early Paleocene. Fluctuations in abundance and lithofacies can be related significant changes in sea level, which may be the result of local tectonic or global climate changes. The delayed recovery of calcareous plankton after mass extinction at the K/T boundary, in both outer neritic and bathyal settings, indicates a relatively cool oceanic regime for the first 1.5 m.y. of the Paleocene.

HOLLIS, C. J. & STRONG, C. P. 2003. Biostratigraphic review of the Cretaceous/Tertiary Boundary transition, mid-Waipara River section, North Canterbury, New Zealand. *New Zealand Journal of Geology and Geophysics* **46**, 243-253.

The mid-Waipara River section is the most complete known record of the Cretaceous/Tertiary (K/T) boundary transition in a South Pacific neritic setting. For local studies it provides a crucial link between bathyal marine and terrestrial records. The section contains abundant and diverse palynomorphs, including dinoflagellate cysts and terrestrial spores and pollen, as well as significant occurrences of biostratigraphically important foraminiferal, calcareous nannofossil, and radiolarian species. Examination of new and existing micropaleontology samples reveals a potentially complete early Paleocene foraminiferal succession correlated to Foraminiferal Zones P0 to P1a-c. Although Cretaceous and basal Paleocene radiolarian assemblages lack age-diagnostic species, higher Paleocene radiolarian assemblages can be correlated to Radiolarian Zones RP2-RP4. Analysis of the distribution of RP3 and RP4 zonal markers in archival samples indicates that the sample sequence of Jenkins, previously published in 1971, is not in stratigraphic order. Bioturbation through the boundary interval and postdepositional leaching are thought to have contributed to relatively low levels of enrichment of K/T boundary fingerprint elements: Ir, Ni, Cr, and Zn. The K/T boundary coincides with a marked decrease in carbonate content, while correlated trends in Si/Al and Ba/Al indicate that biosiliceous productivity increased across the boundary. Extremely low carbonate content and common siliceous microfossils through 30 m of lower Paleocene strata suggest that cool oceanographic conditions prevailed in the northern Canterbury Basin for the first 1-2 m.y. of the Cenozoic.

HOLLIS, C. J., STRONG, C. P., RODGERS, K. A. & ROGERS, K. M. 2003b. Paleoenvironmental changes across the Cretaceous/Tertiary boundary at Flaxbourne River and Woodside Creek, eastern Marlborough, New Zealand. *New Zealand Journal of Geology and Geophysics* **46**, 177-197.

An integrated study of variation in siliceous microfossils, lithofacies, and other geochemical guides to environmental conditions through the retaceous/Tertiary (K/T) boundary transition at Flaxbourne River and Woodside Creek, coastal eastern Marlborough, indicates that the K/T impact disrupted oceanic conditions along the continental margin of eastern New Zealand for c. 1 Ma. Initial effects of the K/T event were a major reduction in carbonate production, associated with calcareous plankton extinctions, and significant increases in terrigenous clay and biogenic silica content. An absence of radiolarian extinctions or significant negative excursions in paleoproductivity indicators (Ba, $d^{13}C$) at the boundary, followed by rapid increases in the abundance of diatoms and spumellarian radiolarians, indicate that biogenic silica production partly compensated for the collapse in calcareous plankton. Increased terrigenous clay in basal Paleocene sediments is more likely due to greatly reduced biogenic input than to significant increased terrigenous input. The earliest Paleocene recovery of calcareous plankton was short-lived, giving way to a progressive increase in siliceous plankton abundance over c. 500 000 yr, which culminated in a c. 400-ka episode of peak biogenic silica production. The dominance of siliceous facies, coupled with the abundance of diatoms and spumellarian radiolarians, indicates climatic or oceanic conditions were significantly cooler than in the Late Cretaceous. Stepped increases in biogenic silica production show c. 100-ka periodicity, suggesting that early Paleocene lithofacies changes were influenced by climate forcing agents at the eccentricity bandwidth.

ISOZAKI, Y., YAO, J. X., MATSUDA, T., et al. 2004. Stratigraphy of the Middle-Upper Permian and Lowermost Triassic at Chaotian, Sichuan, China - Record of Late Permian double mass extinction event. *Proceedings of the Japan Academy Series B-Physical and Biological Sciences* **80** (1), 10-16.

Precise stratigraphic analysis of Middle-Upper Permian and Lower Triassic sequence at Chaotian in northern Sichuan, China, identified two remarkable mass extinction horizons, one at the Middle-Upper Permian (Guadalupian-Lopingian; G-L) boundary and the other at the Upper Perrnian-Lower Triassic (P-T) boundary. Across each of the boundaries, biodiversity declined sharply in fusulinid, rugose coral, brachiopod, ammonite, conodont, and radiolaria. Both boundaries are characterized by two biohorizons, i.e., one marked by major extinction of pre-existing fauna and the other by the first appearance of younger fauna. It is noteworthy that a peculiar rhyo-dacitic tuff bed occurs at each of the extinction horizons. Thus the Late Permian biosphere was strongly affected twice by highly explosive, severe volcanism. Regional correlation of the G-L and P-T boundary tuff beds throughout South China, and partly to Japan, positively suggests a cause-effect link between large-scale explosive volcanism and mass extinction.

ITAKI, T. 2003. Elutriation technique for the extraction of radiolarian skeletons from sandy sediment. *Fossils* (73), 38-41.

ITAKI, T. & IKEHARA, K. 2003. Radiolarian biozonation for the upper Quaternary in the Japan Sea. *Chishitsugaku Zasshi = Journal of the Geological Society of Japan* **109** (2), 96-105.

Rapid and drastic changes in radiolarian assemblages during the last 33 kyr were revealed in three sediment cores from the eastern and northeastern Japan Sea. Such changes occurred synchronously over the Sea according to the correlation by TL layers and AMS ^{14}C dating. On the basis of these bio-events, four radiolarian biozones were established: *Ceratospyris borealis* Interval Biozone (33 to 15 ^{14}C kyr BP), *Stylochlamydium venustum* Interval Biozone (15 to 12 ^{14}C kyr BP), *Cycladophora davisiana* Interval Biozone (12 to 10.5 ^{14}C kyr BP), and *Larcopyle butschlii* Interval Biozone (10.5 ^{14}C kyr BP to Present). These radiolarian biozones are useful for correlating the upper Quaternary sediments in the Japan Sea, where carbonate fossils are poorly preserved below the calcium carbonate compensation depth (CCD).

ITAKI, T., IKEHARA, K., MOTOYAMA, I. & HASEGAWA, S. 2004. Abrupt ventilation changes in a marginal sea of the NW Pacific over the last 30 kyr: Evidence from deep-dwelling Radiolaria in the Japan Sea. *Palaeogeography, Palaeoclimatology, Palaeoecology* **208**, 259-274.

The Japan Sea has its own deep-circulation system, with its deeper parts occupied by cold and highly-oxygenated water formed by winter convection in its northwestern reaches. We elucidate the modern depth distribution of radiolarian species and their relation to water masses, from the study of plankton tows and surface sediments. *Cycladophora davisiana* occurs in a depth interval between 1,000 m and 2,000 m (deep layer of JSPW=Japan Sea Proper Water), and *Actinomma boreale/ leptoderma* Group in depths below 2,000 m (bottom layer of JSPW). The study of seven sediment cores located in water depths ranging from 807 to 3,613 m show that the radiolarian assemblages have varied since 30 cal ka BP, indicating changes in water-ventilation strength in this marginal sea. During the interval from 30 to 17 cal ka BP, ventilation was restricted to an intermediate layer beneath the low-salinity surface water, while the deeper zone was filled with static, anoxic water. Deep ventilation began abruptly at 14 cal ka BP. Cold and oxygen-rich water began to sink into the bottom layer, as a result of cold oceanic inflow from the northwestern Pacific through the Tsugaru Strait in the north. Deep convection activity increased from 13 to 12 cal ka BP, which coincides with the Younger Dryas-like cooling event, and then stopped at 12 to 11.5 cal ka BP. Bottom-water ventilation during the Holocene has been dependent on high-salinity inflow through the Tsushima Strait in the south and winter cooling in the northwestern part of the Japan Sea. Deep water was being actively formed in the early Holocene, in contrast to the static bottom water. This bottom-water formation has resulted in relatively constant water composition since 9 cal ka BP, with the overall increase in high-salinity oceanic-water inflow, although the latter decreased transiently from 7 to 5 cal ka BP in concert with climatic warming.

ITAKI, T., ITO, M., NARITA, H., et al. 2003a. Depth distribution of radiolarians from the Chukchi and Beaufort seas, western Arctic. *Deep-Sea Research Part I-Oceanographic Research Papers* **50** (12), 1507-1522.

The depth distributions of the radiolarian fauna in the Chukchi and Beaufort Seas, marginal seas of the western Arctic Ocean, were examined quantitatively in depth-stratified plankton tows from 4 or 5 intervals above 500 m and in surface sediments from various depths between 163 and 2907 m. The radiolarian assemblage from the water column in September 2000 was dominated by *Amphimelissa setosa* and followed by the *Actinomma boreale/leptoderma* group, *Pseudodictyophimus gracilipes* and *Spongotrochus glacialis*. These species are related to the Arctic Surface Water shallower than 150 m. This assemblage is similar to that in the Greenland Sea relating to the ice edge, but did not contain typical Pacific radiolarians in spite of the flow of water of Pacific origin in this region. The living depth of Ceratocyrtis historicosa was restricted to the relatively warm water between 300 and 500 m corresponding to the upper Arctic Intermediate Water (AIW) originating from the Atlantic Ocean. Radiolarian assemblages in the surface sediments are similar to those in the plankton tows, except for common *Cycladophora davisiana* in sediment samples below 500 m. *C. davisiana* is probably a deep-water species adapted to the lower AIW or the Canadian Basin Deep Water ventilated from the shelves.

ITAKI, T., MATSUOKA, A., YOSHIDA, K., et al. 2003b. Late spring radiolarian fauna in the surface water off Tassha, Aikawa Town, Sado Island, central Japan. *Sci. Rep., Niigata Univ., Ser. E (Geology)* **18**, 41-50.

Fourteen radiolarian species were found in a surface plankton sample collected from shallower than 10 m deep at the eastern margin of the Japan Sea off Tassha, Aikawa Town, Sado Island, central Japan in late May 2002. The late spring fauna was characterized by *Lithomelissa setosa*, *Tetrapyle octacantha*, *Stylodictya* spp. and *Spongodiscus* spp. It is similar to that reported inlate June 2001, but is different from that in early September 2000. Most individuals of warm-water species such as *T. octacantha*, *Didymocyrtis tetrathalamus*, and *Euchitonia furcata* were juvenile.

IVANOVA, E., SCHIEBEL, R., SINGH, A. D., et al. 2003. Primary production in the Arabian Sea during the last 135 000 years. *Palaeogeography, Palaeoclimatology, Palaeoecology* **197**, 61-82.

