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REPORT ON OVERSEAS TOUR - 1964.

by

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SUMMARY

Selected palynological laboratories in India, France, Holland, Great Britain and the United States of America were visited during the period 31st May - 31st July, 1964 under the Commonwealth Government's scheme for officers to study overseas techniques related to oil exploration. Governmental, commercial and academic centres were visited and notes taken of their aims, organisation, principles and laboratory techniques. Where appropriate, specific collections were examined and the inter-continental significance of the Australian microfloras was discussed.

INTRODUCTION

In accordance with the Commonwealth Government's policy of providing opportunities for officers of the B.M.R. to become acquainted with the latest overseas developments in geological techniques related to oil exploration, the author visited selected palynological laboratories in India, France, Holland, Great Britain and the United States of America during a tour which lasted from 31st May to 31st July, 1964. No attempt was made to contact all palynological laboratories in each country, but a variety of governmental, commercial and academic units was visited.

This report outlines the organisations, staffing, laboratory techniques and equipment of interest, and some of the main research topics viewed and discussed at each location.

The laboratories visited were operated by the following organisations :

INDIA :	Geological Survey of India, Calcutta. Departments of Botany and Statistics, Calcutta University. Birbal Sahi Institute of Palaeobotany, Lucknow.
FRANCE:	Institut Francais du Petrole, Rueil Malmaison. Societe Nationale des Petroles d'Aquitaine, Pau.
HOLLAND:	Baatafse Internationale Petroleum Maatschappij N.V., The Hague and Rijswijk.
GREAT BRITAIN:	Department of Geology, University of Sheffield. Departments of Geology and Botany, University of Cambridge. University College, London.
UNITED STATES OF AMERICA:	Jersey Production Research Co., Tulsa, Oklahoma. Pan American Oil Co., Tusla. Sinclair Oil Co., Tulsa. Department of Geology, Oklahoma. University, Norman, Oklahoma. Department of Geology, Stanford University, Stanford, California.

INDIA

The main reasons for going to India were to discover how the Indians generally approached palynology, and to view something of that sub-continent's Lower Gondwana microflora, which at first sight has much in common with the Australian Upper Carboniferous Permian and Triassic assemblages.

Geological Survey of India.

Director-General : Dr. B.C. Roy

Palaeontologist-in-charge : Dr. Shastri

Palaeontologists with the G.S.I. are primarily geologists, posted to the section as necessary. Hence Dr. Shastri has difficulty in keeping a man for any time sufficient for him to be really familiar with his subject. Members of the present professional staff and their main interests are listed below. About ten technical personnel, who assist with preparation of material, and a similar number of bearers are assigned to the section.

Dr. Shastri	Geologist-in-Charge,
Dr. S.S. Sarkar	Cretaceous ammonoids,
Mr. P.R. Chandra	Cretaceous ammonoids and Permian Bryozoans,
Mr. K.N. Prasas	Primates,
Mr. P.P. Satsangi	Triassic vertebrates,
Dr. Chatterji	Micropalaeontology,
Mr. Rao	Micropalaeontology,
Mr. S.C. Shah	Panchet flora (including Glossopteris),
Mr. Gopal Singh	Palaeobotany general,
Mr. A. Chandra	Lower Gondwana palynology,
Mr. M.M. Khan	" " "
Mr. S.C. Pant	Museum curator,
Mr. P.S. Bhamra	" "

The G.S.I. museum is generally very crowded, but has a good display, including types, of the Indian Glossopteris flora.

The collection of faunal type specimens is maintained in the G.S.I. building itself, and is not on general view to the public. The vertebrate collection includes a large number of primitive "elephant" remains, ranging in age from the Miocene onwards. To my untutored eye, the collection of Meteorites also seems to be unusually large.

The library is large, but very crowded. Microfilming equipment is being installed and it will very soon be possible to purchase microfilm copies of otherwise unavailable Indian geological papers.

Tentative prices quoted :

1st 10 pages in 5 frames or part there of - 2/- Re

Each addition 10 pages in 5 frames or

part thereof - 1/37 Re

Add postage etc.

The library also produces a list of Indian geological publications, as part of lists of all publications received. This list is similar to the B.M.R. monthly library list, but would be of use as a check of recent Indian papers published in otherwise little seen Indian journals (e.g. Current Science). The librarian is willing to mail this list to anyone on an exchange basis.

The Indian Lower Gondwana stratigraphy and microfloras were discussed at length.

The G.S.I. regards the Panchet Series, in which they distinguish two divisions, as Triassic in age. They recognize the South African Hystrichosaurus zone towards the base of the lower division. From lithological aspects, the change from Raniganj to Panchets is very similar to our Bandanna/Rewan or Newcastle/Narrabeen change; from coal beds to green shales and sandstones. The problem is to see how similar the microfloral change from the Raniganj to the Panchet is to the P4/Tr1 change. Bhardwaj's summary of the Raniganj microflora shows that very close similarities exist between the Raniganj and the P3-P4 assemblages. Previous G.S.I. palynologists, Shrivastava & Paude, described the microfloral changes between the Raniganj and the Panchets in West Bengal in one bore hole. Their range chart indicates that a considerable assemblage change takes place between there series. The plates in this paper are of insufficient quality to determine the precise nature of the species involved. Examination of the relevant slides, preserved in the G.S.I. collection, did not allow any opinion on the matter. Large saccate striate pollens were in about equal proportion to pteridophyte forms in the "Panchets". The latter included rare ?Kraeuselisportios sp. which were reminiscent of some Narrabeen forms. However, a much better section must be obtained before any firm conclusions on correlation can be drawn.

The G.S.I. palynologists are mainly concerned with coal seam correlations in the Raniganj and Barakar stages. They work almost solely on coal samples and mainly distinguish seams by percentage differences in various types of striate pollens. However, the G.S.I. does not meet the problem of determining which of these series is represented by a particular sample. The main problems concern which seam is represented, and the classic hystogram techniques (counts of up to 500 specimens) are used.

The Raniganj and Barakar assemblages are characterised by abundant winged, striate pollens and a limited number of pteridophyte spores. The presence of these pteridophyte spores is taken as the main difference between the Barakar and the Raniganj. The Barakar winged pollens generally do not include forms with well defined sacs, and the striae are also vaguer than their counterparts in the Raniganj. However, without many photographs available, it is not easy to see these differences.

Both the Barakar and Raniganj coals lack good varieties of pteridophyte spores. If this lack is as general as appeared from the slides seen, then there will be great difficulty in firmly correlating the Indian with the Australian sequences at these levels. The Barakar pteridophyte spores which were viewed are not comparable with known Australian forms. Most of them were rounded triangular, trilete, acanthine. The processes vary from short echinae to fairly long baculae, some are almost clavate. There seems little chance of determining the correlate of the Barakar in the Australian Permian on the basis of these rather indistinctive forms. For the present, I would include the Barakar assemblages broadly in the range of P1d-P2. The critical change from P2 to P3b which is so clearly seen in Australia presumably comes within the Barren Coal Measures between the Barakar and the Raniganj. Bharadwaj has described forms similar to ericianus and villosus from the Raniganj, so this supposition cannot be far out. Chandra & Khan think that the Barren Measures flora is similar to that of the Raniganj, rather than the Barakar. The lack of comparable pteridophyte spores can perhaps be explained by the fact that the Indian studies are mainly on coals, not clastics. Australian coals are noted for having somewhat different (mainly gymnosperm) contents, compared with associated clastic sediments.

Whereas there is a very close resemblance between the gymnosperm varieties of both countries, the ? cycad varities differ. I did not see any good specimens of Marsupipollenites as defined by Balme. Varieties of Ginkocycadophytus are well represented, and some very unusual forms of either the latter genus or Vittatina are well preserved in the Barakar.

It is of course too early to draw any generalizations from these few observations, but it appears that there are many differences in detail between the Indian and Australian Permian Lower Gondwana assemblages. These details will have to be taken into account in any further discussion of the links between the continents (vide "drifters" such as Dr. F. Ahmad).

