H Bartlett

GEOLOGISTS' ASSOCIATION

SOUTH WALES GROUP

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THE GEOLOGISTS' ASSOCIATION: SOUTH WALES GROUP. The Group was formed in 1959 as a direct result of the interest shown by the teachers of geology from Welsh schools attending refresher courses at the University Colleges at Aberystwyth, Cardiff and Swansea. It is designed to further the study of geology, with particular reference to Wales, and to provide a link between the amateur, the student, the teacher and the professional geologist. At present all four groups are strongly represented in the membership of 160 or so. The members are drawn from a catchment area extending from Pembrokeshire to Gloucester.

The Group's session coincides with the academic year. Ordinary Meetings are held monthly from September to March, the Annual General Meeting in March or April, and up to six Field Meetings – including one week-end excursion – between April and September. The Ordinary Meetings take place alternately at Cardiff and Swansea in the Geology Departments of the University Colleges. They are held at 11.00 a.m. on Saturday – usually the third of the month.

The annual subscription is £1 (which includes the cost of *The Welsh Geological Quarterly*). Student membership is 2 shillings. Further details available from: The Secretary, c/o Department of Geology, National Museum of Wales, Cardiff.

Geologists' Association - South Wales Group

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CONTENTS

Page

Cardiff : June, 1969.

NATURE-TIMES NEWS SERVICE

[January to March 1968]

Extracts of geological interest from the items in the Science Reports provided daily in The Times by Nature-Times News Service for October, November and December 1967 were given in volume 3, no.2 of the Quarterly.

The following extracts are taken from the Science Reports for January, February and March, 1968.

During this period 113 items of news were published, of which 7 dealt with geological topics, 8 with geophysics, 5 each with palaeontology, selenology and oceanography - compared with 6 each for physics, astronomy and biology.

The extracts are the first two or three paragraphs of each item; the date, that of the day of appearance in The Times; and the name of the serial (in parentheses), that of the source.

Did magnetism stimulate evolution?

A reassuring calculation has been made of the extent to which living things on the earth would have been exposed to increased doses of radiation from cosmic rays at times in the geological past when the direction of the planet's magnetism was undergoing a reversal.

The calculation will cast doubt on a theory recently in fashion that the reversal of the earth's magnetism would be marked by its temporary disappearance, an accompanying increase in the natural background of radiation, a consequent increase in the rate of genetic mutation and, therefore, an increase in the rate of biological evolution.

There is no dispute about the fact that the earth's magnetism does reverse its direction at intervals of a few hundred thousand years. The magnetization of rocks in the geological past can be used to infer the direction of the magnetic forces at the time of their formation. This record shows that there have been nine such reversals in the past 4m. years. It is also beyond dispute that the pattern of magnetic forces around the earth serves as a means of keeping out a proportion of the cosmic rays which would otherwise reach the planet's surface.

(Nature) 8th January, 1968.

Dating the glaciers of Antarctica.

Study of the volcanic rocks in Taylor Valley, Antarctica, has shown that major glaciation took place at least 2,700,000 years ago. This is the result of a survey carried out by Dr. R.L. Armstrong of Yale University, and his colleagues, and reported in this week's Science.

The result ties in well with the recent estimates of the duration of the Pleistocene Period based on the analysis of sediments recovered from the bottoms of deep oceans. The most recent of these studies have indicated that the temperature of the oceans may have begun to fall sharply between 2,300,000 and 2,500,000 years ago. The antiquity of the ice in Antarctica known from earlier geological studies has for some time been one of the factors in favour of a longer estimate for the age of the Pleistocene.

(Science) 16th January, 1968.

Aerial look at geological structure.

The use of aerial photographs for studying the structure and origin of the Pre-Cambrian rocks in East Africa has been worked out by Dr. John V. Hepworth of the Institute of Geological Sciences, South Kensington. Some of the applications of the method, which should make it possible to distinguish between masses of rock with different geological histories, appears in the current issue of the Quarterly Journal of the Geological Society of London.

Although the use of aerial photographs for geological purposes is not new, the interest of Dr. Hepworth's study is that it provides a powerful demonstration of how to glean precise information from them. By comparison with field surveys, of course, the technique has great advantages. For one thing, it is possible to obtain synoptic surveys of large and inaccessible areas in a comparatively short time.

(Nature-Times News Service) 17th January, 1968.

Drilling deep in Cardigan Bay.

A borehole 2,000ft. deep is being sunk in the north-east corner of Cardigan Bay to determine the nature of rocks and other material under the sea. This is part of a joint project, conducted by the University of Wales at Aberystwyth and the Institute of Geological Sciences, under the direction of Professor A. Wood and Dr. A.W. Woodland. The project, which is costing some £30,000, is being financed by a grant of £4,500 from the Natural Environment Research Council and by the Institute of Geological Sciences.

Cardigan Bay is particularly interesting because the rocks found there are not the same as those on the Welsh mainland or in Ireland. The geophysics of the area has been investigated by a team from Birmingham University, and the new project is a continuation of that work.

What the Birmingham team found, by measuring the velocity of seismic waves from artificial explosions, is that there is a basin of low-velocity material lying offshore extending to a depth of about 1,000ft. This is surprising because the Llanbedr slates, which lie near by, are dense, fine-grained rocks formed by compression of shales and clays. From this it has been concluded that there is a large fault or downthrow just west of the Merioneth coast.

20th January, 1968.

Using coral to work out sea level.

Analysis of radioactivity in coral rocks in Barbados has been used to fix with unfamiliar accuracy the three times during the past 250,000 years at which the sea-level has been comparable with the height of the sea at present. This work is important because it suggests how radioactive analysis may be used to follow the alternations of high and low sea-level that accompany the successive thawing and refreezing of the glacial ice.

Previous attempts to fix the dates of the periods of high sea-level have involved various fossils found in rocks deposited from the sea. On the basis of research like that, it has already been inferred that the height of the sea was comparable with that at present 80,000 and 120,000 years ago.

The radioactive analysis used in this work involves the measurement of the proportions of the isotopes uranium-234 and thorium-230 in geologically ancient rocks. (Science) 23rd January, 1968.

New nature reserve in Wales.

Cors Fochno (Borth Bog) in Cardiganshire, where the Nature Conservancy is to establish a national nature reserve, is an area of considerable scientific interest, both for its present day structure and for its history.

Borth Bog is a rare example of an extensive area of wet acid peat which is known as a raised bog. The convex surface of this bog has a very flat appearance, with the vegetation largely composed of short-stemmed plants. The bog is particularly rich in mosses, including the genus Sphagnum, also known as bog mass, which forms the characteristic spongy cushions of bogs. Among the species present is S.imbricatum, a peat-forming moss which is quite rare in Britain.

This vegetation attracts many field parties from schools and universities, as well as research biologists studying the area. 25th January, 1968.

Organic chemicals from rocks.

How did the primitive earth acquire hydrocarbons? And why are there substantial amounts of carbon in some kinds of meteorites? It is at least possible that these materials were produced by a chemical reaction between hydrogen gas and calcite, a form of calcium carbonate commonly found in association with limestone. One immediate consequence of this suggestion, which arises from experiments carried out at the University of Georgia and the Lawrence Radiation Laboratory at Livermore, California, is that it will complicate the lives of those who seek to link the occurrence of hydrocarbons in pre-Cambrian rocks, for example, with the origin of life. (Science) 25th January, 1968.

Cocos Island as oceanic stepping stone.

How did living things first reach the Galapagos Islands? This has been a puzzle ever since Darwin found that the islands, 700 miles west of South America, were populated by strange forms of tortoises and iguanas which had evolved in isolation for several millions of years. There is now some evidence, suggestive though not conclusive, that Cocos Island, halfway between the mainland of Central America, 900 miles to the north, and the Galapagos Islands, may have served as some kind of a stepping stone. (Nature) 27th January, 1968.

Volcanic flow on the moon.

Photographs of the other side of the moon which have been recovered from the United States Lunar Orbiter satellite seem to have provided convincing evidence of phenomena resembling lava flows on the surface.

In the current issue of Science there is a photograph of an unnamed crater lying at 128° E. and 28°S. from which Mr. S.B. Hixon has been able to come to several conclusions.

From the general topography of the surface in the neighbourhood of this crater, several indepenaent flows of material are recognizable from the shapes of their perimeters. As with coal tips like Aberfan, so on the surface of the moon, a flowing heap of rock ends up by standing on what seems to be a scalloped base.

(Science) 30th January, 1968.

New theory of planet formation.

A new theory of the formation of planets has now been worked out by Professor Fed Hoyle and Dr. N.C. Wickramasinghe, of the Institute of Theoretical Astronomy at Cambridge.

The most striking feature is that the inner planets, including the earth, were formed 4,500 million years ago by the condensation of comparatively hot material with a temperature of about 1,500°C. In recent years the most common view has been that the inner planets were formed by the aggregation of gas and dust left over after the formation of the sun as a cold debris within the solar system.

(Nature) 2nd February, 1968.

Evidence against a variable universe.

A further argument to show that there has been no appreciable change in the values of what are called the fundamental constants of nature has been constructed by Dr. Raymond Gold of the Argonne National Laboratory, from measurements of the spontaneous fission of the most common isotope of uranium - uranium-238.

This issue is important because the possibility that natural constants such as the electrical charge of an electron may have varied during the history of the universe, first seriously suggested by Professor P.A.M. Dirac in 1937, has recently been invoked by Professor George Gamow, of Colorado University, as a means of accounting for some recent unexpected discoveries such as the quasars.

(Physical Review Letters) 3rd February, 1968.

Movable corals found on reef.

Corals which are usually considered to be fixed to the coral reefs which they help to build have been found moving about freely on the Australian Great Barrier Reef. One species of these corals even lives in association with worm-like creatures which help to pull it along.

(Nature) 5th February, 1968.

Fossil squid 300 million years old.

The fossil of a small marine animal, thought to belong to the order that includes squids, has been found at Mazon Creek, Illinois. The rocks in which it was embedded were formed in the Pennsylvanian era of the earth's history, a geological age which began about 310 millions years ago. The oldest fossil squid known hitherto is only 150 million years old.

The fossil, about an inch long, is described by Dr. R.G. Johnson and Dr. E.S. Richardson, of Chicago University, in the current issue of Science. It has 10 tentacles, arranged in a crown, in the centre of which can be seen a black oval area which may have been an ink sac. The tentacles are lined with a double row of minute hooks.

(Science) 6th February, 1968.

Drilling through the Antarctic ice cap.

American scientists have for the first time succeeded in drilling through the Antarctic ice to the bed-rock beneath. The drillers, from the Cold Regions Research and Engineering Laboratory at Hanover, New Hampshire, reached the rock on January 29, after drilling 7,100 ft. deep. The drilling began in November, 1966, but most of the work has been done since November, 1967.

The ice cores should provide a great deal of useful information about the history of the earth. Preliminary investigation has shown two layers of material in the cores at depths of 4,370 and 4,627ft., where the ice is probably 10,000 and 14,000 years old. The material appears to be volcanic ash, and the research workers will be trying to establish whether the deposition of the ash was the result of worldwide or only local volcanic activity.

(Nature-Times News Service) 12th February, 1968.

Infra-red survey from the air.

Infra-red images of the land are being used to reveal variations of temperature between different features of the terrain. One striking example of how this works has been provided by Mr. R.E. Wallace and Mr. R.M. Moxham, of the United States Geological Survey, Mernlo Park, California, who have been investigating the San Andreas fault system in the Carrizo Plain area of California by this technique and have found that, as well as showing the fault line, features such as soil moisture, nature of the rocks and movements in the fault can be identified.

The fault itself is more than 600 miles long. It is a fracture in the earth's crust which has been responsible for a number of earthquakes. During the great earthquake of 1857 the beds of streams in the Carrizo Plain area were shifted as much as 30ft. by movements in the fault line.

Wallace and Moxham say that cumulative shifts of up to 3,200ft. can still be seen in the displacement of valleys crossing the fault, for example, and they suggest that the total cumulative shift in the fault since prehistoric times might be hundreds of miles. It is hoped that studies of past movements along the fault line will aid earthquake prediction techniques that are being developed.

(U.S. Geological Survey Professional Paper 575-D)
13th February, 1968.

Fossils show movement of the earth.

There is now further evidence that the land on the western seaboard of California has moved in relation to the rest of the state. A sideways shift of about 200 miles along the San Andreas fault line has been put forward to account for the anomalous distribution of Miocene fossils in the San Francisco area of California.

(U.S. Geological Survey Professional Paper 593-D) 15th February, 1968.

Volcanic lava on the moon.

Further evidence of the occurrence of volcanic activity on the moon has been extracted from the photographs returned to the earth from the American moon satellite Orbiter V. An interpretation of some of these photographs published in the current issue of Nature shows that volcanic activity must have played an essential part in the formation of the crater Tycho.

The crater, named after the sixteenth-century Danish astronomer Tycho Brahe, is a prominent structure 90km across and lying on the south-east part of the moon. It is conspicuous, especially at full moon, not merely because of its size but because there is a pattern of bright streaks apparently radiating outwards from the crater. These streaks consist of material lying on the surface of the moon, apparently after ejection from the crater.

(Nature) 19th February, 1968.

Prehistoric monsoons in the Indus Valley.

Archaeological excavations in the Indus Valley have shown that the Harappans, who flourished there between 2500 and 1700 B.C., experienced a much wetter climate than exists there today. Evidence that monsoons may have occurred over the Indus Valley during this period has been put forward in the current issue of Nature by Dr. C. Ramaswamy of the New Delhi Observatory.

The Indus Valley at present receives very little rainfall, but the excavations at the Harappan cities of Mohenjodaro, Harappa and elsewhere have suggested that thick vegetation and marshy jungles once covered the area.

(Nature) 20th February, 1968.

Evidence for meteorite formation.

Observations which throw some light on the origin of meteorites have been reported in the current issue of Nature by Mr. J.F. Kerridge of Birkbeck College, London, Meteorites are the rock-like objects from interplanetary space that penetrate the atmosphere of the earth and reach the ground without burning up by frictional heating. So far they are the only objects of extra-terrestrial origin that can be examined in the laboratory.

(Nature) 26th February, 1968.

Small seismic disturbances observed.

The most detailed study so far of the origin of the disturbances of the earth's crust known as microseisms has been provided by an analysis of records kept at the large installation of seismographs built originally for the detection of atomic weapons tests in Montana, United States.

The results of the study, which have been published in the current issue of the journal Science, are based on records obtained from more than 500 independent seismographs distributed over 200 sk. km. of Montana. Microseisms are vibrations of the earth's crust which travel round the world in much the same way as do the seismic disturbances produced by earthquakes or explosions.

(Science) 29th February, 1968.

Clues to the origin of universe.

A new survey of parts of the southern sky made by a radio telescope in Australia may lead to a reopening of some discussions on cosmology which only recently were thought to be closed.

The new results, reported in today's issue of Nature, are the work of J.V. Wall, A.J. Shimmins and J.G. Bolton, and are based on counts of the number of cosmic radio sources detected by the telescope. (Nature) 2nd March, 1968.

Rare horse gives clues to evolution.

The Przewalski horse is one of the rarest animals in the world. The latest International Zoo Yearbook says that only 64 male and 83 female Przewalski horses were living in 35 zoos between February and August last year, although there may still be a few more in the wild. It is believed to be the horse pictured by Stone Age man in the caves of Lascaux 10,000 to 15,000 years ago, and it is considered by most authorities to be the ancestor of modern breeds.

