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IGCP Project short title: Circum-Arctic Palaeozoic Vertebrates

Duration and status: 1996-2000, ending

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Annual Report for 2000

IGCP 406

“Circum-Arctic Lower-Middle Palaeozoic Vertebrate Palaeontology and Biostratigraphy”

1a. Summary of Major Past Achievements of the Project

Collections of fossils and samples have been made from remote areas of countries in the northern hemisphere, many of which are normally effectively inaccessible. As a result an enhanced representative Palaeozoic fauna and flora is thus now available, and is being studied. New taxa have been discovered, displaying unexpected characters which provide a challenge to conventional ideas of inter-relationships. Their study should lead to an improved understanding of the phylogeny of early taxa, their evolutionary trends, their biogeographic distributions, and the plate tectonics of the northern hemisphere. One effect of the pooling of data from the work of participants of a large international project, such as IGCP 406, is that the results of the combination of the individual studies far outweigh the sum of the individual components when working separately.

During 1996, IGCP 406 meetings and workshops were held in Edmonton, Canada, in Uppsala, Sweden, in Tallinn, Estonia, and in Vilnius, Lithuania. International collaborative field work was carried out in northern Canada. Working groups began research initiatives involving the Canadian, Greenland, Spitsbergen, and northern Russian parts of the Circum-Arctic region.

During 1997, IGCP 406 held two meetings, in Buckow, Germany during July, and in St. Petersburg, Russia during September. Both meetings resulted in substantial volumes of abstracts published as special publications of *Ichthyolith Issues*. The St. Petersburg meeting also included a workshop for authors of a volume on Severnaya Zemlya stratigraphy, part of it to be published in Russia and another part by *Geodiversitas*, Museum national d’Histoire naturelle, Paris. In addition, smaller workshops, discussions, and field meetings, funded by other agencies, were held in London, Vilnius, and Edinburgh, and project-related field work took place in northern Canada, Alaska, and Scotland.

In 1998, IGCP 406 met in Warsaw, Poland, during September. More than 50 scientists from 16 countries participated in the scientific sessions, workshops, and field excursion. The meeting abstract volume was published as *Ichthyolith Issues Special Publication 4*, a field-excursion guide book was printed, and manuscripts were submitted for publication in a special issue of *Acta Geologica Polonica*. The above mentioned Severnaya Zemlya volumes also received manuscript submissions at the same meeting and later that year. IGCP 406 members were also key participants in an important palaeontological and biological conference held in London in April. Fruitful IGCP 406-sponsored collaborations included international field work by two different teams in northern Canada.

During 1999, IGCP 406 held its annual meeting in Jurmala (near Riga), Latvia. This meeting brought together more than 100 scientists and graduate students from 16 countries to share research results, to plan further collaborative studies of field sites and fossil collections. The meeting was held in conjunction with the Fourth Baltic Stratigraphical Conference, where our members were important participants. IGCP 406 was also represented at other meetings during 1999. Important examples are the meeting in London on Major Events in Early Vertebrate Evolution, and the Society of Vertebrate Paleontology annual meeting in Denver, U.S.A. In addition, workshops were held in Ukhta and Syktyvkar, Russia, with an associated field meeting in the Subpolar Urals.

By its final year, the project had grown to more than 200 participants from 22 countries.

1b. Overall Aims of the Project

IGCP Project 406 "Circum-Arctic Palaeozoic Vertebrates" (1996-2000) was designed to encourage international cooperation between scientists in the study of the geology of Palaeozoic strata in the Circum-Arctic Region. The actual work was carried out by working groups of the project organized on the basis of geography (Canadian Arctic, Greenland, Barentsia, Baltica, and Siberia). Another working group was set up to study palaeotectonics and palaeogeography of Palaeozoic basins in the Circum-Arctic regions. During the project, an initially small group of about 60 experts on geology grew to a large community of more than 200 persons with similar interests - palaeontology, stratigraphy, lithology and tectonics of Arctic regions. Participants came from 22 countries: Australia, Byelorussia,

Canada, China, Estonia, France, Germany, Ireland, Italy, Japan, Latvia, Lithuania, Netherlands, Norway, Poland, Russia, Sweden, Ukraine, United Kingdom, and U.S.A.

Silurian strata were studied in northern Canada (Cornwallis and Baillie-Hamilton Islands), Mackenzie Mountains, Anderson River, Boothia Peninsula), USA (Alaska), northern Greenland, Baltic countries, Britain, northern Russia [Timan-northern Urals region, Novaya Zemlya, Severnaya Zemlya, New Siberian (Novosibirsk) Islands, Wrangel Island, Taimyr Peninsula, Siberian Platform, and the Polar - Central Urals, Gornyj Altaj]. Devonian - Permian strata were investigated, in addition to the listed regions, also in Prince of Wales, Devon, and Ellesmere Islands (Canada), Spitsbergen, and eastern Greenland.

Canadian Arctic working group

The aims of this working group were to study (1) palaeontology, (2) biostratigraphy, and (3) evolutionary and environmental palaeobiology with field work in the Mackenzie Mountains and the Arctic Archipelago, and visits to different museums of the world to study existing collections.

Baltica and Siberia working groups

This group emphasized material from the northern part of the Baltica palaeocontinent (including Novaya Zemlya, Vajgach, Dolgij, and Kolguev islands; the Northern, Subpolar and Polar Urals, and the Timan Pechora Region) and from Siberia. The main tasks of the Baltica and Siberia working groups were:

- (1) to organize and coordinate co-operative studies of the Russian Arctic regions by scientists from different institutions and countries;
- (2) to study in detail the palaeontology, sedimentology and biostratigraphy of key Silurian and Devonian sections in the remote regions of the East European and Siberian cratons, and in the Russian Arctic islands (Novaya Zemlya, Severnaya Zemlya, Novosibirsk Islands, etc.);
- (3) to encourage co-operative study of taxonomy, succession, and biostratigraphy of different fossil groups to find reliable criteria for subdivision and correlation of sections;
- (4) to check and improve the correlations of local and regional stratigraphical units with the international standard; special interest was to correlate the sections of Russian Arctic islands and northern Siberia, the Timan Pechora Region, the Urals and the East European Platform;
- (5) comparative analysis of the development of the Silurian and Devonian palaeobasins on Laurentia, northern Baltica and Siberia; revision of palaeotectonic and palaeogeographic reconstructions.

Greenland working group

This group had three emphases: (1) to promote studies on Silurian vertebrate palaeontology and biostratigraphy; (2) to collect vertebrate remains from the localities of Eastern Greenland, and to reexamine Devonian fishes and early tetrapods, and (3) to revise the Cambrian-Ordovician problematic taxon *Anatolepis*.

Barentsia working group

It was planned that this group would contribute to knowledge about morphology, biology, interrelationships and environmental impact of different vertebrate groups from Spitsbergen; correlation of vertebrate and palynological biozonations was foreseen.

Working group on palaeotectonics and palaeogeography

This group was established during the meeting in Jurmala, Latvia. Its main task was comparative analysis of data collected by other working groups with the aim of reconstructing the palaeogeographical situation, and evaluating and improving the palaeotectonic reconstructions of the studied region.

1c. Overall Achievements of the Project

Canadian Arctic working group

Achievements in palaeontology.

Silurian and Lower Devonian thelodonts of the Canadian Arctic (Cornwallis and Baillie-Hamilton islands) have been studied (monograph by Märss, T. Wilson M.V.H. and Thorsteinsson R. in progress). Some 39 species (28 new, including 12 species with articulated squamation) from 24 genera (13 new), 16 families (7 new), 5 orders (1 new), and two more taxa of uncertain position are being described. This work is important because both scale taxa and taxa based on articulated thelodont squamations are described, and the body morphology of 12 species is known. New information on the geographical and stratigraphical distribution of thelodonts has also been discovered. This is the first time that a natural classification of thelodonts has been attempted. Scale taxa and "body-fossil" taxa of articulated thelodonts have been united on the basis of the presence of both sets of data for many species, including scale morphology and histology. It is evident that group Thelodonti is much more diverse and includes more than the previously defined orders Katoporida, Thelodontida and Furcaudiformes. The results of the study were reported at the Flagstaff Meeting in May 2000 (Wilson et al., 2000), and the same taxonomy with some additions has been used by Karatajute-Talimaa and Märss in the Russian Palaeontology Handbook.

Collaboration (R. Thorsteinsson and D. Elliott) and intensive study continues on heterostracans from the Canadian Arctic Archipelago, in preparation of another major monographic work whose completion is eagerly anticipated by international specialists.

Scientists from Canada, Germany, Estonia, and France have been studying gnathostome (jawed vertebrate) species from the Mackenzie Mountains, Anderson River, and the Arctic Archipelago. M. Wilson and colleagues have continued study of the Lochkovian (Early Devonian) MOTH locality in the Mackenzie Mountains, which now has an estimated diversity of more than 60 species of vertebrates. Discoveries including the oldest known complete skeletons of chondrichthyans (shark relatives). Silurian strata in the same and nearby sections are also yielding heterostracans and thelodonts. H.-P. Schultze, S. Cumbaa, and colleagues completed excavations in the Lower Devonian Bear Rock Formation at Anderson River, Northwest Territories, and in Bear-Rock-equivalent strata near the Snake River, northern Yukon Territory. The former site yielded the oldest complete skeletons of actinopterygians (ray-finned fishes) (*Dialipina*), and associated acanthodians, placoderms, porolepiforms, and lungfishes.

Achievements in biostratigraphy

Microvertebrate-based correlations of the Llandovery-Wenlock boundary in some sections of the Selwyn (Mackenzie Mountains) and Franklinian (Baillie-Hamilton and Cornwallis islands) sedimentary basins, northern Canada, were carried out (Märss et al. 1998). Additionally, Soehn et al. (2000) have published studies on correlation of Silurian-Devonian sections in the Mackenzie Mountains and summarized present knowledge of the age of numerous other vertebrate-bearing fossil localities in the region.