I was shown a few slides from a borehole in the Upper Gondwanas near Madras. I could not obtain the exact location of these samples or their formation. I think they came from drillholes in a little known area and had been examined to determine the age of the outliers. Shandra assigned them an Upper Jurassic age on the abundance of coniferous pollens, compared with the general reported abundance of cycad pollens in earlier Jurassic sequence. (This reflects the typical attitude taken towards age determination by the G.S.I. palynologists).

Examination of these samples showed the following :

A dominance of Disaccites, Laricoidites cf. L. reidi de Jersey, Tsugaepollenites (dampieri, and trilobatus), and fairly common Microcachryidites sp. incl. aff. C. minor Couper, and Classopollis sp. (p). There were a few Osmundacidites, Perotrilites, some cycads, and Contignisporites spp. (incl. C. cooksonii), Aequitriradites sp. (?nov.), cf. "Cingulatisporites" telatus. I could see no Gleicheniids. The Contignisporites and Aequitriradites spp. are of considerable interest. By Australian standards, this section might be uppermost Jurassic or lowermost Cretaceous (pre-Aptian) in age. It was pointed out to me that similar forms of Contignisporites and Aequitriradites have been reported from Ceylon by Satish Chandra Das Sah (1953).

If this section can be taken to exemplify the Upper Gondwanas (a big assumption), fairly close correlation at several levels within the Upper Gondwanas and the Australian Mesozoic should be possible.

Calcutta University - Botany Department

By arrangement, I visited Dr. A.K. Ghosh of the Botany Department, Calcutta University. Dr. Ghosh was for many years chief palynologist with the Oil and Gas Commission, and was much concerned with palynological studies and correlation in the Indian Tertiaries. He remarks that there are 16 palynologists working for the Commission at the present time, but that they are lacking someone to take over the chief palynologist's position.

Of general palynological interest, Dr. Ghosh regards the abundant polycolpate species which characterize the Indian pre-Miocene to be members of the genus Nothofagus, which has long been known to characterize the Australian pre-Miocene.

Two women research students in his department, Miss Bannerjee, the other with a name which I was unable to record, are at present working on fructifications of Glossopteris. They have at least one fructification from which they have been able to extract winged seeds. They have macerated and mounted several seeds from the one fructification, and there can be no doubt that they are from this fructification. This work is an advance on Plumstead's work in this field.

Calcutta University - Statistical Institute

While at the G.S.I., I met Miss Pamela Lamplugh-Robinson, an authority on Permo-Triassic vertebrates, who at present is working with the Indian Statistical Institute of Calcutta University on some of the Panchet vertebrates. Her concern for these fossils might have a telling effect on the southern hemisphere Permo-Triassic problems. She sees a possibility of establishing extra time links to India via some Russian fish fossils which she hopes to see and study in the near future. She also would like to see more vertebrates discovered in Australia. There is a singular lack of these remains, and what has been found, except for the Triassic remains in the Sydney Basin, is not of adequate quality or quantity for intercontinental correlation.

Miss Robinson thinks that the Triassic of eastern Australia has possibilities as a collecting ground. However, there are certain facies, unfortunately prevalent in the Bowen and Sydney Basins, where vertebrates are unlikely to be found. Where there has been much dump fill, scouring, and current bedding, no corpse will be preserved in entirety; odd bones, or concentrations of bones may be present. Entire skeletons are more likely to be preserved in old lake deposits - represented by fine shales, perhaps forming a large lenticle in the surrounding sandstones. A general lack of organic debris is also conducive to vertebrate preservation. A peaty environment is too acid for the bones to remain.

These pointers should be kept in mind in a subsequent analysis of the Upper Bowen. Discovery of any vertebrates in the Upper Bowen would be of world importance.

Members of the Statistical Institute are taking an interest in the geology of the Godavari Basin in south-eastern peninsula India. They are studying this basin in detail from its sedimentary, palaeontological, and structural aspects. Dr. Pamela Robinson has been working with them for about 12 months. An Indian zoologist, Dr. Jain, will be carrying on her work.

Mr. Subhendu Kumar Baksi, who was with Standard Vacuum of Calcutta for nine years as a palynologist studying the Tertiaries of Assam, is combining mapping of Mesozoics with a hope to employ palynology to date his sections. So far he has had little success - not a surprising result considering the weathered state of the rock samples he must content with. His general approach is to look at all rocks, no matter how weathered.

I discussed the Australian Mesozoic succession with Mr. Baksi at some length. He confirmed that his Assam Tertiary Hexacopites sp. looked very similar indeed to certain forms of Nothofagus as represented by in a slide from Balranald No. 1, in the Murray Basin. Dr. Ghosh's assertion that the Indian and Australian pre-Miocene angiosperm floras have much in common, particularly a dominance of Nothofagus, seem to have much to commend it.

Birbal Sahni Institute of Palaeobotany, Lucknow

Mrs. Birbal Sahni, widow of the founder of the Institute, is its President, Dr. Surange is Director and chief administrator.

The Institute is housed in a spacious building sited next door to the University of Lucknow. In spite of their proximity to each other, the Institute is independent of the University, and is financed by the Indian Union Government. However, it awards post-graduate degrees in accordance with the needs of the local University. It includes adequate room for individual staff and students, and houses a large library, herbarium and well laid out palaeobotanical museum. A separate clerical and accounts wing is built well away from the scientific part of the establishment.

The Institute is subdivided into a number of departments : coal, oil, Palaeozoic, Mesozoic, Quarternary. Each department specializes in the palaeobotanical aspects of its main interests.

Dr. Bhardwaj, one time pupil of Dr. R. Potonie of Krefeld, heads the Coal Department. At present he has under him four research students. Dr. Bhardwaj's approach to palynology is to examine in greatest detail the smallest recognizable distinctions in fossil spores and pollens, to find what are the largest common features making an homogeneous group, which he would refer to as a genus, and to try and distinguish as many such small groups as possible. Dr. Bhardwaj and Dr. Lele claim that spore-pollen morphological entities as described in much of the literature are heterogenous groups which themselves must be greatly split. Balme & Hennelly's work on the Australian Permian could exemplify this contention. Bhardwaj and his colleagues see morphological trends within a selected and limited series of such genera which they regard as illustrative of evolutionary trends. They confess that what they see as distinctions today may well be proved to be variations within the scope of one macro species at a later date, but they claim that what they see now will stand up to this test, from a nomenclatural point of view, and will indicate what might be genetic changes within the pollens or spores of that species through time. The prime need is to obtain fertile fructifications or strobili on the basis of which these matters can be judged.

This approach to the problem is a lengthy one, and, as Dr. Surange and Dr. Bhardwaj pointed out, it has taken them at least ten years to begin to sort out some of their Palaeozoic problems. A geologist must ask whether such detailed research will give finer subdivision of the geological column. The answer must be affirmative to a certain degree. Where alleged evolutionary trends are noted, geological confirmation of the sequence must first be obtained. So far, the Lucknow palynologists have little such assistance, and possibly it must be left to palynologists with better documented geology to check the feasibility of some of these assertions.

An example of this attitude is the work currently undertaken, and in press, by Dr. Lele on the Talchir saccate microfloras. What in the southern hemisphere was generally regarded by most palynologists as forms of the genus Nuskoisporites are thought by Lele to be of fundamentally distinct from that genus. (Fundamental to the extent that saccus attachment is different). He explains the significance of body folds usually found in a Permian "Nuskoisporites", such as N. gondwanensis Balme & Hennelly in terms of effects of depositional compression on a particular body shape. He looks to the variations within his Plicatipollenites and Virkkiipollenites (to which most of the southern hemisphere "Nuskoisporites"forms are allocated) as due to tendency to avoid saccus formation - coupled with a tendency to the monolete condition - such as in Potonieisporites. He visualises the development of a bisaccate condition from the monosaccate condition, but thinks that this trend could have developed in several different stocks. The nature of saccus attachment indicates whether it is a truly monosaccate or disaccate condition, not just whether the sacs are isolate and separate around the equator.

