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REPORT ON OVERSEAS TOUR - 1965-66

by

P.J. Jones

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SUMMARY

Selected micropalaeontological laboratories in West Germany, Sweden, France, Great Britain and the United States of America were visited during the period 15th November, 1965 - 15th January, 1966, to study overseas techniques related to oil exploration. Governmental, commercial and academic centres were visited and notes were taken on current research on ostracods and conodonts, its application to stratigraphy, and laboratory techniques. In some cases, notes were taken on the aims and principles of these organizations. Where appropriate, specific collections were examined and the inter-continental significance of the Australian Upper Devonian and Lower Carboniferous ostracod faunas was discussed. The joint symposium meeting of the Geological Society of London and the Palaeontological Association - "Review of the fossil record" held at Swansea, between 20-21st December, 1965, was attended.

INTRODUCTION

In order to study the latest overseas developments in geological techniques related to oil exploration, I visited selected scientific institutions and oil exploration company laboratories in Germany, Sweden, France, Great Britain and the United States of America during a tour which lasted from 15th November, 1965 to 15th January, 1966. No attempt was made to contact every palaeontological laboratory in each country, but a variety of governmental, industrial and academic institutions was visited.

This report outlines (i) some of the current research of the institutions visited, and (ii) laboratory techniques (particularly photographic). Particular attention was given to recent research on ostracods and conodonts and the application of this research to stratigraphy. Preliminary comparative studies were made between Australian and overseas collections of Upper Devonian-Lower Carboniferous ostracods. Notes taken on these observations will not be included in this report; they will be of value in my systematic study of Western Australian ostracod faunas. Comparisons were also made between the Ordovician conodont faunas of the Amadeus Basin, and those of Minnesota; these will also be of value for later systematic studies.

The scientific institutions and oil exploration company laboratories visited are listed below:-

GERMANY	:	Geological-Palaeontological Institute and Museum, and the Marine Geology Institute, University of Kiel.
SWEDEN	:	Palaeontological Institute, University of Uppsala Geological Institute, University of Stockholm.
FRANCE	:	Société Nationale des Pétroles d'Aquitaine, Pau.
GREAT BRITAIN	:	British Museum (Natural History), London. Departments of Geology, University of Leicester. University College, London, University College, Swansea.
UNITED STATES OF AMERICA	:	United States Geological Survey, Washington. Smithsonian Institution, Washington. Illinois State Geological Survey, Urbana. Department of Geology, University of Illinois, Urbana. Department of Geology, University of Minnesota, Minnesota, Minneapolis. Richfield Oil Corporation, Los Angeles, California.

CURRENT RESEARCH

WEST GERMANY

Kiel University - Geological-Palaeontological Institute and Museum (17th - 20th November, 1965).

Professor K. Krömmelbein - Head of Palaeontological and Stratigraphical Studies.
Dr. H. Bøger - Research assistant and lecturer in Palaeontology and Stratigraphy.
Professor E. Seibold - Head of Marine Geology Institute.

At the moment, Professor Krömmelbein is studying the non-marine Lower Cretaceous ostracod faunas of the west coast of Africa (viz., Nigeria, Ghana, and Gabon), to follow up his studies on the Lower Cretaceous (Neocomian) ostracods from the east coast of Brazil. His work has shown that the faunas from both Africa and Brazil have some 50 species in common, and are unrelated to those of the classical "Wealden" of northwestern Europe. Furthermore, in West Africa within the short time-span of the Neocomian stage, he can recognize the same sequence of ostracod assemblages - seven of the eight faunas that he has described from East Brazil. These remarkable results not only demonstrate the high stratigraphical value of these non-marine Lower Cretaceous ostracods, but also provide some palaeontological evidence in favour of the theory of continental drift (at least between Africa and South America); the lithological sequences on both sides of the Atlantic Ocean also match surprisingly well. He is anxious to obtain non-marine Lower Cretaceous ostracods from India and Australia. When he was approached by French oil companies to undertake biostratigraphical work in West Africa, his taxonomic studies of the Lower Cretaceous non-marine ostracods from Brazil provided the basis on which he could provide a very precise correlation between the two continents.

Krömmelbein has postponed his studies of the Middle Devonian benthonic ostracods from the Eifel Rheinisches Schiefergebirge, until Dr. F. Adamczak of Stockholm University has published his detailed taxonomic work on an ostracod fauna of the same age from the Holy Cross Mountains, Poland. Adamczak's material is well-preserved, and his study will provide a sound taxonomic basis for Krommelbein to study the biostratigraphy of the Middle Devonian ostracods from the type Eifelian.

Bøger has recently completed a palaeoecological study of the Upper Carboniferous (Westphalian) cyclothems of the Ruhr coalfield and he is now studying palaeoecological aspects of Lower Carboniferous reefs and coral faunas.

Marine Geology Institute - Gutstift - Kiel (19th November, 1965).

While at Kiel, I was invited by Professor Krömmelbein to have a brief look at the work of the Marine Geology Institute. This institute is a part of the University of Kiel, and includes a team of eight workers, under the direction of Professor Eugen Seilbold, viz.,

Dr.	Hartmann	Geochemistry.
Dr.	Werner	Sedimentary structures.
Dr.	Vollbrecht	Processes on coast lines, mainly in terms of mathematics and physics.
Dr.	K.H. Nachtigall	Sand Transport.
Dr.	F.W. Haake	Foraminfera Recent

Dr. G.F.	Lutze	Foraminifera Recent, Cretaceous and Jurassic.
Dr.	Krumm	Clay Minerals.
Dr.	Kögler	Design of equipment.

The areas under current study include the littoral zones of the German coastline both in the Baltic Sea and the North Sea. Also a study is being made of material collected from the Persian Gulf by the German hydrographic research ship "Meteor".

Werner is studying unconsolidated sediments for

(i) macroscopic depositional and infaunal structures
(ii) microscopic structures in thin sections, and
(iii) textural differences in core samples by the use of X-rays.