Results of study of the isotope geology

For the first time in the Arctic Islands the isotope values of rock samples from vertebrate-bearing sections were studied. The value curve showed the same pattern as in earlier studies of Baltic sections. In addition, conodont and vertebrate data helped the correlations of the sections with the European ones (Märss et al., 1998a,b).

Baltica and Siberia working groups, and the working group on palaeotectonics and palaeogeography:

Achievements in palaeontology

A monograph including descriptions of main groups of fossils was prepared, based on a general revision and detailed analysis of the material from the Severnaya Zemlya Archipelago (Goujet, D. /ed./ in press). Numerous palaeontologists, stratigraphers, lithologists and palaeogeographers from many countries took part in this work.

Invertebrates from the Russian Arctic have been studied and described in several papers (brachiopods by Modzalevskaya 1997 - 2000 and Beznosova 1998, 2000; ostracodes by Abushik and Evdokimova 1998, 1999, etc.; conodonts by Männik, Melnikov, Kuzmin, etc.).

Anaspids (Agnatha, Vertebrata) of the northern hemisphere, from the localities of Severnaya Zemlya, the Central Urals, the Baltic, Ringerike, southern Sweden, Greenland, the Canadian Arctic, and the

Mackenzie Mountains have been described (Blom H., Märss T. and Miller G., submitted). This study is mainly based on scale material collected during several decades, which had been described as taxa in open nomenclature, and on Norwegian and British articulated specimens from different museums. All together, 24 species (17 new) from 18 genera (12 new) and 8 families (4 new) have been described. These data show that birkeniid anaspids were a rather common group in the faunal communities, and they were rather diverse, and had wide geographic distribution. It was possible to show some tendencies in the development of the morphology and histology of scales. The new species were also used in correlations.

The handbook *Palaeontology of Russia and adjacent countries* under preparation by the Paleontological Institute of RAS, Moscow (in Russian) also deals with vertebrates from the Russian Arctic. Data on 65 thelodont species (belonging to 20 genera, 12 families and 6 orders), including their holotype, their diagnoses, and their distributions, have been given (Karatajute-Talimaa and Märss, submitted); chapters on osteostracans (Afanassieva), acanthodians (O. Lebedev), placoderms (Ivanov and Luksevics), etc. are also submitted or are in preparation.

The results of long-term studies of the Palaeozoic in the Timan Pechora Region and northern Urals are or will be published in two monographs (Melnikov, S. V. 1999; Zhemchugova and Melnikov, in press), and in several papers on corals, Devonian stratigraphy and palaeobiogeography (Kuzmin et al., 1997; Tsyganko, 2000; Tsyganko et al., 2000), and on vertebrates (Ivanov and Luksevics, 1996, 2000; Ivanov et al., 1999).

In the study of the Devonian sections of the Main and Central Devonian Fields, notable results include those on ostracodes (Evdokimova, 2000, PhD thesis under work) and on vertebrates (Ahlberg et al. 1999; Ivanov, Luksevics, 1996a,b, 2000). Valiukevicius has studied acanthodians from the Devonian of Taimyr, Severnaya Zemlya and Timan Pechora Region and brought out the fact that the acanthodians go over the boundaries of the biogeographical provinces. He also established the Early Devonian phylogenetic lineages of nostolepid acanthodians (Valiukevicius, 2000). Ivanov has analyzed the chondrichthyans from the Devonian - Permian of Russian Arctic regions and researched their histological structure and vascularization system (Ivanov, 1998, 1999, 2000).

Achievements in stratigraphy

Using biostratigraphical methods, the Silurian and Devonian strata were subdivided, while local and regional stratigraphical units and their boundaries in the Arctic regions of Baltica and Siberia have been correlated with the standard units more precisely than previously.

Research on Severnaya Zemlya in course of the IGCP Project 406 must be emphasized. A monograph dealing with the general problems of the Lower Palaeozoic stratigraphy of Severnaya Zemlya and comparison of sedimentary basins was published (Matukhin and Menner eds., 1999). In it, the distribution of all main fossil groups were presented, assemblages of fauna and their successions and biozones were established, and different correlations were given. The results of studies of conodonts allowed improvement to the datings and correlations of the Ordovician and lower Silurian strata (Männik, 1999). The upper Wenlock and the whole Upper Silurian were subdivided and correlated using thelodonts (Karatajute-Talimaa and Märss, 1999), and inter-regional correlations were based on thelodont biozonal scheme established in Baltic. It was confirmed that in the Silurian, Severnaya Zemlya, Taimyr and the Timan Pechora Region belonged to the same palaeobiogeographic province which was separated from Siberia.

Biostratigraphical investigations from the Timan-northern Urals region were most important to correlate the sections with those of Baltic countries and thereby with the Global Stratigraphical Standard units (Antoshkina, 1996, 1997a-b, etc.; Abushik, 1999a, 2000, etc.; Melnikov, 1999a,b, etc.; Modzalevskaya 1997a, 1998, etc.). Co-operative studies of reefs and sedimentology from the Timan - northern Urals region and Alaska, North America, have been very productive to find common language between geologists of these remote areas (Antoshkina, 1996, 1998a-e, etc.; Soja and Antoshkina, 1997, 1998).

Results of geological investigations (lithological, biostratigraphical etc.) of the Palaeozoic in South Timan and the Subpolar Urals, have been given in two recent guidebooks (Antoshkina, Malysheva and Männik, 2000; Belyaeva and Ivanov, 2000).

In the Timan-northern Urals region the Lower Devonian sediments are oil-bearing and economically most important. Palaeozoic oil and gas-containing carbonate complexes of the Pechora Basin (structure,

conditions of formation, prognosis for natural reservoirs) were treated in a PhD thesis (Zhemchugova, 2000), a Dr.Sci. thesis (Belyaeva, 2000) and several papers.

Detailed studies on the correlational significance of global, regional and local chronostratigraphical standards in the Silurian of Siberia (Tesakov, 2000) are noteworthy and unsurpassed.

Comparative analysis of the distribution of different fossil groups (ostracodes, vertebrates) allowed correlation of facially highly variable Upper Devonian strata (freshwater, epicontinental, shoal, and reef facies, and facies of deep water uncompensated depressions). For the first time, successions of miospore, conodont, ammonoid, and vertebrate assemblages from the Frasnian (Upper Devonian) were studied in detail, and zonations were worked out. The correlation of the Upper Devonian Regional stages with the Standard Conodont Zonation, and with eustatic cyclicity were specified. The possibility of correlating the Frasnian miospore complexes of the Timan-northern Urals region with those in North America was proved (Obukhovskaya, 2000). Frasnian vertebrate zones were traced in the Timan Pechora Region, the Urals, the Main and Central Devonian fields (Ivanov & Luksevics, 1996). Peculiarities of the Frasnian and Famennian reef buildups, and relationships between the formation of reefs and eustatic cyclicity were established (Tsyganko, 1998). The similarity of the Frasnian reef formations in the Timan-northern Urals region, Ardennes and western Canada was proved

Palaeobasinal analyses

On the basis of new biostratigraphical correlations of the Silurian and Devonian sections from the northern Siberian craton, Taimyr, Severnaya Zemlya, Novaya Zemlya, Spitsbergen, the East European craton, and some regions of North America, a comparative analysis of the development of the Silurian and Devonian palaeobasins on Laurentia, Baltica and Siberia was attempted. Coral, brachiopod, ostracode, conodont and vertebrate data were used (Matukhin, Menner et al., 1998). Possibilities for correlations of regional and global eustatic, anoxic and other events were investigated. Exact coincidence of the Early Silurian eustatic cyclicity in all compared basins was elucidated. The eustatic cycles are less distinct in the Late Silurian. Differences in sedimentation in the Early and Middle Devonian in the northern and eastern East European craton can, most probably, be explained by the appearance of the Late Caledonian orogeny.

Contours of the continent with Old Red type sedimentation in the Arctic were fixed more precisely. Based on the distribution of Devonian thelodonts and heterostracans, the position of the boundary between the North European and Siberian biogeographical provinces was drawn between Severnaya Zemlya and Taimyr. New palaeogeographical reconstructions do not support the existence of a connection between the Urals and Kolyma basins in the Silurian and Devonian across the Taimyr. The Taimyr ocean did not exist at that time.

Stable isotope studies

During recent decades, stable isotope studies of Palaeozoic strata have been a popular topic in investigations to understand the causes of environmental and biotic events. In the Baltic, the stable isotopes are studied in detail in the Upper Ordovician and Silurian strata, and this sequence can be used as a standard (Kaljo, Kiipli and Martma, 1998). In the Baltic whole rock samples are used. The same method, together with faunistic analyses, which gives the time frame, has been applied for each region under study.

Comparative analyses of the distribution of brachiopods and the changes in the C13 values (data from the Upper Silurian brachiopods) suggested a revision of the upper Silurian stratigraphy in the Timan-Pechora region (Modzalevskaya and Wenzel, 1998). Also, the position of the Llandovery-Wenlock boundary in the sequences of Severnaya Zemlya and of the Timan-northern Urals region has been under discussion for more than a decade. The results of the recent stable isotope studies in these regions agree well with the conodont data indicating that the Llandovery-Wenlock boundary lies considerably higher in the sequence than considered up to now (Männik and Martma, 1999, 2000).

2. Achievements This Year

2.1 General scientific achievements (including societal benefits)

As before, the project's aims and activities were publicized through newsletter articles (e.g. *Ichthyolith Issues*), through electronic mail to all participants, and through the *Palaeozoic Microvertebrates* World-Wide-Web page.

In July 2000, the final meeting of the IGCP Project 406 – Circum-Arctic Palaeozoic Vertebrates, or CAPV 2000 – took place in Syktyvkar, Komi Republic, Russian Federation. Approximately 60 scientists attended. The meeting was organized by the Institute of Geology of the Komi Science Centre, Uralian Division of the Russian Academy of Sciences, Syktyvkar, and by the Timan-Pechora Scientific Research Centre, Ukhta. The meeting included two geological excursions – one (pre-conference) to Timan (Upper Devonian) and the other (post-conference) to Ordovician-Permian sections in the Subpolar Urals (Kozhym River) and to selected sections in Timan. To prepare this meeting, workshops in Ukhta and Syktyvkar, and a field meeting in the Subpolar Urals (Kozhym River basin) took place in summer 1999.