Variations in primary productivity (PP) have been reconstructed in eutrophic, mesotrophic and oligotrophic parts of the Arabian Sea over the past 135 000 years applying principal component analysis and transfer function to planktic foraminiferal assemblages. Temporal variation in paleoproductivity is most pronounced in the mesotrophic northern (NAST site) and oligotrophic eastern (EAST site) Arabian Sea, and comparatively weak in the western eutrophic GeoB 3011-1 site in the upwelling area off Oman. Higher PP during interglacials (250-320 g C $m^{-2}year^{-1}$) than during cold stages (210-270 g C m^{-2} $year^{-1}$) at GeoB 3011-1 could have been caused by a strengthened upwelling during intensified summer monsoons and increased wind velocities. At NAST, during interglacials, PP is estimated to exceed 250 g C $m^{-2}year^{-1}$, and during glacials to be as low as 140-180 g C $m^{-2}year^{-1}$. These fluctuations may result from a (1) varying impact of filaments that are associated to the Oman coastal upwelling, and (2) from open-ocean upwelling associated to the Findlater Jet. At EAST, highest productivity of about 380 g C $m^{-2}year^{-1}$ is documented for the transition from isotope stage 5 to 4. We suggest that during isotope stages 2, 4, 5.2, the transition 5/4, and the end of stage 6, deep mixing of surface waters was caused by moderate to strong winter monsoons, and induced an injection of nutrients into the euphotic layer leading to enhanced primary production. The deepening of the mixed layer during these intervals is confirmed by an increased concentration of deep-dwelling planktic foraminiferal species. A high-productivity event in stage 3, displayed by estimated PP values, and by planktic foraminifera and radiolaria flux and accumulation rate, likely resulted from a combination of intensified SW monsoons with moderate to strong NE monsoons. Differential response of *Globigerina bulloides*, *Globigerinita glutinata* and mixed layer species to the availability of food is suited to subdivide productivity regimes on a temporal and spatial scale.

KAMIKURI, S., NISHI, H., MOTOYAMA, I. & SAITO, S. 2004. Middle Miocene to Pleistocene radiolarian biostratigraphy in the Northwest Pacific Ocean, ODP Leg 186. *Island Arc* **13** (1), 191-226.

The Upper Cenozoic sedimentary sequences drilled at Sites 1150 and 1151, Ocean Drilling Program Leg 186, enabled establishment of radiolarian zonation and calibration of the age of bioevents in the forearc area of the northern Japan Islands. The sequences were divided into nine zones from the Pleistocene *Botryostrobus aquilonaris* Zone to the Upper Miocene *Lipmanella redondoensis* Zone at Site 1150, and 11 zones from the Pleistocene *Stylatractus universus* Zone to the Middle Miocene *Dendrospyris*? *sakaii* Zone at Site 1151. These zones correlate successfully with the studied sequences of many of deep-sea cores in the Northwest Pacific Ocean and with some sections of onshore Japan. Of 67 important radiolarian bioevents recognized during the study, 29 Pleistocene to Upper Miocene events were directly tied to the geomagnetic polarity time scale through the well-defined paleomagnetic polarity records, and 21 Upper Miocene events were calibrated based on the diatom biostratigraphy. Of these events, 24 geographically widespread events were selected to test synchroneity and usefulness as time-horizons within the mid-to-high latitude of the Northwest Pacific, involving eight other offshore and onshore sections. Examination showed that most of the zonal boundary events are synchronous within the considered region, and that many diachronous events, most of which are eliminated from the zonal scheme, are unreliable events linked to rare and sporadic occurrences of the species. Radiolarian biostratigraphy of the studied cores clearly indicates three major hiatuses in the Middle Pleistocene, Late Miocene and late Middle Miocene. The latter two hiatuses can be correlated to two global oceanic hiatuses, NH6 and NH3, respectively.

KASHIWAGI, K. & KURIMOTO, C. 2003. Reexamination of radiolarian biochronology of the Shimizu Formation (Northern Chichibu Belt) in the Shimizu-Misato area, western Kii Peninsula, Southwest Japan. *Bulletin of the Geological Survey of Japan* **54** (7/8), 279-293.

KASHIWAGI, K., TSUKADA, K. & MINJIIN, B. C. 2004. Paleozoic spherical radiolarians from the Gorkhi Formation, southwest Khentei range, central Mongolia; a preliminary report. *Mongolian Geoscientist* **24**, 17-26.

This paper is the first report of radiolarian fossils from red chert of the Gorkhi Formation, Khangai-Khentei Zone, central Mongolia. Fourteen samples of red chert were collected from the Gorkhi Formation for extraction of microfossils, and abundant radiolarian fossils with minor amounts of microspheres and sponge spicules were obtained from 2 samples. The radiolarian assemblages from these samples are abundant in spherical radiolarians. The spherical radiolarians with concentric latticed shells might be correlative with entactiniid radiolarians. The inner shell of the spherical radiolarians has smooth surface and pores on it. The microspheres also have smooth shell surface and pores on it, and are interpreted as inner shell of the spherical radiolarian. Some papers reported the Devonian entactiniid radiolarians, which are closely similar to the spherical radiolarians in this paper. Thus, it is likely that the red cherts of the Gorkhi Formation are Devonian in age.

KAVOURAS, C. N. 2000. Mid-Jurassic to earliest Cretaceous (Callovian-Ryazanian) Radiolaria of the North Sea Basin. *Newsletter of Micropalaeontology* **63**, 20.

Eleven wells/exposures from the North Sea, spanning the Mid Jurassic (Callovian) to Earliest Cretaceous (Ryazanian) time interval, have been examined for radiolaria. The inclusion of 2 more wells from the Norwegian and Barents Seas has been used for comparative purposes and contributed to the taxonomic understanding of the less well-preserved North Sea radiolarians. Electron Microprobe analysis of radiolarian tests revealed that: a) the oldest recovered radiolarians are exclusively preserved as pyrite; b) the replacement of silica by calcite, pyrite or sphalerite has not usually occurred totally; c) the pyritised radiolaria do not necessarily have their tests completely replaced by pyrite, although under light microscope this looks to be the case. It is possible that this replacement may be more intense in older tests; d) there is no correlation between the appearance of the non-pyritised tests in reflected light and their chemical composition. A total 129 species/morphotypes from 392 samples has been described and illustrated with scanning electron and light microscope micrographs. By employing careful processing techniques for extraction from the host lithology (boiling in a solution of Sodium carbonate) and taking into account the commonly poor preservation of radiolarians, their biostratigraphic value has been demonstrated by means of the Unitary Associations (UA) method. The ranges of 52 taxa have been used for computer treatment with the BioGraph programme, from which 18 Unitary Associations have been established. These were grouped into 5 zones that were correlated to the standard ammonite zones (figure): Biozone 1 ?early Callovian to mid Kimmeridgian (mid *mutabilis*); Biozone 2 mid Kimmeridgian to Early Volgian (*scitulus*); Biozone 3 Early Volgian to Mid Volgian (*glaucolithus*, tentatively); Biozone 4 Mid Volgian to latest Mid Volgian (*oppressus*, tentatively); Biozone 5 Latest Mid Volgian to Late Ryazanian (mid s*tenomphalus*). The rate of faunal turnover has been estimated using the method of Guex (1991). There is a low similarity for most of the Unitary Associations (gaps in the fossil record). High extinction rates of radiolaria may have been occurred in the late Kimmeridgian to Early Volgian and Early to Mid Volgian. The North Sea radiolarian assemblages, as well as those recovered from the Norwegian and Barents Seas are Northern Boreal in character, sensu Pessagno et al. (1993). The assemblages are characterized by the lack of pantanelliids and the presence of parvicinguliids and praeparvicinguliids. *Perispyridium* (?) spp. is also present (in the Middle Jurassic of the North Sea basin). Typical Tethyan morphotypes such as *Acanthocircus* or *Mirifusus* are absent, although such tests might be expected to be absent from the preparations of the North Sea samples (poor preservation).

KOBAYASHI, F. 2003. Palaeogeographic constraints on the tectonic evolution of the Maizuru Terrane of Southwest Japan to the eastern continental margin of South China during the Permian and Triassic. *Palaeogeography, Palaeoclimatology, Palaeoecology* **195**, 299-317.

The Maizuru Terrane in the Inner Zone of Southwest Japan consists of weakly metamorphosed ophiolitic complexes and Permian and Triassic strata. The Permian Maizuru Group is 1500-3000 m thick and consists mainly of mudstone, sandstone, and alternating beds of sandstone and mudstone. It is subdivided into lower, middle, and upper formations, and is overlain with angular unconformity by the Lower-Middle Triassic Yakuno Group. The Maizuru Group is characterised by the occurrence of the Capitanian *Lepidolina kumaensis* fauna in conglomerates of the middle and upper formations, and the Wuchiapingian *Codonofusiella-Colaniella* and Changhsingian *Palaeofusulina-Colaniella* faunas in lenticular limestones and conglomerates of the upper formation. Pre-Capitanian foraminifera are contained in limestone clasts of conglomerates of the upper formation and the basal part of the Yakuno Group. Examination on the stratigraphy, lithology, foraminiferal fauna, and Late Palaeozoic to Mesozoic tectonics in and around the Maizuru Terrane leads to the following conclusions. Capitanian and Lopingian limestone blocks and clasts were originally deposited on the continental shelf, and were subsequently redeposited on the deeper continental slope. Almost all of the pre-Capitanian limestone clasts were derived from the Akiyoshi Seamount accreted by the early Late Permian, except for those containing *Verella prolixa* and *Pseudostaffella praegorski* which were reworked from the shallow continental shelf. The Maizuru Terrane originated on the active continental margin located close to South China during Permian-Triassic time, but the depositional environment of the Permian and Triassic strata rapidly changed from deeper continental slope to shallow continental shelf.

KOPPERS, A. A. P., STAUDIGEL, H. & DUNCAN, R. A. 2003. High-resolution Ar-40/Ar-39 dating of the oldest oceanic basement basalts in the western Pacific basin. *Geochemistry Geophysics Geosystems* **4**, 1-20 (Online). 8914, doi:10.1029/2003GC000574.

We report new Ar-40/(39) Ar ages for the oldest Pacific oceanic floor at Ocean Drilling Program Site 801C in the Pigafetta basin and Site 1149D close to the Izu- Bonin subduction zone in the Nadezhda basin. These ages were determined by applying high- resolution incremental heating experiments (including 15 - 30 heating steps) to better resolve the primary argon signal from interfering alteration signatures in these low-potassium ocean crust basalts. Combined with previous results from Pringle [1992] for Site 801B and 801C, we arrive at a multistage history for the formation of the Pigafetta ocean crust. The oldest part of the Pacific plate was formed at the spreading ridges at 167.4 +/- 1.4/ 3.4 Ma (n = 2, 2sigma internal/ absolute error), offering an important calibration point on the Geological Reversal Timescale (GRTS) since it represents the old end of the Mesozoic magnetic anomalies. This mid- ocean ridge basalt sequence, however, is overlain by more tholeiites and alkali basalts that were formed 7.3 +/- 1.5 Myr later around 160.1 +/- 0.6 Ma (n = 7, 2s internal error). The older age group is confirmed independently by radiolarian ages ranging from Late Bajocian to Middle Bathonian (167 - 173 Ma [Bartolini and Larson, 2001]) and by profound differences in the structural characteristics of this basement section [Pockalny and Larson, 2003]. Thin layers comprising hydrothermal deposits separate these sequences, which in addition to the difference in isotopic age show distinct major and trace element compositions. This indicates that key volcanic and hydrothermal activity took place 400 - 600 km away from the spreading ridges, on the basis of a Jurassic similar to 66 km/ Myr half spreading rate in the Pacific. It remains unclear if these processes were active continuously after the initial formation of the Pacific oceanic crust, but all our observations seem to point to an episodic history. Site 1149D gives another important calibration point on the GRTS of 127.0 +/- 1.5/ 3.6Ma (n = 1, 2sigma internal/ absolute error) for anomaly M12 that is slightly younger when compared to current timescale compilations (134.2 +/- 2.1 Ma [Gradstein et al., 1995]). This might suggest that the dated basalt from Site 1149D does not represent the age of the ocean crust formed at its ridge axis; it may also be part of the Early Cretaceous intraplate events that have produced dolerite sills in the Pacific crust at Sites 800 and 802 around 114 - 126 Ma.