2nd March, 1968.

Jawbones of early hominid are found.

The continuing controversy about the earliest ancestors of human beings will be reinforced by a new find now reported by Dr. Louis Leakey.

In January, 1967, Dr. Leakey, who was at the National Centre for Prehistory and Palaeontology in Nairobi, announced the finding of fossil jawbone fragments of a very early member of the family to which human beings belong - the Hominidae. This find was believed to put the ancestry of human beings back to about 20 million years ago - a much longer period than had previously been assumed.

(Nature) 4th March, 1968.

Unusual craters on the moon.

Close-up photographs of the moon from automatic spacecraft now suggest that both volcanic and meteoric processes were involved in moulding the lunar surface. For years astronomers have debated the origin of lunar craters. One school favoured the view that most of them were formed by the impact of meteorites; others believed that volcanic processes must be responsible. The controversy still continues to some extent however, because the appearance of volcanic and impact craters can be very similar.

Three astronomers working at the Air Force Cambridge Research Laboratory. Massachussetts, have produced evidence of a volcanic origin for a relatively rare type of lunar crater. The astronomers are J.W. Salisbury, J.E.M. Adler, and V.G. Smalley, and their report is included in the current issue of Monthly Notices of the Royal Astronomical Society.

6th March, 1968.

When the year had more days.

The fine ridges that can be seen on the surface of certain corals and seashells probably correspond to the annual, monthly and even daily growth of an animal. By counting the ridges on two species of fossil shells Professor W.B.N. Berry and Dr. R.M. Barker, of California University, have estimated that in the Cretaceous period of the earth's history (135 to 75 million years ago) there were 370.3 days in the year.

The suggestion that fossil shells may throw some light on the length of ancient days was first made by Professor John Wells, of Cornell University. The ridges on shells are often said to be caused by temperature variations, changes in diet and other environmental factors. Writing in Nature five years ago Professor Wells described how he had marked off a year's growth on a species of living coral and counted the number of ridges. To his gratification he found there were about 360, to him a sure sign that the ridges represented the daily growth of the coral.

(Nature) 9th March, 1968.

Amino-acid: a laboratory synthesis.

A discovery that fills an important gap in the overall picture of how biological molecules arose on the earth is reported by G. Steinman, A.C. Smith and J.J. Silver in the current issue of Science. They have shown that the sulphur-containing amino-acid called methionine is produced when an aqueous solution of ammonium thiocyanate, a simple inorganic chemical, is irradiated with ultraviolet light.

In primeval times, before life began, the earth's atmosphere almost certainly contained varying amounts of such gases as hydrogen, hydrogen cyanide, methane, ammonia, and hydrogen sulphide. Chemically, this must therefore have been a reducing environment and it seems reasonable to believe that amino-acids, nucleotides and even polypeptides first arose from the reaction of water with the condensation products of these gases. Once these biological molecules had appeared, life could evolve.

(Science) 12th March, 1968.

Amphibian fossil from Antarctica.

A fossilized fragment of the jaw bone of a large amphibian has been discovered in Antarctica. The discovery, ammounced in New York yesterday, has been hailed as one of the most important fossil finds of this century.

It is the first fossil of a higher vertebrate to be discovered in Antarctica and it indicates that land vertebrates once inhabited the continent. The discovery has profound implications for the theory of continental drift.

14th March, 1968.

How man changes vegetation.

Pollen found in peat taken from different levels of Borth Bog, in North Cardiganshire, has disclosed that man was most destructive to the forest in this area during the Iron Age and Roman periods and between the fourteenth and eighteenth centuries.

(Nature) 16th March, 1968.

Molten rock under Japan.

The crust of the earth under Japan may be made of layers of very soft material, possibly even molten, interleaved between layers of harder rock. This conclusion is based on measurements of shock waves in the ground generated by earthquakes, and is reported by Dr. Keiiti Aki, of the Massachusetts Institute of Technology, in the Journal of Geophysical Research.

19th March, 1968.

Ooze on the floor of the ocean.

Calcareous and siliceous deposits cover large areas of the ocean floor. They consist largely of the remains of small animals, Foraminifera and Radiolaria, which live in the plankton in the surface waters, and on dying settle to the ocean floor.

Foraminifera usually have shells of calcium carbonate. Radiolaria do not have a shell, but have instead a central capsule and usually a skeleton of spicules. In most Radiolaria these spicules are made of silica.

The processes leading from the living planktonic stage to sediments on the ocean floor is not fully understood. Last year, Dr. W.H. Berger, of the Scripps Institution of Oceanography at San Diego, California, announced that selective solution of foraminiferal shells occurred at depths, and this alters the composition of the foraminiferal ooze.

(Science) 19th March, 1968

A graveyard for frogs.

A deposit containing several thousand fossil frogs has been discovered in Makhtesh Ramon, Israel. This large collection of fossils should provide very detailed information about the evolution and development of pipid frogs. Species of this family are still living today in tropical and subtropical regions of South America and Africa.

(Bull.Museum of Comp.Zool.,Harvard) 21st March, 1968.

Variations in Patagonian glaciers.

The glaciers of the Patagonian ice fields in Argentina have advanced and retreated three times during the past 10,000 years. According to a study carried out by John H. Mercer of Ohio State University, the movements of the glaciers occurred at the same time as similar movements in the northern hemisphere. This confirms the view that the advance and retreat of glaciers, at least in recent times, is a worldwide phenomenon.

(Amer.J.Sci.) 29th March, 1968.

Welsh Geological Quarterly, v.4, no.1, pp.2-10.

NATURE-TIMES NEWS SERVICE

[April to June, 1968]

Dating ice age ebb and flow — The Times, April 2nd.

The use of oceanic sediments for following the ups and downs of temperature during the Pleistocene Period has now led to a rather detailed reconstruction of the geological history of the past 120,000 years.

This argument, based chiefly on cores of ocean sediments collected from the Indian Ocean, is published in the current issue of Science by Dr. William E. Frerichs of the Esso Production Research Company at Houston, Texas.

Although there is at least a possibility that Dr. Frerich's conclusions, which depend on the occurrence of certain kinds of marine micro-fossils, may yet be linked with geological observations of a more conventional kind, geologists will no doubt wish for this to be done before throwing their hats in the air.

(Science, March 29th.)

Explaining the irregularities in ocean floor. — The Times, April 3rd.

The ocean floors are slowly spreading outwards from the central ridges of the Atlantic and Pacific, while new material is being thrust upwards to form the crest of the ridges. This process may not have gone on at a constant rate; a recent study of the North Atlantic suggests that between 10 million and 40 million years ago the ocean floor ceased to spread.

(Nature, March 30th and Science, vol.156, 1967.)

Mountains may not be cooler. — The Times, April 8th.

High ground on Mars may not be appreciably cooler than the lowlands, according to Dr. Carl Sagan and Dr. James B. Pollack of Harvard University. They say factors that make mountains on the earth cooler than the neighbouring lowlands do not apply on Mars.

(Journal of Geophysical Research, vol.73, 1968.)

Computer simulates lunar craters. — The Times, April 24th.

A computer at the laboratory of the United Kingdom Atomic Energy Authority at Culham, Berkshire, has been used to study the way in which craters are formed on the surface of the moon. The computer was programmed to simulate plan views of the lunar surface, which were compared with photographs taken by the American Ranger spacecraft.

One of the scientists responsible for this work is Mr. C.A. Cross, an amateur astronomer, of Northwich, Cheshire. In the current issue of the Monthly Notices of the Royal Astronomical Society, Mr. Cross and Mr. D.L. Fisher describe how the computer at Culham - an English Electric KDF 9 - was programmed to draw diagrams, made up of circles of various sizes and in various positions, to represent the distribution of craters on the moon. Mr. Fisher was, until recently, a member of the computing laboratory at Culham.

(Monthly Notices of the Royal Astronomical Society, vol.139, 1968.)

Were there seas on the moon? The Times, April 29th.

The notion that certain dark rocks on the moon consist of volcanic lava has been challenged by Dr. John Gilvarry, of Stanislaus State College, California. He says there is evidence that seas used to exist on the moon, and that the dark rocks are marine sediments.

This conclusion, likely to be controversial among astronomers, is based on measurements and photographs of the moon made by spacecraft. The dark rock in question is the material on the floors of the lunar maria - broad flat plains, which cover half the visible side of the moon.

(Nature, April 27th.)

Mineral formation in bladder stones The Times, 29th April.

A mineral reported to exist in human bladder stones has now been shown to be the decay product of a common constituent of the stone.

The mineral newberyite, which is composed of magnesium, phosphorus, hydrogen and oxygen, has been found in some analyses of human bladder stones but not in others. Dr. June Sutor, of University College London, points out in the current issue of Nature that struvite, a common constituent of the stones, is known to decay into newberyite with the passage of time.

(Nature, April 20th.)

Another step towards life. The Times, May 7th.

Adenosine monophosphate, one of the most essential molecules in the biochemistry of living organisms, could have been formed spontaneously under the conditions thought to exist on the primitive earth. This finding is a further step forward in the attempt to explain how life on earth began. The result is reported by Dr. Cyril Ponnamperuma and his colleagues at the Ames Research Centre, California.

At first sight it is hard to understand how the ordered chemical machinery of life could have evolved from inorganic matter by the known laws of physics and chemistry. Indeed, the history of that evolution may never be exactly reconstructed, but the possibility of doing so was dramatically shown by S.L. Miller of California University in 1953.

(Nature, May 4th.)

New facts on moon rocks. The Times, May 7th.

First comparisons of chemical and magnetic data transmitted from the moon by Surveyor 7, with similar data from Surveyor 5 and Surveyor 6, suggest that the classical processes of melting, followed by cooling and solidification, which have led on the earth to a partial separation of chemical elements, may have operated also on the moon.

At the least, chemically distinguishable rock types appear to exist. The difference observed is between the surface of the moon's southern highlands (Surveyor 7) and the flat plains known as maria (Surveyors 5 and 6).

Initial data from Surveyor 7, not yet published in the United States, have been supplied by the National Aeronautics and Space Administration to Dr. P.J. Adams of the Institute of Geological Sciences, London, for use in a review of the geology and geography of the moon. His review is published as an illustrated booklet and is accompanied by an exhibition in the institute's museum in South Kensington.

(The Moon, its Geology and Geography, by P.J. Adams.)

Fossil man prey to the crocodile. The Times, May 9th.

On the banks of a Javan river half a million years ago a crocodile seized and ate a man-like animal. The evidence for this incident has come to light from a fossil jaw, first found in 1953, which has now been cleaned and re-examined by Professor G.H.R. von Koenigswald, of Utrecht University. He has found a line of deep holes in the jaw which are exactly fitted by crocodile teeth. It may be that crocodiles account for the scarcity of the fossil evidence of man.

(Proceedings of the Royal Netherlands Academy of Sciences, vol.71, 2B, 1968.)

When were tools first made? The Times, May 13th.

Bones in the Upper Miocene fossil beds of Fort Ternan, in Kenya, show evidence of having been deliberately smashed. Dr. L.S.B. Leakey, of the National Museum Centre for Prehistory and Palaeontology in Nairobi, who made this discovery, suggests that the damage may have been caused by some kind of blunt instrument, used perhaps by Kenyapithecus wickeri, an early member of the Hominidae - the family to which man belongs. Remains of the creature have been found in the same fossil beds as the smashed bones.

Writing in this week's issue of Nature, Dr. Leakey describes examples of mammalian bones which have depressed fractures of the sort that could have been made by a blunt tool of some kind. He also mentions a small broken skull with a depressed fracture with a semicircular outline, showing that part of the skull has been removed.

(Nature, May 11th.)

Gulf stream keeps same course. The Times, May 17th.

Examination of fossils of micro-organisms collected from the bottom of the North Atlantic off the United States have provided evidence to suggest that the Gulf Stream has retained more or less its present pattern of flow for some thousands of years at least. This conclusion is reached by Dr. W.F. Ruddiman, of the Lamont Geological Observatory in New York, and described in the current issue of Deep-Sea Research.

In this connexion, stability is a relative matter. Dr. Ruddiman points out that although the Gulf Stream is only about 20 miles wide at any time, it does meander about, covering a range of two degrees of longitude or thereabouts.

What Dr. Ruddiman has done is to collect cores of sediments from the bottom of the North Atlantic and to examine the microfossils they contain. He has been chiefly concerned to pick out those fossils known to be sensitive to temperature and which are carried into the North Atlantic from the warmer seas in the south.

(Deep Sea Research, Vol.12, 1968.)

Do-it-yourself fossils. The Times, May 27th.

A method for quickly petrifying plant tissue in the laboratory is described by Dr. R.W. Drum, Massachusetts University, in this week's Nature. Plant tissue is petrified by the natural waters, containing high concentration of silicates, that issue from volcanic springs in places like Yellowstone Park, in America, and in New Zealand, but this natural process is slow.

Dr. Drum has devised a way of duplicating it much more quickly in the laboratory. He soaks pieces of plant tissue for up to a day in a concentrated and acid solution of a chemical called sodium metasilicate. The sodium metasilicate is similar to waterglass used to preserve eggs.

The soaking is followed by washing and boiling in acid to remove all the organic material so as to leave the final product a silica replica of the original cells. So far only small pieces of plant tissue about a millimetre cube, have been petrified in this way.

(Nature, May 25th.)

More about the origin of life. The Times, May 28th.

The four compounds that are the sub-units of the genetic material DNA, responsible for coding genetic information, have all now been made from mixtures of simple gases under so-called prebiotic conditions - that is to say, conditions believed to be similar to those on earth before the advent of life.

This reported by Dr. J.P. Ferris, Dr. R.A. Sanchez, and Dr. L.E. Orgel, of the Salk Institute, California, in the current issue of the Journal of Molecular Biology. [Vol.33, 1968].

Error in distance to moon The Times, May 28th.

Calculations of the position of the moon, used by astronomers for more than half a century, are in error, according to two scientists at the Jet Propulsion Laboratory of the California Institute of Technology, Dr. J.D. Mulholland and Dr. C.J. Devine.

Although the errors may amount to something like 400 metres, small compared with the 384,000 km. between the moon and earth, they are important to space engineers planning flights to the moon.

(Science, May 24th.)

Snail shells reflect changes in climate. The Times, May 29th.

In southern England the pattern of banding on the shells of a common species of snail - Cepaea nemoralis - has changed in response to the changing climate since about 4,500 B.C. This has emerged from statistical analyses, made by Dr. J.D. Currey, of York University, and Professor A.J. Cain, of Manchester University, of the banding patterns of subfossil snail shells collected at archaeological sites and of snails living near the sites today.

In living populations of these snails the number of individuals with banded or unbanded shells varies. The banding pattern is genetically controlled and subject to natural selection. The climate, in particular the temperature, is an important selection pressure. (Philosophical Transactions of the Royal Society, vol.253, 1968.)

Solar lake on Red Sea shore. The Times, May 31st.

A solar lake in which the surface layer acts like the glass in a greenhouse and allows the water below to become very hot has been discovered on the shores of the Red Sea, about 20 km. south of Elat.

The discovery, reported in Nature by Dr. F.D. Por of Jerusalem University, was made during a routine survey of the Sinai coast. Skin divers found that the waters of the lake were so hot that they could not penetrate more than about a metre below the surface.

Temperature and salinity measurements made last February showed that the temperature increased from 16°C at the surface to 40°C at a depth of 1.5 metres. At 3-4 metres, the temperature of the Red Sea was 21°C. Salinity at the top of the lake was like that in the open sea, but waters at the bottom of the lake were twice as saline. (Nature,

Ocean ridges may raise sea level. The Times, June 4th.