Also in May 2000, many IGCP 406 members were key participants at the 9th Early/Lower Vertebrates Meeting held in Flagstaff, Arizona. This meeting was followed by an extensive field excursion with 30 participants, to important Devonian vertebrate localities in Utah and Nevada.

Numerous scientific papers presented at both of these meetings consisted of results of IGCP 406 studies; the Flagstaff results will be published as papers contributed to a special issue of *Journal of Vertebrate Paleontology*, edited by D. Elliott. The Syktyvkar results are contained in the conference volume of extended abstracts (Antoshkina et al., eds., 2000), two field-trip guide books, and in numerous technical papers published in scientific journals.

The year 2000 also saw the publication of an important volume (Blicek and Turner, eds., 2000) containing results of IGCP 328 as well as many contributions by IGCP 406 members. As well, volumes edited by Matukhin and Menner (2000) on Severnaya Zemlya biostratigraphy, and by Goujet (in press) on Severnaya Zemlya palaeontology are important contributions. A special volume of the *Proceedings of the Estonian Academy of Sciences* contains five papers by IGCP 406 members.

Other Workshops, Field Meetings, and Field Trips

A number of smaller workshops, meetings, discussions, and field trips, all funded by other agencies, were held by IGCP 406 participants during 1998. These are mentioned where relevant in the Progress by National Groups, and some are listed in a later section of this report.

Progress by National Groups

Australia:

Work is in progress on Silurian and Devonian microvertebrates (thelodonts, acanthodians, placoderms, sarcopterygians) from Arctic Canadian islands including Devon, Cornwallis and Somerset: S. Turner and C. Burrow in conjunction with J. Vergoossen (Netherlands) and Barnes, Savelle, Thorsteinsson, and Uyeno (Canada). New cooperation with E. Daeschler (USA) on Devonian material from Ellesmere Island (S. Turner) has begun. Of significance this year is work carried out by Basden, Burrow, Ritchie and Young on early gnathostomes (Basden et al. 2000; Burrow & Young, 1999).

Gavin Young is finalizing his studies on the Georgina Basin (western Queensland, central Australia) Cravens Peak placoderms (commenced in Paris last year with Daniel Goujet), which include several taxa also known from the Circum-Arctic. In Berlin with Hans Peter Schultze he was investigating phyllolepid placoderms, noteworthy for their Famennian northern hemisphere occurrences (e.g. East Greenland) compared to earlier ranges in Gondwana. Northern-southern hemisphere comparisons are essential for assessing the Devonian vertebrate biostratigraphy of East Gondwana.

Seven Australians were leading participants at the 9th Early/Lower Vertebrates Symposium: IGCP Project 406 Circum- Arctic Palaeozoic Vertebrates Meeting at Flagstaff, Arizona, USA on May 15-19, 2000. S. Turner chaired the first session on early vertebrates which included papers on thelodont phylogeny and biostratigraphy in the Arctic regions. She represented the Australian Working Group at the IGCP 406 business meeting. Many Australians also participated in the field excursion. Unfortunately the project's final Syktyvkar meeting clashed with the Palaeontology Downunder meeting in Orange, NSW.

The Australian contribution has been sustained by a few despite the long distances to meetings and relative inability to undertake field work. Direct work on Arctic materials has come from one Arctic field trip (with participation by Johanson), earlier collecting by Canadian colleagues, or evaluation of older collections in museums or by systematic studies on Silurian to Devonian fishes which are found in arctic regions as well as in Australia. Of the latter, most significant is the discovery of several taxa in

common between Arctic Canada, USA esp. Wisconsin, Nevada and Idaho, and eastern Australia, especially gnathostomes such as acanthodians and placoderms beginning in late Silurian time. Even thelodonts from Arctic Canada and Australia have similar characteristics which Turner et al. (1997) and Märss (1999) have noted. Further investigations of faunas in these regions and from suspect terranes is warranted.

Ichthyolith Issues: 4 Newsletters (17-20) and a supplementary news sheet have been produced, the last (no. 20) being placed on the project's web site.

Canada:

S. Cumbaa continues his collaborations with H.-P. Schultze (Germany) on Devonian vertebrates from the Anderson River area, Northwest Territories, visiting Berlin to collaborate on a new acanthodian taxon in the fall of the year 2000.

R. Reisz continues his collaboration with Russian and UK colleagues on the evolution of the tooth plates of dipnoans. New fossils from northwestern Russia are contributing interesting new data.

M.Sc. student K. Soehn, and Drs. B. Chatterton and M. Wilson continued work on materials from the Avalanche Lake sections (Ordovician -Silurian) of the Mackenzie Mountains, Northwest Territories. Soehn (supervisor: Wilson) continues his work on Silurian heterostracans and vertebrate biostratigraphy. The paper by Soehn, Wilson, Märss, and Hanke on vertebrate biostratigraphy of the Avalanche Lake sections was published in the special volume of IGCP 328 results. Microfossil samples from Llandovery parts of the section were dissolved and analyzed by P. Männik (conodonts) and T. Märss (vertebrates) in Estonia; these prove that some vertebrate levels in the Avalanche Lake sections are Llandovery in age.

G. Hanke and M. Wilson, assisted by undergraduate students L. Budney (heterostracan gut fillings), C. Hermus (Lochkovian *Romundina* specimens), and J. Greeniaus (possible juvenile heterostracans), continue their studies on vertebrates of the Silurian-Devonian 'MOTH' section in the same area. C. Hermus is now a Master's student studying ischnacanthid acanthodians. The total assemblage from the Lochkovian MOTH locality now includes more than 60 species (many undescribed as yet) (Wilson et al. 2000). Soehn, Wilson, and T. Märss (Estonia) are describing an interesting thelodont known from both the Mackenzie Mountains and the Canadian Arctic Archipelago by both articulated specimens and scales. Wilson, Märss, and R. Thorsteinsson are collaborating on a monographic work on Canadian Arctic thelodonts collected in 1994 (by IGCP 328 members) and earlier (by R. Thorsteinsson). D. Elliott (USA) is collaborating with Thorsteinsson on a monographic work describing Canadian Arctic heterostracans.

Hanke's Ph.D. thesis involves 1) a reconstruction and comparison of a fish fauna from the MOTH locality, Mackenzie Mountains using both isolated scales and articulated fossils, 2) an examination of scale variation on articulated fishes for comparison with form taxa, 3) use of fish scales to determine the biostratigraphical position of the MOTH locality Devonian fish layer and 4) cladistic analysis of early gnathostomes to suggest relationships between the Chondrichthyes, the Acanthodii and the newly discovered spiny chondrichthyans from the MOTH locality. Hanke et al. (submitted) describes a new *Tetanopsyrus* species with a cladistic analysis of selected acanthodians. Details from this paper were presented in Flagstaff, Arizona.

P. R. China:

Zhu Min continues his current focus on sarcopterygians in collaboration with H.-P. Schultze of Germany and others, while Chang Meemann continues her studies on Silurian and Devonian sarcopterygians from China and northern Canada. Wang Nianzhong continues his studies of thelodonts and other fishes from the Devonian of northern China and elsewhere.

Estonia:

Graduate student O. Hints attended the Syktyvkar meeting of IGCP 406 along with the field excursion, while continuing his studies.

E. Kurik's research work included the study of Early Devonian placoderms: arthrodiroids, ptyctodontids and rhenanids from Severnaya Zemlya (SZ), the NW of the Siberian Platform, and the New Siberian Islands (Kotelnyj Is.). The SZ arthrodiroids [3-4 new genera, including an actinolepid, 2(?) euleptaspids and a buchanosteid] are still under study and their description will be presented as a manuscript for the

journal *Geodiversitas*. During project 406 (1996-2000) Kurik participated in the meetings in Tallinn, 1996, Warsaw, 1998 (financial support from the project 406), Jurmala, 1999 (with talks in Warsaw and Jurmala). Publications on biostratigraphy, correlation and fish palaeontology (placoderms, psammosteid heterostracans, tetrapods) of the Early and Middle Devonian of Severnaya Zemlya, the Siberian Platform, New Siberian Island, the Baltic area, Belarus, and Scotland. Publications include also some data on the Early/Middle Devonian placoderms of Greenland, Spitsbergen, the Taimyr Peninsula and the Timan-Pechora region.

P. Männik continued to work on conodonts from Estonia, the Severnaya Zemlya and Novosibirsk archipelagos, and from Eastern Siberia; a study of carbon isotopes from the Subpolar Urals (in cooperation with T. Martma) is in progress. Comparative studies of isotopes and of the distribution of conodonts indicate that in the Timan-northern Urals region, and also on Severnaya Zemlya, a considerable gap occurs in the Llandovery-Wenlock boundary interval. Results of comparative studies also agree with the conclusion (based on the distribution of conodonts) that in both regions this boundary lies higher in the sequence than considered traditionally.

In February he visited the All-Russian Geological Research Institute (VSEGEI) in St. Petersburg, where he studied collections of Silurian samples from Siberia; he took about 400 samples to Tallinn and started to process these to study conodonts. In June he took part in a field trip (organized by M. Harris and P. Sheehan) to the Upper Ordovician and Lower Silurian sections in Utah and Nevada. In July he attended and gave presentations about biostratigraphy, palaeogeography, and some problems connected with geochemical correlations at the IGCP 406 annual meeting in Syktyvkar, he attended [and helped organize] the post-conference field trip to the Subpolar Urals and Ukhta region. In late August and in September he visited Texas Tech University to study collections of Silurian conodonts from North America.

He continues to work with conodonts from Estonia, the Severnaya Zemlya and Novosibirsk archipelagos, and from Eastern Siberia; a study of carbon isotopes from the Subpolar Urals (in cooperation with T. Martma) is in progress.

T. Märss, with V. Karatajute-Talimaa, has submitted the chapter "Thelodonti" to the handbook Fossil Vertebrates of Russia and Adjacent Countries (in preparation by the Paleontological Institute of RAS, Moscow; in Russian). This monographic paper deals with thelodonts from Russia (embracing also Arctic regions) and adjacent countries. Data on 65 thelodont species (representing 20 genera, 12 families and 6 orders) - their holotypes, diagnoses, and distribution - are given.