KORCHAGIN, O. A., KUZNETSOVA, K. I. & BRAGIN, N. Y. 2003. Find of early planktonic foraminifers in the Triassic of the Crimea. *Doklady Earth Sciences* **390** (4), 482-486.

Early planktonic Foraminifera were found in the late Triassic (Rhaetian) limestones of Crimea (Ukraine). A new genus *Sphaerogerina* gen. nov., and four new species *Globuligerina almensis* sp. nov., *Sphaerogerina tuberculata* sp. nov., *S. crimica* sp. nov., and *Wernliella explanata* sp. nov., were described.

KUWAHARA, K., YAO, A., EZAKI, Y., et al. 2003. Occurrence of Late Permian radiolarians from the Chituao section, Laibin, Guangxi, China. *Journal of Geosciences, Osaka City University* **46**, 13-23.

Late Permian (Wujiapingian-early Changxingian) radiolarians were detected from the Chituao section, Laibin, Guangxi, China. The radiolarian assemblages have several species similar to those from Southwest Japan. The radiolarian assemblages are compared to the assemblages are compared to the assemblages of the *Follicucullus charveti-Albaillella yamakitai* Zone and the *Neoalbaillella ornithoformis* Zone of Southwest Japan. Correlation of the Upper Permian strata between the Yangzi Platform of South China and the Mino Terrane of Southwest Japan is made by conodont and radiolarian zones. The occurrence of *Follicucullus* aff. *whangaroaensis* from the Chituao section suggests a paleogeographical similarity between the Yangzi Platform of South China and the Waipapa Terrane of New Zealand.

KUZNETSOVA, K. I., BRAGIN, N. Y., VOZNESENSKII, A. I. & TEKIN, U. K. 2003. Jurassic planktonic and benthic cosmopolitan foraminiferal communities of Central Turkey. *Stratigraphy and Geological Correlation* **11** (5), 450-467.

Jurassic sections of Central Turkey (Ankara region) are described. As is established for the first time, they yield diverse assemblages of benthic and planktonic foraminifers, which are represented by 10 genera and different morphotypes. The Jurassic (Sinemurian-Pliensbachian to Oxfordian) sections are largely composed of clastic and carbonate rocks. In the transgressive-type section, basal conglomerates and coastal sandstones (Lower Jurassic) are overlain by relatively deep-water mudstones and tuffites (Middle Jurassic), which grade upsection into hemipelagic to pelagic radiolarian cherts and micritic limestones (Upper Jurassic-Valanginian). Remains of ammonoids occur throughout the section. All foraminiferal assemblages lack endemic taxa characteristic of Tethyan carbonate platforms and consist exclusively of geographically widespread and cosmopolitan species. Cosmopolitan taxa of benthic foraminiferal assemblages are important for interregional correlation of Jurassic sediments. Planktonic species first discovered in the Lower Jurassic interval are diverse, variable in morphology, and substantially widen our knowledge of the origination time and evolution of this important fossil group.

LEMOINE, M. 2003. Schistes Lustres from Corsica to Hungary; back to the original sediments and tentative dating of partly azoic metasediments. *Bulletin de la Societe Geologique de France* **174** (3), 197-209.

The Alpine and Corsican Schistes lustres (SL) are nearly azoic Jurassic-Cretaceous metasediments often associated with ophiolites. They are derived from both the vanished Valais (N-Penninic) and Piemont-Ligurian (S-Penninic) oceans and from their continental margins. Their age is generally poorly known. Because of fossils discovered by Alb. Heim and by S. Franchi at the beginning of the 20th century, they were believed for a long time to be mostly Liassic in age. We know now that the major part of the SL is Cretaceous. Deep-sea sediments, and particularly the SL, are made up of a hemipelagic-pelagic background (HPB) associated with detrital components of local or distant origin. The nature of the HPB, mostly conditioned by Tethyan and worldwide events, is of great help as an at least rough stratigraphic marker; in contrast, detrital material is not a reliable marker because it may occur at different times in different places. The HPB exhibits several successive, 10 to 40 m.y. long episodes which are either predominantly argillaceous (A) or calcareous (C). During the deposition of the Jurassic-Cretaceous SL, seven episodes can be distinguished: C1, calcareous Liassic; A1, marly Upper Liassic; C2, calcareous latest Liassic and early Dogger; A2, shaly or radiolaritic late Dogger-early Malm; C3, calcareous late Malm; A3 shaly or marly early Cretaceous; C4 calcareous late Cretaceous. They can be recognized, each one by its prevailing lithology, and all together by their succession in order from C1 to C4. Nearly all of these subdivision are here and there dated by rare fossils, which allow for a rough dating of the numerous azoic SL series. As they exhibit very different lithologies, from pelagic calcareous oozes to Black Shales and various kinds of flysch and other mass flow deposits, the SL cannot be considered as a specific, well-defined facies: they are not characteristic for a particular stage of the geodynamic evolution of the Alps. Finally, a possible influence of worldwide events is suggested. First, the role of the depth of the CCD, governed by early late Jurassic and early late Cretaceous biotic recoveries. Secondly, the correlation with first order eustatic events: transgressions on platforms seem to be roughly coeval with A episodes in the deep sea, regressions with C episodes.

LI, G. & YANG, Q. 2003. Confirmation of an Early Cretaceous age for the Qihulin Formation in eastern Heilongjiang Province, China: constraints from a new discovery of radiolarians. *Cretaceous Research* **24** (6), 691-696.

The coal-bearing, alternating marine and non-marine Longzhaogou Group in eastern Heilongjiang, northeastern China, has long been considered as Jurassic, or mainly Jurassic, in age. However, recent studies have demonstrated that the ammonites and dinoflagellate cysts are of Early Cretaceous age. This has now been confirmed by new radiolarian evidence. The radiolarian fauna recovered from the upper Qihulin Formation of the Longzhaogou Group consists of nine poorly preserved species referable to nine genera. *Novixitus* is a Cretaceous genus, and the specimens of *Archaeodictyomitra* sp. and *Xitus* sp. recovered resemble *A. vulgaris* Pessagno and *X. spicularius* (Aliev), respectively.

LITTLE, C. T. S., DANELIAN, T., HERRINGTON, R. J. & HAYMON, R. 2004. Early Jurassic hydrothermal vent community from the Franciscan Complex of California. *J. Paleontology* **78** (3), 542-559.

LOPEZ-GARCIA, P., RODRIGUEZ-VALERA, F. & MOREIRA, D. 2002. Toward the monophyly of Haeckel's Radiolaria: 18S rRNA environmental data support the sisterhood of Polycystinea and Acantharea. *Molecular Biology and Evolution* **19** (1), 118-121.

MACDONALD, E. W. 2004. Palaeoscenidiidae (Radiolaria) from the Lower Silurian of the Cape Phillips Formation, Cornwallis Island, Nunavut, Canada. *Journal of Paleontology* **78** (2), 257-274.

Spicular radiolarians of the family Palaeoscenidiidae were recovered from the Llandovery to lower Wenlock of the Cape Phillips Formation, Nunavut, Canada. Several changes are made to the classification of these radiolarians. *Goodbodium rarispinosum* (Goodbody, 1986) was previously placed with *Palaeoscenidium* Deflandre, 1953. *Insolitignum* MacDonald, 1999 is emended to allow for additional apical rays. *Insolitignum cancellatum* (Goodbody, 1986) includes species which were previously assigned to *Polaeoscenidium*, *Palaeotripus* Goodbody, 1986, and *Palaeoephippium* Goodbody, 1986, owing to the variable development of one ray. *Insolitignum peranima* MacDonald, 1999 is synonymized with L dissimile (Goodbody, 1986). *Palaeodecaradium apertum* (Goodbody, 1986) was previously placed with *Palaeoscenidium*; *Palaeotripus nudus* Goodbody, 1986 is considered a synonym of *P. apertum*. *Palaeoephippium* is rediagnosed based on the branching of the basal rays; the new diagnosis also allows for more than six rays and in orientations other than originally diagnosed. *Palaeoephippium aranea* Goodbody, 1986 is a junior synonym of *P. bifurcum* Goodbody, 1986. *Palaeoephippium reteforme* Goodbody, 1986 and *P. ramipendentes* Goodbody, 1986 are synonymized with *P. radices* Goodbody, 1986. *Palaeotripus monospinosum* Goodbody, 1986 is synonymized with *Palaeoephippium spinosum* Goodbody, 1986. One new species, *Palaeodecaradium gordoni*, is described. It possesses six rays; the apical rays are long and curved. The basal rays bear spinules on their lateral margins.

MARTINEZ, J. I. 2003. The paleoecology of Late Cretaceous upwelling events from the Upper Magdalena Basin, Colombia. *Palaios* **18** (4-5), 305-320.

Ten planktonic foraminiferal zones are identified and six stratigraphic sequences are interpreted in the Turonian-Maastrichtian interval of the Michu-1 well in the Upper Magdalena Basin. Anoxic bottom-water conditions prevailed during the Turonian and Coniacian followed by dysoxic conditions in the Santonian and Campanian. Oxic conditions were established during the Maastrichtian age. Upwelling occurred for most of the Late Cretaceous. Coccolithophorids, planktonic foraminifera, radiolaria, ammonites, clupeoid fish, and mosasaurs dominated the food-web structure of the Turonian-Coniacian interval. Following a major turnover during the Coniacian-

Santonian boundary interval, dinoflagellates were the primary producers that sustained radiolarians, a sparse population of planktonic foraminifera, clupeoid fish, and ammonites. Dinoflagellate blooms (peridinoids) were frequent during the Campanian interval and sustained a sparse population of planktonic/braminifera and abundant clupeoid fish whose feces (phosphatic pellets) were grazed extensively by a specialized population of buliminids dominated by the genus *Siphogenerinoides*.

MATSUOKA, A. 2002. Methods and research instruments for living radiolarian studies. *Fossils* (71), 19-27.

MATUL, A. G., GORBARENKO, S. A., MUKHINA, V. V. & LESKOV, V. Y. 2003. The Quaternary micropaleontological and lithophysical records in the sediments of the northern part of the Sea of Okhotsk. *Oceanology* **43** (4), 551-560.

A combined examination of the siliceous microfossils (diatoms and radiolarians) and the lithophysical parameters (magnetic susceptibility and contents of the coarse-grained sediment fraction and the ice-rafted detritus) revealed the stratigraphy of the sediment core from the deep northern shelf of the Sea of Okhotsk in the scale of the oxygen-isotope stages for the last two glacial cycles of the Pleistocene and allowed us to make a number of paleoceanographic conclusions. The data on the ice-rafted detritus exhibit strong variability, and a similar amplitude of such changes existed in the ice formation on the northern shelf of the sea both during the glacial period and during the interglacial period. Based on the data on the assemblages of siliceous microfossils, we can conclude that the interglacial optimum of the oxygen-isotope substage 5e was the warmest interval for the last 220 ky, which reflected the increased influence of the North Pacific water masses on the paleoenvironment of the Sea of Okhotsk.