A mechanism often proposed to account for the changes in the sea level in the geological past is the formation and melting of the polar ice caps. Dr. Kenneth L. Russell, of Princeton University, now suggests that another event may have affected sea levels; he calculates that the rise of the great ocean ridges which split the continents apart could have displaced enough water to raise the sea level by more than 400 ft.

Gondwanaland is the name given to the supercontinent that once comprised South America, Africa, India, Australia, and Antarctica. Present evidence suggests that ridges arising from the underlying crust began to split up the supercontinent some 200 million years ago. The first split occurred along a north-south axis which left South America and Africa in one fragment and India, Australia and Antarctica in the other.

As the fragments drifted apart the ridge that divided them probably grew to dimensions similar to those of the present mid-Atlantic ridge. Treating this ridge as a wedge 2 km. high, 1,600 km. wide and 30,000 km. long, Dr. Russell calculates that the water it displaced would have caused a worldwide rise in sea level of over 400 ft. (Nature, June 1st.)

Basaltic rock theory of maria. The Times, June 12th.

Recent analysis of the composition of the lunar surface, based on the chemical analysis experiment on Survey VI, last November implies that the lunar maria are largely composed of material resembling a rock of a basaltic type.

American scientists have determined that both this site in Sinus Medii and the site of the Surveyor V landing last September in Mare Tranquillitatis, the most abundant chemical element is oxygen, followed by silicon; aluminium is prominent in both samples but only the upper limits of concentration can so far be assigned to the amounts of carbon, sodium and iron present.

(Science,

More hot spots on the moon The Times, June 25th.

A further 22 patches on the surface of the moon which are warmer than their surroundings during the lunar night have been identified by research carried out by Dr. Robert L. Wildey, of the Centre of Astro-geology at Flagstaff, Arizona. In previous investigations of the surface of the moon with sensitive infra red detectors, nearly 100 of these patches had been identified. The new batch consists of features which are somewhat less prominent than those previously identified. The total now known is 119.

In the 22 patches whose positions and properties are described in the current issue of the Monthly Notices of the Royal Astronomical Society, most are identifiable with small features on the surface of the moon which themselves lie near the edges of the lunar seas or maria. Many of them have been observed on more than one occasion and Dr. Wildey has been able to gather enough information about the most prominent of them to be able to infer how rapidly they cool as the fortnight-long lunar night wears on.

This step is an important clue to the nature of these hot spots on the surface of the moon.

(Monthly Notices of the Royal Astronomical Society, vol.139, 1968.)

Counts of Martian craters. The Times, June 26th.

Estimates of the age of the surface of Mars from the number of craters that pockmark the surface of the planet must be regarded with caution, according to Dr. A.H. Marcus, of Bellcomm Incorporated, Washington, in an article in the current issue of Science. Dr. Marcus says this is chiefly because the craters seem to have reached a stage of equilibrium, small craters being formed at the same rate as they are obliterated by the formation of larger ones.

(Science, June 21st.)

NATURE-TIMES NEWS SERVICE

[July to September 1968]

Early jaw from Hongkong drug store. The Times, July 3rd.

A piece of bone bought in a Hongkong drug store nearly 40 years ago has been identified as part of a human jaw, possibly 10,000 years old. Dr. T. Jacob, of Jogjakarta University, who describes the jaw, believes that it may belong to the ancestors of the early inhabitants of Melanesia.

The bone is part of a collection formed by Professor von Koenigswald of Utrecht University. Chinese druggists used to prescribe fossil mammalian teeth as a rejuvenating agent; the teeth were ground up and administered to the patient in water. In the 1930's Professor von Koenigswald made a collection of such teeth and bones from drug stores in China and Indonesia. Many of the finds are still unpublished.

(Proceedings of the Royal Netherlands Academy of Sciences, vol.72. 3B.)

Oil under the south Irish Sea? The Times, July 6th.

Beneath Cardigan Bay there is a basin of sedimentary rocks which may contain oil or gas bearing structures. This is the outcome of a survey of the south Irish Sea carried out by Dr. D.J. Blundell, Dr. F.J. Davey, and Dr. L.J. Graves, of Birmingham University, reported in this week's Nature.

The basin of sedimentary rocks is 30 km. wide, 120 km. long, and its maximum depth is between 3,500 and 6,700 metres. ....

The surveys of the south Irish Sea were carried out between 1965 and 1967. For the first two years the Birmingham geologists chartered coasters to carry their instruments. In 1967 the Royal Research Vessel John Murray became available.

(Nature, July 6th.)

Position of continents in Palaeozoic era. The Times, July 9th.

The direction of magnetization in ancient rocks has been used to plot the positions of the continents during the Palaeozoic era of the earth's history, which lasted from about 570 m. to 225 m. years ago.

From the maps constructed on such evidence, Professor K.M. Creer, of Newcastle upon Tyne University, finds that the continents remained more or less static until the latter part of the era, when they began to drift over the upper mantle of the earth towards their present positions.

(Nature, July 6th.)

New ideas on origin of tektites. The Times, July 11th.

New ideas on the origin of tektites have been put forward by Dr. R.A. Lyttleton, of Cambridge University. Tektites are small, rounded, glassy objects found at several places on the surface of the earth. Dr. Lyttleton says that they may have been formed during an encounter between the earth and either a comet or a large meteorite.

Tektites have been collected from tracts of land as widely scattered as the Philippines, Czechoslovakia, Australia, and Texas. Their rounded aero-dynamic shapes suggest that they may originally have been spherical drops of molten material from beyond the atmosphere. The question which has puzzled scientists is how material like this may have originated.

(Geophysical Journal of the Royal Astronomical Society, vol.15, 1968.)

Space debris on earth 400 million years ago. The Times, 12th July.

Chemical analysis of an ancient bed of rock in Australia suggests that 8,000 tons of extraterrestrial material was reaching the surface of the earth every day at the time the rock was being formed. Similar amounts of material are thought to reach the earth in present times, which means that the rate of arrival has remained fairly constant over the last 400 million years.

Extraterrestrial material arrives in all forms from microscopic dust grains to meteorites the size that caused the Arizona crater. Material like this usually contains chemical elements in proportions different from those naturally occurring on earth. For example, rocks in the earth's crust contain roughly equal amounts of the rare metals osmium and rhenium, whereas in stony meteorites osmium is more than 10 times as abundant as rhenium.

Writing in this week's Nature, J.W. Morgan, of the Australian Atomic Energy Commission, has estimated the amount of extraterrestrial material incorporated in a bed of Silurian shale at Etheridge Creek, Australia.

(Nature, July 13th.)

Proteins in dinosaur bones. The Times, July, 13th.

More or less intact proteins, containing 20 or more amino-acids, have been recovered from individual dinosaur bones 150 million years old by Dr. M.F. Miller and Dr. R.W.G. Wyckoff, of the University of Arizona at Tucson. ......

If it were possible to extract a protein - for example. the skeletal protein collagen, which occurs in tendons and bone - from fossils and compare its chemical composition with present day collagen, it would be possible to measure directly the rate of evolution of the protein.

In the past several analyses of proteins from invertebrate fossils have been made, and Wyckoff and his colleagues have found a protein with a composition similar to modern collagen in fossil bones and teeth from the Pleistocene period. But on a geological time scale that is a recent period, only 1,500,000 years ago. The protein that they have just extracted is about 100 times older, from the Cretaceous and Jurassic periods.

(Proceedings of the U.S. National Academy of Sciences, vol.60, 1968.)

Loess and early man in China. The Times, July 15th.

The development of civilization in China may have been critically influenced by the geological events of the last great ice age which brought about the formation of the loess lands of northern China. According to Dr. I.J. Smalley, of University College London, the ease of cultivation of the loess land may have supported the population growth of China's earliest organized society.

(Man, vol.3, 1968.)

Hot spot likely underneath Scotland. The Times, July 24th.

Evidence that there may be a region of high temperature in the earth's surface less than 100 km. below the southern uplands of Scotland has come to light from measurements of variations in the earth's magnetic field. This may be a remnant of the volcanic activity which occurred in Scotland during the Tertiary, a geological period when much mountain building took place.

The evidence for the high temperature region is based on measurements of the earth's magnetic field at a number of observing stations in southern Scotland and Northern Ireland, and is reported in the Geophysical Journal of the Royal Astronomical Society by Dr. J.E.A. Osemeikhian and Dr. J.E. Everett, who, until recently, were at Cambridge University.

(Geophysical Journal of the Royal Astronomical Society, vol.15, 1968.)

Fires killed the early marsupials. The Times, July 26th.

A fascinating explanation of how some Australian marsupials became extinct has been proposed. The suggestion, originally put forward in a lecture last year by Dr. D. Merrilees, of the Western Australian Museum, has been published in full. Dr. Merrilees suggests that fires started by Australian aborigines may have so changed the vegetation that the marsupials could no longer survive.

It is known that man coexisted with the marsupials on the Australian mainland in the late Quaternary period, about 10,000 years ago. It is also known that the aborigines were able to light fires, and Dr. Merrilees says that even quite small bush fires, if they were repeated often enough, would have had a serious effect on the marsupial populations.

The proposal is interesting because of the light it throws on the extinction of large mammals by early man.

(Journal of the Royal Society of Western Australia, vol.51, 1968.)

Magnetic tests show earth's hot spots. The Times, July 26th.

Measurements of the earth's magnetic field at observing stations in Iceland seem to have confirmed the presence of a mass of molten lava beneath the island, noted among geologists for its volcanic activity. According to the new measurements, the suspected mass of lava extends beneath the entire island at a probable depth of about 30 km.

The way in which the presence of the lava is inferred from the magnetic measurements is, in essence, the same as the argument for the existence of a high temperature region beneath the southern uplands of Scotland, already described in Science Report. In southern Scotland, measurements of the way the earth's magnetic field varies with time show localized irregularities, which may be caused by a region of high electrical conductivity beneath the southern uplands.

It is more difficult to make inferences about the earth's structure from the Icelandic measurements because here the local magnetic field is also known to be influenced by the aurora - the Northern Lights.

(Journal of Geophysical Research, vol.73, 1968.)

Galapagos sea floor spreading. The Times, July 30th.

Another of the sub-oceanic regions where the floor of the oceans seems to be spreading away from a central rift valley has been discovered in the Pacific, extending eastwards from the Galapagos Islands towards South America. This is reported by Arthur D. Raff of the Scripps Institution of Oceanography, California, and is based on surveys of the earth's magnetic field between the Galapagos Islands and South America.

The magnetic field in this region changes noticeably from place to place, according to surveys which have been carried out. The pattern of the variations in the magnetic field measurements seems to be symmetrical about an axis extending eastwards from the Galapagos and is associated with a rise, having a central valley, in the general level of the ocean floor.

According to Dr. Raff, the pattern of the magnetic variations resembles similar patterns associated with the great oceanic rises, which are widely believed to represent regions where the sea floor is gradually spreading away from an axis marked by a rift valley. He estimated the rate of spreading of the sea floor from the axis to one side to be 3.2 centimetres a year for the area east of the Galapagos.

(Journal of Geophysical Research, vol.73, 1968.)

Spread of Qanats in Old World. The Times, August 2nd.

The tunnel-well, or qanat, is an ancient method of irrigation which is still widely used in Iran, Cyprus, and Morocco. Professor Paul English, of Texas University, has traced the spread of qanats throughout the Old World from the borders of Persia, where they were probably first developed about 2,500 years ago.

A qanat is a gently sloping tunnel, sometimes 10 miles long, which taps water-laden strata in the highlands and conveys the water by gravity to the point where it is needed. Its construction demands considerable surveying and engineering skills, which are exercised with simple instruments and materials.

(Proceedings of the American Philosophical Society, vol.112, 1968.)

Amphibian fossil from Antarctica — The Times, August 6th.

The first animal fossil to be found in Antarctica is described in detail in this week's Science. The fossil, whose discovery was announced earlier this year (Science Report March 14), is a small piece of jaw bone belonging to a primitive amphibian which lived about 230 million years ago.

The presence of the fossil confirms that Antarctica was once joined to other land masses, as suggested by the theory of continental drift.

The fossil was discovered on December 28 last by Dr. Peter J. Barrett, of Ohio State University. It was embedded in soft sandstone rock three-quarters of the way up a ridge near the Beardmore Glacier, about 325 miles from the South Pole. The sandstone lies some 250 ft. above the base of a layer of rock which contains fossil leaves of the fern Glossopteris. This is one of the characteristic flora of the Permian Age, which ended about 230 million years ago.

(Science, August 2nd.)

Earth's magnetic field origin. — The Times, August 17th.

Many attempts have been made to explain why the Earth has a magnetic field. So far, most of them have been found wanting, and only one, the dynamo theory, is widely accepted. This theory suggests that the magnetic field is set up by the action of electric currents generated by some sort of dynamo in the fluid core of the Earth.

Because very little is known about conditions deep inside the Earth, there has been plenty of room for speculation. Even so, it is quite difficult to show, theoretically, that the dynamo theory could work, even if the most convenient assumptions are made. One mechanism which seems to work was put forward in 1958 by Dr. A. Herzenberg.

This theory, which is really a convenient mathematical model rather than an attempt to suggest what the motions in the Earth's core actually are, suggests that a conducting stationary sphere in which two smaller spheres are rotating acts as a dynamo. Because all three spheres are assumed to be rigid, the model cannot immediately be applied to the Earth.

Experiments recently carried out at th School of Physics at the University of Newcastle and reported in this week's Nature, lend some further support to the theory

(Nature, **August 17th.**)

During the period of the British Association Meeting in Dundee (August 21 to 28) the Science Reports were replaced by summaries of papers read at the Annual Meeting. They included: Streams a key to diet - Diet deficiencies in men, animals and plants have been uncovered in experiments with a recent method for mineral prospecting. Geochemists have found that streams hold the secret.

Oceanic silica controlled biologically. The Times, September 2nd.

An explanation of why sea water contains much less silica than river water has been constructed by Dr. S.E. Calvert, of the Grant Institute of Geology at Edinburgh, on the basis of information gathered from a great variety of sources. The nub of his conclusion is that silica is removed from the oceans as quickly as it is carried there by several agencies, and that biological activity of various kinds is chiefly responsible for carrying it away.

(Nature, August 31st.)

Little hope of predicting Iran quakes. The Times, September 4th.

The earthquakes that have devastated north-eastern Iran are the consequence of a geophysical process that has been in motion for some hundreds of millions of years.

An ancient sea, called the Tethys, once divided Africa and India from the Eurasian land mass. The layers of sediment on the floor of the Tethys were pinched up into the great system of mountains that stretches from the Alps to the Himalayas when the two continental systems began to move towards each other.

So far as can be judged, this movement is still in progress, and the resultant stresses in the rock formations are what makes the region liable to earthquakes. Study of the way in which the ancient layers of sediment are buckled up suggests that within the past few million years .... the African and Eurasian land masses have moved at least 70 kilometres closer to each other.

Geologists believe that most of the movement is of the African continent while the Eurasian continent is staying still. Arabia, for example, appears to be moving north-eastwards, and the underlying crust of Arabia may have pushed under the neighbouring Asian crust to throw up the Zagros mountains of Iran.

Although the Zagros range is the area of Iran most liable to earthquakes, these can occur throughout the country. The ubiquity of earthquakes in Iran is one of the problems that face any attempt to predict them.