H. Blom (Sweden), T. Märss and G. Miller (UK) submitted a manuscript on the anaspids from the northern hemisphere, from the localities on Severnaya Zemlya, in the Central Urals, Baltic, Ringerike, southern Sweden, Greenland, Canadian Arctic, and Mackenzie Mountains. The data indicate that the birkeniid anaspids were a rather common and variable group in the faunal communities, and had wide geographical distribution. It was possible to show some tendencies in the development of the morphology and histology of scales. New species were used in correlations.

T. Märss, M.V.H. Wilson (Canada) and R. Thorsteinsson (Canada) have a manuscript in progress dealing with the Silurian and Lower Devonian thelodonts from the Canadian Arctic Archipelago (Cornwallis and Baillie-Hamilton islands) in progress. Some 39 species (28 new, including 12 species with articulated squamation) from 24 genera (13 new), from 16 families (7 new), 5 orders (1 new) and one group of uncertain taxonomic level are described. This work is important because both scale taxa and those based on the articulated thelodont squamations were described and body morphology of 12 species studied. The results of this study were reported in the Flagstaff Meeting in May 2000 (Wilson et al., 2000), and the same systematics with some additions are used in the chapter "Thelodonti" (by Karatajute-Talimaa and Märss) in the new Russian Palaeontology Handbook.

T. Martma participated in the Syktyvkar meeting and the Subpolar Urals field excursions. He continues to study stable isotopes from Ordovician and Silurian strata in the East Baltic, Severnaya Zemlya and the Subpolar Urals.

France:

Most of the activity of the French Group of IGCP 406 has been devoted to the 9th Early/Lower Vertebrates Symposium & associated IGCP 406 Circum-Arctic Palaeozoic Vertebrates Meeting which took place in Flagstaff, Arizona, USA, May 15-19, 2000, together with the field excursion to Devonian

fish localities of Nevada and Utah. Abstracts were published in the abstract volume of the conference (Elliott *et al.*, 2000). For details, see the individual reports here below. Several contributions recently published in the IGCP 328 final scientific volume are also concerned with topics of the IGCP 406 project (Blieck & Turner, 2000).

The French National IGCP Committee provided 30,000 FRF to the four participants to the Flagstaff meeting, viz., Blieck, Clément, Goujet, Poplin (7,500 FRF each); and 4,000 FRF to A. Blieck for a workshop in Vilnius, in October 2000.

1) IGCP 328 / IGCP 406 results contributions to biostratigraphy: new synthesis of the Silurian-Devonian vertebrate assemblages and biozones of the Old Red Sandstones Continent (ORSC) [Blieck & Turner, 2000; Blieck, in press], with reviews of Lower Devonian assemblages (Blieck *et al.*, 2000).

2) Systematics: biodiversity of pteraspidomorph faunas (*Handbook of Paleoichthyology*): Siluro-Devonian assemblages from bore holes of Poland; revision of Lower Devonian *Protopteraspis* of England (Blieck & Tarrant, in press); Lower and Middle Devonian heterostracans of Severnaya Zemlya, Russia (IGCP 406 project; collaboration with V.N. Karatajute-Talimaa, Vilnius; new data on corvaspid material has been presented at the Flagstaff meeting: Blieck, 2000c; Blieck & Karatajute-Talimaa, in press); new localities from the Ardennes Massif, both in Belgium and the Grand Duchy of Luxembourg.

3) Biogeography / palaeoecology: a study of new Lower Devonian (Emsian) localities from Atlantic Canada is in a preliminary stage in collaboration with R. Cloutier (Rimouski Univ., Quebec); various fish assemblages are known there; co-occurring miospores + sometimes acritarchs + sometimes invertebrates should help in reevaluating the classical paradigm "ORSC + fish = fresh water environments"; other conclusion will include taxonomy and biostratigraphy (correlation with North America and Europe).

4) IGCP 406 Workshop: a third workshop on Silurian-Devonian heterostracans from Severnaya Zemlya, Russia, will be held in Vilnius from October 13 to October 20, in collaboration with V.N. Karatajute-Talimaa. This should result in the publication of at least a paper on the Early Devonian corvaspids, to be proposed to *Jl. Vert. Paleontol.* (Flagstaff symposium volume, D.K. Elliott ed.).

G. Clément is finishing his PhD research about the "Anatomy and systematics of the Porolepidae (Porolepiformes, Sarcopterygii) from the Devonian of Spitsbergen and phylogeny of the Dipnomorpha." An oral communication was given on this material during the Flagstaff meeting (Clément, 2000). He is also working on the anatomy and systematics of some large Tristichopteridae (Sarcopterygii, Tetrapodomorpha) from the Evieux Formation (Late Famennian) of Belgium and on the genus *Macropoma* (Coelacanthiformes, Sarcopterygii) from the Oxfordian (Late Jurassic) of France. In both cases the palaeobiological and phylogenetic implications are under study.

P. Janvier's activity has been limited, as concerns Circum-Arctic fossils, in 1999-2000, as he was mainly involved in research on Gondwanan or Chinese material. However, in August 2000 he made a joint field study with Per Ahlberg (London) and Henning Blom (Sweden) on the Silurian of Gotland, with the aim of finding more, anatomically significant, material of *Andreolepis*. In addition, I have supervised PhD student Gaël Clément, and DEA memoirs students: Vincent Lacombe: "Etude du genre *Bothriolepis* (Placodermi, Antiarchi). Analyse phylogénétique"; Vincent Pernègre: "Le genre *Doryaspis* White (Heterostraci) dans le Dévonien inférieur du Spitsberg" (in collaboration with D. Goujet).

C. Poplin is involved with 1) Study of the Carboniferous (Namurian) ichthyofauna from Bear Gulch (Montana, USA): study of the fish distribution (agnathans, acanthodians, chondrichthyans, actinopterygians and coelacanthiforms) within the 80 outcrops of Bear Gulch, description of the different palaeoecosystems (Lund & Poplin, 1999); study of the actinopterygians (anatomy, systematics, phylogeny, and functional morphological adaptations): two new deep bodied forms (Poplin & Lund, in press); phylogenetic study of Tarrasiidae (Lund & Poplin, 2000, abstract for the "Early Vertebrates/Lower Vertebrates Symposium" at Flagstaff); in preparation, study of a new genus and two new species of palaeoniscoids. 2) Lower Permian of the Buxières-les-Mines Basin (Massif Central, France): synthesis about actinopterygians within a collective work (Steyer *et al.*, 2000). 3) The Stephano-Autunian Basin of Montceau-les-Mines (Massif Central, France): in preparation, study of a new form of Aeduellidae. 4) Activities about collections: scientific responsibility of the fossiliferous nodule collection (about 120,000) from Montceau-les-Mines, deposited in the Museum of Natural History of Autun; determination of the fossil actinopterygian fishes in the collection of the Museum of

Natural History of Lille (Blieck *et al.*, 1999). 5) Responsibility for the elaboration of the "*Handbook of Paleoichthyology*" about non-teleostean actinopterygians.

Germany:

G. Arratia, K. Dietze, M. Otto, and H.-P. Schultze all attended the Flagstaff meeting, presenting research results. H.-P. Schultze continued to study Early Devonian fishes (the basal actinopterygian *Dialipina*, the basal holoptychiid *Nasogaluakus*, the basal dipnoan *Melanognathus* and an acanthodian), and is completing his study of Middle Devonian fishes (arthrodires, rhipidistians and acanthodians) from the Canadian Arctic. K. Dietze presented results of her Ph.D. research on paramblypterid and amblypterid actinopterygians; a detailed phylogenetic treatment was published this year in the journal *Palaeontology*.

Ireland:

M. Duncan successfully defended her thesis on Lower Carboniferous (Tournaisian and Tournaisian/Viséan) ichthyoliths (microvertebrates) from Ireland, including more than 90 plates illustrating the microvertebrate fauna. She also participated in the Flagstaff E/LV and IGCP 406 meeting. She is now employed evaluating geological features of protected areas in Ireland.

Japan:

Once again M. Goto was active in IGCP 406-related research, publishing a number of papers and reports emphasizing the evolution of bony tissues in vertebrates and the fossil record of chondrichthyans in Japan (see publications list).

Latvia:

Ervins Luk_evi_s attended the Flagstaff meeting and field excursion. His studies of bothriolepidid antiarchs from Severnaya Zemlya and Timan-Pechora regions are nearly finished. In the fall he spent four weeks at Cambridge University, studying primitive tetrapods from Greenland.

I. Upeniece participated in the Syktyvkar meeting, presenting a paper on the fauna of the Lode Quarry, and is nearing completion of her doctoral thesis on preservation of Devonian fishes and associated fossil parasites from Lode Quarry, Latvia.

I. Zupins took part in the Weeman and Syktyvkar meetings, giving a paper on the morphology of *Glyptolepis baltica* Gross.

Lithuania:

V. Karatajute-Talimaa made progress with studies of the Upper Silurian and Lower Devonian heterostracans from Severnaya Zemlya, the Timan-Pechora Region, and the south-western part of the Russian Platform (in collaboration with A.Blieck).

Jonas Seckus finished his Bachelor's degree and is studying for his Master's degree to be finished in 2002. He studies microremains of actinopterygian fishes of the Middle-Upper Devonian of the Baltic States and the Timan-Pechora region, and presented a paper in Syktyvkar on Lithuanian palaeoniscoids.

J. Valiukevicius studied Early and Middle Devonian acanthodians from the Timan-Pechora Region. Descriptions of new taxa, including 15 new species and 1 new genus, are submitted for publication to *Acta Geologica Polonica*. He also reviewed the biostratigraphy of Timan-Pechora acanthodians. He plans to work out zonations for all structural-facial areas of the region and will include the distribution of taxa in each studied drill core, characterization of zonal assemblages, and their implications for inter-regional correlations. This work will be finished in 2001.