MILLER, C., THOENI, M., FRANK, W., et al. 2003. Geochemistry and tectonomagmatic affinity of the Yungbwa Ophiolite, SW Tibet. *Lithos* **66**, 155-172.

The Yungbwa ophiolite is a thrust sheet of about 800 km (super 2) tectonically overlying an Upper Cretaceous melange south of the Indus-Tsangpo Suture Zone in SW Tibet. Both units have been thrust over the sedimentary series of the Tibetan Tethys zone in the course of the India-Eurasia collision. Harzburgite and clinopyroxene-poor lherzolite are the dominant lithologies. Occasional gabbronoritic and basaltic dikes crosscut the mantle tectonites, but plutonic and volcanic sections are notably absent. The majority of basaltic dikes are tholeiitic and similar to N-MORB with respect to LREE depletion, ratios of diagnostic trace elements and Sr and Nd isotope systematics. Sm-Nd isotope data of three tholeiitic samples yielded an isochron age of 147+ or -25 Ma (MSWD = 0.59), and an initial epsilon (t)Nd value of +8.8. In addition, magnesio-hornblende in a tholeiitic basaltic dike yielded a (super 40) Ar/ (super 39) Ar age of 152+ or -33 Ma. The mineral chemistry of the spinel-peridotites is consistent with an origin in a tectonic setting similar to abyssal peridotites. The nearly chondritic initial (super 187) Os/ (super 188) Os value of a Re-poor orthopyroxene concentrate matches the composition of abyssal peridotites. The strongly LREE depleted trace element signature of the peridotite clinopyroxenes resembles that of clinopyroxenes from ocean floor peridotites. The Nd isotopic composition of a clinopyroxene concentrate is extremely depleted ((super 143) Nd/ (super 144) Nd = 0.514420), indicating an early Jurassic time of depletion (T (sub DM) = 187 Ma) and suggesting that this clinopyroxene represents residual mantle material. In contrast, the bulk peridotites are characterized by convex-downward REE patterns, coupled with low (super 143) Nd/ (super 144) Nd ratios and elevated (super 87) Sr/ (super 86) Sr ratios. We suggest that these geochemical signatures resulted from secondary processes during or after emplacement of the ophiolite complex.

MOORE, T. C., NIGRINI, C., SANFILIPPO, A., et al. in press. The Paleogene tropical Pacific: clues to circulation, productivity and plate motion. *Paleoceanography.*

Stratigraphic data from 63 DSDP and ODP Sites that sample the lower Neogene and Paleogene sediments of the tropical Pacific have been compiled and put on the biostratigraphic and paleomagnetic timescale refined by Leg 199 scientists. Sediment accumulation rates have been calculated for ten intervals ranging in age from 10 Ma to 56 Ma and plotted midpoint of each interval at the associated paleo-position for each site used. A fixed hotspot model was used for rotation of the Pacific lithospheric plate. The reconstruction of the intervals show the development of a tongue of high accumulation rates associated with the oceanographic divergence at the geographic equator. The development of this equatorial band is weakest between 46 Ma - 56 Ma, the time of the peak warmth in the Paleogene climate. Possible motion of the Hawaiian hotspot or true polar wander between 40 Ma and 56 Ma appears to have had little effect on the plate rotation estimate of the position of the equator. In addition temporal changes in the CCD and in productivity, the biggest change in patterns of sediment accumulation rates in the eastern tropical Pacific was the development of a relatively strong divergence between 6° and 10°, near the region of divergence between the modern North Equatorial Current and the North Equatorial Counter Current. Changes in the equatorial circulation appear to be associated in time with the opening and closing of oceanic gateways - particularly the complex closing of the Caribbean - Pacific gateways.

MOTOYAMA, I., NIITSUMA, N., MARUYAMA, T., et al. 2004. Middle Miocene to Pleistocene magneto-biostratigraphy of ODP Sites 1150 and 1151, northwest Pacific: Sedimentation rate and updated regional geological timescale. *Island Arc* **13** (1), 289-305.

Shipboard and shore-based investigation on siliceous and calcareous microfossil biostratigraphy, magneto-stratigraphy and tephrostratigraphy identified numerous datum events from the sedimentary sequences of Sites 1150 and 1151 drilled on the forearc basin of northern Japan by the Ocean Drilling Program Leg 186. Some 83 datum events were selected to construct new age-depth models for the sites. Based on the reliable magnetostratigraphy from the Pleistocene to the Upper Miocene, which were correlated to the standard geomagnetic polarity timescale, and on excellent records of diatom and radiolarian biostratigraphy throughout the sequences, the shipboard age model was revised. Major revisions referred to stratigraphic position of the Miocene-Pliocene boundary that has been shifted more than 200 m downward in each sequence. The age-depth relations of the forearc sites represent drastic changes in the sedimentation rate-extremely high (40 cm/k.y. on average) in the Early Pliocene and low (less than 2 cm/k.y. on average) in the Middle Miocene-and several hiatuses exist throughout the sequence. The drastic changes can be related mostly to changes in diatom sedimentation and the tectonics of the Japanese Island Arc. Local ages for some foraminiferal, calcareous nannofossil and radiolarian bioevents are estimated from the age-depth models at each site. These newly calibrated bioevents and biozones as well as established diatom biostratigraphy are incorporated into the updated magneto-biochronologic timescale, which will contribute to an improvement in biochronologic accuracy of Neogene sediments in northern Japan and adjacent areas.

MURPHY, L. & WARNKE, D. A. 2003. Ice-rafted debris of the Pliocene portion of ODP Site 1092. *Proceedings of the Ocean Drilling Program, Scientific Results* **177**.

In the following report, we describe the methodology employed to generate the ice-rafted debris (IRD) data for Murphy et al. (in press) followed by the pertinent data set. Raw data files can be obtained from the corresponding author.

NAVE, S., SALGUEIRO, E. & ABRANTES, F. 2003. Siliceous sedimentary record of the last 280 kyr in the Canary Basin (NW Africa). *Marine Geology* **196**, 21-35.

Siliceous microfossils were quantified in four sedimentary sequences off Northwest Africa in order to disclose the productivity story of the last 280 kyr. Three sediment cores retrieved along an E-W profile, at about 29 degrees N (GeoB4240, GeoB4241 and GeoB4242), and one core (GeoB4216) from the highly productive area off Cape Ghir in the Canary Island region. At 29 degrees N, along all but the most offshore sequences (GeoB4242), coincidence of high diatom accumulation rates (DAR) and high abundances of *Chaetoceros* spores, the upwelling-related species, indicate glacial stages (isotope stages (IS) 4 and 2) as more productive than the interglacial intervals (IS5 and Holocene). The DAR in the coastal area of the Canary basin during IS2 is of the same order of magnitude (10^8 valves $cm^{-2}kyr^{-1}$) reported for Cape Blanc and one order of magnitude higher than reported for the Iberian margin. The deviation observed between the offshore (higher DAR at IS3 and 6) and the coastal diatom records (higher DAR at IS2 and 4) may be a reflection of local productivity generated by wind input of nutrients and advection from coastal sources. The occurrence of DAR spikes at the timing of some Heinrich events seems to support the hypothesis of productivity maxima associated with the presence of meltwater off NW Africa, as previously proposed by other authors.

NEUMANN, P. & ZACHER, W. 2004. The Cretaceous sedimentary history of the Pindos Basin (Greece). *International Journal of Earth Sciences* **93** (1), 119-131.

The Cretaceous sedimentary rocks of the Pindos Zone in western Greece document the evolution of a Tethyan deep-water basin. New sedimentological and micropalaeontological studies reveal a complex basin history. Siliceous sediments with abundant radiolaria and organic-rich facies prevailed up to the early Late Cretaceous. Within the sediment-starved pre-Middle Cenomanian, marked black shale levels appear that are probably linked to oceanic anoxic events. At the change from the late Early to the early Middle Cenomanian, the sedimentary regime altered abruptly. The early Late Cretaceous is characterized by major calcareous redepositional events (orbitoline horizons) and often associated siliciclastic turbidite deposition (submarine-fan environments). In the late Late Cretaceous, carbonate supply increased rapidly, resulting in the evolution of a carbonate slope and basin-plain setting. Pelagic and allodapic limestones recorded basinwide blooms in planktonic foraminifera (*elevata* event) and a polyphase redepositional history that is interpreted to reflect the sensitivity of the basin to the tectonic evolution of Apulia.

NIMMERGUT, A. 2002. Radiolarians in the Sea of Okhotsk: Actuopaleontological characterisation of the biocenosis and taphocenosis. *Berichte zur Polar- und Meeresforschung* **406**, 1-151.

Radiolarians in the plankton and in surface sediments from the Sea of Okhotsk were studied for a better understanding of their ecological preferences. To improve palaeoecological reconstructions a better knowledge about the significance of the radiolarian signal in the sediments is achieved by comparing the radiolarian biocenosis. The regional and depth distribution of the radiolarians was investigated at 24 plankton stations collected with opening/closing nets from five depth intervals down to a water depth of 1000 m during the summer of 1998 and the spring of 1997. The radiolarian standing stock varied seasonally and regionally from 10 to 1775 skeletons/m^3 and is associated with the plankton succession in the Sea of Okhotsk. It was low during the diatom bloom and the maximum export production of biogenic silica in spring (less than 300 skeletons/m^3 at most stations) but increased in summer, when the production of heterotrophic organisms is the highest. The maximum radiolarian standing stock was found in the western part of the Sea of Okhotsk. The radiolarian taxa undergo a seasonal succession in which Phaeodaria dominate during spring and Nassellaria dominate during summer. 55 taxa and 56 taxa were found in the water column during spring and summer, respectively. *Antarctissa* (?) sp. 1, *Ceratospyris borealis*, *Cycladophora davisiana*, *Dictyophimus hirundo*, *Euphysetta* sp. aff. *C. neptuni*, *Lophospyris* sp. 1, Peridium sp. 1, the Plagoniidae, *Protocystis tridens*, and Rhizoplegma boreale make up 87% of the spring assemblage and 77% of the summer assemblage. Seven factor assemblages, which are associated with specific water masses, are revealed by factor analysis. Distinct regional differences in the radiolarian absolute abundances and assemblage composition were also found in 35 surface sediment samples. Comparing the radiolarian concentration with the radiolarian accumulation in the surface sediments it becomes obvious that the radiolarian concentration is affected by terrigenous input. As a result, the concentrations in vicinity to the coast are low and maximum values of up to 39200 skeletons/g are restricted to the central area of the Sea of Okhotsk. In contrast, the radiolarian accumulation rate reflects the radiolarian production and maximum values up to 1100 X 10^4 skeletons m^{-2} $year^{-1}$ are found in the western part of the investigated area. Three assemblages defined by factor analysis reflect the water masses and biological production. Single indicator species, which are not important in the factor analysis, and the accumulation rate of taxa provide additional ecological information. A first evaluation of the ecological signal in the sediment is attempted by comparing the radiolarian biocenosis with the taphocenosis. The radiolarian taphocenosis is ecological meaningful and mainly represents the summer radiolarian production from 200 to 500 m water depth.

NISHIMURA, A. 2003. The skeletal structure of *Prunopyle antarctica* Dreyer (Radiolaria) in sediment samples from the Antarctic Ocean. *Micropaleontology* **49** (2), 197-200.