Werner's methods of making peels of recent sedimentary structures for laboratory study mainly follows those described by Bouma (1964). All the minute details of cross-bedding, scour and fill surfaces, burrows of worms and pelecypods etc., are preserved as a permanent record. Each peel is accompanied by data on the direction and velocity of the actual winds and currents responsible for making the structures. The ultimate aim of this work is to reach the stage when such sedimentary structures of the geological record can be interpreted exactly in terms of these parameters. His technique for preparing thin sections of unconsolidated sediments follows standard methods, except that the samples are dried by rapid freezing in liquid air or nitrogen to prevent cracking, and the interstitial water examined chemically. Examination of unconsolidated sediments by X-rays largely follows the method described by Calvert & Veevers (1962), in which textural differences within the sediments dan be detected by differences in the absorption of X-rays.

Nachtigall is studying the movement of sand by long-shore drift. This involves studies of the direction and velocity of winds and currents, and recent movements of sand by echo-sounding of sand-bars at frequent and regular intervals, and the use of fluorescent dyes to stain sand-grains which are counted electronically under ultra-violet light. Some interesting contrasts can be made in the sand transport between the coast-line of the North Sea, and that of the tideless Baltic Sea.

Lutze is studying living specimens of foraminifers collected from the Baltic Sea and the Persian Gulf. Cultures of species belonging to the genus Heterostegina are being bred in the laboratory to study their life-cycles, and as they have thick calcareous tests, this makes them especially suitable for the determination of trace-elements. Special high-power microscopes are used with the objective placed below the stage, and green filters and low intensity microscope lamps are used to avoid killing the specimens (living specimens cannot survive the heat generated by ordinary lamps). Living specimens of Heterostegina under the microscope showed wall-canals similar to those described by Hofker, which Lutze regards as due to optical effects rather than a definite morphological structure.

The results of many research projects on marine geology conducted at Kiel are published by the Geological Institute of the University in Meyniana. This journal first appeared in 1950, and is published annually for exchange. It is not received by the B.M.R., and would be a useful addition to our library.

SWEDEN

Uppsala University - Palaeontological Institute
(21st, 23rd, 26th November, 1965).

Professor P. Thorslund - Director.
Dr. V. Jaanusson - also Assistant Curator of Paleozoology
Department of the Riksmuseet, Stockholm.
Dr. A. Martinsson - Docent - Uppsala.

Professor Thorslund is no longer active in the field of ostracod research, so my discussions at Uppsala were mainly with Drs. Jaanusson and Martinsson.

Jaanusson is at present studying the internal structures, muscle scars, and position of appendages of the Recent platycope ostracod species Cytherella abyssorum Sars, in which it has long been known that the females show an inflation of the posterior end. Many students of Palaeozoic ostracods have assumed that the dimorphism of the Carboniferous genus Cavellina has a sexual significance on the basis of comparison with the Recent genus Cytherella. On the other hand, some neontologists have shown that posterior inflation occurs in the males of Recent ostracod species. Jaanusson's studies demonstrate that the species which show this belong to three distinct groups, i.e.,

(i) those in which the females carry a variable number of eggs loosely between the posterior part of the body and the inner epithelium of the mantle (e.g., in podocopes),

(ii) those in which the genitial organs (penes or ovaries) are large, and occupy a large volume of the posterior part of the body cavity (e.g., also in podocopes), and

(iii) those in which the number of eggs are restricted to 6-8, and are attached to the inner epithelium of the posterior, and held in position by means of an internal vertical ridge (e.g. only in platycopes).

From shell morphology, no clear-cut distinction can be made between males and females belonging the groups (i) and (ii), but in group (iii) the presence of posterior inflation and an internal vertical ridge reflects the sexual function of the female carapace. Thus, Jaanusson has shown that the Carboniferous genus Cavellina definitely belongs to the order Platycopa. Posterior dimorphism has long been known to occur in the Kloedenellacea, a Palaeozoic superfamily in which several workers have reported the presence of an internal vertical ridge, and Jaanusson's studies of the Recent species Cytherella abyssorum may have special significance in resolving the taxonomic relationships of the Cavellinidae and the Kloedenellacea.

Martinsson is studying primitiopsid ostracods from the Silurian of Gotland, together with their dimorphic structures (e.g., the primitiopsid ridge). He is preparing a joint paper with Professor Jaeger of Berlin on the genus Xenusion, thought to be an onychophoran, and originally described from an erratic boulder, of presumed Late Precambrian origin; the results of this work describe some hitherto overlooked morphological features, and show that the original locality is Lower Cambrian, and not Precambrian. Martinsson is also describing thelodont scales from the Wenlockian of Gotland, which represents one of the earliest occurrences known in the Brito-baltic province. When published, this study will be a useful reference with which to compare the coelolepid fish-scales which I have found in the Lower Devonian-Upper Silurian Craven Peak Beds of the Toko Range, western Queensland.

Stockholm University - Geological Institute
(22nd, 24th, 25th November, 1965)

Professor I. Hessland - Director; interests - General and Historical Geology, Sedimentology, and Palaeozoic Ostracoda.
Professor R. Reyment - Biometrics, ammonites, Mesozoic and Cainozoic Ostracoda and Foraminifera.
Dr. H. Mutvie - Acting Professor of Historical Geology and Palaeontology Palaeozoic Cephalopoda.
Dr. F. Adamczak - Docent in Palaeontology (of the Palaeozoological Institute, University of Warsaw, temporarily at Stockholm), - Palaeozoic Ostracoda.
Miss Elsa Wikander - Research Student - Palaeozoic Ostracoda.