From the viewpoint of inter-continental correlation, it is apparent, that the Talchir Stage correlates with some of our eastern Australian glacially derived deposits such as the uppermost Joe Joe Formation. The same microflora is to be found in the overlying Karahbari Stage. It should be noted that no microfloras has yet been found within the Talchir Boulder Bed. Only the overlying Needle Shales of the Talchir Stage have so far yielded microfossils. On present knowledge, the Talchir Needle Shales correlate with Unit P1c, within the Joe Joe Formation, still stratigraphically younger than the beds with Cardiopteris (=P1a).

Placing beds younger than the Karahbari in the Australian sequence is difficult. The Barakar Coal Measures contains an abundance of striate pollens, and quite a variety of pteridophytes, but the latter, although considered of great diagnostic stratigraphic value in the Institute does not include e.g. A. cornutus, T. cicatricosa of P2 age. Are the Karahbaris older or younger than P2? A possible answer to the question might come from recognition of a cf. M. villosa in the Barakar, which might make it as young as the top of Unit P2, if not in P3a. The striatiti are of little help. Monosacciti are fairly prevalent in the Barakar, and in two seams at least, forms generally referable to Cirratriradites splendens Balme & Hennelly are abundant. This group incidentally is now split by the Lucknow palynologists into more than one genus - understandably so. Balme recognized an abundance of C. splendens at one horizon in the Permian of Western Australia, and possibly this might represent a comparable level to these Barakar coals, but this form of evidence is very unreliable. Nothing is known at Lucknow about the Barren Measures. The Raniganj microflora is almost certainly like our late Permian P4, but here again there are differences. For example, no one has yet found Dulhuntyispora in India. Even the coals of the Australian P4, although yielding few pteridophytes, do occasionally contain this genus. Yet of the many coal samples from the Raniganj which by now have been examined in India, none has yielded the genus.

The Institute's palaeobotanical museum contains an excellent presentation of good macrofloral remains in stratigraphic order from the Precambrian Fermoria and algae to Quaternary seeds. Nothing is cluttered, and adequate airy diagrams accompany the collection. Apparently most specimens in this museum are from the late Birbal Sahni's collection. The museum also includes a somewhat ingenious foundation stone, laid by Pandit Nehru, into which petrified plant fossils have been inlaid. A smaller room incorporates displays of fossils laid out in botanical categories. Of interest to palynology are a number of plaster-of-parts models of pollens grains. A collection of such models would be invaluable in any palynological teaching collection.

Preparation facilities are standard. They have a palynological chemical room of similar dimensions to that in the B.M.R. It is not dust sealed, although there is a great problem of wind-blown dust filtering into every crevice of the building. Microscopes employed are of varied manufacture. They have more than one Leitz Ortholux, but the all-India problems of foreign exchange forces the institute to buy when and where the government allows. They have a number of Japanese Olympus machines which have creditable optics, but which are clumsy to operate in comparison to the Leitz machines.

FRANCE

Arrangements were made to visit only two research centres in France, although other laboratories in that country are very active in the palynological field. French geologists and palynologists have made considerable and successful use of the science particularly in North Africa.

INSTITUTE FRANCAIS DU PETROLE

The I.F.P. was formed by the Franch government to assist the petroleum industry by training personnel and supplying technical aid. It is financed by a tax imposed on petroleum products, but expenses incurred for work conducted on the behalf of particular companies or organizations are repaid by the parties concerned. With these objectives, the I.F.P. maintains an engineers graduate school, a large documentation division and a technical division. The latter includes a Bureau of Geological Studies, which incorporates a research laboratory dealing with palynology, micropalaeontology and sedimentology.

These laboratories are supervized by Mr. J. Debyser. The palynological team is headed by Dr. B. de Jekhowsky and includes :

Madame Goubin (spores and pollens),

Mr. Bouché (chitinozoa),

Mr. Corraeia (techniques and spores and pollens),

Mlle Vachay (hystrichospheres),

four technical assistants and a secretary.

De Jekhowsky is reknowned for his statistical approach to palynology but classical stratigraphic palaeontological methods are applied to the Chitinzoa.

The statistical approach requires a standardized processing technique. The process to be followed depends on the fossils to be extracted but each process is programmed to be completed in one week. Fossil extraction from a given batch of samples is commenced on a Monday, and the programme follows a flow chart which indicates the time at which each step must be taken. There are considerable pauses in the process, many of which are taken up with the settling and decanting method of washing out reaction by-products which obviates the need for a centrifuge. Heavy liquid separation is not employed. Residues are unstained and mounted in glycerine jelly.

This method has the advantage of releasing the processor for other duties at intervals during the course of the day. The main disadvantages seem to be in the relatively inefficient chemical removal of unwanted mineral and organic matter (which could be improved with the use of a centrifuge and heavy liquids) and the often thin spread of fossils in the resultant slides.

Chitinozoans are hand-picked from the residues by a technician who uses a simple, but efficient method of picking. The residue (in alcohol) is spread on a strip of blotting paper which in turn is supported by a metal tray. The paper is kept moist with alcohol, but free pools of the liquid are not allowed to form. A fine "needle" of uncooked canada balsam, drawn out on the end of a glass rod, is used to pick the chitinozoans from the residue and to transfer them to a balsam coated slide.

Observations are documented on 10" x 8" (appr.) edge-punched cards. Many photographs are taken and assemblage atlases for each section are compiled.

De Jekhowsky is applying his statistical methods to a variety of topics on both correlative and palaeoecological matters. His recent project on Madagascar (1963) is a case in point where the correlations were made on the basis of vertical abundance variations and where lateral variations in relative abundances were interpreted as indicators of areas of particular depositional environments. This particular work is being followed with descriptive papers (compiled by Madame Goubin) on the floras encountered. The Madagascan project, based on about seven well sections sampled at approximately 100 m. intervals, resulted in a number of palynological subdivisions of the Jurassic roughly equal to the number recognized in the eastern Australian Jurassic by classical methods. The precise position of palynological boundaries in relation to critical formation boundaries are not so readily determinable by the statistical method, but, assuming sufficient significant variables can be recognized, this method is a speedy way of completing the first stages of such a regional study.

The chitinozoa, studied at the I.F.P. by Mr. Bouché cannot be processed in a manner applicable to the statistical technique, but the relatively distinctive features and short ranges of many species give these forms considerable stratigraphic value in the calssical sense. Bouché recognizes twenty chitinozoan zones from the Tremadocian to the Devonian in the Sahara. They are best developed in the Ordovician, and best employed for local, rather than regional inter-basinal correlations.

The I.F.P. is also interested in the problem of carbonization of palynomorphs. They see it as a possible function of temperature and tectonic metamorphism, but they are planning to examine the problem in conjunction with geochemical studies, adequate facilities for which exist in their geochemical laboratories.

Slides viewed included selected Madagascan spore assemblages and Saharan Lower Palaeozoic hystrichospheres and chitinozoans. The Madagascan material was of interest because of the similarity of the Triassic assemblages with comparable Australian forms, and the dissimilarity of the "Upper Permian" from Australian, Indian and Congolese Lower Gondwana types.

A tour of other branches of the I.F.P. centre was arranged. Of particular note was the Documentation centre which provides a comprehensive abstracting service to the organization. The I.F.P. in 1956 founded the publishing company TECHNIP to ensure adequate and speedy distribution of scientific and technical results acquired

in its laboratories and research departments. TECHNIP periodically publishes the Revue de l'Institut Francais du Petrole, a bibliographic card index, the Revue Photo Interpretation and the Revue Gas Europe Information. It also prints books and manuals of basic practice for the petroleum industry, of lectures given to the Ecole Nationale Supérieure du Pétrole et des Moteurs (E.N.S.P.M.), and memoirs of the Bureau de Réchorches Géologiques et Minieres (B.R.G.M.). Subscriptions to TECHNIP publications are accepted from anyone. The Revue de l'Institut Français du Pétrole which is produced approximately at bimonthly intervals is of interest to geologists and palaeontologists and is a vehicle for many palynological articles from within and outside the I.F.P.