The skeletal structure of *Prunopyle antarctica* Dreyer is examined and redescribed on the basis of new observations from sediment samples from the Antarctic Ocean. Various forms of the species are illustrated.

NIWA, M., KASHIWAGI, K. & TSUKADA, K. 2003. Jurassic, Triassic and Permian radiolarians from the

Hirayu complex of the Mino Belt in the Nyukawa-Hirayu area, Gifu Prefecture, central Japan. *The Journal of Earth and Planetary Sciences Nagoya University* **50**, 13-42.

This study is focused on radiolarians from the Hirayu complex in the Nyukawa-Hirayu area, central Japan. The Hirayu Complex, which is a part of the Jurassic accretionary complex of the Mino Belt, is characterized by a melange including clasts of sandstone, felsic tuff, siliceous mudstone, red mudstone, chert, limestone and mafic volcanic rocks in a matrix of black mudstone and gray siltstone. Newly obtained radiolarians from this area constrain the age of black mudstone, gray siltstone, felsic tuff, siliceous mudstone and red mudstone as follows: black mudstone is Bajocian to Callovian, gray siltstone is Bajocian, felsic tuff is late Pliensbachian to Bajocian, siliceous mudstone is Toarcian to early Aalenian and red mudstone is Toarcian in age. Radiolarians from chert in this study indicate Permian to Early Triassic, early Anisian of Middle Triassic and middle Sinemurian to early Aalenian of Jurassic in age. The radiolarians clearly show that the clasts of siliceous mudstone, red mudstone and chert are older in age than the melange matrix.

OHKUSHI, K., ITAKI, T. & NEMOTO, N. 2003. Last glacial-Holocene change in intermediate-water ventilation in the northwestern Pacific. *Quaternary Science Reviews* **22** (14), 1477-1484.

The modern North Pacific is the terminus for deep-water circulation. While no deep-water mass is formed today, the region is the source of North Pacific Intermediate Water (300-800 m) formed primarily in the Sea of Okhotsk. However, the source and strength of intermediate-water in the glacial North Pacific was likely different from the present intermediate-water. Here we present microfossil evidence of late Quaternary ventilation changes associated with changes in intermediate-water. Intermediate-water ventilation decreased drastically at the glacial termination when it switched to the modern circulation system. The ventilation change appears to have been widespread and synchronous in the North Pacific. Glacial microfossil assemblages indicate that there was relatively strong ventilation of intermediate-water, which seems to have been cold and well-oxygenated as if produced by brine rejection during the formation of sea ice. On the basis of the glacial distribution of microfossils in the North Pacific, we suggest that intermediate-water was derived from the Bering Sea during the glacials, rather than the Sea of Okhotsk.

OKAMOTO, K., SHINJOE, H., KATAYAMA, I., et al. 2004. SHRIMP U-Pb zircon dating of quartz-bearing eclogite from the Sanbagawa Belt, south-west Japan: implications for metamorphic evolution of subducted protolith. *Terra Nova* **16** (2), 81-89.

In order to decipher the origin of eclogite in the high-P/T Sanbagawa metamorphic belt, SHRIMP U-Pb ages of zircons from quartz-bearing eclogite and associated quartz-rich rock (metasandstone) were determined. One zircon core of the quartz-rich rock yields an extremely old provenance age of 1899 +/- 79 Ma, suggesting that the core is of detrital origin. Eight other core ages are in the 148-134 Ma range, and are older than the estimated age for trench sedimentation as indicated by the youngest radiolarian fossil age of 139-135 Ma from the Sanbagawa schists. Ages of metamorphic zircon rims (132-112 Ma) from the quartz-rich rock are consistent with metamorphic zircon ages from the quartz-bearing eclogite, indicating that eclogite facies metamorphism peaked at 120-110 Ma. These new data are consistent with both the Iratsu eclogite body and surrounding highest-grade Sanbagawa schists undergoing coeval subduction-zone metamorphism, and subsequent re-equilibration under epidote amphibolite facies conditions during exhumation.

OKAZAKI, Y., TAKAHASHI, K., YOSHITANI, H., et al. 2003. Radiolarians under the seasonally sea-ice covered conditions in the Okhotsk Sea: flux and their implications for paleoceanography. *Marine Micropaleontology* **49** (3), 195-230.

Four time-series sediment traps at two stations and three piston cores from the Okhotsk Sea were quantitatively examined for coarse-sized radiolarian shells (> 63 mum). Traps were deployed at 300 m and 1550 m at Station M4 (53°01'N, 145°30'E) and at 300 m and 700 m at Station M6 (49°30'N, 146°28'E) during August 1998 through May 2000. The chronologies of the piston cores were established applying 5180 and paleomagnetic intensity variations; they provide records extending back to marine isotope stage (MIS) 5.51. The modern and past changes in radiolarian assemblages are associated with environmental and productivity changes. Radiolarian fluxes in the sediment traps exhibited significant summer to autumn flux peaks with suppressed values during the winter when sea-ice covered the sea surface at the trap sites. Total radiolarian accumulation rate (RAR) variations in each core tended to correspond to glacial-interglacial cycles and increased during the last deglaciation. In particular, the temporal RAR variation in Core XP98-PC1 (off Kamchatka) showed a similar trend with the climatic changes expressed by delta(18)O values during the glacial-interglacial cycles for the last 125 kyr. Regional differences were also apparent. RARs showed extremely low values during 12-40 kyr and 63-70 kyr in Core XP98-PC2 (central Okhotsk Sea), indicating the enhanced sea-ice impact. The sea-ice coverage might have continued for a significant part of the year during the intervals since radiolarians did not appear to increase even during the summer to autumn. RAR variations in Core XP98-PC4 (off Sakhalin) showed higher values than XP98-PC2 during MIS 2 and 4. Thus, in eastern Sakhalin around Site XP98-PC4, sea-ice coverage might have been seasonal, but not perennial even during MIS 2 and 4. Among the radiolarian taxa, *Cycladophora davisiana* was the most abundant species at the lower traps and in all cores. The fluxes of *C. davisiana* at lower traps showed much higher values than those of upper traps, and also showed similar temporal patterns with the fluxes of aluminum and terrigenous materials. Therefore, *C. davisiana* fluxes may be associated with terrigenous organic materials. Increased nutrient supply from the continental shelves, presumably transported by seasonal sea-ice and released by sea-ice melting, might be mainly responsible for the high production of *C. davisiana* in the Okhotsk Sea, especially during the last deglaciation.

PETERS, S. G., ARMSTRONG, A. K., HARRIS, A. G., et al. 2003. Biostratigraphy and structure of Paleozoic host rocks and their relationship to carlin-type gold deposits in the Jerritt Canyon mining district, Nevada. *Economic Geology and the Bulletin of the Society of Economic Geologists* **98** (2), 317-337.

The Jerritt Canyon mining district in the northern Independence Range, northern Nevada, contains multiple, nearly horizontal, thrust masses of platform carbonate rocks that are exposed in a series of north-to north-east-elongated, tectonic windows through rocks of the Roberts Mountains allochthon. The Roberts Mountains allochthon was emplaced during the Late Devonian to Early Mississippian Antler orogeny. These thrust masses contain structurally and stratigraphically controlled Carlin-type gold deposits. The gold deposits are hosted in tectonically truncated units of the Silurian to Devonian Hanson Creek and Roberts Mountains Formations that lie within structural slices of an Eastern assemblage of Cambrian to Devonian carbonate rocks. In addition, these multiply thrust-faulted and folded host rocks are structurally interleaved with Mississippian siliciclastic rocks and are overlain structurally by Cambrian to Devonian siliciclastic units of the Roberts Mountains allochthon. All sedimentary rocks were involved in thrusting high-angle faulting, and folding, and some of these events indicate substantial late Paleozoic and/or Mesozoic regional shortening. Early Pennsylvanian and late Eocene dikes also intrude the sedimentary rocks. These rocks all were uplifted into a northeast-trending range by subsequent late Cenozoic Basin and Range faulting. Eocene sedimentary and volcanic rocks flank part of the range. Pathways of hydrothermal fluid flow and locations of Carlin-type gold orebodies in the Jerritt Canyon mining district were controlled by structural and host-rock geometries within specific lithologies of the stacked thrust masses of Eastern assemblage rocks. The gold deposits are most common proximal to intersections of northeast-striking faults, northwest-striking dikes, and thrust planes that lie adjacent to permeable stratigraphic horizons. The host stratigraphic units include carbonate sequences that contained primary intercrystalline permeability, which provided initial pathways for fluid flow and later served as precipitation sites for one minerals. Alteration, during, and perhaps prior to mineralization, enhanced primary permeability by dissolution, by removal of calcite, and by formation of dolomite. Ore-stage sulfide minerals and alteration minerals commonly precipitated in pore spaces among dolomite grains. Microveinlets and microbreciation in zones of intense alteration also provided networks of secondary permeability that further enhanced fluid flux and produced additional sites for ore deposition.

RADIONOVA, E. P., BENIAMOVSKI, V. N., IAKOVLEVA, A. I., et al. 2003. Early Paleogene transgressions; stratigraphical and sedimentological evidence from the northern Peri-Tethys. *Special Paper Geological Society of America* **369**, 239-261.

Our study in lithologically diverse lower Paleogene deposits of the former southern USSR and West Siberia resolves three sedimentary provinces: (i) Southern (Crimea-Caucasus and Central Asia), dominated by biogenic calcareous sediments of the deepest basinal portions; (ii) Transitional (southern Russian craton and Turan plate), displaying calcareous and siliceous clayey deposits; and (iii) Northern (central Russian craton and West Siberian plate), showing biogenic siliceous and terrigenous-siliceous sediments of basinal margin. We used standard and regional scales based on seven microfossil groups (planktonic and benthic foraminifers, nannoplankton, radiolaria, diatoms, silicoflagellates, and dinocysts) to correlate various sediment facies among approximately 80 reference sections across the study area. Correlation was performed for the Transitional province, where the presence of both calcareous and siliceous facies affords the use of calcareous and siliceous planktonic and dinocyst scales with varying resolutions. Besides, in the Transitional province, we established regional sedimentary cycles corresponding to the late Thanetian, Ypresian, and late Lutetian-Bartonian. These cycles are traceable into the Northern province, enabling us to determine or refine ages of the sequences, and into the Southern province. Each sedimentary supercycle falls into three units, often with hiatus at the base, correlatable to 3rd order eustatic cycles and featured by distinctive facies. The facies succession appears to reiterate through the upper Thanetian, Ypresian, and upper Lutetian-Bartonian cycles. The lower units of each supercycle are composed of calcareous sediments rich in nannofossils and foraminifers and are traceable from the Southern province into the Transitional province, the late Lutetian unit extending as far as the Northern province. The middle unit is high in organic matter in the Southern province and passes into terrigenous-siliceous sediments rich in radiolaria, diatoms, and dinocysts in the Transitional and Northern provinces. The upper unit is terrigenous-carbonate and, in places, terrigenous-siliceous in the Southern province, becoming terrigenous-siliceous and biogenic siliceous (spongolites, diatomites) in the Transitional and Northern provinces. Calcareous plankton (lower unit) giving way to siliceous (upper unit) might record changes in basinal circulation due to Peri-Tethys communicating with the North Atlantic and/or Arctic. The sedimentary provinces shifted southward as the Peri-Tethys shrank and climate changed between the Thanetian and Bartonian.