My purpose in visiting the University of Stockholm was to discuss Devonian ostracods with Dr. Adamczak, who is conducting detailed morphological studies of the Middle Devonian ostracods from the Holy Cross Mountains of Poland. His work includes investigations of internal features (hinge-line, contact margin, and muscle-scars) of palaeocope, platycope, metacope and podocope ostracods. Adamczak is using electron microscope photographs to study the shell structure of thin sections of various ostracod genera and the problematical genus Cryptophyllus. The latter differs from ostracods by its (i) multilamellar growth, (ii) equivalve shell, and (iii) shell structure - laminated cells instead of prismatic.

Miss Elsa Wikander is studying Lower Ordovician ostracods from Sweden. I saw her preparing a species of the dimorphic genus Glossomorphites for study. The specimens were preserved in a hard limestone, and had to be painstakingly extracted with the use of needles and a dental drill.

FRANCE

Société Nationale des Pétroles d'Aquitaine (S.N.P.A.) Centre de Recherches Pau (C.R.P.)
(28th November - 3rd December, 1965)

The Société Nationale des Pétroles d'Aquitaine manages oil and gas fields in southwestern France (Lacq), in the Sahara (El Gassi and El Agreb), and actively conducts exploration overseas, including Australia (viz., Australian Aquitaine Petroleum Pty. Ltd. - A.A.P.). This company has operated a research laboratory at Pau since 1960, which studies problems of drilling and production, geophysics, geology and physical chemistry. The geological section is divided into a "stratigraphy group and a "sedimentology-geochemistry" group. The stratigraphic group, headed by Dr. Colo, covers micropalaeontological, palynological, sedimentary, petrological, and micro-facies studies.

Dr. G. Colo	Head of Stratigraphic section, France and overseas.
Mr. J. Caye	Head of stratigraphic work in Australia.
Dr. H.J. Oertli	Chief Micropalaeontologist - Mesozoic - Recent ostracods.
Mr. J. LeFevre	Palaeozoic ostracods and conodonts.

I visited this laboratory for several reasons, viz.,

(1) To examine ostracods recovered from samples collected by A.A.P. from the Upper Devonian and Lower Carboniferous succession of the Bonaparte Gulf Basin, and submitted to C.R.P. The ultimate aim is to establish a uniform nomenclature for ostracod species to facilitate mutual understanding of B.M.R. and C.R.P. species-range charts.

(2) To briefly examine Lower Carboniferous ostracods and conodonts from the Sahara and the Franco-Belgian Basin.

(3) To note the methods of study and laboratory techniques in use at Pau.

LeFevre is conducting routine investigations of conodonts and Palaeozoic ostracods recovered from samples submitted by the subsidiary companies of S.N.P.A. operating overseas e.g., Spain, Sahara, Canada, and Australia. As a result of the need for rapid age-determinations, more emphasis is placed upon stratigraphical aspects, and less on taxonomic descriptive work. Neglect of taxonomy however, can tend to leave many stratigraphical problems unresolved. The laboratory employs a great number of technicians to carry out routine tasks such as picking, photography, and general drafting. Documentation is also an important duty of technical staff. Although the laboratory is well-organized, and has excellent facilities, occasionally there appears to be lack of liaison between the field staff and the individual specialists. LeFevre appreciated much fundamental information e.g., on localities and stratigraphy, which I had learned from my own experience in the Bonaparte Gulf Basin; although possibly contained within the organization, this was unknown to him.

I also had the opportunity to meet Dr. Van Oyen, the Chief Palynologist, who described to me some of the results the company has obtained from the application of the study of chitinozoans, and scolecodonts to stratigraphical problems. This work, as with all stratigraphical work, largely depends upon thorough documentation.

GREAT BRITAIN

University College, London, Department of Geology
(6-7th, 13-15th December, 1965)

Professor S.E. Hollingworth - Head of department.
Professor T. Barnard - Head of Micropalaeontology department.
Dr. J.E. Robinson - Lecturer - Palaeontology.

The University of London is, as far as I know, the only university in Great Britain which has a separate department of Micropalaeontology. This department, which was formed at U.C.L. under the direction of Dr. T. Barnard, now offers a one-year M.Sc. course in Micropalaeontology, to give a basic knowledge of Foraminifera, Ostracoda, Conodonts and Palynology.

My purpose in visiting U.C.L. was to discuss my work with Dr. Robinson, who is studying Lower Carboniferous ostracods in Britain and making taxonomic revisions of species described by previous workers (viz., T.R. Jones & J.W. Kirkby) during the latter half of the last century.

Robinson's collections contain abundant topotypic material based on detailed sampling of the Yoredale cyclothem sequence of northern England. He places special emphasis upon stratigraphic aspects, and the value of topotypic material before referring to the type specimens in the British Museum (Natural History). An important result of his study of the ostracods about the Tournaisian-Visean boundary is that he can demonstrate that the Tournaisian sea extended into northern England, north of the ancient land barrier "St. Georges land". Also the Tournaisian sea had several channels through the ancient land mass of the Southern Uplands, in order to account for the occurrence of Tournaisian ostracods in the Central Lowlands of Scotland. This view conflicts with the Lower Carboniferous palaeogeographical interpretations of Professor T.N. George, who maintains

that St. Georges Land confined the Tournaisian sea to southern England only. Robinsons' view, however, is confirmed by the studies by Dr. R.H. Cummings on the foraminifers.

Robinson has also prepared two manuscripts which resolve the morphological and taxonomic problems posed by the ostracod genera Bernix and Moorea. Discussions with Robinson helped me to clarify my concepts of various genera e.g., Beyrichiopsis and Glyptopleura, and comparison of our respective Lower Carboniferous ostracod faunas was of mutual help.

British Museum (Natural History)
(22nd, 23rd December, 1965)

Dr. R.H. Bate	Curator - Ostracoda.
Mr. S.H. Eager	Assistant Curator - Ostracoda.

I was unable to meet Dr. Bate, but Mr. Eagar kindly assisted me in my search through the Jones & Kirkby and Armstrong collections of Carboniferous Ostracoda. Time was sufficient to make only the most cursory examination. I did manage, however, to examine specimens of Bairdia, Youngiella, Geisina, Knoxiella (viz., K. eichwaldi (Jones & Kirkby) and Ogmoconcha (this genus has previously been recorded only from the Triassic-early Jurassic, but is present in the Lower Carboniferous of Australia and Great Britain). Specimens of the problematical microfossil Draffania Cummings were also examined.