SOCIÉTÉ NATIONALE DES PÉTROLE D'AQUITAINE, PAU

The Société Nationale du Pétroles d'Aquitaine, a commercial company which manages the oil and gas fields of Lacq in south-western France and fields in the Sahara and actively conducts overseas exploration,(+) operates a research laboratory at Pau, Basses Pyrenées. This laboratory, which came into operation in 1960, tackles 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 palynological as well as micropalaeontological, sedimentary petrological, and micro-facies studies.

The palynological team consists of :

Dr. F. Van Oyen (Chief Palynologist)

Mr. Y. Caro,

Mr. G. Peniguel,

Mr. J. Aubert,

Mr. C. Boulard,

Mr. C. Poumot,

Mr. F. Calandra.

They are helped by a chief laboratory technician and two processing assistants, two assistants working on reference collections, three picking and general assistants, an I.B.M. clerk, and a stenographer who also assists with photo-mounting. This large team (by any standards) may be increased in the future. The need for a unit of this size is indicated by the wide range of local and overseas interests taken up by the S.N.P.A. and their practice of returning large quantities of material to Pau for study. The S.N.P.A. does not operate any field palynological laboratories.

The approach to palynological problems adopted by the S.N.P.A. was outlined by Van Oyen to the Seventh French Colloquium of Applied Palynology at Bordeaux in October 1963. Quantitative palynology is suspected to be of doubtful value to stratigraphic correlation. A qualitative analysis of assemblages into "types" and "morpho-groups" based on morphological keys is undertaken prior to stratigraphic snythesis. The sensitivity of this otherwise standard

(+) The Australian Aquitaine Petroleum Co. is an affiliate of the S.N.P.A.

stratigraphical palaeontological method, which basically differs from other methods only in nomenclature of units, depends on the precision by which forms can be allocated to the morphological key.

Photography plays a key part in the transactions of Van Oyen's method. Photographs for "type" cards and assemblage cards (for each sample) are taken and printed. Printing of this high output is handled by means of a Gevaert PAKOMATIC automatic printer which enlarges 35 mm. film to a standard 6 cm. x 9 cm. format on a roll of paper.

HOLLAND

B.I.P.M. Laboratories at Rijswijk, near the Hague

B.I.P.M. (Shell) has pioneered oil palynology for many years, and possesses a central operational palynological laboratory under Dr. Beck and Emeis, with Dr. C. Hopping as senior research palynologist. Hopping has recently replaced Dr. R. Couper, who is changing over to other activities in the B.I.P.M. organisation. B.I.P.M. have progressed to the stage of decentralising most of their palynological investigations to regional offices in e.g. Trinidad, Argentina, Algeria, Lybia, Nigeria, Gabon, Syria and Borneo. Each of these regional offices is autonomous, although their personnel are trained at The Hague and thus apply a standard technique to their operations. Shell Oil of America has its own palynological teams centred on Houston, Texas. Operations at Rijswijk are limited to initial studies of fields where no regional office is yet established (such as Australia), and to specific original research problems as the occasions arise.

Computers are used to a great extent for documentation, statistical correlation and environment analysis.

Present trends in palynological research follow Shell's main interests in the tropical Tertiary, particularly in palaeoecology. Tropic vegetations include relatively few anemophilous pollen groups and, while these, when recognised, form the basis for time correlations, the remainder of the assemblages are likely to follow certain facies trends. Thus palynology for this company is becoming closely associated with the general problems of sedimentology.

Whereas Hopping is part of the Operations Section, a separate research laboratory employs a botanist, Dr. Fuchs on the nature of recent palynomorphs from lowland tropical floras in order to determine the characters of the related Tertiary marker tribes and to decide which are the ecologically significant forms.

The laboratories necessary for these tasks were obviously adequate and well staffed. Female technical assistants were employed, taken from the lower level of Dutch High Schools. Of interest was the mechanical crusher which worked on the pneumatic drill principle of a rapidly descending piston moved by compressed air and controlled by a foot switch. (See p. 21).

GREAT BRITAIN

The period spent in Britain was intended to cover certain university palynological research centres. The Geological Survey of Great Britain is only just contemplating the employment of a palynologist, while the only known commercial laboratory in the country, run by B.P. at Sudbury-on-Thames could not be visited in the time available.

Sheffield

Met Professor L.R. Moore,

Dr. C. Downie,

Dr. R. Neves,

Miss M. Butterworth,

Dr. H. Sullivan and Mr. G. Williams (research student) had recently left Sheffield for Pan American Oil in Tulsa, Oklahoma. Dr. L. Love was away from Sheffield during my stay. Relatively new to the staff, but also away from Sheffield at the time is Dr. R.W. Wagner, one time of B.I.P.M., Holland.

Downie's interests continue in Palaeozoic microplankton, particularly of the Welsh Borderland area. For the first time he has a student, (T. Jenkins), examining some British Chitinozoa. Jenkins has been studying the Ordovician Chitinozoa of the Onny River and Shelve areas. These studies have not yet reached the status of the French investigations, but apparently a regional distinctiveness in these microfossils is apparent, when compared with the German and North African assemblages (cf. Bouche's opinions noted on p.9).

A somewhat different facet of the carbonization - metamorphism problem was encountered during this Chitinozoan study :, that of dynamic metamorphism and the preservation of the fossils only when the cleavage direction paralleled the bedding planes. Jenkins remarked on the discovery of specimens which apparently had been fractured by cleavage. Successful extraction depends on the mechanical strength of the fossils, in turn this would depend on the fossils carbonized state. It seems that the Chitinozoa survive a greater degree of metamorphism than other palynomorphs.

Dr. Wagner is studying floras from Spain and Turkey and is interested in the floral provinces of the Carboniferous - Permian and Gondwanaland. G. Williams, for his thesis, examined microplankton from the Tertiary London Clay. Apparently a very abundant and diverse assemblage occurs in this formation, and Williams' work is being continued by a Pakistani, Hussein, from Karachi. Williams had the problem of a large content of reworked Mesozoic microplankton which had to be identified before the autocthonous Tertiary forms could be described.

Miss Butterworth is continuing to compile data on the Upper Carboniferous obtained from many years study while with the National Coal Board.

Dr. Neves and Dr. Downie are engaged in the production of a text-book of palynology aimed at third year undergraduates and first year research students.

With Neves, I discussed at length the use of ultrasonic cavitating machines. In contrast to other users, of such equipment the Sheffield researchers prefer to use a low powered machine for a short period.

Neves has also been involved in the comparative preparation tests conducted by the C.I.M.P. An important result of these test is that the differential swelling of spores caused by treatment with alkalis is at a maximum with KOH and a minimum with NH_4OH.

CAMBRIDGE

(a) Sedgwick Museum Department of Geology

Met Dr. N.F. Hughes,

Miss J. McCreavy, Research Assistant,

Miss E. Fowler, Research Student.

Dr. Hughes' interests lie mainly in the English Wealden palynology and palynoecology and this formed the main topic of discussion during my stay. He is also concerned with the nomenclatural problems distinctive to palynology, and with the problem of the first appearance of the angiosperms. Miss McCreavy assists Dr. Hughes in his particular projects, she also directs the laboratory processing undertaken by a junior laboratory assistant. Miss Fowler, graduate of the University of Western Australia is at present studying the Perth Basin Cretaceous Osborne Formation microfloras, but may extend her interests to some Portuguese Cretaceous assemblages.

While with Dr. Hughes I had the opportunity to meet a technical salesman from Mullard Electrical Industries and discuss with him the various types of ultrasonic machines marketed by his firm. Cambridge has been using for some time a Mullard probe type of machine, but Dr. Hughes was investigating the possibility of using the bath type. Comments on the Mullard equipment are supplied below (p. 22).