R.Mertiniene continued her work on chondrichthyan teeth and scales collection from the Upper Devonian – Lower Carboniferous of the Timan-Pechora region and the Main Devonian Field.

Netherlands:

J. Vergoossen attended the Flagstaff meeting and presented results on Late Silurian vertebrate microfossils from Scania, Sweden.

Poland:

Michal Ginter presented a paper at the Flagstaff meeting on Upper Famennian chondrichthyan biofacies in the Western United States.

Russia:

Participation by Russian scientists was again extensive during the past year; although only a few were able to attend the Flagstaff meeting, many more attended (and organized) the final meeting in Syktyvkar.

A.F. Abushik continued to describe the Silurian and Early Devonian leperditicopid ostracodes from the Russian Arctic. Silurian ostracodes from the Taimyr Peninsula and Kotelnyi Island were studied for the first time. Two papers on the Silurian ostracodes from the Taimyr Peninsula have been prepared [in Russian]. Comparative study of the Silurian leperditicopids of Podolia and Baltic regions (in collaboration with Drs L. Sarv and T. Meidla, Estonia) was carried out.

O. B. Afanassieva continues to work on osteostracans from different regions. She is working on the chapter Osteostraci for the handbook *Fossil Vertebrates of Russia and Adjacent Countries* under preparation by the Paleontological Institute of RAS, Moscow. At the Flagstaff meeting she reported the results of studies of osteostracan microremains from Severnaya Zemlya Archipelago (Afanassieva, 2000, abstracts).

A. Antoshkina continued her research on Palaeozoic reef associations of the Urals Mountains, Russia, and North America especially Alaska (see publications list), much of it in collaboration with C. Soja (USA). She hosted the ICGP 406 Meeting in Syktyvkar, guided the field excursion to the Subpolar Urals, edited the conference volume, and edited and co-wrote the excursion guide book.

N. Belyaeva helped with the Syktyvkar meeting, led the field excursion to South Timan, and co-wrote the field guide. Also in 2000 she defended her Dr.Sci. thesis: "Sedimentary model of the Frasnian-Tournaisian deposits of north-eastern European Platform" at Moscow University.

T. Beznosova hosted the Syktyvkar meeting, helped lead and organize the field excursion to the Subpolar Urals, and contributed to technical papers on Silurian correlations.

P. Chekhovich's work suggests that eustatic fluctuations in the Silurian did not exceed ± 10 m, whereas the rapid high-magnitude (~30-150 m) variations in depth of basins were caused by uplift and subsidence of the crust. This suggests that the rapid fluctuations in water depth elsewhere, used for the construction of the Silurian eustatic standard, were actually related to regional tectonic movements. These results cast doubt on rapid and high-magnitude eustatic fluctuations during other epochs as well.

I. O. Evdokimova has been working on her thesis entitled "Frasnian ostracodes and biostratigraphy of the Russian Platform." This study is based on samples collected from numerous Upper Devonian sections in the Main and Central Devonian Fields in 1997-1999. In addition, extensive material was collected during the field excursions to the western part of the Main Devonian Field (Latvia, 1999) and to the Southern Timan (Russia, 2000).

A. Ivanov continues to work on Devonian placoderms and Devonian-Permian elasmobranchs from the Arctic regions. Together with Ervins Luksevics, he is preparing the chapter Placodermi for the handbook "Fossil Vertebrates of Russia and Adjacent Countries." He also studied the development of the vascularization system and histological structure in Palaeozoic sharks, phoebodontids and symmoriids.

V. Lukin continued to study the Silurian and Devonian tabulate corals and biostratigraphy of the NE part of the East European Platform. In April, 2000, he took part in the organization of the 14th Conference of Young Scientists of Komi Republic in Syktyvkar.

S. Melnikov continued to study the taxonomy, distribution, and ecology of the Early Palaeozoic shallow water conodonts in the Timan-northern Urals region. Connections between the stratigraphical and geographical distribution of conodont faunas, and the evolution of Early Palaeozoic carbonate sedimentation in the basin, were evaluated. Datings of the lower Silurian strata in the Timan-northern Urals region were reinterpreted, and a database on the distribution of conodonts and ichthyofauna in the Early Palaeozoic strata in the Timan-northern Urals region was created.

V. V. Menner V. and R. G. Matukhin, the leaders of the Siberia working group, compared faunal assemblages allowing them and several palaeontologists to correlate the Severnaya Zemlya Palaeozoic sequence not only with the sections in North Siberia and northern Europe, but also with the international standard, with considerably higher precision.

T. L. Modzalevskaya finished her study of the Ordovician and Silurian brachiopods from Taimyr. These data will be published in the *Atlas of the Ordovician and Silurian Faunas and Stratigraphy of Taimyr* (Norilsk). Silurian pentamerid brachiopods from Timan Ridge were revised.

The Ordovician, Silurian and Early Devonian brachiopods from Severnaya Zemlya and Taimyr were studied. The middle Ashgill brachiopods in the Taimyr Peninsula are represented by a diverse assemblage including *Holorhynchus* (upper part of the *Climacograptus supernus* Zone). The majority of species occurring in the Llandovery brachiopod assemblage on Severnaya Zemlya and Taimyr have been identified also from Siberia. The lower part of the Andrei Formation, Taimyr, can be correlated with the Rhuddanian - Aeronian - Telychian interval based on both ostracodes and brachiopods.

The results of the comparative biostratigraphical and geochemical (trace elements, stable isotopes) studies of the upper Silurian brachiopods from Bolshezemelskaya Tundra, Timan-Pechora region, were presented for the first time. Isotopic data derived from the non-luminescent samples of the upper Silurian brachiopods show a significant negative ^{13}C shift during the Early Ludfordian (*Didymothyris didyma* Zone). Above this horizon, increasing ^{13}C values can be observed both in the brachiopods from the northeastern edge of the East European Platform and in whole rock samples of carbonates from Austria and Australia. The Middle Ludfordian isotope variations is a worldwide chemostratigraphic marker level.

O Telnova continued research on palynological correlations in Timan, while Yu. Tesakov continues to study the Silurian zonation of the Siberian Platform and Taimyr.

V. S. Tsyganko continued to study Silurian and Devonian rugose corals, Devonian stratigraphy and palaeontology, and palaeobiogeography and stratigraphy of the NE part of the East European Platform.

A. Yudina continued study of Upper Devonian sections on the Syv'yu River, Subpolar Urals, including palaeontological (goniatites, ostracodes, brachiopods, trilobites, conodonts, spores), sedimentological, and geochemical samples

Z. P. Yur'eva attended the Syktyvkar meeting and the Subpolar Urals field excursion. She continues to work on the definition and evaluation of new zones of hydrocarbon accumulation in the northern part of the Timan-Pechora oil and gas province.

A. V. Zhuravlev studied the Upper Devonian (Frasnian) conodont biostratigraphy from the northern part of the Russian Platform, Upper Devonian-Lower Carboniferous conodonts of the northern part of the Urals and Russian Platform, conodont histology (including comparative histology of conodonts and fish teeth and scales), and palaeolandscape reconstruction for the Middle and Late Palaeozoic of the northern regions of the European part of Russia. He has compiled a regional conodont zonation of the northern Urals for Lower Carboniferous shallow-water and deep-water deposits (Zhuravlev, 2000).

Sweden:

H. Blom defended his Ph.D. thesis and completed studies of 1) Late Silurian -Early Devonian microremains of vertebrates from the upper part of the Franklinian Basin, North Greenland, as well as Lower Silurian thelodonts from North Greenland; 2) taxonomic, biostratigraphic, and palaeogeographical significance of the Devonian thelodont taxon, *Amaltheolepis*, based on material from the Circum-Arctic region; 3) significance of thelodonts from Spitsbergen; 4) birkeniid anaspids from the Circum-Arctic, Baltoscandia and Britain. Blom is currently taking up a postdoctoral position in England (with J. Clack, Cambridge University).

U. Borgen has completed a monograph on osteolepiforms from East Greenland.

J. Peel continues his research on the Palaeozoic stratigraphy of North Greenland.

Ukraine:

T. Nemirovskaya continues her studies of Carboniferous conodonts and biostratigraphy.

United Kingdom:

V. T. Young, U.K. correspondent, reports that UK project participants participated very actively in national and international meetings in 2000. Eleven U.K. participants attended the Flagstaff meeting, where they presented important research results. V. T. Young and G. Miller also attended the Syktyvkar meeting and participated in the Subpolar Urals field excursion.

Highlights of progress made by individual UK project members follow:

P. Ahlberg joined in the Flagstaff meeting. During the summer of 2000 he collected samples from the Hemse Marls of the Ludlovian (Silurian) of Gotland, Sweden, to be processed for micro-remains of vertebrates. The volume resulting from his Morphology and Development meeting (1999), including several papers by project members, is nearing publication.

K. Dennis-Bryan attended the Flagstaff meeting and field excursion and is working on a revision of the brachydeirids with M. Otto.

J. Clack and S. Neiningner continue to study fossil remains of ichthyostegids and fishes collected from the Famennian of Central East Greenland in summer 1998. Clack gave a paper about a new vertebrate species from that deposit in Flagstaff.

R. Davidson and N. Trewin presented a poster at both the SVP Conference in Edinburgh and at Palaeontological Association '99 in Manchester on "Unusual soft part preservation in Middle Devonian fish-bearing nodule beds." Their work on the sedimentology of the nodule beds of the Moray Firth area was on hold last year but is planned to resume in 2001. Davidson and M. Newman are preparing a poster for Palaeontological Association 2000 detailing work in progress in the case for synonymy of some of the five species of the Scottish acanthodian genus, *Euthacanthus*.

C. Duffin continues to work with Palaeozoic sharks, their morphology, biogeography, biostratigraphy and palaeoenvironment.

Duncan Howley and a co-author have just published a paper on Pant-Y-Maes quarry, and have organized a national conference for 140 earth science teachers in Swansea.

J. Marshall and T. Astin continued their involvement in the Devonian of Scotland and East Greenland.

G. Miller participated in the Syktyvkar meeting and Subpolar Urals field excursion, collecting samples for conodont and ostracode studies. He reported at Syktyvkar on beyrichiian ostracodes from the Cape Phillips Formation of Arctic Canada.