(Nature-Times News Service.)

Spreading of the Pacific Ocean floor. The Times, September 5th.

Outcrops of basalt along the crest of a ridge on the floor of the Pacific Ocean, known as the East Pacific Rise, were discovered last year on a cruise of the research vessel Pillsbury, owned by the Institute of Marine Science at Miami University.

Writing in this week's Science, Dr. E. Bonatti, of the institute, gives details of the discovery which are further convincing evidence for the theory of sea floor spreading which results in continental drift.

(Science, August 30th.)

Fresh light on genesis of petroleum. The Times, September 7th.

Further light has been shed on the chemical history of petroleum by W. Henderson and his colleagues at Bristol University. From their experiments it seems that the natural heating and catalytic processes in rocks go a long way towards accounting for the complex mixture of chemicals found in petroleum. (Nature, September 7th.)

Oldest fossils on earth found in Swaziland. The Times, September 10th.

Small spherical and cup-shaped structures rich in carbon have been discovered in sedimentary rocks from Swaziland which are more than 3,200 million years old. Although an unequivocal interpretation of these microscopically small objects is extremely difficult, a team of six American scientists led by Dr. A.E.J. Engel, of the University of California, believe they are true fossils, the oldest yet identified. (Science, September 7th.)

Antarctic ice sheet penetrated. The Times, September 11th.

The first bore hole to be sunk through the Antarctic ice sheet has reached bedrock at a depth of more than 7,000 ft. The core of ice retrieved from the hole has revealed layers of volcanic ash deposited on the surface of the ice sheet some 20,000 years ago.

The hole was drilled at Byrd Station in west Antarctica by scientists from the United States Army Cold Regions Research and Engineering Laboratory, who a few years ago sank the first hole through the Greenland ice sheet.

(Science, September 6th.)

Discovery of buried rift valley. The Times, September 12th.

The technique of using seismic signals to explore the structure of the earth's crust has won a remarkable and somewhat unexpected prize in North America - the discovery of a pre-Cambrian rift valley between 50 and 200 km. across which is now buried under more than 20 km. of rock deposits.

The rift valley must have been formed early in the geological history of the earth at an age that has been estimated at about 1,350 million years ago. The scientific importance of the discovery is that it shows that geological processes now under way were already at work at a much earlier stage, but there also seems to be a good chance that the new discovery will throw light on the ways in which important concentrations of minerals are brought about.

(Science, September 6th.)

Diet of a Dorsetshire ichthyosaur. The Times, September 16th.

A small ichthyosaur which lived about 150 million years ago has been found near Lyme Regis. By a fortunate accident its stomach contents have been fossilized with the skeleton, which has allowed Dr. J.E. Pollard, of

Manchester University, to discuss the feeding habits of these extinct animals. ...

The stomach of the Lyme Regis ichthyosaur contains thousands of small fossilized hooklets, of the type which lined the arms of ancient cephalopods, the group of marine animals that includes octupuses and squids. The hooklets are a primitive feature of cephalopods; in modern members of the group they have been replaced by suckers, which are a more efficient method of grasping prey.

(Palaeontology, vol.3, 1968.)

Earthquakes keep earth wobbling. The Times, September 20th.

Large earthquakes may contribute to the slight wobble of the earth about its axis of rotation, and variations in the wobble may even be a sign that earthquakes are about to occur, according to L. Mansinha and D.E. Smylie at Western Ontario University.

The wobble in the earth's axis of rotation is such that the North Pole completes an anticlockwise circular path about once every 14 months. The displacement, measured in terms of a few tens of feet, appears as a variation in latitude as determined by the position of the stars. Because of its rotation, the earth is not a perfect sphere but is flattened at the poles, and theoretical studies suggest that this flattening should damp down the wobble. Geophysicists have been searching for the factor that counteracts the damping and keeps the wobble in motion.

(Science, September 13th.)

TECHNIQUES FOR THE EXTRACTION OF SELECTED MICROFOSSILS

A.C. Higgins and E.G. Spinner

INTRODUCTION

At a conference for geology teachers held in Sheffield in 1964 one of the most successful exhibits was a demonstration of microfossils which enabled teachers to pick megaspores from a residue and add them to their school collections. Since that time conferences for The Association of Teachers of Geology have been held and at these meetings requests for information on microfossil extraction techniques have been received from teachers. On the suggestion of Professor L.R. Moore, this article has been written as an attempt to satisfy these requests.

The use of microfossils in teaching palaeontology and stratigraphy in schools has much to recommend it. It involves collecting samples, which necessitates participation in field work. At the same time it involves intelligent field work including the use of geological maps and sections, possibly even the drawing up of sections in order to locate the samples accurately. The very abundance of samples immediately opens up the possibility of their use in local projects, particularly since there are few areas which do not have some abundant microfossil assemblages. Even in regions covered by Recent or Pleistocene sediments it is possible to find bands rich in pollen. In the laboratory it is no longer necessary for pupils to spend all their time working through collections of prepared fossils for they can participate in the extraction and mounting of the microfossils they find. Attaching specific names to the fossils will be difficult in most instances, but this disadvantage is small compared to the interest which should be aroused by class participation in what is normally regarded as very advanced work. In any event the differences between assemblages should be obvious and the names one would normally attach to these are of minor importance at this introductory level.

Despite the tremendous growth of micropalaeontology in the last twenty years there is still remarkably little information on microfossils available for teaching purposes. Most basic information is still lost amid a wealth of detail in journals. Furthermore, such text books which have been written become quickly out of date as research into each group surges forward at a rapid rate, often through the economic pressure of oil companies. At the same time the amount of knowledge available is such as to preclude the possibility of one person being able to produce a balanced, all-embracing account of the whole field, particularly in the field of extraction techniques. Therefore we are only attempting to provide what we think is a basic, but adequate, technique for each group and each lithology - one which does not require elaborate equipment. At the same time we have included a number of plates which give accurate line diagrams of selected microfossils from each group which have been chosen to show some of the variations in form of the microfossils which can be found in this country. The plate explanations summarize the basic characters of each microfossil type and indicate the horizon at which they can be found and will complement the techniques section. This information has been given because we feel that there is a lack of text-books which introduce people to the subject.

DESCRIPTION OF TECHNIQUES

Microfossil techniques are generally described in one of two ways. The first involves subdivision of microfossils into two groups - "acid soluble" and "acid insoluble". The second places the emphasis on the containing rock and describes techniques for the breakdown of rock types. Both methods have the advantage of grouping microfossils, which cuts down the amount of description, but they ignore the fact that each microfossil group is different. They are different in shape, strength of their structure and details of ornamentation and therefore each type should usually be considered separately. It is rarely a good idea to preserve the fine residue from a conodont separation in order to extract the spores and acritarchs from it because of the dangers of contamination and the necessity to restrict the amount of treatment to a minimum.

General Precautions

A major problem in extracting microfossils is avoiding contamination. Contamination can occur at two periods. It can happen during the collection of the sample either through carelessness by not cleaning the hammer or by using dirty sample bags. It can also occur because of careless sampling, for example by collecting from the bottom of shale slopes where microfossils may have collected after being washed out of different levels of the shale. It may also occur because of the use of dirty equipment, particularly dirty sieves or improperly cleaned sinter glass funnels. Where spores are concerned it may occur by leaving open mounts lying on benches for long periods allowing modern spores and pollen to settle on them or by using tap water instead of distilled water during the preparation of the sample. When dealing with fossil groups which have modern representatives the greatest care should be taken at all stages of the preparation and glassware should be cleaned with a mixture of sulphuric acid and potassium dichromate for two days. Sieves should be cleaned with a strong jet of water and a wire brush.

When handling strong acids, gloves and preferably at least a laboratory coat should be worn. When using Hydrofluoric acid protective goggles are advisable and the utmost care should be taken to avoid any contact of the acid with the skin. The smallest spot of acid which falls on the skin should be taken seriously and treated medically at once. All acid techniques should be carried out in a fume cupboard or in the open air. Acetic acid may be used in the laboratory but vessels containing the acid should be covered.

Microscopes

A microscope is probably the most expensive piece of equipment required for microfossil studies. If absolutely necessary it is possible to do most of the work with an ordinary biological microscope, but for some of the groups of larger microfossils a stereo-binocular is desirable. Specimens are studied by either reflected or transmitted light, sometimes both.

1. Reflected light. Reflected light studies involve mounting the specimens in a cardboard slide. A stereo binocular microscope with a magnification range from x20 to x100 is desirable for studying specimens mounted in this way. Conodonts, foraminifera, ostracods, megaspores and scolecodonts may be studied by this means.

2. Transmitted light. Transmitted light studies involve mounting specimens on a glass slide. A monocular or binocular biological micrcscope with a magnification range of x50 to x400 is desirable. Groups studied in this way include megaspores, miospores, pollen, chitinozoa, scolecodonts, dinoflagell-ates and acritarchs.

CONODONTS

Sample size. 1 - 2 lbs.

Preparation. Oven dry the sample to remove interstitial water. Break sample into 1" diameter pieces with a hammer or jaw-breaker. Avoid unnecessary hammering because this may cause fracturing of the specimens. Place the sample in a polythene bucket or large beaker (1-2 litre) preferably suspending it on a coarse wire net which is suspended above the base of the vessel. This allows free circulation of the dissolving medium around the sample. Cover the vessel with a lid or sheet of polythene.

1. Calcareous rocks.

a. Acetic acid. A 10 - 14% solution of glacial or commercial acetic will break down most calcareous rocks but several weeks may be required to dissolve a large sample because of the production of calcium acetate during the reaction. This salt, which is only slightly soluble in water, coats the sample and retards the reaction. This can be overcome to some extent by changing the acid every two or three days. Keeping the acid at a constant temperature of about 75°F will also speed up the reaction.

b. Monochloracetic acid. A faster reaction is obtained with mono-chloracetic acid because its calcium salt is more soluble in water. It is also a better acid to use with impure calcareous rocks such as dolomitic limestone. If changed about every 8 hours a large sample can be broken down in 1-2 days. However, it is considerably more expensive than acetic acid, it blisters the skin more easily and it can damage the specimens if they are left in the acid too long.

c. Other acids. Formic acid, tartaric acid and citric acid have been used to dissolve limestones but they are more expensive than acetic acid.

2. Argillaceous rocks.

In North America, many conodont faunas have been extracted from argillaceous rocks but in Europe such lithologies tend to be more indurated and extraction of complete specimens poses more problems. Calcareous shales and mudstones can normally be broken down with acids but others, particularly black shales, require rather different techniques such as oxidation of the organic matter. Often, it is advisable to sample slightly weathered material providing the conodonts themselves are not weathered. When weathered they appear as white spots on bedding planes which can be identified as conodonts with a hand lens. Alternatively latex replicas can be made from the moulds left by weathered material.

a. White spirit or petrol. One of the most effective methods of reducing shales to a fine mud is to soak the sample in white spirit or petrol for a period of 1-24 hours and then drain off the spirit and boil in water until a mud is produced. A drop of teepol added to the water will help to clean the specimens.

b. Hydrogen peroxide. A well-tried technique involves soaking the sample in 15% Hydrogen peroxide for 24 hours, followed by boiling in water. The Hydrogen peroxide should be reduced from 30% strength and not stored at full strength because of the danger of explosion. This technique is not often effective on black shales.

c. Sodium hypochlorite. Most argillaceous sediments will eventually break down in sodium hypochlorite but it may be necessary to soak the sample for 3-4 weeks, after which time some of the specimens may be bleached white. However, they are still identifiable. After soaking, the sample should be boiled in water and teepol.

3. Siliceous rocks.

These are the most difficult rocks to break down unless they have a calcareous cement. With highly indurated rocks one can only treat them with Hydrofluoric acid which fluoritizes the conodonts whilst removing the silica. The process produces some distortion of the specimens but they are still identifiable.

Sieving. The residue of the breakdown process can be washed and further concentrated by sieving, using 16 and 100 or 150 mesh sieves. Wash with a fine jet of water for at least 15 minutes to remove any trace of the dissolving medium and fine-grained particles. The contents of the fine sieve are then washed into a beaker.

Heavy liquids. If further concentration is required, as with shales for example, heavy liquids such as bromoform or tetrabromoethane may be used. These should be reduced to sp. gr. of 2.75 (piece of calcite just floats) with acetone or benzene. Place the dried residue in a glass or polythene funnel which is closed by a clipped piece of rubber tubing. Pour on the heavy liquid and leave for about one hour. Gently release the clip and drain off the heavy fraction into a filter paper. Drain off the remainder into a second filter paper and reclaim the heavy liquid for further use. The conodonts (sp. gr. 2.84-3.1) will eventually sink. The heavy fraction should then be thoroughly washed in benzene.

Drying. The final residue should be dried at air temperature, or, to avoid caking, in an oven at low temperature.

Picking. Specimens should be picked with a 00 sable hair brush under a low power (x20) binocular microscope. Ideally, the picking tray should consist of a metal or plastic rectangular dish (4" x 3") painted black and marked out in white squares about $\frac{1}{4}$"-$\frac{1}{2}$" square. Picking can be made easier and faster if the tray is supported at the sides and holes punched through from the underside at regular intervals. Specimens can then be dropped through the nearest hole into a slide tray beneath. The cheapest and often the most useful type of slide tray is the single cell type with a black background.

OSTRACODS

Sample size. 1 - 2 lbs.

Preparation.

1. Calcareous rocks.

These are difficult rocks from which to extract ostracods because of the similarity between the composition of the fossil and the containing rock. This precludes the use of acids and one normally has to rely on physical techniques. Surprisingly, one of the most successful methods is simple mechanical pounding. The sample is first broken into pieces about one inch in diameter and then each separate piece is pounded with a pestle and mortar into fragments less than one centimetre in size. These fragments are then removed and the next piece is broken down. Boiling the fragments in water with a drop of teepol added will clean dirty specimens. Even oolitic limestone will yield a fauna if treated in this manner. However, the major problem in dealing with oolites is that the specimens are often coated with a deposit of calcium carbonate. This can usually be removed with a strong solution of tartaric acid by immersing coated specimens in the acid for about two minutes and then boiling them in teepol and water for a few minutes.

Silicified ostracods can be extracted with normal acid techniques using 10% hydrochloric or acetic acid. The residue should be removed and washed each time the acid is changed.

2. Argillaceous rocks.

Clays and soft shales, after bein reduced to half-inch fragments, will usually break down easily with the boiling-in-teepol technique. This is done for about half an hour. With harder shales and mudstones, argillaceous limestones and calcareous shales boiling in 10% sodium carbonate will often produce the desired result. Soaking in white spirit, sodium hypochlorite or hydrogen peroxide will also produce breakdown but tend to take a rather longer time. With highly indurated rocks or when dealing with very fragile or highly ornamental specimens, boiling is not recommended because of the breakage of specimens it is liable to produce. The only method in such instances is cleaning and removal of the specimens with needles and Vibrotool from the bedding plane of the rock.

Sieving. A 200 mesh sieve is needed for the smallest ostracods, otherwise the sieving techniques are the same as for conodonts.

Drying. As for conodonts.

Picking. As for conodonts.

Calcium fluoride conversion. Study of ostracods may sometimes be improved by converting the calcium carbonate carapace to calcium fluoride when it becomes transparent in water. This is achieved by immersing the carapace in 20% by volume Hydrofluoric acid for 2-24 hours.

FORAMINIFERA

Sample size. 1 - 2 lbs.