Eager is continuing his studies of Tertiary Ostracoda, particularly the Eocene fauna from the London Clay of Enborne Valley, Berkshire. Bate is continuing his research on Jurassic Ostracoda.

Leicester University - Department of Geology
(8-10th December, 1965)

Professor P.C. Sylvester-Bradley - Head of Department.
Mr. Qadeer Siddiqui) - Research students
Mr. Michael E. Keen)

Current ostracod research at Leicester includes studies on the Eocene Ostracoda of West Pakistan (Siddiqui), and Eocene and Oligocene Ostracoda from various localities in northwestern Europe (Keen). Discussions with both Siddiqui and Keen were mainly confined to techniques, although Siddiqui greatly valued an examination of a small collection of Recent ostracods from the Vestfold Hills, Antarctica, which I carried with me. My Antarctic material includes several species previously described by Benson (1964) from McMurdo Sound, U.S. Antarctic Territory. Siddiqui having read this paper thought that two new genera of Recent ostracods (Australicythere and Patagonicythere described by Benson, also occurred in his Eocene fauna from Pakistan. As both of these genera are present in the Vestfold Hills, his examination of my material confirmed that he could confidently assign some of his Pakistani species to Australicythere and Patagonicythere, thus extending the ranges of these living genera back as far as the Eocene.

Swansea University College - Department of Geology
(16th-21st December, 1965)

Professor F.H.T. Rhodes - Head of Department.
Mr. A.T.S. Ramsey - Research student.

The object of my visit to Swansea was three-fold;

(i) to compare and contrast the respective Lower Carboniferous ostracod faunas of the Southwest Province of Britain, and the Bonaparte Gulf Basin, of northwestern Australia.

(ii) to observe laboratory techniques, especially photographic, and

(iii) to attend the joint symposium meeting of the Geological Society of London and the Palaeontological Association on "Review of the fossil record".

The Lower Carboniferous Ostracoda of the Southwest Province are being studied by Mr. Ramsay, who is concentrating mainly on the Lower Avonian (= Tournaisian) coral-brachiopod zones K and Z, from three sections viz., at Mitcheldean in the Forest of Dean, the lower part of the Avon Gorge, at Bristol, and at Abergavenny, Glamorganshire. Ramsay collected his samples from shales, which include a great abundance of carapaces and isolated valves, which show hinge structures and contact margins. The material is slightly recrystallized, but is sufficiently abundant to allow study of the morphogenesis of several species by preparing size-dispersion diagrams. Such graphs suggest that the genus Paraparchites is dimorphic, and that some forms previously described (by Jones & Kirkby, late last century) as distinct species belonging to Paraparchites, are actually juvenile instars of larger species. Thin sections of some species of Paraparchites show a rudimentary duplicature (= duplicature simplex of Triebel), with or without vestibule.

Ramsey's Tournaisian microfauna includes species which he referred to the following genera:- Beyrichiopsis, Glyptopleura, Knoxina, Oliganisus, Hypotetragona, Geffenia, Paraparchites, Cavellina, Bairdia (2 species), Acratia (A. mucronata Cooper, 1941), Sansabella, "Bythocypris", and Healdia. To this list may be added species belonging to the genera Youngiella and Monoceratina, which Ramsay regard as dimorphs (I do not agree with this view), and species which I identified as belonging to Coryellina, and Libumella. This ostracod fauna bears a general resemblance to that of the Lower Mississippian of Alberta (Green, 1963), and to a slightly lesser extent to that of the Tournaisian of the Bonaparte Gulf and Fitzroy Basins.

I also had discussions with Dr. J. Pollard (Department of Geology, University of Manchester), and Dr. R. Austin (Department of Geology, University of Southampton), who were both attending the Fossil Record symposium in Swansea. Pollard is working on the Upper Carboniferous ostracods in the marine bands of the Coal Measures of northern England, and Nova Scotia, Canada, which include species belonging to the genera Carbonita, Geisina, and Hollinella. Austin is at present co-ordinating the results of a joint study, together with E.C. Druce and Professor Rhodes, on British Carboniferous conodont faunas, to be published shortly, and is continuing his own studies on Lower Carboniferous and Upper Devonian conodonts.

"Review of the fossil record" - Joint symposium meeting of the Geological Society of London and Palaeontological Association, 20th-21st December, 1965 in the Department of Geology, University College, Swansea.

The main aim of the symposium was to document the first appearances and final disappearances of all fossil groups at various taxonomic levels above genera. The basic data was prepared by specialists in the fossil groups and forwarded to Dr. B.M. Funnell and Dr. J.L. Cutbill of Cambridge University for processing on the electronic data computer. The results were presented at the symposium together with other papers which gave brief details regarding the faunal changes. Both Funnell and Cutbill were well aware of the traps of forming conclusions based upon suprageneric taxa, and they cautiously stated that their job was "to do the arithmetic, and not to formulate the theories." From their figures, the two major breaks in the evolution of life at the Permian-Triassic boundary and the Cretaceous-Tertiary boundary respectively, were readily apparent.

Some papers described the origins of various groups e.g.,

"Precambrian life and the base of the Cambrian" - W.F. Whittard,

"Lower Palaeozoic appearances" - M.R. House,

"The evolutionary radiation of birds" - J. Fisher, and

"Plant-insect relationships" - N.F. Hughes & J. Smart.

Other papers described major faunal changes e.g.,

"Permian-Triassic changes" - F.H.T. Rhodes & M.J.S. Rudwick,

"Triassic-Jurassic vertebrate changes" - C.B. Cox, and

"Cretaceous-Tertiary marine faunal changes" - J.M. Hancock.