(b) Sedgwick Museum Sub-department of Quaternary Studies

The Quarternary Studies Sub-department of the Botany School under Prof. Godwin is actively engaged in palynological studies of Quaternary and Recent aspects. I spent most of my time in this section in the company of Dr. D. Churchill, Senior Research Assistant and graduate of the University of Western Australia.

As the Quaternary is beyond my normal field of study, discussions were restricted to Tertiary problems, particularly that of the Alice Springs Farm area, which may be of a nature similar to that described by Churchill and Balme from the Coolgardie district of Western Australia. I also took the opportunity to view the "freshwater" microplankton of Holocene age from south western Western Australia which were described by Sargeant and Churchill in Grana Palynologica. The full significance of these micro-organisms is not yet very clear and the original locations of discovery probably need further study. An obvious environmental difference exists between these Western Australian forms which were derived from peats and, for example, the controversial Lower Jurassic microplankton of Queensland which occur in sandstones and siltstones associated with chamositic clay pellets. Nevertheless, the slides held by Churchill contain hystrichosphaerids and, at one locality at least, a dinoflagellate, which occur in swarming proportions.

Laboratory techniques employed in the department were correspondingly different from those required for older samples, but two distinctive items of equipment were noticed. One was mechanical counter, constructed from P.M.G. telephone relays that greatly facilitated the AP and NAP etc counts required for peat pollen spectra. The other was the silicone oil used in place of glycerine as a mountant. Silicone oils are completely inert and never dry out. Permanent fluid mounts which do not have to be sealed can easily be made with this medium.

University College, London

I visited U.C. to meet Dr. W. Challoner, but at the same time encountered Dr. Martin, from the University of Sydney who was working at U.C. during sabbatical leave.

Discussions with Dr. Challoner centred on the Permian and Triassic microfloras, and on the documentation problem. Challoner pointed to the advantages of using the Vistem feature card system of documenting published data. This subject is further discussed on (p.).

J. Pettitt, a student of Challoner, is also a palaeobotanist with the British Museum and is interested in fructification and seed morphology. He is at present producing interesting electron microscope photographs of thin sections of spore exine walls.

UNITED STATES OF AMERICA

Palynology is now studied at many centres in America and used by many companies for stratigraphic analysis. However, enquiry was concentrated mainly in Tulsa and Norman, Oklahoma as insufficient time was available to make a comprehensive tour of the American laboratories.

Jersey Production Research Centre, Tulsa, Oklahoma

Standard Oil of New Jersey at one time had a 100% affiliation with Carter Oil, which operated a palynological research centre at Tulsa, Oklahoma. Standard Oil also held a 50% interest in Humble Oil, which operated a palynological research centre at Houston, Texas. Standard has since taken over Carter and Humble and runs both palynological laboratories. Tulsa handles overseas problems, and Houston undertakes American projects. The Standard affiliate, Imperial Oil, in Calgary, deals with Canadian matters. Apart from these research centres, the company also maintains field laboratories, including five in the U.S.A.

The staff at Jersey includes :

Manager of Research Centre	Dr. R. Sarmiento,
Assistant Manager	Dr. Kidwell,
Palynologists	Dr. L. Stover,
	H. Laffingwell.

Technical Staff (palaeontological section) : Three assistants, one of whom works exclusively for the palynologists, and a photographic dark room assistant. Jersey also employs summer students for three monthly periods, on particular problems during their Ph.D. courses.

Great emphasis is placed on laboratory hygiene. A high standard is achieved by the application of the "use once - then throw away" principle. This involves the use of aluminium custard-pie cans as receptacles in which the samples are initially crushed; plastic drinking cups for the HF digestion; polythene tubing during the heavy liquid separations.

A heavy liquid separation, employing a commercially prepared solution of $ZnBr_2$, followed by ultrasonic cleaning, and residues mounted in Clearcol and Canada Balsam are standard procedures.

The main aim is to produce a comprehensively illustrated and discussed report of each study. Hence there is not a great emphasis on speed of production of results. Fossil classifications are based on published nomenclature. No code system is employed.

Pan American Oil Corporation

Although not on the original itinerary, I visited Pan American for one afternoon, by arrangement through the Jersey Production Centre. Pan American operate a large research unit in Tulsa, which considers problems of geochemistry, sedimentary petrology, mathematical applications to geology (viz. computer studies), invertebrate palaeontology and palynology.

Pan American has taken to palynology only in the past two years, but maintains a large staff of experienced researchers, who covered a wide segment of palynology :

Head of Section J. Grayson,

C. Upshaw,

D. Engelhart,

K. Neumann,

K. Klement,

H. Sullivan,

G. Willaims.

The company is not willing to take in new personnel and train them.

Four technical assistants are employed to process about 150–200 samples per week. The unit is completed with two secretaries.

Grayson firmly considers that the professional staff should be kept away from technical procedures, and gives them freedom of action within the prime policy of obtaining basic data. Pan American have reached the stage of establishing a field office only in the Rocky Mountains area – to deal with the Cretaceous. Others will presumably follow later.

Such a large volume of work requires a suitable documentation system. To this end a clerk is employed full time on putting information onto I.B.M. cards. I discussed the needs and methods of documentation with Grayson at length, but did not see his classification system for the I.B.M. machine. Of interest, however, were his comments from previous experience with Socony-Mobil where he developed a catalogue of about 25,000 items of published material. Grayson thought that a catalogue of only about 5,000 items can be usefully put on punch cards, and he thus developed a five subject index in which each item was separately catalogued.

1. Fossil name,

2. Author,

3. Morphology,

4. Stratigraphy,

5. Numerical.

This catalogue could be used by any number of researchers in one organization. A search for the appropriate item was conducted through one of the first four subjects. No card could be extracted from these subject indices, but, when found, its item number was noted, and the corresponding card was extracted from the numerical catalogue. Thus cards in each classification system were always available for reference, while it was easy for any untrained assistant to replace cards in the numerical system when they were no longer needed. The cards were made by xeroxing the text and photographing the plates in each publication and compiling a master set of 5" x 8" cards. The master cards were photographed and five prints of each made. Several cards were photographed and printed by large format camera and enlarger and the multiple prints cut into the original 5" x 8" size. This system has much to commend itself for its simplicity of format and usage. The main drawback to its application stems from the labour and photographic facilities needed to develop it.

Sinclair Oil Corporation Research Centre

No prior arrangement to visit Sinclair had been planned, but Dr. Wilson of Oklahoma University kindly arranged for my entry to their research centre. This unit divides its effort between problems of :

Exploration,

Exploitation,

Technical Services,

Engineering.

The palynologists, Mr. D. Potter and two professional assistants, are engaged in both exploratory and service projects. However, they only undertake projects supplied by the Sinclair Production and Exploration Company.

The three palynologists are assisted by one technician. They have an efficient laboratory and dark room, but do most of the necessary processing and photography themselves. Their scope of interest is wide, including the Rocky Mountain Cretaceous - Tertiary and Gulf Coast Tertiaries. Like B.I.P.M. they are also interested in palaeoecological palynology. Several useful items of equipment which were noted at Sinclair are listed in Appendix .

Oklahoma University, Norman, Oklahoma

It was my original intention to see how both the Oklahoma Geological Survey and the Oklahoma University approached palynology, but I found that in effect the palynological work of these organisations stemmed from the same source, Dr. L.R. Wilson and his students.

Dr. Wilson has a self-contained laboratory in one wing of the Geology Department of the Oklahoma University. In the same department and below Wilson's laboratory, the Oklahoma Survey maintained an office. Dr. Wilson is a Research Professor at the University and is also maintained by the Survey. In addition he is free to consult for industry at his own will.

Wilson maintains a laboratory for himself and about six students. He has one secretary and no technical staff, but his laboratory is well equipped. Possibly the most impressive part of his organisation is the neat documentation system employed - and the size of his palynological library. His organisation and documentation is as follows :

1. Collect samples and assign each rock section an Oklahoma Palynology (OP) number. Secure this number from the Consecutive Number file.