Preparation. Oven dry the sample and break into pieces about pebble size.

1. Calcareous rocks.

a. Acid extraction. This is not normally possible unless one is extracting arenaceous foraminifera. These one sometimes finds in conodont residues where acetic acid has been used.

b. Mechanical extraction. Where calcareous forams are present, normal acid techniques obviously do not apply and in such cases crushing and boiling in teepol (see Ostracods) may well liberate some specimens although many will inevitably be fragmented. Some Mesozoic limestones, such as hard chalk, can be broken down by heating in a dilute solution of hydrogen peroxide for several hours. These techniques will not normally work with highly indurated limestones, such as the Carboniferous limestones, and in such instances the rock must be thin-sectioned.

2. Argillaceous rocks.

Deflocculation. Soft clays and shales can be easily disaggregated by boiling the sample in water to which is added a deflocculant such as sodium carbonate. It may be necessary to decant several times during the boiling in order to break down the sample completely. This technique will be satisfactory for most Mesozoic and Tertiary samples but is unlikely to be successful on Palaeozoic rocks. In these cases the techniques described for conodonts can be used.

Sieving. 16 and 200 mesh sieves can be used to sieve the residue, most of the forams being caught on the lower one. The material should not be poured into the sink because many forams are air-filled and will float on the surface of the water.

Flotation. When concentrating specimens of Mesozoic and Tertiary age (which are often hollow) it may be quicker to use a flotation technique to concentrate the residue. This can be done by adding a drop of detergent to the water and floating the forams off in the bubbles. Alternatively the residue can be heated and then thrown onto cold water when the shells are filled with warm air. A more expensive way is to use a heavy liquid such as carbon tetrachloride or zinc bromide and float the test to the top.

Drying and picking. The same techniques described for conodonts apply here.

MEGASPORES

Sample size. Coal - about 10 grams.

Preparation.

Stage A. Break sample into 5-10 mm. fragments and place in clean glass flask. Add Schulze's solution (oxidising agent cold concentrated nitric acid saturated potassium chlorate solution 3:1) sufficient to cover sample. Leave flask in fume cupboard. The violence of the reaction varies with the type of sample. The explosive reaction which might occur with a weathered sample (such as an outcrop coal) can be lessened by mixing the sample with distilled water before adding Schulze's solution. If still too violent - i.e. much heat and effervescence - place flask in a larger beaker of cold water. This part of the process must be carried out in a fume cupboard because of the powerful fumes released.

The time necessary for sufficient oxidation of samples can only be determined by experimentation. As a guide it is suggested that approximately 12 hours (left overnight) is sufficient for weathered coals. Severely weathered coals often need little oxidation. If in doubt place a part of the sample in potassium hydroxide (KOH) solution (5-10%). A dark brown colouring of the mixture suggests that little oxidation is necessary and that stage B (see below) should be carried out first. Unweathered "fresh" samples (underground workings) often react slowly with Schulze's solution and may need 72 hours before stage B is commenced.

Stage B. Decant as much Schulze's solution as possible, taking care not to lose any of sample. Neutralize (pH 7) by adding distilled water at each decanting. Add (about 250 ml.) potassium hydroxide solution (5-10%) and gently stir for a few seconds with a glass rod. The mixture turns dark brown when the KOH is added. Leave the sample in the alkali for approximately 4 hours which will allow much of the humic substances in the coal to be dissolved. The degree of separation of the megaspores from the coaly mass is checked by washing the sample in a sieve until the water passing through the sieve is clear. Transfer the residue on the sieve to a small glass beaker by tilting the sieve and applying a fine jet of water from underneath.

Picking and mounting. The residue, after acid and alkali treatment, will probably contain megaspores, cuticles and other plant debris. Place a small amount of the material in a small petri dish or similar shallow flat-bottomed container, examine under a microscope using magnification x50 and reflected light. The megaspores should be yellow-brown but may be dark brown or black if further oxidation is necessary. If the water turns brown while the material is being examined more alkali should be added (but not to excess because it may cause the spores to swell and break up) followed by further washing with water.

The method used for isolating the megaspores from the residue depends on the type of slide used. The simplest method involves sorting the material in water using a fine (00) brush and needle. The needle is useful for cleaning unwanted material away from the spores and for gently pushing the spore onto the brush. The spores can then be temporarily stored in small glass tubes containing distilled water until the entire sample has been examined.

Alternatively, allow the residue to dry after removing alkali. Take a small portion of residue at a time, place on a small white procelain plate and sort under the microscope. Transfer individual spores to single cell cardboard slides with a moistened brush. This method is not highly recommended as material can easily be lost due to air currents and vibration in the laboratory. It also restricts study to the use of reflected light.

Mounting the megaspores for detailed examination depends upon the type of spore and means of light and microscope available. In general, transmitted light (light from below, as used in standard biological microscope work) reveals the greatest detail. The smaller thin-walled spores are most easily prepared for this method. Many different mounting mediums are available, each having its advantages and disadvantages. Two of these methods which are relatively simple are the use of a water mounting medium or glycerine jelly. The advantage of the former is its simplicity. Place a small drop (sufficient to well cover the spore) of mountant on a clean glass slide. Select the spore from the picked reservoir (see above) and transfer it to the slide with a fine brush (wash brush in water after use). Lower a clean cover glass gently onto material. Problems likely to be encountered initially are presence of air bubbles and quantity of mountant used. These can be overcome by experimentation and experience with the technique. Slides prepared using this medium are not permanent - i.e. will dry out with time - and should be ringed with a resin if preservation is required. A more permanent mounting medium such as canada balsam may be used but the spores must be dehydrated in alcohol first. It is suggested that a certain amount of expertise with temporary mounts as described above is advisable before attempting the more complex mounting techniques.

Many of the larger thick-walled megaspores are not easily prepared for transmitted light study. These types are ideal for reflected light examination, and because of their size, sufficient detail can often be obtained by this method. Spores picked dry and placed in cardboard slides are ready for reflected light study. Spores picked wet are a little more difficult to handle. To prevent them sticking to the slide and to facilitate their transfer to the dry slide a small piece of glass coverslip with a drop of water on it should be placed at the bottom of the cell. Allow this to dry before examining with reflected light.

Sample size. Limestone shale - about 30-50 gms.

Preparation. The same as for coal except that prior treatment with hydrochloric and hydrofluoric acid is necessary. Break sample into pieces 10-15 mm., place in polythene pot with a screw lid. Drill a few small holes in lid to prevent pressure build-up. Add a small amount of HCL to test for carbonate. If positive leave sample in HCL until reaction stops, wash with distilled water. Add a sufficient quantity of cold concentrated HF to cover sample. Leave for some days, stirring the mixture regularly. When most of the mineral matter has been dissolved, decant off acid, neutralize with distilled water, then treat as a coal. Considerable care should be taken whilst decanting not to lose any floating organic material.

Although treatment with HCL and HF is desirable for good results in dealing with carbonaceous shale, some success can usually be obtained if treated as coal. The spores obtained are likely to have mineral matter adhering to them. However, this should not deter people who have no facilities for HF treatment.

MIOSPORES

Various techniques have been employed in obtaining miospores from sedimentary rocks. Many are, however, refinements of a basic technique (described below) and involve equipment which is not normally available in a school laboratory. The technique given here is a well-known method and yields good results suitable for general palynological work.

Sample. Coal 1 - 5 gms.

Preparation. Crush 5 grams of material in pestle and mortar until material particles are not greater than 2 mms. diameter. Place 1/3 of crushed material in a buchner sinter glass funnel (porosity 2), wash with distilled water. Store remainder of crushed material in a small glass tube (reservoir). Place funnel in a flask large enough to accommodate a considerable quantity of filtrate and to support the funnel in a vertical position. Add a few ccs. of cold concentrated nitric acid onto material in funnel. The time necessary for sufficient oxidation can only be arrived at by experimentation. It is suggested that 30 minutes could be a suitable starting point. The acid can be retained in the funnel by an air lock at the base of the funnel for a period of time before allowing filtration to take place. This way, only a small quantity of acid (enough to cover the material) is necessary. Wash the remaining acid through the filter using distilled water then add a few drops of dilute potassium hydroxide solution (2%). A brown colouration of the filtrate should result, indicating the removal of humic substance from the sample. Wash the material with distilled water until a clear filtrate is produced.

If the treatment has been successful, examination under the microscope of a small drop of the residue in the funnel, using x100-200 magnification, will reveal small yellow-brown miospores and pieces of plant tissue. Need for further chemical treatment may be indicated by brown-black bodies, partly exposed miospores, or apparent absence of any miospores. Pale yellow-brown miospores and tissue suggest that the treatment has been excessive and that the process should be started again with a fresh portion taken from the reservoir, the time factor being decreased.

Mounting. Melt a small piece of glycerine jelly on a glass slide over a warm hotplate. Add a drop of the concentrated residue to the melted jelly and mix with a fine needle or wisp of glass. Lower a glass coverslip and allow to cool. Examine slide under microscope (x40 objective). Although this method of mounting is relatively easy and gives good results, there are some disadvantages. At first, problems of air bubbles and amount of glycerine jelly and treated sample to be used may arise. There is no simple answer to these and are best overcome by experimentation by individual workers. Other disadvantages being that as as the material is mounted on the slide, constant change of focus will be necessary during traverses under high magnification, also the slide will tend to dry out with time. Water mounting mediums can be used instead of glycerine jelly (see also megaspores) and do not necessitate use of a hot plate.

Possibly a more refined method is the use of canada balsam and cellosize (hydroxyethyl cellulose). The cellosize acts as a dispersal agent and forms a thin film on drying (full details of preparations of cellosize solutions are given by Jeffords and Jones 1959, p.345).

Take a small amount (few drops) of the sample and mix with approximately ½ quantity of cellosize solution in a small glass tube. Spread (by pipetting) the mixture evenly over a number of glass cover glasses and allow to dry at room temperature or on a warmed hot plate. A cover (e.g. a small petri dish) over the drying material will prevent foreign material from the atmosphere falling onto the sample whilst drying. Heat a small quantity of canada balsam on a glass slide over a hot plate (100° C) for a short time (1-2 minutes), invert dried cover glasses and lower gently onto the heated balsam. Remove slides from hot plates, allow to cool. Advantages of this method are that the balsam, on cooling, hardens and forms a more permanent mount, i.e. does not deteriorate with time. The material being on coverslip is almost all in one plane of focus, which aids the examination under the microscope.

Sample. Shales, limestones, etc. 20 - 50 gms. used.

Preparation and mounting. As for coal samples except that carbonate and silicates must be removed by HCL, HF treatment (see megaspores) before nitric acid treatment.

MODERN POLLEN

Sample. Peat or mud from lakes, about 1 cc. used.

Preparation. Place sample in glass beaker containing a solution of potassium hydroxide (10%). Wash with distilled water (by decanting). If much mineral is present, i.e. mud, transfer sample to polythene pot and add hydrofluoric acid (see miospores). Transfer sample to sinter glass funnel (porosity 3), take care if HF has been used to check that sample is neutral. Add a small quantity of glacial acetic acid (to remove water). In a small beaker prepare a mixture of 1 part sulphuric acid added to 9 parts acetic anhydride. Transfer sample to this mixture and boil for 2-3 minutes (acetolysis). Return sample to sinter glass funnel and wash with glacial acetic acid followed by distilled water. Boil sample for a further two minutes in potassium hydroxide (10%) solution, return to sinter funnel and wash with distilled water. The material should now be ready for mounting.

Instead of using a sinter glass funnel the process can be carried out in a centrifuge tube, the material being centrifuged after each stage.

Mounting. Melt a quantity of glycerine jelly in a small glass tube on a warm (60°C) hot plate. Add a few drops of safranine "O". Pipette a few drops of the prepared sample into the tube (still on the hot plate) and leave for a few minutes. Slides can then be made by pipetting drops of the mixture on slides and lowering coverslip before the mixture cools.

CHITINOZOA and SCOLECODONTS

These microfossils are extremely fragile and all stages of preparation, chemical or physical, should be gentle so as not to cause excessive damage to the material.

Sample. Calcareous shale 400 gms. used.

Preparation. Break rock into pieces $\frac{1}{4}$" - $\frac{1}{2}$" diameter with pestle and mortar. Discard fine material (chitinozoans likely to be broken). Split sample in two, retaining half as a reservoir for further use. Place other half of sample into a large glass beaker (1 litre). Cover with approximately 500 mls. of distilled water and add drops of concentrated hydrochloric acid over a period of time until reaction ceases. The reaction between the calcium carbonate present and the acid thus proceeds gently. Neutralise by decanting and adding distilled water but avoid agitating the partially broken down sample as far as possible. Take care not to lose finer part of the sample during decanting.

Transfer sample to polythene pot (250 ml.) with screw lid. Add approximately 100 ml. of cold hydrochloric acid (40%). It is possible that initially the reaction might be violent. To avoid this, cover sample with distilled water and add a few drops of the acid and leave for a few hours before increasing the strength of the acid. Leave sample in acid for a few days, agitating by tilting the pot until the mineral matter has been dissolved. Neutralise as for HCL treatment (above).

Wash neutralised sample through a sieve (330 mesh - 50 aperture is a suitable size to retain the small chitinozoa, 200 mesh for scolecodonts). Keep the mesh of the sieve below the level of the water, so as to avoid any unnecessary damage to the material. Sieving is a rather long process as only a small part of sample can be successfully worked at one time. However, it has the advantage of concentrating the chitinozoa and scolecodonts and allowing the finer particles to be removed. The material retained on the sieve is transferred to a small stoppered bottle or beaker by directing a gentle stream of water from below the sieve.

At this point, the material should be checked for presence of chitinozoa and similar microfossils. Place a small quantity of the sample into a white backed petri dish or other flat-bottomed container and examine under a microscope using reflected light. Chitinozoa, if present, will appear as brown-black bottle-shaped bodies with various forms of ornamentation. If no chitinozoa are found, it is more likely to be due to their absence in the original rock sample than due to the technique described above. Scolecodonts appear as jet-black tooth-like structures.

Picking and mounting. Selected specimens can be picked from the residue using a pipette or very fine paint brush. This will be difficult at first due to the small size of the organism, but with experience a large number of specimens can soon be separated from the residue.

Several different mounting media may be used. Chitinozoa and scolecodonts may be mounted dry (see megaspores) in white-bottomed cells (not recommended). Glycerine jelly involves similar problems as already described for miospores. One of the most successful ways of mounting them is using cellosize and canada balsam. The selected chitinozoa picked from the treated sample are placed in a 2% cellosize on a cover glass (protected from dust, etc.) and allowed to dry. The specimens are held onto the cover glass by a thin film of cellosize and the cover glass is inverted and lowered on to heated canada balsam on a glass slide over a hot plate. After cooling, the slide should be examined (magnification x100) using transmitted light and the position of the chitinozoa indicated by ringing (biro pen is quite effective) the cover glass.

For the detailed study, the specimens will often be too dark to allow sufficient light through. With experience, specimens in this state can be recognised while picking from the sample. This problem can be overcome by careful bleaching out of the colour. Place specimens in a small petri dish (white-bottomed) containing some distilled water. Add a few drops of sodium hypochlorite solution. This tends to remove the colour and the process can be followed under the microscope. When specimens appear to be sufficiently translucent, stop reaction by adding excess sodium sulphite solution. Add distilled water and by decanting remove the sulphite solution before mounting specimens as described above.

DINOFLAGELLATES and ACRITARCHS

Sample clay approx. 10 gms. used.