RASMUSSEN, J. A. & SHELDON, E. 2003. Microfossil biostratigraphy of the Palaeogene succession in the Davis Strait, offshore West Greenland. *Marine and Petroleum Geology* **20** (9), 1017-1030.

A new microfossil based biostratigraphy of the Paleocene and Lower Eocene sediments of the Hellefisk-1, Ikermiut-1, Kangamiut-1, Nukik-1, and Nukik-2 boreholes offshore West Greenland has been established. In general, the five boreholes contain fairly well-preserved, diverse microfossil faunas and floras consisting mainly of foraminifera, radiolaria, ostracods and diatoms. The studied interval was subdivided into three foraminiferid biostratigraphic intervals, in ascending stratigraphic order, the *Stensioeina beccariiformis*, *Praeglobobulimina ovata* and *Pseudohastigerina wilcoxensis* intervals and five biostratigraphic intervals based on additional microfossil groups (the *Thalassiosiropsis wittiana*, *Fenestrella antigua-Coscinodiscus morsianus*, Ostracod, *Aulacodiscus hirtus* and *Cenodiscus-*, *Cenosphaera* intervals). The intervals are more easily recognised in the two basinal boreholes, Ikermiut-1 and Kangamiut-1, than in the three more nearshore boreholes, Nukik-1, Nukik-2 and Hellefisk-1, due to a higher microfossil diversity and abundance.

ROBERTSON, A. H. F. & USTAOMER, T. 2004. Tectonic evolution of the intra-pontide suture zone in the Armutlu Peninsula, NW Turkey. *Tectonophysics* **381** (1-4), 175-209.

The Armutlu Peninsula and adjacent areas in NW Turkey play a critical role in tectonic reconstructions of the southern margin of Eurasia in NW Turkey. This region includes an inferred Intra-Pontide oceanic basin that rifted from Eurasia in Early Mesozoic time and closed by Late Cretaceous time. The Armutlu Peninsula is divisible into two metamorphic units. The first, the Armutlu Metamorphics, comprises a ?Precambrian high-grade metamorphic basement, unconformably overlain by a ?Palaeozoic low-grade, mixed siliciclastic/carbonate/volcanogenic succession, including bimodal volcanics of inferred extensional origin, with a possibly inherited subduction signature. The second unit, the low-grade Iznik Metamorphics, is interpreted as a Triassic rift infilled with terrigenous, calcareous and volcanogenic lithologies, including basalts of within-plate type. The Triassic rift was unconformably overlain by a subsiding Jurassic-Late Cretaceous (Cenomanian) passive margin including siliciclastic/carbonate turbidites, radiolarian cherts and manganese deposits. The margin later collapsed to form a flexural foredeep associated with the emplacement of ophiolitic rocks in Turonian time. Geochemical evidence from meta-basalt blocks within ophiolite-derived melange suggests a supra-subduction zone origin for the ophiolite. The above major tectonic units of the Armutlu Peninsula were sealed by a Maastrichtian unconformity. Comparative evidence comes from the separate

Almacik Flake further cast.Considering alternatives, it is concluded that a Mesozoic Intra-Pontide oceanic basin separated Eurasia from a Sakarya microcontinent, with a wider Northern Neotethys to the south. Lateral displacement of exotic terranes along the south-Eurasian continental margin probably also played a role, e.g. during Late Cretaceous suturing, in addition to overthrusting.

SACCANI, E., PHOTIADES, A. & PADOA, E. 2003. Geochemistry, petrogenesis and tectono-magmatic significance of volcanic and subvolcanic rocks from the Koziakas Melange (Western Thessaly, Greece). *Ofioliti* **28** (1), 43-57.

The Koziakas ophiolites have previously been interpreted as a Jurassic complex generated at a mid-ocean spreading ridge, and have been subdivided into a lower volcanic unit and an upper ultramafic unit.The data presented in this paper demonstrate that the lower volcanic unit is, in fact. a tectonic melange consisting of a polygenetic, multiple packet of stacked thrust-bound slices, representing distinct volcanic sequences and radiolarian chert successions.Volcanic sequences include pillowed and massive lava varieties, which are frequently crosscut by dikes of various nature, including boninitic dikes. Both lava varieties and dikes are predominantly aphyric, though a few samples display slightly porphyritic textures, where phenocryst assemblages include olivine and/or plagioclase in pillow and massive lavas, clinopyroxene, plagioclase and sanidine in trachytic dikes, clinopyroxene in boninitic dikes.Geochemical data point out the presence of three compositionally distinct groups of lavas: (1) transitional to alkaline basalts, trachyandesites, trachytes; (2) tholeiitic basalts: (3) very low-Ti (boninitic) basaltic andesites and andesites.The transitional to alkaline rocks displays high Nb/Y ratios and enriched incompatible element characteristics, similar to those of many intraplate oceanic island basalts (OIB).The tholeiitic group display lower abundances of incompatible elements and includes rocks resembling normal mid-ocean ridge basalts (N-MORB) with light REE (LREE) depletion (La-N/Sm-N = 0.29) and very low Ce/Y, Ta/Hf, Th/Yb ratios, as well as rocks resembling enriched mid-ocean ridge basalts (E-MORB) showing moderate LREE enrichment (La-N/Sm-N = 1.26-1.52) and Ce/Y, Ta/Hf. Th/Yb ratios higher than those of N-MORBs.The very low-Ti group displays greatly depleted incompatible element abundances and the U-shaped REE patterns typical of boninites generated in supra-subduction settings.The Koziakas Melange appears to have formed due to tectonic dismemberment and accretion of material generated in an oceanic environment (MORBs and OIB-type rocks). possibly in an intra-oceanic forearc setting. After their accretion these rocks were affected by widespread boninitic dikes generated by partial melting of depleted peridotites in the fore-arc setting.The record of different lava types in the Koziakas Melange is in accordance with the general geological evolution of the Neo-Tethyan Pindos oceanic basin, from the Permo-Triassic rifting to the Middle-Late Jurassic intra-oceanic convergence phase.

SAITO, M. & TOSHIMITSU, S. 2003. Permian radiolarian fossils from the basement of the Lower Cretaceous Tomochi Formation in the Tomochi area, central Kyushu. *Chishitsugaku Zasshi = Journal of the Geological Society of Japan* **109** (1), 71-74.

Early Cretaceous Tomochi Formation in central Kyushu is occupied by northern margin of the Chichibu Belt along the Usuki-Yatsushiro Tectonic Line. The Tomochi Formation is shallow marine sediment and correlative with the Monobegawa Group in Shikoku. The Tomochi Formation unconformably covers the Hirodaira Unit composed of melange. We have discovered Late Permian radiolarian fossils from terrigenous sediments of the Hirodaira Unit. We clarified that the correlative of the Monobegawa Group in Kyushu covers the Permian accretionary complex same as in central Shikoku. And it has revealed that the Permian accretionary complex occurs in two rows around the area.

SHIMIZU, I. & YOSHIDA, S. 2004. Strain geometries in the Sanbagawa Metamorphic Belt inferred from deformation structures in metabasite. *Island Arc* **13** (1), 95-109.

Ductile deformation in the Sanbagawa Metamorphic Belt has been considered to be characterized by uniaxial elongation parallel to the east-west-trending lineation, based on strain analysis of radiolarian fossils in metachert. However, only limited data were available to test this idea in strongly recrystallized schists. Strain measurements on deformed pillow structures in central Shikoku show uniaxial flattening, whereas pressure shadows around pyrite in the Kanto Mountains indicate constrictional strain. In addition, in the low-grade part of the Sanbagawa Metamorphic Belt belonging to the Northern Chichibu Belt in the Kanto Mountains, deformed amygdules in pillow lava show flattening strain, which is consistent with the results of strain measurements using radiolarian fossils in the same area. These observations, together with the results of other strain analyses reported so far, indicate that the strain field is not uniform and that the east-west-trending shearing and stretching were not pervasive in the Sanbagawa Metamorphic Belt.

SHYAMPRASAD, M., GUPTA, S. M. & KODAGALI, V. N. 2003. Two layers of Australasian impact ejecta in the Indian Ocean? *Meteoritics & Planetary Sciences* **38** (9), 1373-1381.

Only 2 Australasian tektites have been found in the Indian Ocean, and both are associated with surficial sediments. We collected cores from both locations where the tektites have been reported. Microtektites in these cores (and both the tektites, as reported earlier) have chemical composition within the compositional range previously reported for Australasian tektites and microtektites. In both locations, while tektites are occurring at the sediment / water interface, the microtektites are found buried in older horizons beneath the sea floor at the stratigraphic levels conforming to the radiometric ages of the strewn field. Thus, at first glance, there appear to be 2 layers of Australasian impact ejecta in the Indian Ocean. However, the manganese nodules are associated with tektites which, although million of years old, are invariably resting on recent sediments. Therefore, the mechanism that retains nodules at the sea floor also seems to be operative on the tektites, thus leading to this apparent “age paradox” of tektites/microtektites distribution in the Indian Ocean, although they both belong to the same impact event.

SISSON, V. B., HARLOW, G., AVÉ LALLEMANT, H. G., et al. 2003. Two belts of jadeitite and other high-pressure rocks in serpentinites, Motagua fault zone, Guatemala. *Abstracts with Programs Geological Society of America* **35** (4), 75.

The Motagua River of Guatemala follows the present plate boundary zone (PBZ) between the North American (Maya Block) and Caribbean plates (Chortis Block). The central portion of the Motagua River Valley is bordered by E-W striking tectonic slices of serpentinite, some of which contain blocks of high P/T rocks, including eclogites, amphibolites, and jadeitites. Previously, this has been interpreted as a single ophiolite complex - El Tambor Group. However, the sheeted dikes and gabbros of a complete ophiolite are rare, and the units are strongly dismembered. Metamorphosed basaltic rocks (prehnite-pumpellyite facies and, in cases, actinolite-bearing), radiolarian cherts, and greywackes occur sporadically within fault slices of the El Tambor Group. Recent exploration for commercial jadeitite - jade - has revealed large quantities in serpentinite bodies farther from the river; there is a far greater areal distribution of jadeitite than previously recognized. The southern bodies, adjacent to Chortis basement, also contain abundant eclogite, glaucophane eclogite, blueschist, and other high P/T rocks. The northern bodies, adjacent to Maya basement, include abundant jadeitite, albitite, and amphibolite but rare eclogite. Our initial studies find metasomatic signatures in most of the high-P/T rocks and mineralogical differences between the northern and southern jadeitites. Preliminary Ar/Ar dating of phengite consistently shows the northern rocks with 65-77 Ma ages and southern with 116-125 Ma ages; surprisingly, two high P/T events are evident. These dates would suggest the El Tambor Group is actually comprised of some combination of ophiolite and two sets of exhumed serpentinite, the older one emplaced into the Chortis block and the younger into the Maya block. The southern belt may record collision of the Chortis block with Mexico. This suite was exhumed during by transpression and left lateral strike-slip faulting along the ancestral MFZ. The younger ages in the Maya block probably reflect subduction of the Chortis block during closure of a back arc basin; the back arc basin is now represented as the Santa Cruz and other ophiolite belts. Thus, MFZ contains two high-pressure belts with different exhumation histories in the PBZ in Guatemala.

SU, S., MCARDLE, B. H., RODGERS, K. A. & HOLLIS, C. J. 2003. Wavelet analysis of variations in geochemical and microfossil data across the Cretaceous/Tertiary boundary at Flaxbourne River. *New Zealand Journal of Geology and Geophysics* **46**, 199-208.