R. Williams and colleagues continue studies of fossil fish sites in the Welsh Borderlands Old Red Sandstone.

V. T. Young also participated in Syktyvkar meeting and the Subpolar Urals field excursion. Collected samples and fossils were returned to the Natural History Museum, London, for future study. Her presentation at Syktyvkar reviewed Early Palaeozoic fishes from Spitsbergen in the collections of the Natural History Museum, London.

USA:

R. Carr attended the Flagstaff meeting and continues collaborations with E. Kurik (Estonia) on placoderm taxonomy and distribution.

D. Elliott is hosted the 9th International Meeting on Early Vertebrates/Lower Vertebrates, in Flagstaff, in May, and organized and led the post-meeting field excursion to the Devonian of Utah and Nevada. He is finishing his term as Editor (Lower Vertebrates) for the important, international *Journal of Vertebrate Paleontology*. Elliott continues to collaborate with R. Thorsteinsson (Canada) on completion of a long-awaited monograph on Canadian Arctic heterostracans.

E. Daeschler, in July 2000, participated in a field party (with N. Shubin, M. Davis, J. Downs, K. Middleton, S. Madsen) from the Academy of Natural Sciences to collect vertebrate fossils in Late Devonian (Frasnian) strata on southern Ellesmere Island, Nunavut, Canada. J. Downs (B.Sc.), A. Frumes (B.Sc.), J. Lane (M.Sc.), and M. Davis (Ph.D.) are students working on Devonian vertebrates from the Red Hill site in Pennsylvania.

J. Repetski was active in assembling and documenting Cambrian and Ordovician conodont faunas in Alaska and western Siberia (with colleagues in the USGS and Russia) to establish a biostratigraphy for that interval and to better understand the palaeobiogeographic setting of that region. Also, he has been

working on cooler water faunas of the lower palaeozoic of eastern North America and correlating them with coeval faunas in, e.g., Baltoscandia, again to assess the palaeobiogeographic relations among the various terranes across Iapetus.

Societal benefits

Benefits include greater international cooperation, and greater focus on common problems of correlation and taxonomy. There was especially good interaction this year among researchers from diverse nations at the IGCP 406 meeting in Syktyvkar, and at the Flagstaff Early/Lower Vertebrates Meeting. In addition, IGCP 406 participants made outstanding contributions at a large number of national and international meetings, and continued a strong record of publication of scientific results and news articles.

Other significant benefits include provision of assistance for scientists, including graduate students, from countries with limited financial resources; sharing of samples and joint field work on geological sections (normally inaccessible to those from different countries) for international, multidisciplinary studies (e.g., Subpolar Urals, South Timan, Severnaya Zemlya, western USA); and intensive study of exceptional fossiliferous deposits (e.g. Devonian localities at 'MOTH' and Anderson River in the Northwest Territories of Canada; Silurian localities on Cornwallis Island in the Canadian Arctic Archipelago; Devonian tetrapod-bearing sites in East Greenland) that are potential candidates for protection under national and international laws.

The exchange of scientific samples and results, together with the international workshops, field excursions, and conference visits, have combined to strengthen feelings of membership in the international community and to promote good will among the researchers involved. IGCP 406 participants have ended this project with strong feelings of friendship and shared goals, and look forward to supporting new IGCP projects in the years ahead.

Theses defended by project participants

- Antoshkina, A. I., Syktyvkar, 2000. Palaeozoic reefs in the Pechora Urals and adjacent regions. Dr.Sci. thesis, Institute of Geology, Syktyvkar.
- Belyaeva, N. V., 2000, Syktyvkar: "Sedimentary model of the Frasnian-Tournaisian deposits of north-eastern European Platform." Dr.Sci. thesis, Moscow University.
- Blom, H. 1995. Vertebrate remains from the Chester Bjerg Formation (Late Silurian?), Hall Land, North Greenland. - M.Sc. thesis, Department of Earth Sciences, Historical Geology and Palaeontology, Uppsala University, Uppsala, Sweden. 22 pp.
- Blom, H. 1998. Vertebrate remains from the Upper Silurian-Lower Devonian of North Greenland. - Filosofie Licentiat thesis, Department of Earth Sciences, Historical Geology and Palaeontology, Uppsala University, Uppsala, Sweden. 167 pp.
- Blom, H., 2000. "Silurian - Devonian Vertebrates from the Northern Hemisphere." Department of Earth Sciences, Historical Geology and Palaeontology. PhD thesis, Uppsala University, Sweden. 24 pp.
- Duncan, M. 2000. Lower Carboniferous ichthyoliths from Ireland. Ph.D. thesis, Dublin, Ireland.
- Ivanov, A.. 1997. Frasnian arthrodires (Placodermi, Brachythoraci) of the East European Platform. PhD thesis, St. Petersburg University, St. Petersburg, Russia.
- Trinajstic, K. 1999. Ph.D. thesis, University of Western Australia, Perth, Australia.
- Yudina, A. 2000 "Biostratigraphy and Upper Devonian conodonts of the Chernyshev Ridge and Subpolar Urals." Ph.D. thesis, Institute of Geology, Syktyvkar.
- Verduyn, S. (2000).- Etude des microfossiles de Vertébrés du Dévonien du nord de l'Espagne. Maîtrise Sci. Terre Univ., Univ. Sci. Technol. Lille, France. Mém: 19 p.
- Zhemchugova, V. A., 2000. Palaeozoic oil and gas-containing carbonate complexes of the Pechora Basin (structure, conditions of the formations, prognosis of the natural reservoirs). Ph.D. thesis. Ukhta Technical University, Ukhta.

Students currently working on PhD or Master's theses

Among project participants are these current research students:

Pavel Beznosov, Institute of Geology, Syktyvkar: "Late Devonian - Early Permian acanthodians".

Irina Evdokimova, VSEGEI, St.Petersburg: "Late Devonian ostracodes of the Main Devonian Field".

Olga Rodina, Institute of Petroleum Geology, Novosibirsk: "Carboniferous chondrichthyans of Siberia".

Jonas Seckus, Lithuanian Institute of Geology, Vilnius: "Actinopterygian fishes of Middle-Upper Devonian of Baltic countries and Timan-Pechora Region".

Ieva Upeniece, Institute of Geology, University of Latvia, Riga, "Studies on preservation of Devonian fishes in the Lode Quarry."

Ivars Zupins, Institute of Geology, University of Latvia, Riga, Middle-Late Devonian sarcopterygians of Latvia".

Gavin Hanke, University of Alberta, Edmonton, Canada, "Morphology and histology of acanthodians and putative chondrichthyans from the Devonian MOTH locality, Mackenzie Mountains, Canada."

Chelsea Hermus, University of Alberta, Edmonton, Canada, "Taxonomy and growth of ischnacanthid acanthodians from the MOTH locality, Mackenzie Mountains, Canada."

Carole Burrow (thesis submitted 15-8-00): "Late Silurian to Middle Devonian acanthodians of eastern Australia." PhD thesis, University of Queensland, 226 pp.

G. Clément, France, "Anatomy and systematics of the Porolepidae (Porolepiformes, Sarcopterygii) from the Devonian of Spitsbergen, and phylogeny of the Dipnomorpha."

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For hosting major meetings and field excursions, we are particularly grateful to the following individuals, their colleagues, and institutions: H.-P. Schultze and G. Arratia (Germany); B. Paton (Scotland); A. Ivanov (Russia); M. Ginter (Poland); E. Luksevics (Latvia); D. Elliott (USA); A. Antoshkina and T. Besnosova (Russia). Many others kindly hosted smaller workshops, for which we are also grateful.

2.2 List of meetings with approximate attendance and number of countries

2.2a. Meetings, Workshops and Field Trips During the Life of the Project

Annual IGCP 406 meetings

Annual meetings were each year devoted to a certain topic (see the list of participants and abstracts in the corresponding Abstract Volume).

1996 - Meeting on Greenland Geology took place in Uppsala, Sweden, in May.

- Meeting on the Canadian Arctic took place in Edmonton, Canada, in July.

- Meeting on Barentsia, Baltica, and Siberia was held in Tallinn, Estonia, in October.

1997 - Circum-Arctic Palaeozoic Vertebrates: Biological and Geological Significance. July 4-6, 1997, Buckow, Germany (see Wilson, M.V.H., ed. 1997).

- Palaeozoic Strata and Fossils of the Eurasian Arctic. September 23-26, 1997, St. Petersburg, Russia (see Ivanov, A., Wilson M.V.H. and Zhuravlev, A., eds, 1977).

1998 - Circum-Arctic Palaeozoic Faunas and Facies. September 3-8, 1998, Warsaw, Poland (see Ginter, M. and Wilson, M.V.H., eds, 1998; Ginter, M. and Wilson, M.V.H., eds., 1999).

1999 - Lower-Middle Palaeozoic Events Across the Circum-Arctic. September 27 - October 2, 1999, Jurmala, Latvia (see Luksevics E., Stinkulis G. and Wilson M.V.H., eds., 1999).

2000 - Flagstaff, Arizona, USA: 9th International Meeting "Early Vertebrates/Lower Vertebrates", and field trip to the Arizona, Utah, Nevada and Colorado geological sites (mostly Devonian in age). May, 2000.

- Pan-Arctic Palaeozoic Tectonics, Evolution of Basins and Faunas. July 12-15, 2000, Syktyvkar, Russia (see Antoshkina A., Malysheva E., and Wilson M.V.H., eds., 2000).