Professor Rhodes and Dr. Rudwick concluded in their paper that the Permian-Triassic break may be more apparent than real, as sections where a distinct faunal break occurs within an apparently conformable sequence e.g., in the Salt Range, Pakistan, (Kummel & Teichert, 1966) are now known to be actually unconformable (more precisely, paraconformable). Recently, Ruzhenstev & Sarytcheva (1965) have described a section in the Caucasus (Armenia & Nakhichevan), which is regarded as a continuous sequence, and contains a fauna transitional from the Permian to the Triassic.

Dr. D.V. Ager criticized some of the papers on the grounds that the apparently sudden appearance or disappearance of many fossil groups may have other explanations than those advanced by the authors. For instance, the sudden disappearance of many groups may be due to environmental changes, and the sudden explosive evolution within a group may be due to "monographic outbursts" in documentation.

UNITED STATES OF AMERICA

United States Geological Survey & United States National Museum (Smithsonian Institution), Washington, D.C.

(28th-31st December, 1965)

Dr. I.G. Sohn	United States Geological Survey.
Dr. Jean M. Berdan	United States Geological Survey.
Dr. R.H. Benson	United States National Museum.
Dr. Rosalie F. Maddocks	" " " "
Dr. L.S. Kornicker	" " " "
Dr. J.E. Hazel	" " " "

Probably nowhere else in the world are there as many ostracod workers situated in the one place as there are in Washington. Six specialists work in the same building - the U.S. National Museum; of these, two work for

the Geological Survey, studying mainly Palaeozoic ostracods, and the remaining four work for the National Museum, studying mainly the ecology of recent ostracods. Each specialist appeared to be able to devote most of his or her time to research work. Although technical assistance was available, some preferred to prepare their own specimens for study e.g., Benson preferred to photograph his own specimens.

Sohn is at present studying Triassic ostracods, mainly from Israel and Nevada. Other projects include a revision of the ostracod fauna from the Upper Mississippian Fayetteville Shale of Arkansas, originally described by Girty (1910), and the description of a newly found ostracod fauna from the Lower Mississippian of Alaska. Sohn, like Adamczak in Stockholm, is also using electron-microscope photographs to study the shell structure of thin sections of various ostracod genera.

Jean Berdan is continuing her study of the ostracods about the Silurian-Devonian boundary of the eastern United States. She kindly made this material available for my inspection, together with collections of younger Devonian ostracods from the Tully Limestone (Middle Devonian) of New York State, the Snyder Creek Shale (Upper Devonian Frasnian) of Missouri, and the Three Forks Shale (Upper Devonian Famennian) of Idaho.

Benson and Rosalie Maddocks are making a large-scale study of the ecology of living ostracod species, in which their data is programmed for the computor. They are using the methods outlined by Sokal & Sneath (1963) by computing coefficients of association (also known as coefficients of similarity or relationship, or matching coefficients). The minimum sample size that Benson required must contain at least 300 specimens, which could consist of as many as 30 species. Data is being collected on a world-wide scale, from ostracod faunas in Arctic and Antarctic waters, and from the Atlantic, Pacific and Indian Oceans. A number of localities are in Australian waters off the coast of New South Wales and Tasmania.

Kornicker is conducting ecological studies of ostracods on a smaller scale than Benson. He studies in detail the morphology, and as many ecological factors as possible for a small group of related species, over a relatively small region e.g., Bairdiinae from Bimini Island, north-western part of the Great Bahama Bank.

Illinois State Geological Survey - Urbana, Illinois
(1st-5th January, 1966)

Dr. J.C. Frye - Chief Geologist.
Dr. C.W. Collinson - Head of Stratigraphy and Areal Geology.

The Illinois Geological Survey conducts a continuous programme of geological exploration, mapping, research, and organization and interpretation of data. As a division of the Department of Registration and Education, it is extremely aware of the benefits to be gained from maintaining good public relations. The Education Extension Section of the Geological Survey publishes popular and educational booklets designed for the use of Illinois teachers and students. All of the Survey's publications are distributed free to schools, teachers, and professional geologists, upon request. The Survey also assembles and distributes, at no cost, labelled collections of rocks, fossils, and minerals for class use in Illinois schools, and educational purposes by any non-profit making organization e.g., Boy Scout groups. Members of the Survey staff give free illustrated lectures to organized groups about the geology and mineral resources of the state. Six field trips are conducted each year in various parts of the state, for teachers, students, and interested laymen. In this way, the Illinois tax-payer becomes more aware of the Survey's activities, the results of which

form a part of his general education. Thus, well-informed public opinion eventually makes its impression in governmental circles, and in the liberal way in which public funds are allocated to the Survey.

The purpose of my visit to the Illinois Geological Survey was to examine some of the type collections of Carboniferous ostracods (e.g., Cooper 1941, 1945 collections; Benson & Collinson, 1958 collection), although time was insufficient to make a thorough coverage of all the available material.

Besides his study of Lower Carboniferous intercontinental correlations based on conodonts, Collinson is also conducting a detailed conodont examination of subsurface core material from thick sequences of Silurian and Ordovician carbonates in Illinois. Continuous coring by oil companies operating in Illinois is now the rule, rather than the exception, e.g., a continuous 6-inch diameter core, cut for 8,000 feet throughout the Silurian and Ordovician sequence, is now being examined for conodonts.

Collinson & E.C. Druce (1966), have recently published an abstract of preliminary results of a study of Upper Silurian conodonts from the Whitcliffe Beds (uppermost Ludlovian) of the Welsh Borderland. The conodont fauna is referred to Walliser's (1964) uppermost Silurian conodont zone (eosteinhornensis zone) of the European mainland, which indicates that the top of the Ludlovian correlates with the top of the Bohemian Budnany (e β 2).

University of Illinois - Department of Geology
(1st-5th January, 1966)

Professor H.W. Scott - Ostracod taxonomy.
Dr. P. Sandberg - Tertiary and Recent brackish-water ostracods.