2. Write notes in field note book. Return note book to file when you return from the field.

3. Transcribe field notes for Collection Record immediately upon return from field.

4. Record OP number on card in Consecutive Number file.

5. Store samples in glass jars and properly label each.

6. Prepare a descriptive card for each sample. This will be filed under county, state, or country in the Rock Sample Catalogue.

7. Process samples, place unused portion of sample in Rock Sample Collection in Oklahoma Geological Survey.

8. Store residues in small wide-mouthed bottles. After microscope slides are made then file the residues in storage cabinet in Oklahoma Geological Survey.

9. Study slides, describe and illustrate the fossil assemblage, write report. All slides and materials cited in the report are placed on permanent file in the collections of the Oklahoma Geological Survey.

Dr. Wilson maintains the following collections and files :

COLLECTIONS

Modern material

1. Voucher specimen herbarium.
2. Modern spore and pollen residue collection.
3. Modern spore and pollen microscope slide collection.
4. Exchange slide collection.

Fossil material

5. Rock sample collection.
6. Processed sample collection.
7. Microscope slide collection of fossils.
8. Type and illustrated specimen collection.
9. Photographic negative collection (modern and fossil species).
10. Lantern slide collection (modern and fossil species).
11. Exchange slide collection.

CARD FILES

1. Reprint and literature, by authors and subjects.
2. Microfilm collection, by authors.
3. Modern spore and pollen collection file.
4. Rock sample library.
5. Fossil taxonomy, descriptions of genera and species.
    1. Spore and pollen
    2. Hystrichosphaerids
    3. Chitinozoa
    4. Scolecodonts
    5. Dinoflagellates
6. Fossil assemblage studies.

LIBRARY

1. Reprint collection.
2. Microfilm collection.
3. Map and chart collection.

During this visit the following subjects were discussed :

(a) Carbonization

This has been a subject for study by Dr. Wilson for many years. He has been recently collecting bottom-of-hole temperature data for comparison with carbonization values.

(b) Permian

The American Permian palynological sequence still has many gaps and detailed comparisons between the American and overseas assemblages must await further work.

(c) Pennsylvanian

The Oklahoman Pennsylvanian has been a subject of systematic palynological study by Wilson's students. An atlas of the Pennsylvanian microflora will eventually be produced. In the mean time, Wilson has made available abstracts of the students' theses.

(d) Printing of these abstracts was of interest as they were simply, but effectively reproduced by spirit duplicator and photographs of the relevant fossils printed by offset printing. Whereas their print quality is not up to normal publication standard, the plates are readily understandable. This quick and cheap method of plate printing has much to commend itself for internal, unpublished reports.

STANDARD UNIVERSITY, CALIFORNIA

An arrangement to meet Dr. W.R. Evitt of Stanford University, Palo Alto, California, was unfortunately not fulfilled due to delays in Dr. Evitt's summer field trip away from California. However, I visited his laboratory to meet his assistant Miss S. Davidson and Mr. J.S. Warren a graduate student assistant and discussed with them the scope of their intended projects. The Californian Mesozoic and Tertiary seem to be a virtually untouched source of palynological study outside the oil companies.

COMMENTS

As individual research topics which were discussed in the trip cannot be elaborated in a report of this type, comment is restricted to the aims, organisation, and techniques in palynology employed in the places visited.

Aims and Organisation

This rapid tour of a few academic, governmental and commercial palynological laboratories has demonstrated how varied the aims and the means by which they are achieved can be for this particular branch of palaeontology.

None of the university groups, other than at Oklahoma, seems to be taking a very close look at stratigraphic palynology or palaeoecology. Their present interests are broadly taxonomic and morphologic with emphasis on particular palynomorphic groups. The Birbal Sahni Institute expressed an interest in these matters but regarded them as logical sequiturs to the morphography. Only University College, London (Dr. Challoner) operated without any assisting staff. Either research or laboratory assistants were employed in the other establishments to speed the task of these more limited objectives.

Government sponsored palynology was met only at the G.S.I. and the I.F.P. The United States Geological Survey and Canadian Geological Survey could perhaps have been visited with profit for data on their usage of the science. The G.S.I. had very limited objectives in coalfield correlations, and little ambition to enter into nation-wide studies. Their system of returning palaeontologists to the field side after a few years in the laboratory will not permit them to adequately advance Indian palynology in the near future. However, their ratio of professional to non-professional staff must ease their research burden to a great extent.

The I.F.P. is organised to follow specific projects on distinctive principles. Their projects could cover many parts of the globe, and thereby the organisation's equivalents are on a par with commercial firms' needs. The proportion of professional to non-professional staff seems to be well balanced to these needs. Presumably this has been achieved through the apparently flexible staffing and financing systems of the I.F.P. Individuals of the professional staff at the I.F.P. work on specific palynologic groups (e.g. Mesozoic spores and pollens, Palaeozoic hystrichospheres, Palaeozoic Chitinozoa) so that each must become a specialist in one branch of the science.

Their prime task is to assist the resolution of stratigraphic problems and so taxonomic and morphographic projects are of secondary importance, but by no means neglected. The unique but rigidly controlled statistical analyses applied to the I.F.P. projects trend to the production of palaeofacies data as well as correlative interpretations.

The aims and organisations of the commercial enterprises vary greatly, but all seem to be well balanced against their parent companies needs. The commercial laboratories can perhaps be divided into two groups. Those which have been in the field for a number of years (e.g. B.I.P.M. and Jersey) have evolved from the stage of centralised research to the development of field laboratories. The original research centres are now modest in size and endowed with adequate and sophisticated techniques and documentation systems. The second group, (e.g. S.N.P.A. and Pan American) entered at a relatively late stage into the palynological field, but they are meeting their requirements with adequate facilities and large staffs. They look for assistance to mechanical documentation and analysis aids and to data classification schemes that tend to diverge from the classical systems of stratigraphic and palaeontologic nomenclature. Sinclair Oil is an exception to these categories as its operations are limited and data supplied by the production and exploration company and by the lack of technical staff.

The research projects of the commercial laboratories cover a great diversity of subjects and age. They are expected to take on problems of any age or climate. There seems to be an increasing interest in the role that palynology might play in sedimentology.

Dr. Wilson at Norman, Oklahoma, must be separately listed for his unique position in academic, governmental and commercial palynology.

All laboratories are staffed at three distinctive levels : a senior palynologist; a group of professional palynologists who study sepcific stratigraphic projects or projects related to particular ages of fossil groups; clerical and technical assistants who are allocated to specific aspects of the palynologic technique. I did not encounter an organisation where individuals specialized in particular geographic provinces or geologic basins. All the palynologists with whom I talked were required to possess and use a wide field of their discipline's basic data.

Laboratories and Techniques

All the places visited had special laboratory facilities which were not shared with other branches of their parent organisation. However, few of the processing stages employed were common to two or more laboratories. Custom seemed to be the chief motive force behind a number of these actions. The effectiveness of several laboratories' methods was demonstrated by the C.I.M.P. to be very varied. There seems to be a great need for a number of carefully controlled experiments on each stage of the extractions techniques to lift them from the present status of kitchen cookery to that of controlled chemical or physical processes.

The common factor to all such processes is the Hydrofluoric Acid - Oxidation - Alkali - Heavy Liquid Technique. To describe each laboratory's method of applying this process would serve no purpose, so the following comments are restricted to specific items or procedure which stand out as advantageously different from some Australian palynological customs.