Other meetings and workshops with IGCP 406 participation

The participants of Project 406 took part in following meetings (as made known to us):

- 1996 - Rochester, USA: Participation in the 2nd International Symposium on the Silurian System, the meeting of the Subcommittee on the Silurian Stratigraphy, and post-meeting field trip to the Niagara and Rochester areas of western New York.
 - Warsaw, Poland: ECOS VI
 - St.Petersburg, Russia: Vsesoyuznoe Paleontologicheskoe Obshchestvo
- 1997 - Bristol, UK: Participation in the 5th International Congress of Vertebrate Morphology; study of Canadian Arctic vertebrate collections at the Bristol University (coll. Drs D. Dineley and E. Loeffler).
 - St.Petersburg, Russia: Europroba, VNIIOkeangeologia
 - London, UK
 - Edinburgh, UK
 - Alaska, USA
 - Chicago, USA
- 1998 - Edmonton, Canada: Canadian Arctic workshop
 - Snowbird, USA: Society of Vertebrate Paleontology
 - Madrid, Spain, and Portugal: SW Iberia Field Meeting of the International Subcommittee on Silurian Stratigraphy (IUGS-UNESCO)
 - Bologna, Modena, Italy: ECOS VII
- 1999 - Denver, USA: Society of Vertebrate Paleontology
 - Moscow: XLV All-Russian Palaeontological Society
 - London, UK: "Major events in Early Vertebrate Evolution"
 - Interdepartmental Stratigraphic Committee on the Northern Caucasus
 - Boulogne-sur-Mer, France: European Elasmobranch Association
 - Perm, Russia: Geology of the Western Urals on the Boundary of the XXI Century
 - Portsmouth, UK: Palaeontological Association
 - Cambridge, UK: New Perspectives on the Old Red Sandstone
 - Edinburgh, UK: International Symposium of Vertebrate Palaeontology and Comparative Anatomy
 - Calgary, Canada: Canadian Palaeontology Conference
 - Ukhta and Syktyvkar, Russia: Subpolar Urals field meeting and workshops
 - Jurmala, Latvia: 4th Baltic Stratigraphical Conference
- 2000 - Weeman Meeting
 - Portsmouth, UK: Symposium of Palaeontological Preparators and Conservators
 - Portsmouth, UK: Symposium of Vertebrate Paleontology and Comparative Anatomy
 - Manchester, UK: Palaeontological Association Annual Meeting
 - Cambridge, UK: Workshop on primitive tetrapods of Greenland
 - Utah and Nevada, USA: field trips to Upper Ordovician and Lower Silurian sections
 - Texas Tech University, USA: conodont workshop
 - Vilnius, Latvia: workshop

Field trips to the Arctic and Sub-Arctic (1996-2000):

- 1996 - Mackenzie Mountains, Canada: Estonia and Canada
 - Anderson River, Canada: Germany and Canada
- 1997 - Alaska, USA: USA and Russia
- 1998 - Mackenzie Mountains, Canada: Germany and Canada
 - East Greenland: UK and Denmark
- 1999 - Anderson River, Canada: Germany and Canada
 - Canadian Arctic Islands: USA
 - Subpolar Urals, Russia: Estonia, Russia
- 2000 - Arctic Islands, Canada: USA
 - the Polar Urals, Russia: Russia
 - the Subpolar Urals, Russia: Canada, Russia, UK
 - South Timan, Russia: Estonia, Latvia, Russia
 - Northern Rocky Mountains, Canada: Canada

2.2b Meetings This Year

9th Early Vertebrates/Lower Vertebrates Meeting

- Flagstaff, Arizona, USA, May 16-19, 2000.
- Field Excursion to Devonian of Utah and Nevada, and other geological sites in Colorado and Arizona, May 20-27, 2000.
- Some 75 researchers (including 42 IGCP 406 members) from 16 countries (15 IGCP 406) attended.

IGCP 406 members were key participants at this meeting hosted by Dr. D. Elliott and colleagues at the University of Northern Arizona, Flagstaff, USA.

A field excursion was also organized to study and collect from the early Palaeozoic sediments of Utah and Nevada, May 20-27. A field guide was produced for the use of excursion participants.

The countries participating were: Russia, Estonia, UK, Latvia, Canada, South Africa, Germany, USA, Sweden, Australia, Ireland, France, Poland, Italy, and the Netherlands.

A business meeting of IGCP 406 was held on 15th July, and included about 30 participants. Discussion centered mostly on planning for the Syktyvkar meeting, publication of special volumes, and plans for future projects.

Pan-Arctic Palaeozoic Tectonics, Evolution of Basins and Faunas

Syktyvkar, Russia, July 12-15, 2000.

Field Excursion to South Timan.

Field Excursion to Subpolar Urals and South Timan, and workshop in Ukhta.

More than 60 researchers from 7 countries attended.

A final meeting of Project IGCP 406 Circum-Arctic Palaeozoic Vertebrates took place at Syktyvkar, Komi Province, Russia, from 12th to 15th July 2000, organized and hosted by Institute of Geology, Komi Science Centre, Uralian Division of the Russian Academy of Sciences.

Two separate field excursions were organized to study and collect from the early Palaeozoic sediments of South Timan (from 6th to 11th July), and of the Sub-Polar Urals Mountains (from 16th to 23rd July). A field guide was published for each field excursion as a supplement of *Ichthyolith Issues Special Publication 6*.

The conference meetings were attended by about 60 delegates from seven countries: Russia, Estonia, England, Belarus, Lithuania, Latvia, Canada. They included scientific verbal presentations, poster sessions, a visit to the Chernov Geological Museum of the Institute of Geology and a business meeting on 15th July, all held at Komi Science Centre, Syktyvkar. Abstracts of presentations from the meeting were published by the Institute of Geology, Komi Science Centre, Uralian Division, Russian Academy of Sciences, as *Ichthyolith Issues Special Publication 6*.

The final business meeting of IGCP 406 was held on 15th July, and included about 20 participants. Discussion centered mostly on the successes of the project, the work that remains to be done, and suggestions for possible successor projects.

This is the final year of the project, and it has been successful in involving many nations from a variety of disciplines, and has many achievements. It is hoped that future IGCP projects will develop from this one.

2.3 List of most important publications (including maps)

Volumes

Antoshkina, A., Malysheva, E. & P. Männik. 2000. Sub-Polar Urals Field Trip Guidebook. July 16-23, 2000. *Supplement to Special Publication of Ichthyolith Issues 6*. Published by Institute of Geology, Komi Science Centre, Uralian Division, Russian Academy of Sciences. ISSN 1302-1314. pp. 1-119.

- Antoshkina, A., Malysheva, E. & Wilson, M. V. H. 2000. Pan-Arctic Palaeozoic tectonics, Evolution of Basins and Faunas. *Ichthyolith Issues Special Publication 6*. Published by Institute of Geology, Komi Science Centre, Uralian Division, Russian Academy of Sciences. ISSN 1302-1314. pp. i-vii + 1-166.
- Belyaeva, N. V. & A. O. Ivanov (Editors). 2000. South Timan Field Trip Guidebook July 6-11, 2000. *Supplement to Special Publication of Ichthyolith Issues 6*. Published by Institute of Geology, Komi Science Centre, Uralian Division, Russian Academy of Sciences. ISSN 1302-1314. pp. 1-84.
- Blieck, A. & Turner, S. eds (2000). Palaeozoic vertebrate biochronology and global marine/non-marine correlation Final report of IGCP 328 (1991-1996). *Cour. Forsch. Inst. Senckenberg*, **22?** : 575 p., 140 figs, 29 tables, 37 plates, 50 authors, 25 papers; Frankfurt a.M.
- Blom, H. 1999b. Vertebrate remains from Upper Silurian - Lower Devonian beds of Hall Land, North Greenland. *Geology of Greenland Survey Bulletin*, 182, 1-80.
- Goujet, D. (ed.) In press. Palaeontology and stratigraphy of the Silurian-Devonian of Severnaya Zemlya, Russia (IGCP 406 volume). Geodiversitas, Paris.
- Matukhin, R.G. & V. VI. Menner. 1999. Silurian and Devonian stratigraphy of the Severnaya Zemlya Archipelago. SNIIGGiMS, Novosibirsk, 174 pp. [in Russian]
- Zhemchugova, V. A. and Melnikov, S. V. (monograph). Lower Palaeozoic of the Timan-northern Ural Region.

Research Papers

- Abushik, A. F. 2000. Silurian-earliest Devonian ostracode biostratigraphy of the Timan-northern Ural region. *Proceedings of the Estonian Academy of Sciences. Geology*, 49, 2, 112-125.
- Afanassieva, O.B. & Karatajute-Talimaa V.N. Osteostracans. *Stratigrafiya silura i devona arhipelaga Severnaya Zemlya (Silurian and Devonian Stratigraphy of Severnaya Zemlya Archipelago)*, Matukhin R. G. and Menner, V. VI., Eds. Novosibirsk, 1999, pp. 137-139. (in Russian).
- Ahlberg P.E., Luksevics E. and Mark-Kurik E. 2000. A near-tetrapod from the Baltic Middle Devonian. *Palaeontology*, 43, 3, 533-548.
- Antoshkina, A. I. 2000. The Silurian of the Timan-northern Ural Region. *Proceedings of the Estonian Academy of Sciences. Geology*, 49, 2, 69-84.
- Beznosova, T.M. 2000. Silurian brachiopods in the Timan-northern Ural region: zonation and palaeocology. - *Proceedings of the Estonian Academy of Sciences, Geology*, 49(2).126-146.
- Blieck, A. & Karatajute-Talimaa, V.N. (in press). Upper Silurian and Devonian heterostracan pteraspidomorphs (Vertebrata) from Severnaya Zemlya (Russia): a preliminary report with biogeographical and biostratigraphical implications. *In: Goujet, D. (ed.), Palaeontology and stratigraphy of the Silurian-Devonian of Severnaya Zemlya, Russia (IGCP 406 volume)*. Geodiversitas, Paris.
- Blieck, A., Turner, S. & Young, G.C. with contributions of Luksevics, E., Mark-Kurik, E., Talimaa, V. & Valiukevicius, J. 2000. Devonian vertebrate biochronology and global marine/non-marine correlation. *In: Bultynck, P. (ed.), Subcommission on Devonian Stratigraphy - Fossil groups important for boundary definition. Courier Forschungsinstitute Senckenberg*, 220: 161-193.
- Blom, H., Märss, T. and Miller, G. In press. Silurian and lowermost Devonian birkeniid anaspids from the northern hemisphere. *Transactions of the Royal Society of Edinburgh: Earth Sciences*.
- Burrow, C.J., Vergoossen, J.J., Turner, S., Thorsteinsson, R., & Uyeno, T. 1999. Microvertebrates from the Late Silurian of Cornwallis island, Arctic Canada. *Canadian Journal of Earth Sciences*, 36:349-361.
- Daeschler, E. B and N. H. Shubin. 1998. Fish with fingers? *Nature* 391:133.
- Dumoulin, J.A., Harris, A.G., Gagiev, Mussa, Bradley, D.C., and Repetski, J.E. in press. Lithostratigraphic and faunal links between lower Paleozoic strata in northern and central Alaska and northeastern Russia, *In Miller, E., and Grantz, A. (eds.), Geological Society of America, Special Paper, Beringia volume*.