I briefly examined more type collections of ostracods deposited in the Department of Geology (e.g., Mississippian collections Geis, 1932, and Scott, 1942, and the Silurian collection of Lundin, 1965) , and had discussions with both Dr. Scott and Dr. Sandberg on the morphology and taxonomy of ostracods. Dr. Scott pointed out to me the features which he considered to be important for ostracod classification (e.g., nature of overlap of valves, the presence or absence of duplicature, hinge-structure, etc.,), which he has proposed in the ostracod volume of the Treatise of Invertebrate Paleontology.

University of Minnesota - Department of Geology - Minneapolis
(5th-9th January, 1966).

Professor F.M. Swain - Head of Department; Tertiary-Recent ostracods, and geochemistry.
Dr. G.F. Webers - Ordovician conodonts and Cambrian trilobites.

At present, Dr. Swain is studying ostracods from phosphate deposits of late Oligocene-early Miocene age from the Cape Hatteras region of South Carolina. Radiolaria also occur in the phosphate deposit, and benthonic foraminifers are absent, but they are abundant in the beds both above and below. The phosphate deposit is quite sandy, and does not necessarily represent conditions near to the edge of the shelf; it was probably formed by upwelling currents in the littoral zone. I also saw some of Swain's geochemical studies in progress. He dry-freezes samples to extract the connate water, which is examined for residual organic compounds (e.g., amino acids, furfurals, carbohydrates) by paper chromatography.

I briefly examined ostracod type specimens from the Lower Devonian Camden Chert of western Tennessee (Swain, 1953), and from the Upper Ordovician Decorah Shale of Minnesota (Swain and co-workers.). Several reference slides of ostracods were also examined e.g., Middle Devonian Silica Shale of Ohio, and subsurface Upper Devonian from oil wells in North Dakota, Williston Basin.

Dr. Webers' studies of the conodonts from the Middle and Upper Ordovician of Minnesota have involved taxonomic revisions of many of the species described by earlier workers (e.g., Stauffer). Many conodont species found in the Ordovician sequence of the Northern Territory and western Queensland appear to be conspecific with the North American forms. Consequently, the main reason of my visit to Minneapolis was to discuss with Webers the taxonomic and stratigraphical significance of these faunas, and to examine his material. His study (Webers, 1966) is based on 35,000 specimens collected from the Glenwood Shale, Platteville Limestone, Decorah Shale, Galena Limestone, and Dubuque Formation. He reports "stratigraphic distribution and relative abundances of the individual form species, together with size differences and "secondary characteristics" have made it possible to describe 33 individual form species or groups of form species as "biological" or "natural" species. Problems stemming from the present invalid dual nomenclature of conodonts can be solved by using a statistical approach to the determination of "natural assemblages". The stratigraphic distribution of conodonts permits subdivision of the Middle and Upper Ordovician strata of Minnesota into biostratigraphic zones. A major faunal shift is recorded in the Galena Limestone and the Dubuque Formation by an increase of European elements at the expense of American Midcontinent elements."

The statistical approach for the determination of "natural assemblages" of conodonts was discovered independently, by both Professor W.C. Sweet of Ohio State University and Webers of Minnesota University at the same time.

Research students include Mr. Frank Gunther, who is studying Recent Ostracoda from the Gulf of Panama, and Mr. Richard Benson, who is studying Recent Radiolaria in the Gulf of California.

Richfield Oil Corporation - Los Angeles - California
(9th-12th January, 1966).

Mr. W.T. Rothwell Jnr. - Chief Micropalaeontologist.
Mr. R. Brooks - Micropalaeontologist.
Mr. R. Anderson - Micropalaeontologist.
Mr. L. Norem - Palynologist.

I visited the Long Beach laboratory of Richfield Oil Corporation to study the methods and techniques employed by this company, and to discuss uniformity in nomenclature of our ostracod species in the Lower Carboniferous and Upper Devonian of the Bonaparte Gulf Basin. This company, which has been mainly responsible for the exploration and exploitation of the Los Angeles and Ventura Basins, is now exploiting the off-shore oil-pools. Four Foraminifera workers are employed on the study of the Miocene-Pleistocene biostratigraphy of current wells being drilled off the coast. Their work now forms a routine pattern, based on the data accummulated for more than 30 years, since Natland's (1933) classical study, in which he showed that the biostratigraphic zones of the Pliocene-Pleistocene section were similar to the depth zones in Recent sediments off the coast.

Rothwell is studying the stratigraphical distribution of the Pacific foraminiferal benthos in the Oligocene and early Miocene of the Californian region, to which he has applied the biomere concept of Palmer (1965)*. He regards the long-ranging species of the genera Uvigerina and Siphogenerina as representing a stable basic-stock of slowly evolving forms, which lived in the cold deep water of the oceanic environment. According to Rothwell, successive invasions of these species into the warm shallow water of the shelf environment in Oligocene and early Miocene times, were accompanied by annihilation of most of the earlier species of the region. This allowed several successive periods of gradual evolution to take place in the foraminiferal benthos of the shelf, bounded by abrupt non-evolutionary breaks.

Anderson is conducting routine examination of Foraminifera from the Tertiary of California, the Lower Cretaceous of Alaska, and the Lower Carboniferous of the Bonaparte Gulf Basin, Australia. He is not an ostracod specialist, so discussions with him on the Lower Carboniferous ostracods of the Bonaparte Gulf Basin were useful to establish a uniform nomenclature for species so that our respective species-range charts are mutually intelligible.

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* Palmer (1965) introduced the term biomere as a "regional biostratigraphic unit bounded by abrupt non-evolutionary changes in the dominant elements of a single phylum. These changes are not necessarily related to physical discontinuities in the sedimentary record, and they are, or may be, diachronous." The typical biomere is the Pterocephalic Biomere, which includes the Aphelaspis, Elvinia and intermediate zones of the Upper Cambrian of the western United States.