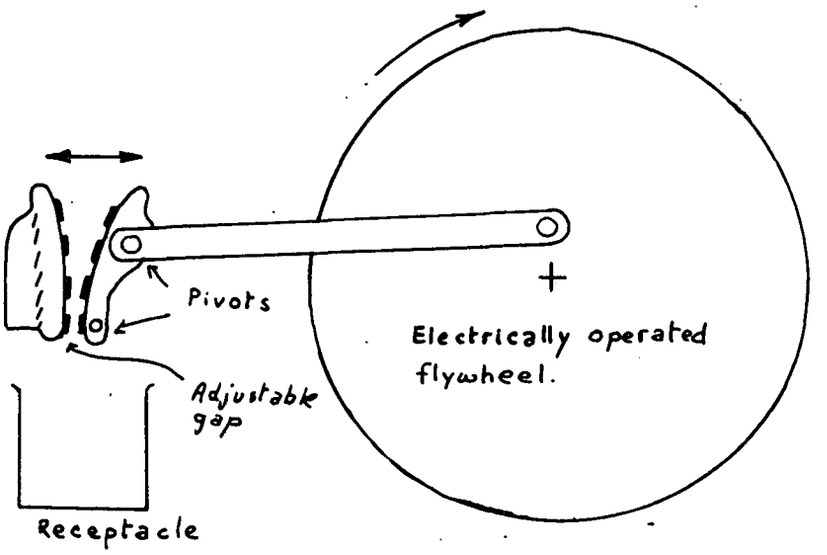

FIG. 1 — Mechanical rock crusher employed by the I.F.P. & S.N.P.A.

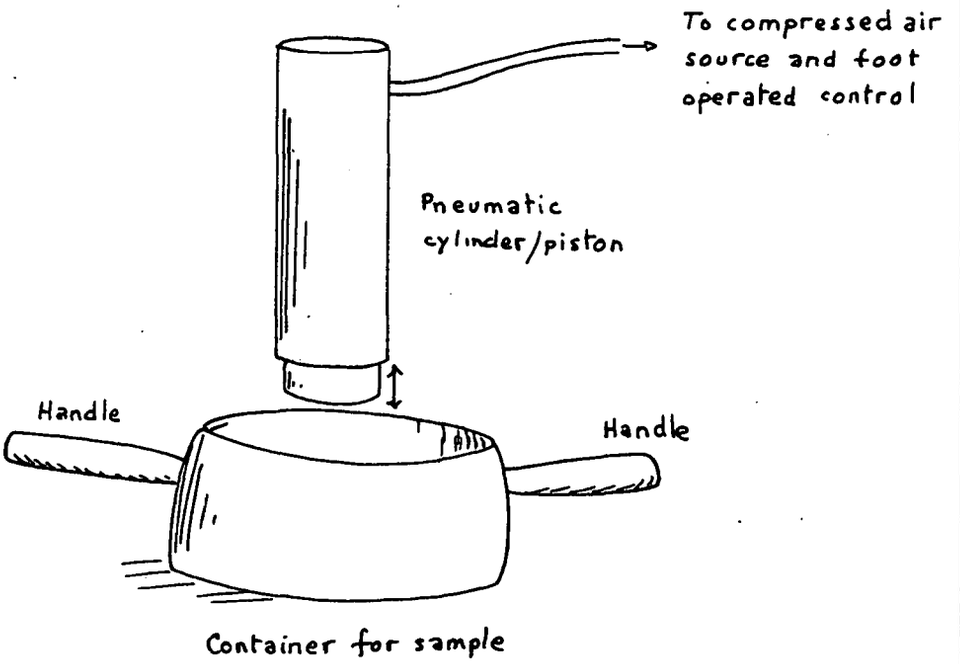

FIG. 2 — Mechanical crusher employed by B.I.P.M.

Sept. 64 π

Bureau of Mineral Resources. To accompany Record 1964/152.

1. Initial sample preparation

That a sample should initially be crushed is commonly accepted as a means of accelerating chemical processing. The I.F.P. and S.N.P.A. employ a mechanical crusher, which is roughly illustrated in figure 1. The width of the gap at the base of the curved jaws can be varied to alter the size of the crushed particles. The jaws and receptacle are cleaned by a compressed air jet. This is not a very hygenic machine, and it only crushes a proportion of a sample to pieces smaller than about $\frac{1}{8}$". However it is a relatively quiet machine and can rapidly crush a large quantity of material without becoming clogged. The I.F.P. sieves the crushed sample and uses that portion which passes a 100 micron mesh. The machine could be a hazard to an operator's fingers. It is probably ideal for micropalaeontological preparations.

B.I.P.M. used a crushing machine similar to that sketched in figure 2. Its action closely approaches that of a pestle mortar, as it operates like a slow cycle, long stroke pneumatic drill. The piston end and mortars are made of a special steel to B.I.P.M.'s formula. The operator holds the mortar by the handles and moves it about until the sample within is suitably crushed. This machine permits good control of the operation. It is readily cleaned by washing or air, but, from a hygiene point of view, it is little better than the fly wheel-type. The noise generated can be heard throughout the laboratory, and it could be quite dangerous unless the operator takes some care.

In contrast, the method employed by Jersey, Sinclair and Dr. Evitt is simple and very hygenic. The mortar consists of an aluminium dish, such as those used to contain custard pies. The dish containing a sample rests on a flat metal plate. Once used the dish is thrown away, thus removing the need to clean the mortar between each sample. A normal steel pestle or ordinary hammer is employed, but this can be more readily cleaned or refaced than a mortar. A test on a tough Australian Precambrian sample showed that aluminium will readily withstand this form of treatment.

2. Chemical Treatment

The Hydrofluoric Acid treatment employed in the laboratories visited varies greatly. Digestions in an open beaker for several hours, possibly heated in a water-bath, is considered satisfactory, although a fairly large undigested residue always remains. Nowhere were the samples heated in the manner employed in the B.M.R.

Jersey and Dr. Evitt employed cheap drinking beakers made of polyurethane as containers at this stage and threw them away after they had been used once. This again is a first class way of avoid contamination.

Very diverse opinions about the oxidation stage exist. The $KClO_3 + HNO_3$ system is generally thought to be rather vigorous and other oxidising agents are generally favoured. The I.F.P. adds NaCl to HNO_3 as an oxidant. Sheffield avoids oxidation completely through the use of an ultrasonic cleaning machine (see below).

Alkali treatments have been subjected to comparative tests at Sheffield. KOH treatment was found to swell the grains by up to 20%. NH_4OH treatment is recommended as the best as swelling does not exceed 5%. These figures probably should be viewed with caution because they do not take into account the apparent shrinking effect of alcohol and bromoform which could be used in a later heavy liquid separation treatment. This matter has been considered before in the B.M.R. and seemed to be the reason why, when a KOH plus alcohol/bromoform treatment was used, the resultant grains tended to be smaller than those described from residues extracted without heavy liquids.

3. Heavy Liquid separations

Heavy liquid separations were either not employed (I.F.P., Sheffield) or mainly carried out with $Zn\ Br_2$ (Cambridge, Americans). Only Churchill (Cambridge) thought that the bromoform/alcohol method was the best. The I.F.P. statistical system does not permit the use of a heavy liquid, but the resulting slides often contain a significant proportion of inorganic residue. The Americans were able to purchase a ready made solution of $Zn\ Br_2$. A. Lichfield at the A.N.U., in recent tests was unable to satisfactorily separate pollen grains by this means. However, the American technique is to centrifuge at high speed for about 10 minutes in the solution. Satisfactory utilization of $Zn\ Br_2$ should save considerable time otherwise spent in dehydrating the residue then removing the bromofrom, and it is far less toxic than Bromoform.

4. Staining and Mounting

Very different opinions were voiced on the use of stain. Many used none at all, claiming it ruined the chance to photograph. Others claimed the reverse. L. Stover and W. Evitt "stained" their specimens to a light brown by acetolyisis.

Slide mounting media varied. The Indians and Europeans favour Glycerine Jelly, but the Americans used Clearcoal and Canada Balsam. The latter combination is permanent and places the grains in the optically correct position in the slide. There seems to be a tendency for Safranine to bleed into the Clearcol, but this is possibly due to incomplete washing of excess stain from a residue prior to slide mounting, or perhaps to an incorrect pH.

5. Utrasonic Cleaning Apparatus

Ultrasonic cleaning apparatus is to be found in most of the palynological laboratories visited. However, varied explanations of their effect, and great variations in usage were noted.