Preparation as for miospores.

The smaller acritarchs vary in size, 10-20 microns diameter, and it is suggested that a fine sinter glass funnel should be used (Par. 3). Also, as some acritarchs and dinoflagellates lack prominent body colour, their examination can be improved by staining of the specimens. This can be done after the oxidation stage of the technique. Wash the material in the funnel with distilled water until neutral then add a few drops of safranin "O", allow to filter. By pipetting a small drop of the material into a glass slide and examining under the microscope, check the extent to which the stain has been taken up. If necessary, repeat the process. Do not expect all specimens to be stained uniformly, for the amount of staining taken up varies considerably within individuals of a species.

Mounting. As for miospores.

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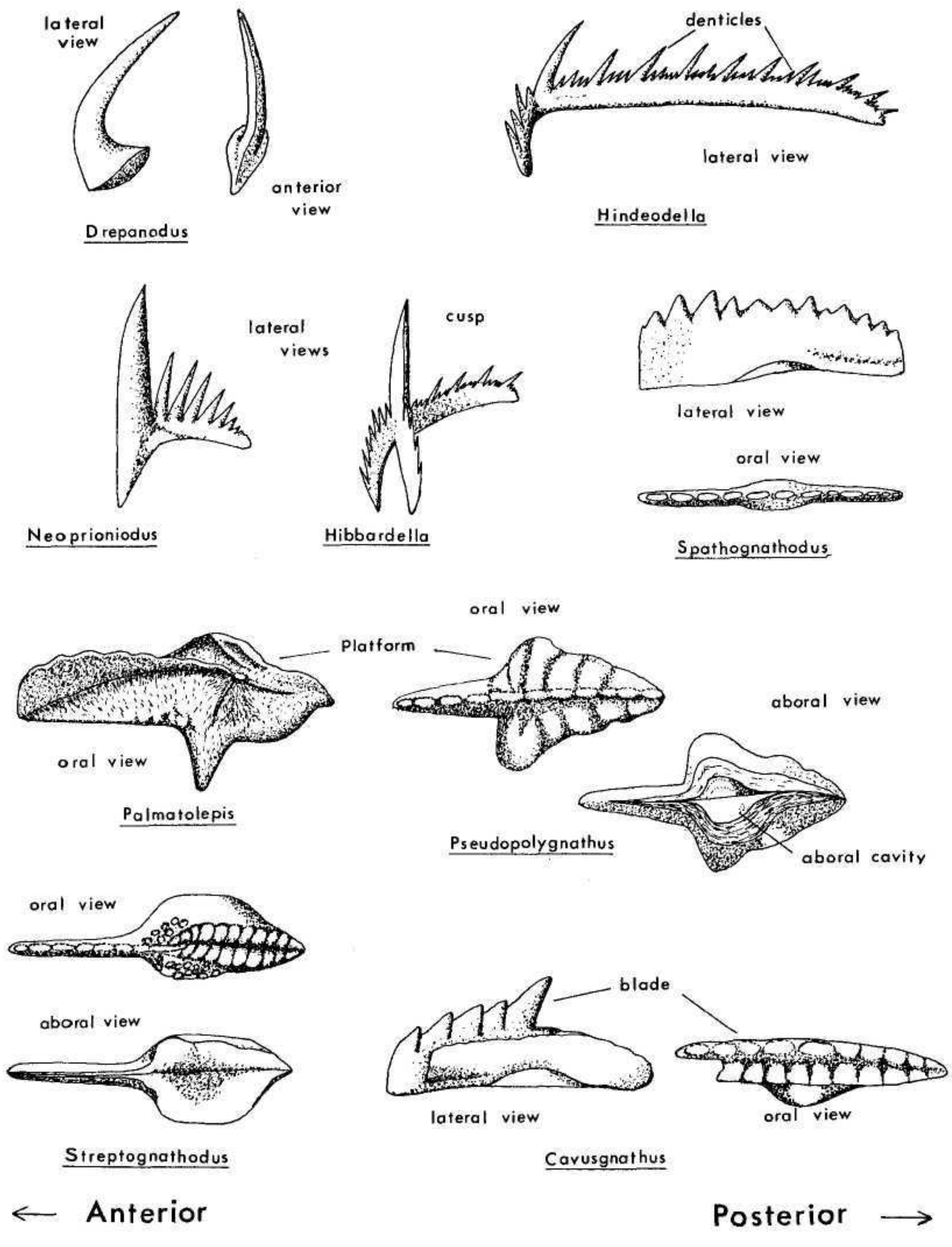


PLATE 1

CONODONTS

Conodonts are parts of an unknown animal, probably a primitive vertebrate, which are found in rocks of Cambrian to Triassic age but in this country only occur in Ordovician to Carboniferous rocks. The conodont animal was entirely marine but ranged over a wide variety of environments and was therefore probably nektonic or pelagic. Conodonts consist of sheets of calcium phosphate which grew around a basal cavity which can be seen in well-preserved material in transmitted light. They are characterised by rapid evolution and hence are now extensively used in stratigraphy in the Palaeozoic. They range in size from 2-5 mm.

Drepanodus. Single cone, nearly symmetrical. Lower Ordovician-Upper Devonian. Common in Lower Ordovician rocks.

Hindeodella. Both anterior and posterior processes present. Middle Ordovician-Middle Triassic. Common in Carboniferous Bullion Limestones.

Neoprioniodus. Large cusp, posterior process. Middle Devonian-Upper Carboniferous. Common in Lower Carboniferous (upper part).

Hibbardella. Symmetrical, three processes. Middle Ordovician-Middle Triassic. Sparse throughout.

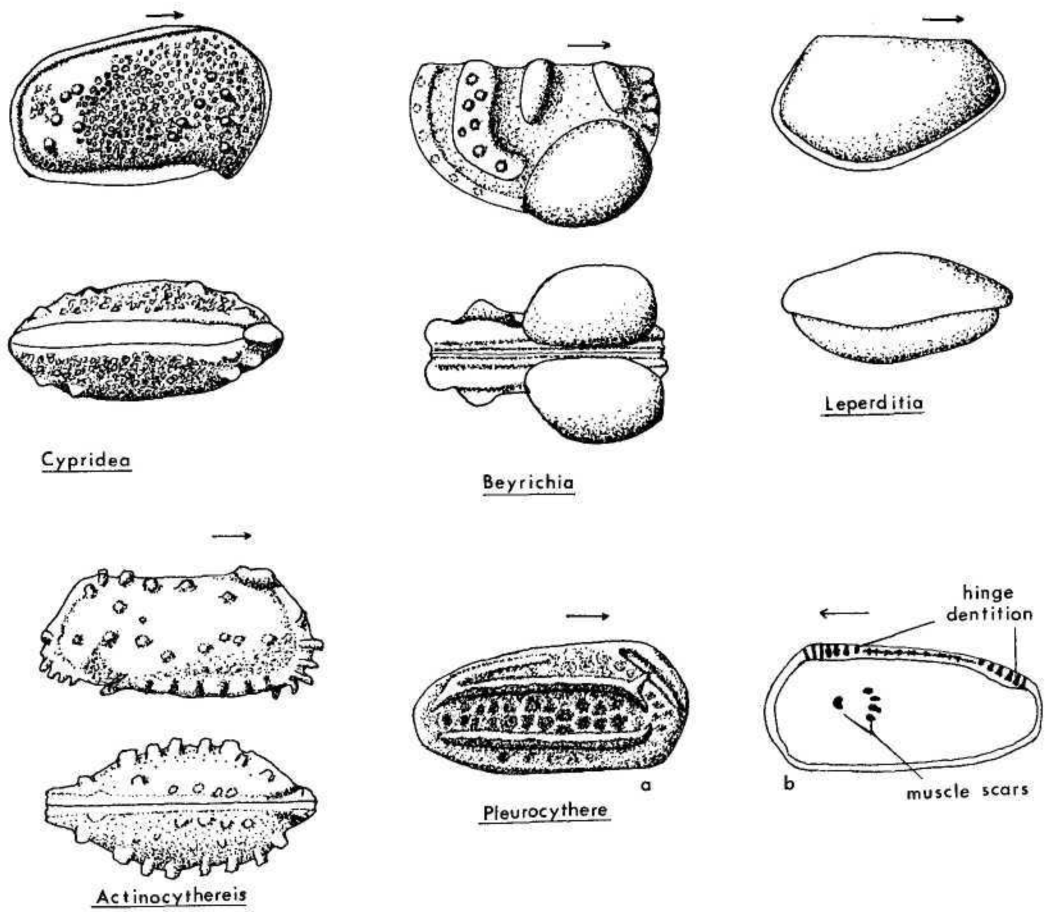
Spathognathodus. Subequal denticles, aboral cavity in median position. Middle Ordovician-Middle Triassic. Common in late Devonian and early Carboniferous rocks.

Palmatolepis. Leaf-like platform. Upper Devonian. Very abundant throughout.

Pseudopolygnathus. Asymmetric platform which is strongly ridged. Upper Devonian-Lower Carboniferous. Common in Lower Carboniferous.

Streptognathodus. Ridged platform, large aboral cavity. Upper Carboniferous-Lower Permian. Common in Coal Measures marine bands.

Cavusgnathus. Lateral blade, higher than platform. Lower Carboniferous-Lower Permian. More common in Upper Carboniferous and Yoredale limestones.



SCOLECODONTS

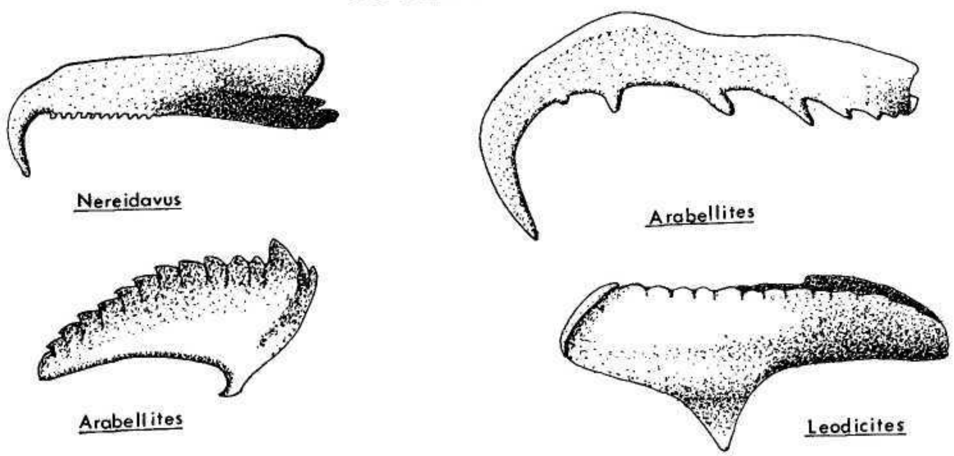


PLATE 2

OSTRACODS

Ostracods are small crustaceans with a bivalved carapace of calcium carbonate which is the only part preserved as fossil. They occupy marine and non-marine aquatic and, very rarely, terrestrial environments. They are mostly benthonic. The majority are microscopic, ranging in size from 0·4-1·5 mm. but some range up to 30 mm. in length. The arrow on the plate indicates the anterior end.

Cypridea. Belongs to a group with curved dorsal margin – if straight, dorsal margin is shorter than total length. Middle Jurassic-Lower Cretaceous. Common in freshwater environments such as those of the Purbeck and Wealden.

Beyrichia. Dorsal margin long and straight, lobes and sulci common. Lower Silurian-Middle Devonian.

Leperditia. Large, thick carapace, with long straight hinge. Lower Silurian-Upper Devonian.

Actinocythereis. Belongs to one of the largest groups of ostracod. Highly ornamented. Eocene-Recent.

Pleurocythere. Highly ornamented. Three costae. Jurassic.

SCOLECODONTS

Scolecodonts are the fossilized teeth of polychaete worms which are mostly crawling or swimming animals. They are jet black in colour and are chitinous in composition. They are marine, the worms occupying shallow water environments. Though they range from Cambrian to Recent most fossil forms have been found in Ordovician to Devonian strata.

Arabellites.
Nereidavus. } Ordovician-Silurian.
Leodicites.

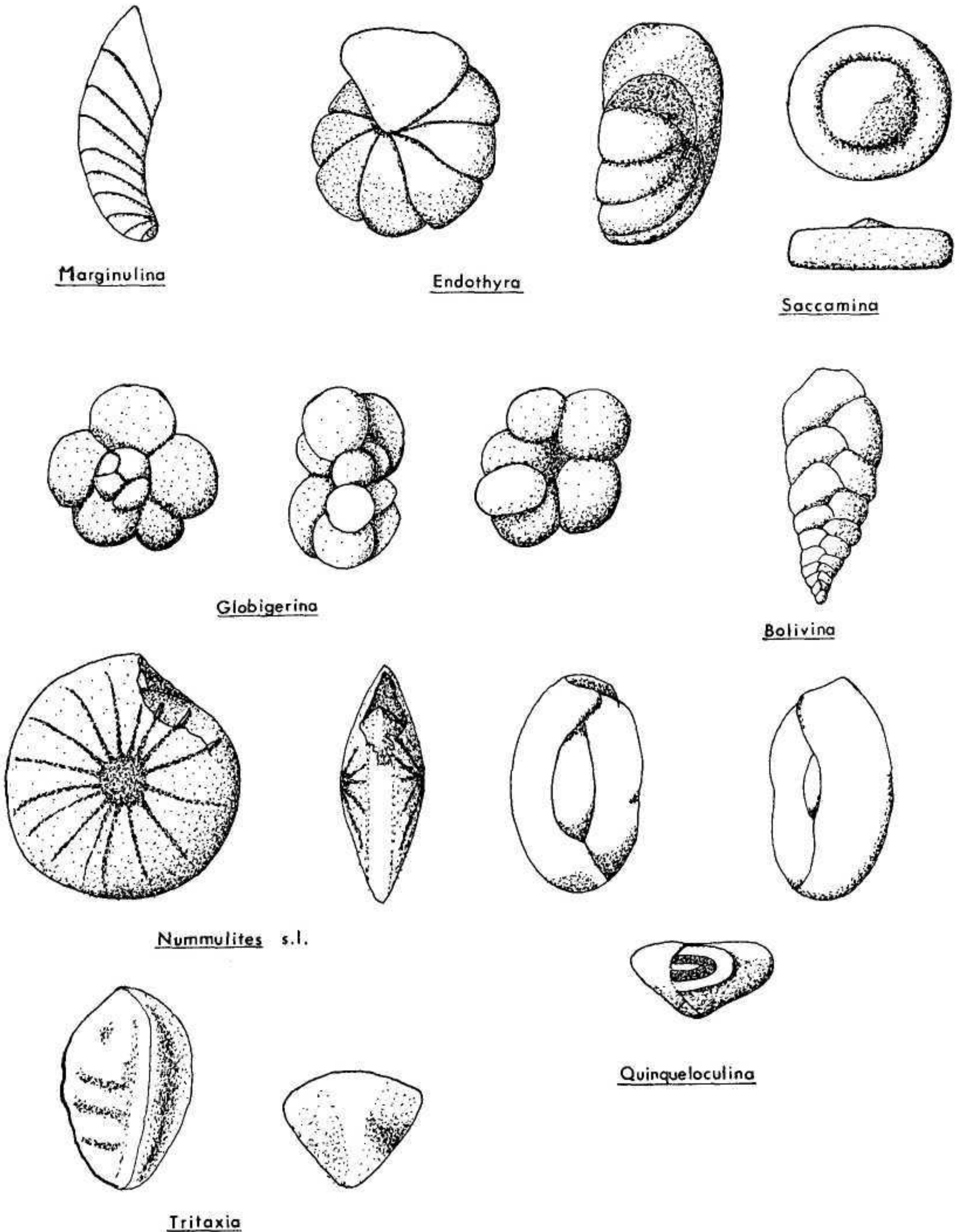


PLATE 3

FORAMINIFERA

The foraminifera are single celled members of the Protozoa which are extremely abundant as fossils and at the present day. They occupy aquatic environments, mainly marine, and are mostly benthonic, living attached to sand grains or other shells, although planktonic forms originated in the Jurassic and were important in the Tertiary. Some palaeontologists classify them according to size—microforaminifera (approximately 0·02 mm.), smaller foraminifera (approximately 0·4—2 mm.) and larger foraminifera (approximately 2—110 mm.). To a certain extent this classification reflects increasing complexity and the techniques used to extract them from the rocks. However, biologically they are classified according to shell composition of which there are two major types — agglutinated or arenaceous and calcareous. The former consists of cemented foreign particles, the latter of calcium carbonate in various forms such as porcellanous (chalky, dull), microgranular, and hyaline (glassy).