- Evdokimova I. O. & Abushik, A.F. (in press). The Early Devonian ostracodes from Severnaya Zemlya (Russia). *In: Goujet, D. (ed.), Palaeontology and stratigraphy of the Silurian-Devonian of Severnaya Zemlya, Russia (IGCP 406 volume). Geodiversitas, Paris.*
- Ginter, M. and Ivanov, A. 2000. Stratigraphic distribution of chondrichthyans in the Devonian on the East European Platform margins. *In: Blicek A. and Turner S. (eds). Palaeozoic Vertebrate Biochronology and Global Marine and Non-marine Correlations. Final Report of IGCP 328 (1991-1996). Courier Forschungsinstitut Senckenberg, 223, 325-340.*
- Ineson, J.R. and Peel, J.S. 1997: Cambrian shelf stratigraphy of North Greenland. *Geology of Greenland Survey Bulletin 173, 120 pp.*
- Ivanov, A. and Luksevics, E. 2000. Vertebrate zonation of the Main Devonian Field and its correlation with other regions. *In: Blicek A. and Turner S. (eds). Palaeozoic Vertebrate Biochronology and Global Marine and Non-marine Correlations. Final Report of IGCP 328 (1991-1996). Courier Forschungsinstitut Senckenberg, 223, 342-350.*
- Karatajute-Talimaa, V. and Märss, T. In press. Upper Silurian thelodonts of Severnaya Zemlya Archipelago. *In: Goujet, D. (ed.), Palaeontology and stratigraphy of the Silurian-Devonian of Severnaya Zemlya, Russia (IGCP 406 volume). Geodiversitas, Paris.*
- Männik, P. 1999. Konodonty ordovika i silura. pp. 110-120 *In: Matukhin R. G. & Menner, V. VI. (eds) Stratigrafiya silura i devona arhipelaga Severnaya Zemlya. SNIIGGiMS, Novosibirsk, 174 pp.*
- Mark-Kurik, E. 1999. Placoderms (Arthrodira). pp. 139-142 *In: Matukhin, R.G. & Menner, VI.V. (eds). Silurian and Devonian stratigraphy of Severnaya Zemlya Archipelago [Stratigrafiya silura i devona arhipelaga Severnaya Zemlya]. SNIIGGiMS, Novosibirsk, 174 pp.*
- Marshall, J. E. A., Astin, T. Clack, J. 2000 East Greenland tetrapods are Devonian in age. *Geology 27: 637-640.*
- Schultze, H. P. 2000: A primitive porolepiform Rhipidistian from the Lower Devonian of the Canadian Arctic. *Mitt. Mus. Naturkde, Geowiss. Reihe, 3: 97-107.*
- Soehn, K. L., Hanke, G. F., Märss, T. and Wilson, M. V. H. 2000. Preliminary vertebrate biostratigraphy of the Avalanche Lake sections (Wenlock, Silurian), southern Mackenzie Mountains, N.W.T., and review of northwestern Canadian vertebrate localities of Silurian Age. *In: Blicek A. and Turner S. (eds). Palaeozoic Vertebrate Biochronology and Global Marine and Non-marine Correlations. Final Report of IGCP 328 (1991-1996). Courier Forschungsinstitut Senckenberg, 223, 129-155.*
- Turner, S. 2000. New Llandovery to early Pridoli microvertebrates including Early Silurian zone fossil, *Loganellia avonia* nov. sp., from Britain. *Courier Forschungs-Institut Senckenberg, 223: 91-107.*
- Valiukevicius, J. and Kruchek, S. 2000. Acanthodian biostratigraphy and interregional correlations of the Devonian of the Baltic States, Belarus, Ukraine and Russia. *In: Blicek A. and Turner S. (eds). Palaeozoic Vertebrate Biochronology and Global Marine and Non-marine Correlations. Final Report of IGCP 328 (1991-1996). Courier Forschungsinstitut Senckenberg, 223: 271-280.*
- Zhuravlev, A.V. & Sobolev, D.B. 2000. Conodonts of the Viséan-Serpukhovian boundary beds of the southern part of the Tchernyshev Ridge (Izyayu River). *Syktyvkarskiy paleontologicheskij sbornik, 4: 84-89.*

2.4 List of countries involved in the project (*countries active this year)

*Australia	Belgium
*Byelorussia	*Canada
*China	*Estonia
*France	*Germany
*Ireland	*Italy
*Japan	*Latvia
*Lithuania	*Netherlands
Norway	*Poland
Portugal	*Russia
*Sweden	Ukraine
*United Kingdom	*U.S.A.

2.5 Activities involving other IGCP projects or IUGS

IGCP 406 began as a successor project to IGCP 328 (Palaeozoic Microvertebrates), which ended in 1996, and is helping to bring some IGCP 328 initiatives to a productive conclusion. For example, IGCP 406 participants are collaborating in study of specimens collected under IGCP 328-sponsored field work in Arctic Canada, and IGCP 406 participants (A. Blicek and S. Turner, editors, 2000; with numerous IGCP 406 members as authors) played a major role in bringing IGCP 328's final volume to completion and publication in *CFS*. Research on Severnaya Zemlya vertebrates and biostratigraphy continues, and publication of the Russian (Menner and Matukhin, eds) and French volumes (D. Goujet, editor, for *Geodiversitas*) on this subject have also furthered the aims of IGCP 328. IGCP 406 continues to make good use of the newsletter *Ichthyolith Issues* (S. Turner, editor) and the *Paleozoic Microvertebrates* WWW page (M. Wilson, editor), both begun under IGCP 328, to keep participants informed and to disseminate project news and announcements.

Members of IGCP 406 are also active in and supportive of some other IGCP projects, including IGCP 421 "North Gondwana mid-Palaeozoic biogeography/bioevent patterns in relation to crustal dynamics" and IGCP 410 "The great Ordovician biodiversification event." Many participants are also associated with one or more of the relevant subcommissions of the International Commission on Stratigraphy, especially the Subcommission on Devonian Stratigraphy (SDS) and the Subcommission on Silurian Stratigraphy (SSS).

2.6 Participation of scientists from developing countries

IGCP 406 has excellent participation from several countries of the former Soviet Union: Russia (including remote regions), Byelorussia, Estonia, Latvia, Lithuania, and Ukraine, as well as from Poland. This year, we had especially good participation by scientists from remote parts of Russia, especially northern Russia (Ukhta and Syktyvkar). We also have several participants from P.R. China, who are active in problems of global correlation and palaeobiogeography.

3. Proposed activities of the project for the year ahead

3.1 General goals

This was the last year of project IGCP 406. Future plans include completing several publication projects (e.g. the *Geodiversitas* volume edited by D. Goujet) and helping to plan future projects to continue the momentum established during the lives of IGCP 328 and 406.

Ongoing collaborations

1. Members of the Canadian Arctic Working Group will continue their collaborative studies with German and Estonian colleagues on Devonian acanthodian faunas (Canada, France) and Silurian-Devonian heterostracan and thelodont faunas (Canada, Estonia) from the Mackenzie Mountains, on Lower Devonian vertebrates from the Anderson River (Canada, Germany), and on heterostracan, thelodont, anaspid, and placoderm faunas from Cornwallis, Baillie-Hamilton, Prince of Wales, and Somerset Islands (Australia, Canada, Estonia, Germany, Sweden).
3. Members of the Greenland Working Group continue studies of biostratigraphically and palaeobiologically important fossils from Greenland.
4. For the working groups dealing with the Russian Arctic, completion and publication of manuscripts on the geology and palaeontology of Severnaya Zemlya, Timan-Pechora, Kotelnnyi Island, etc. is a main goal. Collaboration on the study of samples collected in earlier years will be encouraged by sharing acid residues and rock samples with researchers in as many disciplines as possible. Geochemical and micropalaeontological samples collected during the Subpolar Urals field trips of 1999 and 2000 will be processed and analyzed.

Possible Successor Projects

Suggested successor projects include these ideas:

- 1) Mesozoic microvertebrates and Palaeozoic-Mesozoic boundary (proposed by S. Turner and M. Richter). The focus would be on extending the studies of Late Palaeozoic microvertebrate biostratigraphy across the end-Palaeozoic boundary and applying similar methods to Triassic and later rocks, where these methods have been little used.
- 2) Geological events and evolution of Palaeozoic craniates (including conodonts) (a suggestion by T. Märss, M. Wilson, A. Zhuravlev, and others). The focus would be on event horizons (geochemical excursions, extinction horizons, sea-level changes, etc.) and their correlation with conodont and vertebrate zonation schemes, extinction events, and evolutionary radiations. This would have the advantage of including a broad spectrum of specialists and geologic ages, a broad (global) geographic focus, and continuing the cross-fertilization of ideas between geologists and palaeobiologists.
- (3) Evolution of basins (proposed by V. Menner, P. Männik, and others). Basin evolution is of fundamental importance to regional geologists; comparison of techniques and global correlation of strata between basins could be of interest to many stratigraphers.

There seems no good reason to limit the possibilities to a single project, and all three of the above ideas are worthy of further development.

3.2 Specific meetings and field trips

None (project has concluded).

3.3. Future plans: 2001 and beyond

None (project has concluded).

4. Project funding request

None (project has concluded).

5. Intention to propose successor project

Several ideas are being discussed, but final decisions and leadership have not been finalized as yet. It is likely that a successor project will not be proposed until a year from now.