LABORATORY TECHNIQUES (Micropalaeontological)

Various laboratory techniques were studied, and particular emphasis was placed on the photography of microfossils.

Preparation of sample

(a) Disaggregation

Many techniques are used to prepare ostracods and conodonts for study, each one dependent on the lithology of the sample. Soft rocks, such as clays, marls and shales may be disaggregated by boiling and washing in water. Martinsson (1962) has extracted many thousands of well-preserved ostracod specimens by disintegrating weathered marly samples in hot water. Robinson, at U.C.L., recovers rich ostracod faunas from soft calcareous shales, simply by washing; he omits the boiling process. Other methods are used to disintegrate sample which do not break down by boiling and washing in water. Hydrogen peroxide is commonly used, and if the sample is still not sufficiently clean, the Pau laboratory dries the sample and adds either Bradosol or Beloran (both manufactured by CIBA), after the method described by Eckert (1963). This worker (Eckert, 1963, p. 1007) claims that all the small pieces of matrix adhering to the surface of the microfossils are removed by this method. Kerosene or petrol are often used as a reagent to disintegrate shale samples, and Richfield Oil laboratory commonly uses Klenzine for this purpose.

Hard rocks such as limestone, dolomite, sandstone, and some shales will yield calcareous fossils (e.g., ostracods) only by manual preparation (needles, and dental drills), or by crushing. Evans (1964) has previously described the types of mechanical rock-crushers employed by the S.N.P.A., and other institutions. Phosphatic fossils (e.g., conodonts, and inarticulate brachiopods), and silicified forms (which include ostracods, brachiopods, and other groups) preserved in limestones, may be released by acid treatment. Various acids are used - acetic acid is used by the Illinois Geological Survey, and at Swansea; formic acid is used by the University of Minnesota, but none of the institutions visited use monochloracetic acid as in the B.M.R. Some of the institutions visited e.g., University College, Swansea, and Illinois Geological Survey have specially designed laboratories for acid treatment. Basically, these consist of well-ventilated rooms, with wooden racks capable of supporting a great number of two-gallon plastic buckets. One of the problems involved with the construction of acid laboratories is the task of good ventilation without loss of heat, which would inhibit chemical reaction.

To carry out his project on the subsurface stratigraphy of the Devonian and Silurian rocks of Illinois, Collinson is studying continuously cored sections as follows. The core is quartered, length-wise, and two-foot lengths of one-quarter of the core are taken as continuous channel samples for acid digestion. Additional portions of the core are taken at narrower intervals, over the sections which yield conodonts. Collinson washes the insoluble residue at each acid change, in order to avoid the possibility of etching freshly released conodont specimens.

(b) Separation

Conodonts may be concentrated and separated from the remainder of the insoluble residue by various methods depending on the mineralogy. Quartz and calcite can be removed by flotation in bromoform, or tetrabromoethane, which is preferable because of its higher specific gravity (2.89), low toxicity, low volatility, and relatively inoffensive odour. A battery technique of separating funnels has been described by Collinson (1963). Diiodomethane can be used to separate conodonts from pyrite. Limonite can be removed with a Franz Isodynamic Separator.

Ostracods, as a rule, do not lend themselves to separation by heavy-liquids, but must be hand-picked instead. Hollow foraminiferal tests are usually concentrated by flotation in carbon tetrachloride. Richfield Oil Corporation laboratory concentrates them in the heavy residues, by floating off the quartz grains in a mixture of potasium iodide, mercuric iodide and water.

Preparation of specimens

(a) Cleaning

Most of the laboratories that I visited use ultrasonic methods to clean fragments of rock matrix from individual specimens. Small bench-mounted types are used, consisting of a generator, and a small transducer tank. Adamczak uses a type manufactured under the name 'Disontegrator-System Forty; which develops 80 watts, with an input of 80 k/cycles - made by Ultrasonic Industries Inc., 141, Albertson Ave., Albertson, N.Y. Richfield use a type manufactured by Acoustica Associates, Inc., 10400, Aviation Blvd., Los Angeles, California. The disadvantage of this method is that if ostracod specimens have incipient fractures, they tend to break.

Some workers prefer to clean individual ostracod specimens manually, using needles, dental drills, and Vibro-tools e.g., Martinsson (Uppsala) and Miss Wikander (Stockholm). Martinsson regards the preparation of the specimen for photography far more important and time-consuming than the actual photography itself. The specimen is mounted on a clean glass slide with a cellulose cement (the Swedish brand 'Karlsons Klister' - the German brand 'Uhu' or 'Peligom' is just as good); it is then cleaned with the use of a needle and a camel-hair brush. He cuts the hairs of the brush down to about ¼ inch and rubs the specimen fairly vigourously. Ethyl alcohol is used to clean the specimen, and not water, which has the disadvantage of a higher surface tension and dries too slowly.

As a rule, conodonts can be extracted from the heavy residue quite cleanly.

(b) Coating specimens for photography

Most students of Palaeozoic ostracods whiten their specimens with a sublimate of ammonium chloride (e.g., Sohn, Martinsson, Jaanusson, Adamczak). A most effective technique for whitening has been described by Martinsson (1962, p. 42) and Sohn (1965, p. 85). The apparatus consists of a short glass tube, about 6 inches long, and about ¼ inch internal diameter, which is drawn out into a fine nozzle at one end. The ammonium chloride is scooped up in the open end of the tube, and heated over a spirit lamp. No excessive heat is used, and the slide to which the specimen is attached is held up-side down in line with the ascending fumes of ammonium chloride. By this technique a very thin coat of ammonium chloride can be applied.

At Kiel, Krömmelbein whitens his ostracod specimens in a similar manner to that practised at the B.M.R. The specimen is coated with washable ink or malachite-green stain, and then whitened by the ascending fumes of burning magnesium ribbon. The advantage of using magnesium oxide compared with sublimated ammonium chloride is that it is non-hygroscopic, and easier to control.