The principle by which the apparatus works is to induce physical movement of a solid object at ultrasonic frequencies by electrical impulse (piezo-electric or magnetostrictive). The movement is transmitted via a fluid to a suspension of the fossils to be cleaned. Transmission can be achieved in two ways : (a) by insertion of a probe vibrating in the suspension; (b) by insertion of a container which holds the fossil suspension into a bath which covers the impulse transmitter. Resultant "cavitation" shakes loose any attached articles adhering to the fossils.

The main problems are to introduce the ultrasonic energy in a manner which does not prejudice sample hygiene, and in just sufficient quantity to remove the adhering particles without destroying the actual fossils.

Systems observed or discussed.

(a) Cambridge.

Mullard probe transducer. This machine is in fact designed for drilling ceramics. The power input can be varied by tuning the generator away from the resonant frequency and by altering the end diameter of the probe attached to the transducer. Mullard regard this as a very powerful machine. It is used by inserting the probe into a centrifuge tube containing the fossil suspension. Main drawbacks to this system are the great power input and the difficulty of satisfactorily cleaning the probe between samples.

(b) Sheffield.

Mullard L326 magnetostrictive bath type machine. This has a peak power of 250 watts but a total power input of 55 watts (because of its wave form). The L326 includes two beakers of about 1 litre capacity. (Apparently several sizes of machine are available, varying from ½ litre to 4 litre). It operates on a frequency of 40Kc, and is used for 30 sec after HF treatment. Its use is claimed to obviate the need for oxidation treatment.

(c) Cambridge.

Mullard L364 generator and L368 litre tank. This machine was demonstrated by a Mullard technician, and was under consideration for purchase by Dr. Hughes. The generator has a power output of 500 watts, averaging about 125 watts, at a frequency of 40Kc, which can be off tuned. Alternative systems are available employing 18 litre and 25 litre tanks. The latter can be bench mounted and needs two L364 generators to operate it. The transducers are sensitive to temperature: hot water above 50°C will permanently destroy their properties. All these machines can be used to "clean" a batch of samples while still in their centrifuge tubes.

(d) Ultrasonics Ltd, Otley, Yorks.

Rapiclean T3 and S3 magnetostrictive bath type cleaners. This machine is automatically tuned at 13kc. on a continuous energy input system (comparing with the Mullard L326 system), and has the bath and generator in one cabinet. A probe transducer can be attached at will. Power output 100 watts.

(e) Tulsa and Oklahoma.

Bath type cleaner of unknown power output, manufactured by Branson Ultrasonic Corp., Stamford, Conn. Jersey Research used the machine for 30 minutes prior to heavy liquid separation.

Comparison of systems.

(a) The probe type of cleaner is difficult to clean and possibly too powerful for general use. A machine (such as the Ultrasonics products) which can take a probe transducer may be useful and versatile.

(b) The bath type cleaner allows several samples to be processed at once, and avoids the possibility of probe contamination.

(c) A bath cleaner is not ideal for centrifuge tubes as a rounded centrifuge tube bottom does not so readily transmit energy generated from the bottom of a bath. Flat bottomed tubes would help the problem (Sheffield uses a specifically designed tube), but a higher energy output would probably solve the problem.

(d) The type of power generation affects the number of samples which can be cleaned at one time. The magnetostrictive transducer tends to focus power to one point in a given bath and so its energy is unevenly distributed. Uniform distribution is achieved by the piezo-electric machines, but these can suffer irremediably from temperature increase.

(e) A bath type cleaner should be readily emptied in case of spillage. The Mullard 18 and 25 litre tanks have drain cocks on them.

(f) Although maximum cavitation takes place in the 13-15 kc range, these are audio frequencies and could be very troublesome to the operator. The Ultrasonics Ltd. Rapiclean system would develop such a noise. The Mullard systems work on a 40kc frequency: its extra power generation presumably makes up for the loss of efficiency at this frequency.

(g) Most of the machines viewed are quite tall. A bench mounted machine would probably be very useful in a palynological laboratory.

(h) The use of ultrasonic machines in palynology is still incompletely tested. Sheffield seems to have the most logical usage, to scatter clays and bitumens after HF treatment. They apply the minimum ultrasonic energy to achieve this purpose. By so doing they remove the need to oxidize most samples and put the treated residue into a most favourable dispersed state prior to heavy liquid separation. Utrasonics are used in America after the heavy liquid separation to disperse a sample prior to slide mounting.

In conclusion, an ultrasonic cleaner is a useful tool in a palynological laboratory. The bath type cleaner is best suited to this purpose. Magnetostrictive cleaners could be used where only a few samples are processed at a time. Where considerable numbers of samples are involved, the piezo-electric type is needed. Care must be taken not to add hot water to such a cleaner. The Mullard designs with drain cocks on the tanks seem to best satisfy most palynological needs. A bench recessed machine would be easier to manipulate than any other type.

Documentation

Palynology laboratories are by no means exempt from the problem common to all scientific establishments, documentation. Of specific importance to palynologists is the question how to cope with (a) an ever increasing volume of literature and a sometimes obscurely located old literature, (b) a vast quantity of unpublished data, (c) stratigraphic utilization of these data. Some form of data storage and retrieval system is needed to deal with the situation.

A simple, unillustrated card index is insufficient as few libraries contain a complete set of palynological literature. Dr. Wilson's collection in Norman is close to being an exception to this state. The Kremp & Spackman catalogue, although well reproduced, covers only a small proportion of the published literature and does not readily lend itself to incorporation in an overall catalogue of published and unpublished data. None of the palynologists with whom this matter was discussed made much use of the Kremp & Spackmann catalogue.

The alternative must take the form of an illustrated card catalogue of each laboratories own manufacture. It could take the form of :

Simple 6" x 4" or 5" x 8" cards,
Edge punched cards,
Feature cards, such as the Vistem System,
I.B.M. or similar mechanical documentation systems.

The systems employed in the laboratories visited naturally varied with the research topics under study and with the budgets and inclinations of the researchers. The English Universities maintained card systems. Sheffield has developed an illustrated card catalogue for many years. The I.F.P. and S.N.P.A. employed edge-punched cards approx. 10" x 8" in size, both morphographic and stratigraphic but both groups are taking an interest in computer documentation. B.I.P.M. seem to have a well established I.B.M. system for storage and analysis which, for example, can print out distribution charts. The edge-punched card item system has many limitations, one of which, as Grayson of Pan American pointed out, in that the maximum number of cards which can be readily sorted by this means is rather limited. Grayson's personally referred alternative of a simple card system in quintuplet requires a specialized photographic system. Feature cards, on the other hand, can be used to catalogue and sort a large number of items without having to handle a great number of cards in any one operation. Although they work on similar principles to the machine systems, feature cards can be kept immediately on hand and do not require the aid of a mechanical sorter, a considerable advantage to the needs of a palynologist.

Whatever the documentation systems employed, there is an initial need for a fossil morphograhic/reproducing facilities to deal key a with published plates and original photomicrographs. Where this need was recognized, relatively adequate technical staff and equipment were provided to fulfill it. The standard procedure of enlargement, cutting and pasting was employed by all. The exceptional firm was S.N.P.A. which used the Pakomatic printing machine for routine photo-micrographs. Although very expensive, this machine permitted one photographer to cope with a large daily output of negatives from seven palynologists among other duties.

The sequitur to data collection, storage and interpretation, the final report could also be considered under the subject of documentation. Those laboratories with a wide (commercial) field of interests customarily produced illustrated reports. Illustrated even if unpublished reports, are of great value to further investigations. The S.N.P.A. for example recognises this and usually produces two parts of a report, a text, and a separately bound set of

illustrations. The plates are photographic enlargements. Dr. Wilson has tackled the same point by reproducing abstracts of his students' theses together with off-set printed copies of the plates. Dr. Wilson also has the excellent medium of the Oklahoma Geology Notes as a quickly printed vehicle for short publications on palynological topics.

APPENDIX: LIST OF SEPARATES RECEIVED

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