The plate illustrates a few of this very large and economically important microfossil group. They are forams which may be found in Britain.

Marginulina. Test calcareous, hyaline. Ranges from Triassic-Recent. Belongs to a group which was dominant in the Jurassic e.g. Liassic clays.

Endothyra. Test calcareous, microgranular calcite. Ranges from Lower Carboniferous-Permian. The group to which it belongs was dominant in the Carboniferous.

Saccamina. Test agglutinated. Ranges from Silurian-Recent.

Globigerina. Calcareous test, hyaline. Palaeocene-Recent. Planktonic. Found in Eocene-Oligocene in Britain.

Bolivina. Test calcareous, hyaline. Upper Cretaceous-Recent. Common in marly bands in Chalk.

Nummulites. sl. Test calcareous, hyaline. Palaeocene-Recent. Found in Eocene and Oligocene rocks.

Quinqueloculina. Test calcareous, porcellanous. Jurassic-Recent.

Tritaxia. Test agglutinated. Lower Cretaceous-Recent. Found in chalk, particularly in marly bands.

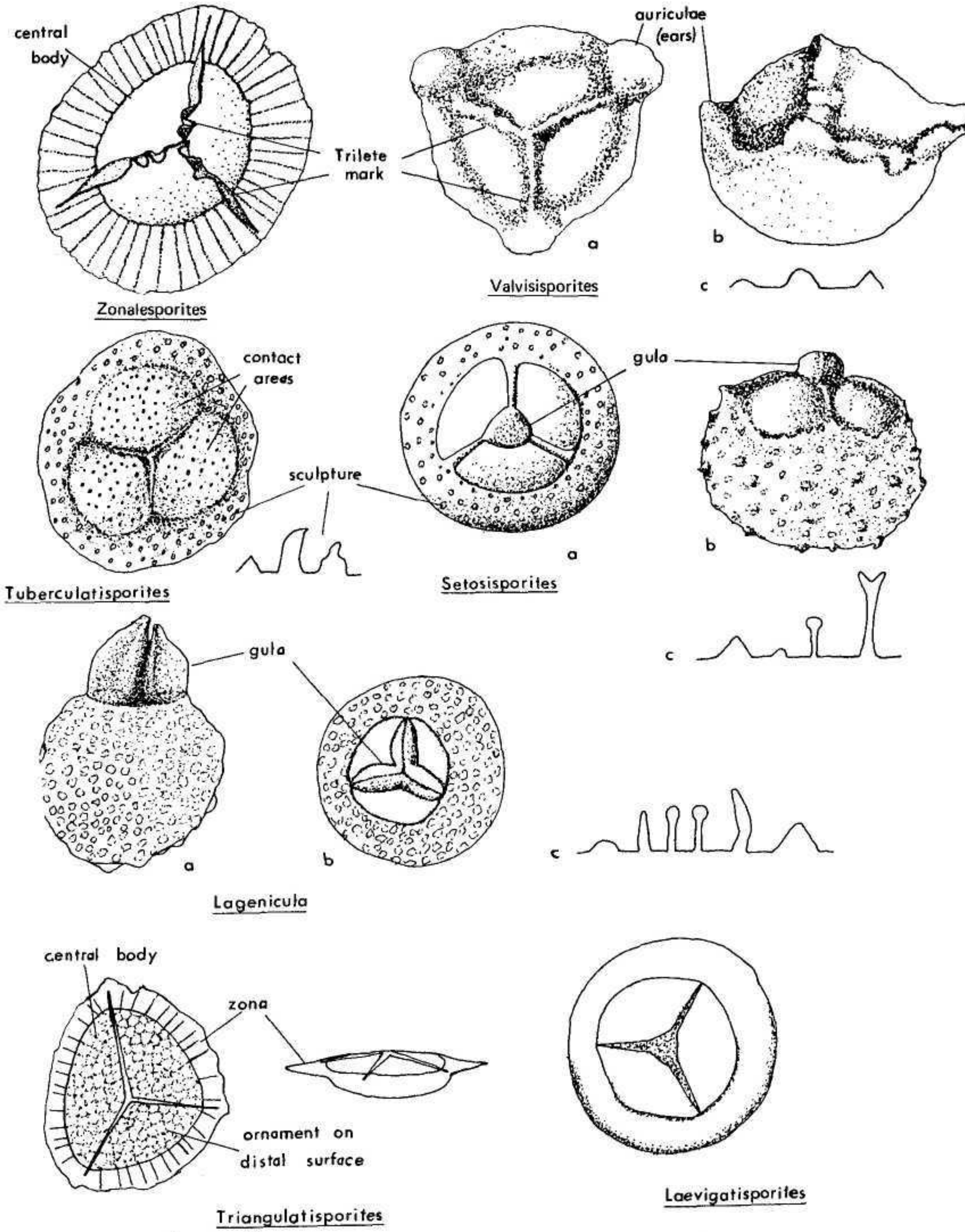


PLATE 4

MEGASPORES

Megaspores are reproductive organs of spore-producing plants consisting of the female gametophyte surrounded by a protective non-cellular layer, the spore wall. In sediments only the spore wall is normally preserved, and it is probably more correct to refer to these forms as sporomorphs (Greek 'morphe'–form, shape) rather than spores. Since, however, the term spores has common usage in literature it is employed here. Dispersed spores larger than 200 microns are usually considered to be megaspores, no botanical function ('female') being implied. Megaspores have been found in rocks ranging from Devonian age to the present day, but in the British Isles are most readily obtainable from coals and carbonaceous shales of Carboniferous age.

Complex in chemical composition (cellulose-carotenoid exine), megaspores consist basically of a central body characterised by a trilete mark and contact areas which indicate the relation of the individual to the three other daughter cells formed by the meiotic division of the spore mother cell. The spore body is characterised by various structural (e.g. corona) and sculptural (e.g. cones) features. Megaspores are valuable in stratigraphic correlation and in the interpretation of palaeoecologies. Size range 200-12000 microns maximum diameter.

Zonalesporites. Rounded triangular in outline, with equatorial corona; Upper Carboniferous in age, common in Westphalian coals and shales. Size 500-3000 microns.

Valvisisporites. Rounded triangular in outline, characterised by auriculae which may vary in outline. Spore body smooth, maybe ornamented; common in Westphalian coals. Size 500-3000 microns.
(a) polar compression; (b) lateral compression;
(c) variation in outline of auriculae.

Tuberculatisporites. Circular to oval in outline. Spore body characterised by tubercular-shaped elements. Common in Westphalian coals. Size 500-3000 microns.

Setosisporites. Circular to bottle-shaped in outline, characterised by a small expansion i.e. gula at junction of laesurae/Y rays. Spore wall may be smooth or ornamented. Carboniferous age. Size 200-3000 microns.
(a) polar compression; (b) lateral compression;
(c) variation in ornamentation.

Lagenicula. Similar to ***Setosisporites*** but gula formed by expansion of the greater part of the laesurae and contact areas. Wall smooth or ornamented. Carboniferous age. Size 500-2000 microns.
(a) lateral compression; (b) polar compression;
(c) variation in ornamentation.

Triangulatisporites. Rounded triangular outline characterised by central body and equatorial zona, reticulate ornament on distal surface. Carboniferous. Size 300-1000 microns.

Laevigatisporites. Circular to oval in outline, smooth-walled, prominent open/ruptured laesurae. Carboniferous. Size 500-3000 microns.

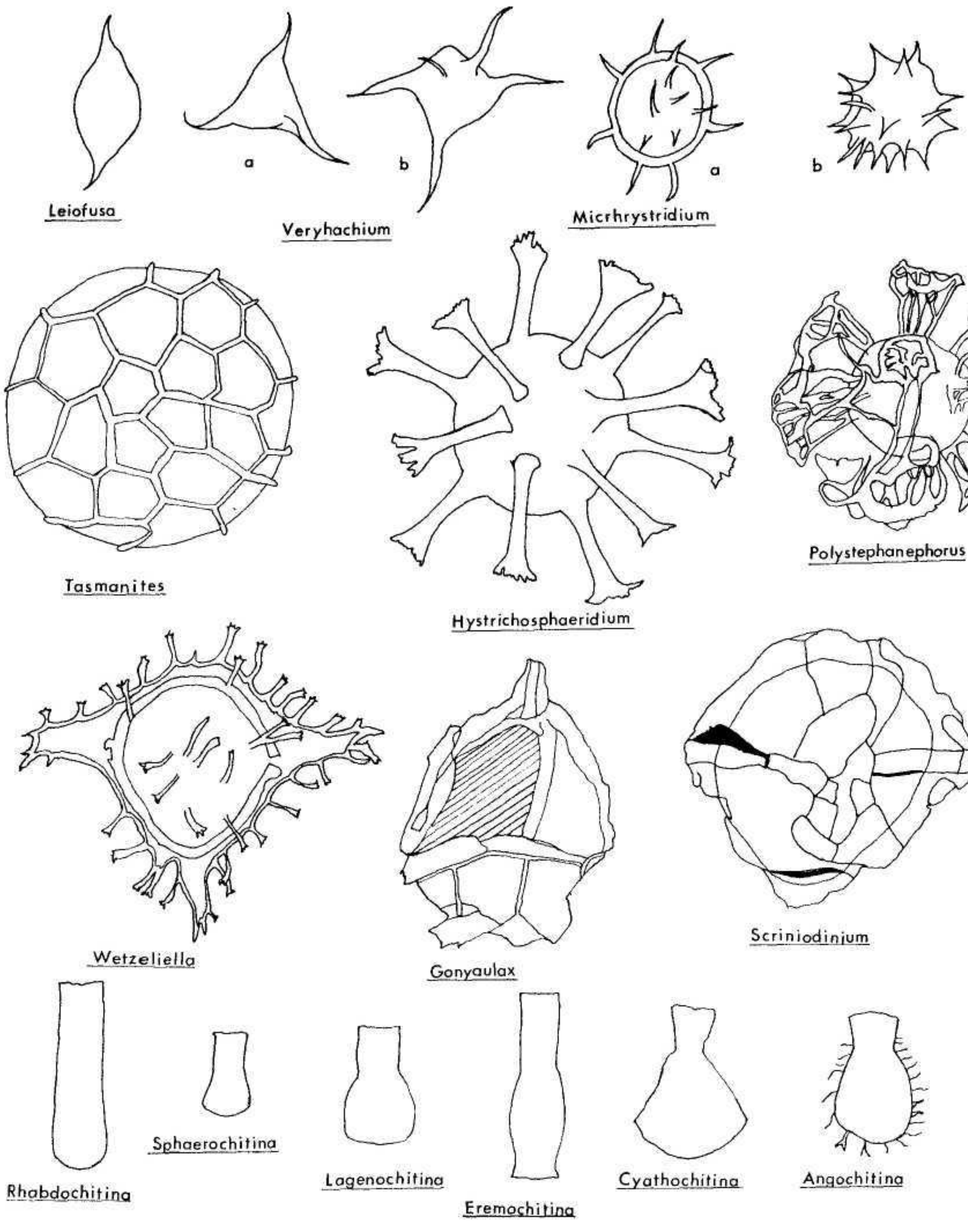


PLATE 5

DINOFLAGELLATES

Dinoflagellates are a major group of the Dinophyceae class of algae, first recorded from the Silurian, but continuous records exist from the Upper Triassic to the present day. These forms occur mainly in rocks deposited under marine conditions, but some freshwater occurrences are known from the Eocene. Three forms of dinoflagellate are illustrated here and stratigraphic horizons are indicated from which these forms may be obtained.

Gonyaulax. Oxford Clay, Jurassic.

Wetzeliella. London Clay, Tertiary.

Scriniodinium. Ampthill Clay, Calcareous Grit Yorkshire Middle Jurassic.

ACRITARCHS

Acritarchs are grouped as a class within the algae, some forms may represent the cysts of dinoflagellates, but the affinities of most forms are uncertain. Records exist from Precambrian rocks over 2,000 million years old up to deposits of Tertiary age. The class is dominant amongst the fossil plankton of the Palaeozoic occurring in rocks deposited in a marine environment. Forms range in diameter from 3–5 microns, up to 250 microns, but are generally less than 100 microns. Some of the more common forms are illustrated here, and a stratigraphic horizon is given from which specimens of these forms can be obtained.

Leiofusa. Common in the Permian marls, Liassic clays, and London Clay of Great Britain.

Veryhachium. Common in Wenlock shales, Permian marls, Liassic clays and London Clay of Great Britain.

Micrhystridium. } Common in Liassic clays of Great Britain.
Tasmanites. }

Hystrichosphaeridium. Common in London Clay of Great Britain.

Polystephanephorus. Common in Oxford Clay of Great Britain.

CHITINOZOA

Chitinozoa are an extinct group of microscopic organisms (marine) consisting of a hollow test with a pseudochitinous wall open at one end. The shape and ornamentation of the test varies considerably, but all have a basic radial symmetry around a central elongated axis. Chitinozoans may be found singly or in chains. Their affinities are not well-known, having been referred to the protozoa, and also compared with the egg capsules of some metazoans. They may be considered benthonic – attached to a substrate or free moving. Although the group is well-known from the Lower Palaeozoic of continental Europe, North America and North Africa, very little research work has been published on the occurrence of the group in the Lower Palaeozoic of the British Isles. The illustrations given here have been taken from specimens ***(Rhabdochitina, Sphaerochitina, Lagenochitina, Eremochitina, Cyathochitina, Angochitina)*** obtained and described by Dr. W. A. Jenkins (a former research student in the Department of Geology, University of Sheffield) from the Llanvirnian, Llandeilian and Caradocian deposits of Shropshire. Size range 200–1000 microns length, 200 300 microns diameter.