Wavelet analysis of 58 elemental, mineralogical, and bioclastic variables, taken from 33 samples collected at -2 to +5 m across the Cretaceous/Tertiary (K/T) boundary at Flaxbourne River, eastern Marlborough, identified 9 classes of variables exhibiting 3 main styles of behaviour: (1) classes 1, 3, and 5 exhibit abrupt enrichment at the boundary with either sudden, rapid, or gradual decline in the Paleocene (e.g., Zn, Cr, Pb, Ni, Al, Fe, Rb, Th, Ga, quartz); (2) classes 2 and 4 exhibit an abrupt decrease at the K/T boundary followed by progressive decline in the Paleocene (e.g., Ca, Mn, Sr, La, Sc, calcite), and (3) classes 6, 7, and 9 exhibit a minor change at the boundary followed by progressive increase in the Paleocene (e.g., Ba, Si, Ba/Ti, radiolarian diversity, radiolarian abundance, diatom/radiolarian ratio). In class 8 ($d^{13}C$, $d^{18}O$) there is little change other than a gradual increase or gradual decrease across the boundary. Classes 1-6 include 37 of the 59 variables analysed and the first principal component accounts for $\geq 75\%$ of variation, indicating a significant level of congruity through time that is lacking among the trajectories of the wavelet trends of the members of classes 7-9. Nine parameters display unclassifiable trends, due either to truly unique trends or anomalous values. The analysis was undertaken with no prior geological-based grouping of any of the variables. Nonetheless, the resulting classification groups well-established K/T boundary markers as well as paleoenvironmental indicators. However, where postdepositional processes have affected the values of parameters (e.g., opal-CT, stable isotopes), wavelet trends either display a low level of coherency and/or fail to follow simple geological trends.

SUZUKI, H. & GAWLICK, H.-J. 2003a. Biostratigraphie und Taxonomie der Radiolarien aus den Kieselsedimenten der Blaa Alm und nördlich des Loser (Nördliche Kalkalpen, Callovium-Oxfordium). [Biostratigraphy and taxonomy of radiolarians from cherty sedimentary rocks of Blaa Alm and north of Loser (Northern Calcareous Alps, Callovian-Oxfordian).]. *Mitteilungen der Gesellschaft der Geologie und Bergbaustudenten in Österreich* **46**, 137-228.

Cherty sedimentary rocks (cherty carbonates, radiolarites) with a thickness nearby 200 m, mapped as the Allgäu Formation (Lower Jurassic to ?Late Jurassic) previously, in the Hallstatt Zone north of Loser and in the Blaa Alm area are dated newly by radiolarians as Callovian to Oxfordian. These data show that the cherty sedimentary rocks north of Loser and in the Blaa Alm area are not a part of the Allgäu Formation, but are a part of the Ruhpolding Radiolarite Group, especially the Strubberg Formation. On the basis of these results it can be demonstrated that the Callovian to Oxfordian cherty sedimentary rocks are tectonically underlying the Loser unit (= Late Triassic to Late Jurassic) or separated from it by a fault zone. 13 families, 56 genera, 113 species and 8 subspecies of radiolarians are described in the systematic part. One species, *Stichomitra annibill* KOCHER, is emended.

SUZUKI, H. & GAWLICK, H.-J. 2003b. Die jurassischen Radiolarienzonen der Nördlichen Kalkalpen. [The Jurassic radiolarian zones of the Northern Calcareous Alps.]. *Gmundner Geo-Studien* **2**, 115-122.

We propose the comprehensive radiolarian zonation for the Jurassic of the Northern Calcareous Alps for the first time. The proposed zonation consists of the six zones, i. e. *Trexus dodgensis* zone (Hattangian-Sinemurian), *Hsuum exiguum* zone (Toarcian-Aalenian), *Eucyrtidiellum unumaense* zone (Bajocian-Bathonian), *Zhamoidellum ovum* zone (Callovian-Oxfordian), *Podocapsa amphitreptera* zone (Kimmeridgian) and *Cingulotur-ris cylindra* zone (lower Tithonian). The *Trexus dodgensis* zone is subdivided into the three subzones: *Gorgansium alpinum* subzone (Hettangian), *Bagotum* sp. A subzone (Hettangian/Sinemurian boundary) and *Bagotum erraticum* subzone (Sinemurian). The *Hsuum exiguum* zone is subdivided into the two subzones: *Eucyrtidiellum* cf. *disparile* subzone (lower Toarcian) and *Hexasaturnalis hexagonus* subzone (upper Toarcian-Aalenian). The *Zhamoidellum ovum* zone is subdivided into the three subzones: *Protunuma lanosus* subzone (Callovian), *Williriedellum dierschei* subzone (lower Oxfordian) and *Eucyrtidiellum unumaense-Podocapsa amphitreptera* interval zone (upper Oxfordian). Taking these zones/subzones and the two zones of Steiger (1992) into consideration, the Jurassic of the Northern Calcareous Alps can be divided into thirteen radiolarian zones.

SUZUKI, H. & KUWAHARA, K. 2003. Permian radiolarians from the Kosado area of Sado Island, central Japan. *Chishitsugaku Zasshi = Journal of the Geological Society of Japan* **109** (8), 489-492.

Late Permian (early Kuman) radiolarians are reported and depicted from Sado Island of Niigata Prefecture, central Japan, for the first time. The radiolarian fauna is obtained from mudstone. It is composed of *Follicucullus charveti* Caridroit et De Wever, *Follicucullus ventricosus* Ormiston et Babcock, *Entactinosphaera* aff. *cimelia* Nazarov et Ormiston, *Entactinosphaera pseudocimelia* Sashida et Tonishi, *Hegleria mammilla* (Sheng et Wang) and so on. A part of the pre-Tertiary rocks of Sado

Island should be correlated to the Permian of the Ultra-Tanba Belt or Joetsu Belt, although they have previously been regarded as one of the Mesozoic accretionary complexes of the Ashio Belt.

SUZUKI, H., KUWAHARA, K., KOMINE, A., et al. 2004. Geologisches Alter der Tanba-Gruppe im Gebiet Takagamine der Stadt Kyoto, Japan. [Geologic age of the Tanba Group in the Takagamine area of Kyoto City, Japan.]. *Nature and its Environment [Japanese with German and English abstracts]* **6**, 14-27.

Jurassic radiolarians have been newly found from chert and siliceous mudstone of the Takagamine area, northwestern part of Kyoto City and their ages can be discussed for the first time. The black chert can be correlated to the Upper Sinemurian to Pliensbachian on the basis of following radiolarians: *Cenosphaera clathrata* Parona, *Parahsuum simplum* Yao, *Parahsuum* aff. *simplum* Yao, *Praeconocaryomma immodica* Pessagno et Poisson, *Praeconocaryomma* aff. *magnimamma* (Rüst), *Sphaerostylus lanceola* (Parona), *Stichocapsa* cf. *obesa* (Yeh) und *Syringocapsa westermanni* (Whalen et Cater). The rock fragment included in black mudstone yields following radiolarians and can be correlated to the Bajocian: *Praezhamoidellum* cf. *yaoi* Kozur, *Hemicryptocapsa* cf. *szeligoviensis* (Widz et De Wever), *Triversus hexagonatus* (Heitzer), *Parahsuum longiconicum* Sashida, *Archaeodictyomitra gifuensis* Takemura, *Zartus* cf. *dickinsoni* Pessagno et Blome, *Quarticella* cf. *conica* Takemura and *Eucyrtidiellum unumaense unumaense* (Yao). The siliceous mudstone can be correlated to the Callovian to lower Oxfordian on the basis of following radiolarians: *Cyrtocapsa* sp. A sensu Matsuoka, *Eucyrtidiellum* cf. *nodosum* Wakita, *Eucyrtidiellum ptyctum* (Riedel et Sanfilippo), *Gongylothorax* aff. *favosus* Dumitrica, *Gongylothorax sakawaensis* Matsuoka, *Hsuum* cf. *maxwelli* Pessagno, *Parahsuum* aff. *simplum* Yao, *Praezhamoidellum buekkense* Kozur, *Stichocapsa* cf. *naradaniensis* Matsuoka, *Stichocapsa robusta* Matsuoka, *Tricolocapsa conexa* Matsuoka, *Tricolocapsa plicarum* Yao, *Tricolocapsa undulata* (Heitzer), *Williriedellum dierschei* Suzuki et Gawlick. Our age determination elucidates that the accretionary complex of the Takagamine area belongs to the Type I Suite of the Tanba Group. The occurrence of Callovian/lower Oxfordian siliceous mudstone, the lithologic characteristic and the tectonic position suggest that the accretionary complex of the Takagamine area is correlated to the Tsurugaoka Complex of the northern Tanba Belt.

SUZUKI, H., PRINZ-GRIMM, P. & SCHMIDT-EFFING, R. 2002. Radiolarians from the Hettangian/Sinemurian boundary of northern Peru. *Palaeontologische Zeitschrift* **76** (2), 163-187.

Well-preserved radiolarians are described from the Lower Jurassic of Tingo, Utcubamba valley, northern Peru. The section "Cerro Negro" is well dated by ammonites. The radiolaria-bearing horizon can be correlated with the *Pseudaetomoceras* Zone of the Hettangian/Sinemurian boundary. In the systematic part 23 genera and 37 species of the order Polycystida are described, including a new species *Perseus tingoensis*. This is the first detailed description of Lower Jurassic radiolarians from South America, and the stratigraphic range of described taxa is revised.

TAKAHASHI, O., MAYAMA, S. & MATSUOKA, A. 2003. Host-symbiont associations of polycystine Radiolaria: epifluorescence microscopic observation of living Radiolaria. *Marine Micropaleontology* **49** (3), 187-194.

In all 29 polycystine radiolarian species were obtained from surface seawater on May 28, 1999, using a plankton-net at one station (Site 990528; 26°37'18"N, 127°47'35"E) approximately 5 km northwest of Okinawa Island, Japan. In most polycystine radiolarians of the orders Nassellarida and Spumellarida symbiotic algae were observed under light microscopy. The light microscopic (LM) images of the symbionts, however, varied in clarity among individuals because of the variations in micro-anatomy of the host radiolarian cells. On the other hand, epifluorescence microscopic (EFM) observation easily detected and confirmed the existence of the algal symbionts within the host cytoplasm even in radiolarians such as *Dictyocoryne truncatum* (Ehrenberg) that include algal symbionts in the depth of the cytoplasm. The chloroplasts of the algal symbionts emitted autofluorescence in ultraviolet irradiation and they appeared red. That is, the autofluorescence images of the chloroplasts can be used to recognize the existence of the algal symbionts within the host radiolarians. Moreover, staining of the symbiont cells with 4',6-diamido-2-phenylindle permitted visualization of the nucleus in the center of the symbiont cell, confirming the existence of living endosymbiotic algae within the polycystine radiolarians. Both the LM and EFM observations of eight polycystine radiolarian species revealed the specific patterns of various host-symbiont associations. (1) The investigated polycystine radiolarians all possess algal symbionts, except for one species, i.e. *Dictyocoryne profunda* Ehrenberg. (2) The size of the algal symbionts depends on the radiolarian species. The symbionts are largely classified into two types based on the size of their diameters, i.e. about 8-10 μm for the larger group and about 5 μm for the smaller one. (3) The algal symbionts show a variety of locations within the host radiolarian cytoplasm. The types of distribution of algal symbionts may be a useful characteristic for radiolarian taxonomy.