Mesozoic-Recent ostracod workers such as Oertli in Pau, and Benson in Washington, use silver nitrate to coat their specimens, after the 'Triebel-technique'. The specimen is heated in a small platinium crucible for about 10 seconds, immersed in a 2% solution of silver nitrate for 5 seconds, and then reheated.

Although the ammonium chloride technique shows surface detail, some conodont workers (e.g., Lindström, Bergström, Webers et al.) prefer to study their specimens in the uncoated condition, in order to show their natural transparency and internal detail.

Photography

Most of the institutions visited use the same basic photographic equipment - a Leitz Aristophot with a standard 35 mm Leica M1 camera, and a Laborlux microscope. Almost all of the laboratories used Adox KB 14 film. The emulsion layer of this film is extremely thin, giving it a greater resolution than any other film. The method used by Martinsson is described here, as it represents a standard well-tried technique, which has given excellent results.

Martinsson uses either a Summar 42 mm or a Photar 40 mm objective. The lower diaphragm of the bellows is kept open permanently, so that it is necessary to operate only the dual-control cable-release mechanism when taking a picture. This operates both the lens-shutter, and removes the prism. Illumination is provided by a Bausch & Lomb day-light lamp, consisting of two parallel fluorescent tubes each 6 inches long. The shadows are softened by a small reflector, a rectangular strip of white cardboard folded three times, at right angles. The glass slide is then mounted on an adjustable platform (which Martinsson has calibrated for height), and the reflector placed close to the specimen. The image on the negative is made as large as possible within the depth of focus. Depth of focus is increased by stopping down the diaphragm, but below f11 definition is lost. Exposures between 10 and 15 seconds are taken.

Prints are made on a hard glossy paper, and large prints of the specimens are preferred to small ones. In contrast to most institutions that I visited, none of the Swedish school (Martinsson, Jaanusson, Adamczak) enlarge the prints for final reduction, when published. The background of the prints is then blackened with black indian ink, which can be applied to the glossy surface, without eventually cracking. At Leicester, Sylvester-Bradley does not use indian ink, but instead uses Process-Black (made by Windsor & Newton).

This is a water soluble ink which can be easily removed, should part of the image of the specimen be accidentally covered. To obtain a uniform white background in prints of thin-sections, the outline around the margin of the fossil is opaqued on the negative. For this purpose, Oertli uses a solution of New Coccine.

The Swedish school aims at producing prints which do not have to be retouched. Other workers, however, regard retouching as inevitable. Oertli, for example, uses paints - Halie Photohilfsmittel - Retouching outfit, (obtainable from A. Jäckel, Arzberg, Bavaria, B.D.R.), or sometimes he uses a wax crayon - (Negro no. 350.1, manufactured by L. & C. Hardtmuth, Austria).

For rapid comparison and documentation of microfossils, Oertli at the C.R.P. has developed the technique of photographing whole assemblages and random scatters on a single frame. The specimens are mounted close together on a piece of black glass, and photographed with a Zeiss plate camera, with a ground glass screen. With a 40 mm objective, exposures of 25 seconds are taken, at f8 - 11; attempts to photograph specimens of different sizes limit the use of the prints to preliminary work only, as they are rarely of publication standard.

Because of the problems of restricted depth of field involved in photographing some conodonts with high relief, many students of Ordovician conodonts (e.g., Stauffer, Furnish, Lindström, Bergström, Ethington et al.) prefer to draw their specimens using Abbe's apparatus. Webers (1966), of the University of Minnesota, has attempted to photograph his Ordovician conodonts in the uncoated condition, with considerable success. He uses a

combination of transmitted and reflected light, which shows the natural transparency of the specimens, and gives a white background. Two or three lamps are used for reflected light, and a universal stage is used to orient the specimen in the position of least reflection. He used a Brinkmann bellows camera with 120 roll-film (Kodak Verichrome Pan Professional) to illustrate his recent publication (1966) on the Middle and Upper Ordovician conodont faunas of Minnessota. His prints are on a white background, cut well away from the margin of the conodont. These are assembled as a plate on a white background, which is photographed, and the dark shadow formed by the thickness of the individual prints is opaqued on the negative.

Documentation

In order to determine the stratigraphical significance of published and unpublished data, some form of data storage and retrieval is very necessary. The systems used in the laboratories visited varied with the needs and the budgets of individual workers. Naturally, the Ellis & Messina Catalogue of Ostracoda is a standard reference, but no such catalogue has been prepared of conodonts.

Many laboratories maintain simple illustrated card catalogues. S.N.P.A. have such catalogues to index species, and genera. Also simple edge-punched cards are used to record data concerning samples and published literature. The need for fossil morphological keys is basic to all stratigraphical research, and requires the equipment and technical staff to copy a great number of published plates and original photomicrographs. Thus the S.N.P.A. uses an automatic printing machine ('Pakomatic') to mass-produce routine photomicrographs for both card indices and illustrated reports. Although unpublished, illustrated reports are often useful to the S.N.P.A. for further investigations.

Exchange of photographs and of individual specimens, either donated or on loan, is recognized by the S.N.P.A. as a very necessary part of stratigraphic documentation. To this end, slides of specimens are despatched to overseas workers for comparison, in extremely well-designed cardboard boxes. They are made of compressed cardboard, and are of a convenient size (5" x 4" x $\frac{3}{4}$") with a marginal flange, which makes them capable of withstanding rough handling in transit. They are available from A. Duchene, 73, Avenue Victor Hugo, Clamart, (Seine), France.

CONCLUSIONS AND RECOMMENDATIONS

To conclude, the laboratory techniques studied overseas are essentially the same as those employed in the micropalaeontological section of the B.M.R. Although in some laboratories different material may be used, basically the processes are the same.

In the B.M.R., more time could be given to preparation of specimens for photography, and the use of ultra-sonic methods could be considered. The finer details of Martinsson's photographic techniques have been studied, and these will be applied to illustrate the systematic description of the Ostracoda.

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