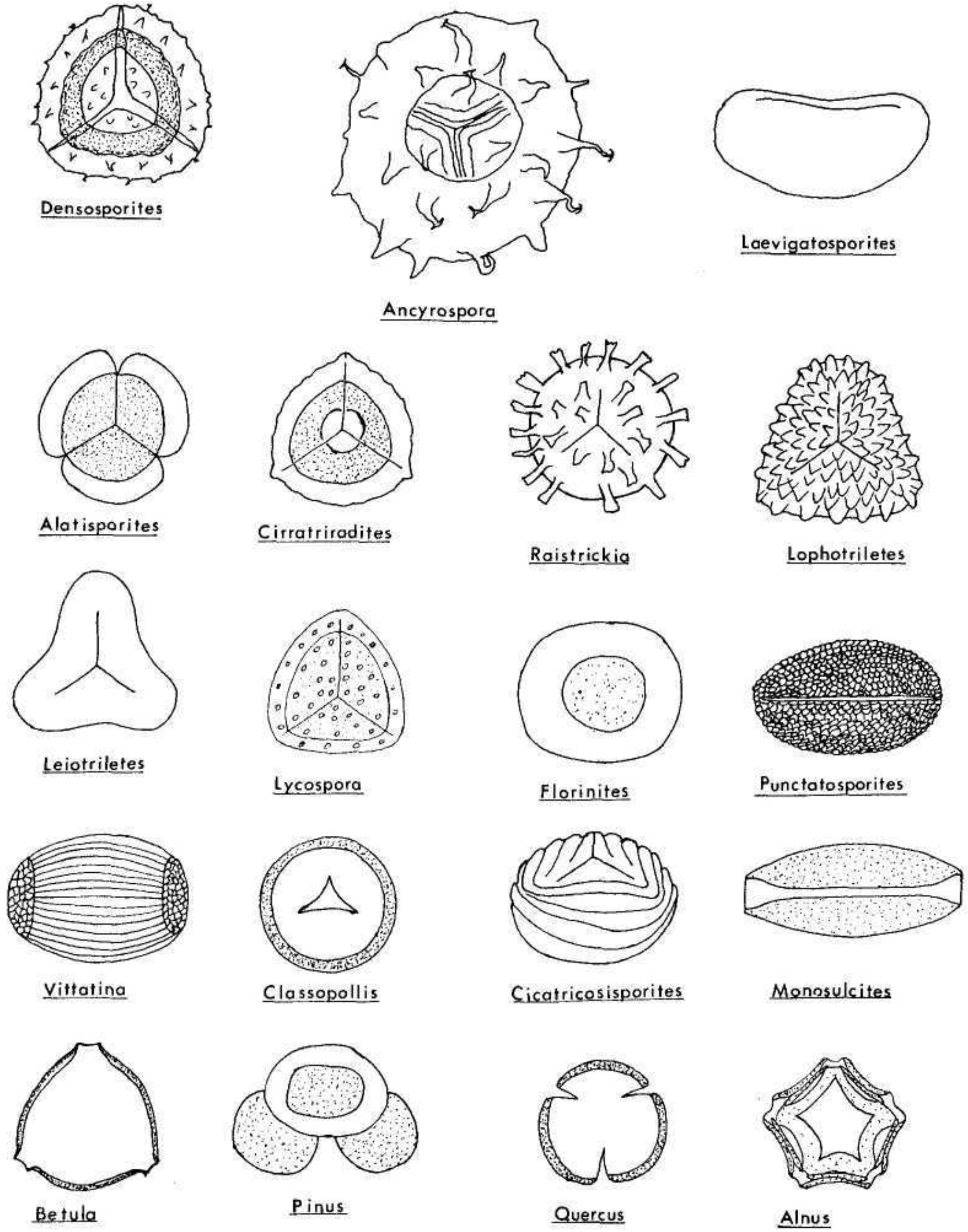


PLATE 6
MIOSPORES AND POLLEN

Miospores and pollen are specialized bodies involved in the reproduction of plants, consisting of the gametophyte surrounded by a protective non-cellular layer. It is the protective layer which is normally fossilized, and it is this layer which is referred to in the study of dispersed spores and pollen in sediments. Generally, these small structures are considered to have had a "male" function, but this is by no means certain. Hence, the term miospore (Greek "meion"– less, smaller) is often used for spores and pollen less than 200 microns in diameter. For those spores greater than 200 microns, the term megaspore (used here) or macrospore (Greek "makros" – great, large) can be employed. Spores from land plants are known from the Silurian to the present day.

Laevigatosporites, *Alatisporites*, *Florinites*, *Punctatosporites* — First recorded in Carboniferous, common in Westphalian coals and shales.

Densosporites, *Raistrickia*, *Lycospora*, *Cirratriradites* — First recorded in Devonian, common in Westphalian coals and shales.

Lophotriletes. First recorded in the Silurian, common in Westphalian coals.

Ancyrospora. Devonian, Cromarty nodule beds Scotland; Portishead beds, Burrington Combe, Mendip Hills, Somerset.

Vittatina. Permian e.g. Hilton Plant Bed, Westmoreland.

Classopollis. Rhaetic to Cretaceous e.g. Purbeck Wealden beds, S. England.

Cicatricosisporites. Purbeck, Wealden beds, England.

Monosulcites. Range Lias, Jurassic, Lower Cretaceous, e.g. beds of the Upper Deltaic Series, Yorkshire.

Betula, *Pinus*, *Quercus*, *Alnus* — Tree pollen common in Quarternary deposits, modern sediments.

The comments made on the morphology of megaspores (see above Pl. 4) can be applied generally to miospores.

LETTERS TO THE EDITOR

Dear Dr. Bassett,

18 April, 1968.

Geologists' erosion in Pembrokeshire

The Haverfordwest Corporation has just had to clear away more than five tons of spoil that was spilling onto the road from the foot of the exposure of the Gasworks Sandstones of the Lower Llandovery. At least another five tons is heaped back against the face. Any more hammering of this exposure, except amongst the spoil, will lead to the denial of access to it in defence of the footpath above.

The crude assault with hammers by parties of students is defacing too much of interest to geologists in Pembrokeshire; every year is worse than the last. The Nine Wells trilobite site in the Menevian is a mess. What is the point of smashing up erratics which are interesting and good teaching material only as long as they lie there?

This appeal is to all those who organise field trips, to see to it that only the most circumspect use of hammers is allowed on living material and that far more use be made of spoil heaps. These heaps are not the waste material of serious work but come from unthinking, undisciplined banging away, followed by minimal, or no, inspection of what falls. The evidence for the teaching of conservation in geology departments is conspicuous by its absence amongst too many students.

Yours sincerely,

John H. Barrett
(Warden, Dale Fort Field Centre.)

Welsh Geological Quarterly, vol.4, no.1, p.37.

NEWS AND NOTES

A CAVERN BELOW THE MILLSTONE GRIT NEAR ABERGAVENNY

The discovery of a large cavern below the Millstone Grit was made on 11th October, 1967, by members of the Cwmbran Caving Club after examining a small rift near the top of the Carboniferous Limestone and 30-40 feet below the grit at Pwlldu overlooking Abergavenny to the east, and the Blackrock to the north.

The cavern in many ways is unique. It contains peat stalactites measuring from 0.3 to 76.2 cm. in length and 0.1 to 7.62 cm. in diameter. They are unconsolidated and for the most part conical in shape, although there is a variety of remarkable shapes ranging from twists to oval forms. The colour range is from black to darkish brown, and rupture has occurred to the large oval forms. Examination of the cross-section reveals concentric growth rings with distinct colour markings. There is a marked resemblance in formation to calcite stalactites, but they are semi-flexible when in position. Once removed and dried they become extremely brittle and revert to a fine powder when crushed. Some of the peat stalactites are veined with calcite.

The floor consists of a mass of huge boulders covered with a blackish brown substance which could be a form of peat. Samples of the rock floor removed and dried, take on a blue metallic hue, and become hard and brittle. At present the peat stalactites exist at one end of the cavern only and this may be due to two factors - (1) the material carried in suspension through the sandstones and grits from the peat bogs above and (2) the sandstones and grits following the dip of the underlying limestones, and so influencing the flow of water toward that area. Test on the peat stalactites has shown a carbon content of 2.39 per cent.

The cavern extends about 120 feet in length and 82 feet in width, dipping down to form what is best described as a huge underground swallet hole 30 feet in depth, and very unstable. The sides are rather shattered in places, and undercut to a depth of 7-8 feet, to reveal the stratified rock, clay and shale layers. The top of the limestones can be seen some 15 feet below.

Small streams are present, and to the east side there is a reddish brown sediment, possibly iron residue, which is semi-liquid, but holds its shape to simulate that of flowstone for a length of 4-5 feet.

The shallow pools of crystal clear water are surrounded by miniature waterfalls with a lacy stone network of dripstone below the suspended stalactites. To the south end, there is evidence of vertical collapse caused by the enormous pressure from above, and so enlarging the cavern.

The roof is composed entirely of Millstone Grit and shows many fine examples of the casts of fossilized trees, one of which is approximately 15 feet long and 18 inches across, which leaves a segmental arch in the roof.

Many theories have been put forward regarding the formation of swallow or swallet holes, each with its own merits.

The discovery of a cavern of this magnitude below the Millstone Grit may be important, because I have not found evidence of a discovery of this nature before in South Wales. Therefore we may have found the halfway stage in the development of large swallow holes. A sketch map of the cavern has been prepared from the information collected by Mr. M. Austwick, Mr. R. Howells and myself and is available to anyone who is interested. A number of excellent photographs have been taken by Mr. Edgar Elliott of the internal structures showing the peat stalactites, etc. We were, however, unable to obtain photographs of the fossilized roof.

The cavern has been aptly named "Black Cavern", Pwlldu.

(P.H. Playford.)

EUROPEAN DIPLOMA FOR NATURE CONSERVATION

Created by the Council of Europe in 1965, the Diploma is granted for a renewable period of five years for landscapes, nature reservations, or natural features of European interest, where rigorous protection measures are ensured. The authorities in charge of ensuring this protection are required to send in annual reports on the management of the area concerned. In 1966, Belgium, France and the United Kingdom were the first three countries to receive the European Diploma for Nature Conservation for the Hautes Fagnes Nature Reserve, the Camargue Nature Reserve and the Peak District National Park.

At the end of last year, the second set of Diplomas were awarded to six sites and national parks in five other Council of Europe countries: the Krimmler Waterfalls in Austria; the Abruzzi National Park in Italy; the Luneburg Heath in the Federal Republic of Germany; the Swiss National Park; the Muddus, and Sarek and Padjelanta National Parks in Sweden.

(Forward in Europe, February-March, 1968.)

NEW GEOLOGICAL MAP OF CHURCH STRETTON AREA

A new geological map (scale 2½ in. to 1 mile) and 80-page explanatory booklet* describing the Church Stretton area of Shropshire were published in March 1968 by the Institute of Geological Sciences. First of a new series, they are intended to provide both the amateur and the professional geologist with a useful guide to this classic area.

*Geological Sheet SO49 Church Stretton. Scale 1:25,000. 11s.
The Geology of the Church Stretton area HMSO. 4s.

THE PEMBROKESHIRE COUNTRYSIDE UNIT

The Field Studies Council has accepted the invitation of the Countryside Commission to establish a Countryside Unit in Pembrokeshire. This will be something new in the British countryside and a contribution towards the Commission's educational and information services. It will fulfil also one of the original intentions of the Field Studies Council when its first field centres were established in 1946 and 1947 to provide nuclei from which all who were interested in any aspect of the countryside might develop their study.

The Countryside Unit intends to provide information for as many people as possible. It will prepare guides and itineraries so that anyone, including the family on holiday, can obtain introductions to such things as the natural history of rocky shores and the geology of Pembrokeshire; itineraries will give directions to groups of antiquities, saying not only how to get there but just what they are and why they are important and how they relate to other monuments elsewhere. Further sections of the Pembrokeshire coastal footpath will be annotated in much the same way as that already done for the Dale peninsula.* The aim will be to present these things in a way to be understood by people without specialist knowledge.

At appropriate times during the year, and particularly in summer, field excursions will be organised to display something of the natural history, the geology, and the history and impact of man on the landscape. Evening lectures in village halls will widen the general background of the details seen in the field.

The pressures on land use and the problems of conservation and preservation will be a constant theme and the unit will take every chance to emphasise personal responsibility for the countryside.

Organised parties of students or members of natural history or antiquarian societies will be welcome to ask the unit for local knowledge or for guidance during a day's field work.

Something for nothing was never a good idea. So the various publications will be sold; a small charge will be made for the conducted excursions and the lectures; a fee will be set for leading an organised party.

The Director of the Countryside Unit will be John H. Barrett, M.A., F.I.Biol., who ran Dale Fort Field Centre and Skokholm Bird Observatory for twenty-two years from 1947. He was nominated by the Minister of Housing and Local Government to be a member of the Pembrokeshire National Park Committee on which he has served since its inception in 1952. The unit will start work on October 1, 1968. Until a permanent headquarters is available its address will be: Anchor Cottage, Dale, Haverfordwest, Pembrokeshire.

*A Plain Man's Guide to the Paths round the Dale Peninsula. (3/- from Information Centres, etc., or 3/6 by post from Dale Fort Field Centre, Haverfordwest.)

(Taken from the Leaflet issued on 1st August, 1968.)

Welsh Geological Quarterly, vol.4, no.1, pp.38-40.

GEOLOGISTS' ASSOCIATION - SOUTH WALES GROUP

1968-1969

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<u>The Welsh Geological Quarterly</u> : Editor, D.A. Bassett, Ph.D.
Publication and distribution, D.E. Morgan, R. Parsons, A.J. Thomas.

ANNUAL REPORT

Session 1967-1968

Ordinary Meetings (held alternately at the University Colleges in Swansea and in Cardiff).

October 14, 1967. (Swansea)	Extraordinary General Meeting (to consider the annual subscription). Members' meeting: "Expedition to Balinka Pit, Yugoslavia" - Mr. J. Hartwell, Midland Silicones Ltd., Barry. "Aspects of the transportation of coastal sediments along part of the Glamorgan coast" - Dr. D. Keatch, Cardiff College of Education.
November 18, 1967. (Cardiff)	"The geochemistry of sediments" - Dr. T.W. Bloxham, University College, Swansea.
December 16, 1967. (Swansea)	"Landforms and geology of Canyonlands, S.E. Utah, America's new national park" - Mr. T.M. Thomas, Welsh Office, Cardiff.
January 27, 1968. (Cardiff)	"The structure of the sea floor" - Professor D.H. Griffiths, University of Birmingham.
February 17, 1968. (Swansea)	"The Pleistocene development of the Bristol Channel coastline with special reference to the Somerset coast" - Professor C. Kidson, University College, Aberystwyth.
March 16, 1968. (Cardiff)	Symposium on Palaeontology. "Recent research on ammonites" - Dr. J.W. Cope, University College, Swansea. "Graptolites" - Dr. I. Strachan, University of Birmingham. "The natural history of trilobites" - Professor H.B. Whittington, University of Cambridge.
April 6, 1968. (Swansea)	Ninth Annual General Meeting. "Problems associated with the evolution of surface and drainage in South Wales" - Mr. T.R. Owen, University College, Swansea. (Chairman's Address.)

Field Meetings

March 30, 1968.	"The geology of the Fishguard and Strumble Head area with particular reference to the Fishguard Volcanic Series" - Mr. T.M. Thomas, Welsh Office, Cardiff.
May 4, 1968.	"The coastal Pleistocene deposits and landforms of Gower" - Dr. D.Q. Bowen, University College, Aberystwyth.
May 11-12, 1968.	"The geology of the Malvern Hills" - Dr. M.J. Brooks, University College, Swansea.

Membership — During the year the membership was 192.

Publications — The Welsh Geological Quarterly, volume 2 (1966-1967), number 4, Summer 1967 (December 1967) and volume 3 (1967-1968), number 1, Autumn 1967 (February 1968).

William Lewis (Printers) Ltd, Cardiff