TEKIN, U. K. & YURTSEVER, T. S. 2003. Late Triassic (Early to Middle Norian) radiolarians from the Antalya Nappes, Antalya, SW Turkey. *Journal of Micropalaeontology* **22**, 147-162.

The Gökdere Formation in Alakircay Nappe of the Antalya Nappes mainly consists of cherty limestone and limestone with calciturbidite intercalations. Moderately to well-preserved radiolarians were obtained from the Gökcam section measured from Gökdere Formation at the west of Antalya City, southwestern Turkey. The radiolarians of the Gökdere Formation obtained in this study are well correlative to the fauna researched in Queen Charlotte Islands, British Columbia and Antalya Nappes, southwestern Turkey. The age range of the radiolarians is late Early Norian to early Middle Norian based on the co-occurrence of *Capnodoce serisa*, *Harsa siscwaiensis*, *Xiphosphaera fistulata* and associated fauna.Three species (*Nodocapnuchosphaera altineri*, *Renzium whalenae* and *Enoplocampe* ? *norica*) and one subspecies (*Kinyrosphaera helicata goekcamensis*) are defined as new.

TUZOV, V. P., MITROFANOVA, L. I., DANCHENKO, R. V. & BOLDYREVA, V. P. 2003. Kurasiysk-Maruyam complex of Neogene sediments of South Sakhalin. *Petroleum Geology* **37**, 196-204.

VISHNEVSKAYA, V. S. 2002. New species of late Cretaceous radiolarians from the southern Koryak

Upland (Northeastern Russia). *Paleontologicheskii Zhurnal* (5), 3-6.

Three new radiolarian species, i.e., *Heliodiscus borealis* sp. nov., *Spongasteriscus rozanovi* sp. nov., and *Prunopyle stanislavi* sp. nov., from the Upper Cretaceous deposits of the Koryak Upland are described. The species were collected in the lower Campanian inoceramid *Pennatoceramus orientalis* Zone of the Vatyna River basin, where radiolarians occur together with foraminifers. The stratigraphic ranges of the genera *Heliodiscus*, *Spongasteriscus*, and *Prunopyle*, which previously were thought to be restricted to the Cenozoic, are extended into the Cretaceous.

VISHNEVSKAYA, V. S. & MURCHEY, B. L. 2002. Climatic affinity and possible correlation of some Jurassic to Lower Cretaceous radiolarian assemblages from Russia and North America. *Micropaleontology* **48** (Supplement 1), 89-111.

The recent distribution of ancient radiolarian faunas within the northern Pacific Rim does not reflect the initial location of paleoclimatic belts, and paleolatitudinal affinities are speculative. The correlation for typical Jurassic-Lower Cretaceous high-latitude boreal faunas of the Barents-Laptev-Upper Volga Basins with coeval eastern- and western-Pacific faunas is considered. The first appearance of typical *Parvicingula* Pessagno s.s. in the Bering-Okhotsk Region of Zone 7 and the abundance of *Parvicingula* in the lower Kimmeridgian ammonite *Kitchini* Zone (=*Buchia concentrica* Zone) of the Barents-Laptev-Volga Basin, as well as in Californian Subzone 2, where *Buchia concentrica* (Sowerby) was found in California and the ammonite *Idoceras* was collected in Mexico, presents opportunities to correlate these stratigraphic divisions. The first appearance of typical *Parvicingula elegans*. Pessagno and Whalen (within the *Buchia mosquensis* Zone) in the Kimmeridgian of the Barents-Laptev-Volga Basin allows correlation of the top of Bering-Okhotsk Zone 7 with the top of the lower part of California Subzone 3. The middle Volgian *Parvicingula haeckeli* Zone (=*Panderi* Ammonite Zone) probably can be correlated with the upper part of Californian Subzone 3 due to the presence of *Parvicingula jonesi* Pessagno. The presence of *Buchia piochii* (Dabb) in the upper Volgian *Subditus* Zone of northern Russia, associated with *Durangites* in western North American strata, can be used to correlate the *Pseudocrolanium planocephala* - *Sethocapsa devorata* Assemblage-Zone with Californian Zone 4. The correlation of the Bering-Okhotsk and California radiolarian zonations is proposed.

VISHNEVSKAYA, V. S. & SEDAEVA, K. M. 2002. A revision of some foraminiferal taxa of the order *Parathuramminida* and discussion of foraminiferal and radiolarian evolution. *Paleontologicheskii Zhurnal* (6), 15-24.

The microorganisms that have a secretory calcareous wall in the shell of spherical skeletons and are referred to the primitive foraminifers of the order *Parathuramminida* Mikhalevich 1980 (Mikropaleontologiya, 1995), which was originally described in thin sections, are revised. It is shown that many species of so-called smaller foraminifers from the Devonian-Lower Carboniferous with supposed planktonic habit are radiolarians. Most of the representatives of genera of *Archaesphaera* Suleimanov, 1945; *Parathurammina* Suleimanov, 1945; *Radiosphaera* Reitlinger, 1960; *Vicinesphaera* Antropov, 1950; *Bykovaella* Zadorozhnyi, 1984; *Parathuramminites* Antropov, 1970; *Suleimanovella* Juferov, 1984; *Salpingothurammina* Pojarkov, 1961, *Cribrosphaera* Reitlinger, 1959; *Uralinella* Bykova, 1952; and *Neoarchaesphaera* M.-Maclay, 1963, which were of worldwide distribution in the Upper Devonian-Lower Carboniferous, should apparently be transferred from the calcispheres and foraminifers to the radiolarians.

WANG, R. J., CLEMENS, S., HUANG, B. Q. & CHEN, M. H. 2003a. Quaternary palaeoceanographic changes in the northern South China Sea (ODP Site 1146): radiolarian evidence. *Journal of Quaternary Science* **18** (8), 745-756.

The abundance and accumulation rates of siliceous microfossils in the northern South China Sea, including radiolarians, diatoms and sponge spicules, increased during most glacial intervals within the past 1100 kyr. Similar trends are observed in the index of thermocline surface radiolarians (TSR), diatom accumulation rates (DAR), charcoal accumulation rates (CAR) and the abundance of radiolarian species *Cycladophora davisiana davisiana*. Decreasing sea-surface temperature accompanied by increased seasonality since 900 ka is indicated by a decline in the tropical radiolarian assemblage, including *Tetrapyle octacantha* and *Octopyle stenozona*, and by an increase in the subtropical assemblage, including *Pterocotys zancleus*, *Peromelissa phalacra* and *Ommatartuts tetrathalamus tetrathalamus*. Rapid increases at about 800 to 700 ka of siliceous microfossils, charcoal, subsurface and intermediate radiolarians, as well as the TSR index and the DAR, imply a fundamental shift in climate and a shoaling thermocline. Although these fundamental changes in the silicious fauna and flora of the South China Sea take place within the context of a developing 100-kyr cycle, they do not change in step with changing sea-level as indicated by marine delta(18)O. This is most clearly illustrated by the step-like increase in silica accumulation (radiolaria, diatoms and sponge spicules) at 680 ka. Rather, these fundamental changes probably reflect intensified surface productivity associated with enhanced East Asian winter-monsoon circulation.

WANG, Y., AITCHISON, J. C. & LUO, H. 2003b. Devonian radiolarian faunas from South China. *Micropaleontology* **49** (2), 127-145.

Devonian radiolarians from four new sections at Shaijingpo, Lila, Bazhai, and Shiti Reservoir in southern China are described. Faunas from these localities are assigned to eight families, 15 genera and 30 species, with the introduction of one new species *Trilonche parapalimbola* n. sp. Wang. The stratigraphic significance of the Middle Devonian *Eoalbaillella lilaensis* fauna, morphotypic variation within the genus *Helenifore* and the abundance and diversity of the Upper Devonian *Holoeciscus foremanae* fauna are discussed.

WANG, Y.-J., WANG, J.-P. & PEI, F. 2002. A Late Triassic radiolarian fauna in the Dingqing ophiolite belt, Xizang (Tibet). *Acta Micropalaeontologica Sinica* **19** (4), 323-336.

The Late Triassic (Carnian) radiolarian faunas found in Dingqing area, Tibet comprise 35 species (including 7 unidentified species), belonging to 19 genera, which are grouped in 16 family (subfamily). The above mentioned radiolarians are dominated by the genera *Capnuchosphaera*, *Palaeosaturnalis*, *Perispongidium*, *Spongostylus*, *Annulotriassocampe*, *Poulpus*, *Xenorum*, *Veghicyclia*, *Tetraporobrachia*, *Canoptum*, *Xiphotheca* and named the *Capnuchosphaera triassica* assemblage zone. Because the genus *Capnuchosphaera* is widely distributed in the world, the *Capnuchosphaera*-dominated radiolarian fauna is considered as important base for correlation in the international Carnian to Early-Middle Norian radiolarian biostratigraphic sequences.

YOSHIDA, K. & MATSUOKA, A. 2003. Pile-nappe structure of the Ryokami-yama chert unit in the Chichibu composite terrane of the Kanto Mountains, central Japan. *Chishitsugaku Zasshi = Journal of the Geological Society of Japan* **109** (6), 324-335.

Detailed mapping of the Ryokami area in the Kanto Mountains, Saitama Prefecture, revealed that the Ryokami-yama chert unit is divided into three subunits (Subunit 1, 2 and 3 from bottom to top). Each subunit is composed mainly of chert beds and overlying clastic rocks. This unit is characterized by a pile-nappe structure of chert-clastics sequences. Middle Jurassic radiolarian fossils were found from the uppermost part of chert beds of Subunit 1 and Subunit 2 as well as from the siliceous mudstone of Subunit 1 and Subunit 2. The transitional horizon from chert to clastics in these subunits is of Bajocian to early Bathonian age. Judging from lithological features and geological age, the Kashiwagi Formation and the Hashidate Group in the Northern Chichibu terrane should not be the origin of the Ryokami-yama chert unit. This disagrees with the previous interpretation. The Ryokami-yama chert unit is better compared to the Unazawa Formation in the Southern Chichibu terrane or to the Kamiyoshida Formation in the Northern Chichibu terrane.

ZHANG, F. & FENG, Q.-L. 2002. Early Carboniferous Radiolarians in phosphoric nodule from Manxin, Menglian, South-Western Yunnan. *Acta Micropalaeontologica Sinica* **19** (1), 99-104.

There are many nodules in the silicalite interlayer in the volcanic rock of Pingzhang Formation in the Lower Carboniferous from the Changning-Menglian structure belt, South-West Yunnan. It's proved that they are all phosphoric nodules according to X-ray diffraction analysis. The fossil radiolarians in one of them consist 9 species (including 1 undefined species) belonging to 7 genera, *Albaillella paradoxa* Deflandre, *Archocyrtium* sp., *Robotium validum* Cheng, *Triaenosphaera sicarius* Deflandre, *Entactinia herculea* Foreman, *Entactinia parva* Won, *Astroentactinia multispinosa* (Won), *Entactinosphaera inusitata* Foreman, *Entactosphaera palimbola* Foreman, which belong to *Albaillella paradoxa* zone in the middle of Tournaisian age. These phosphoric nodule should be deposited in oceanic island formed by uplifted oceanic flow, not in rift valley.