DOCUMENT RESUME

ED 104 675 SE 018 829

AUTHOR	Hak, Abdul; And Others
TITLE	Field Manual for Museums. Museums and Monuments, XII.
INSTITUTION	United Nations Educational, Scientific, and Cultural Organization, Paris (France).
PUB DATE	70
NOTE	168p.
AVAILABLE FROM	UNIPUB, Inc., P.O. Box 443, New York, NY 10016 ($9.00)
EDRS PRICE	MF-$0.76 HC Not Available from EDRS..PLUS POSTAGE
DESCRIPTORS	*Archaeology; Botany; *Educational Facilities; Environmental Education; *Ethnology; Field Studies; Geology; *Guides; *Museums; Research Methodology; Science Education; Social Sciences; Social Studies
IDENTIFIERS	UNESCO

ABSTRACT

This manual is intended to provide museum staff throughout the world with basic information needed in organizing field work and adding to their collections, to help museums by stimulating research, and to encourage research personnel to bring a rigorously scientific approach to their investigations. Various specialists in archaeology, ethnography, and natural sciences have described the techniques and methods they have devised and successfully used themselves. This manual contains the following ten papers: (1) Introduction; (2) General remarks concerning the organization of expeditions; (3) Standard methods of field documentation; (4) The techniques of archaeological excavation; (5) Prospecting methods in archaeology; (6) The recovery, removal and reconstruction of skeletal remains--some new techniques; (7) Hints for ethnographers; (8) Field work techniques in geology and mineralogy; (9) Field work techniques in botany; and (10) Field work techniques in zoology. Illustrations, photographs, tables, and bibliographies are also included. (TK)

museums and monuments · XII

Field manual for museums

unesco

Titles in this series:

I *Sites and monuments: problems of today.*
100 pages, 115 illustrations, plans, index, 2nd ed., 1953 (bilingual), out of print.

II *The care of paintings.*
164 pages, 87 illlustrations, diagrams, index, 2nd ed., 1952 (bilingual), out of print.

III *Cuzco: reconstruction of the town and restoration of its monuments.*
64 illustrations and maps, 1952 (also in French and Spanish), out of print.

IV *Saint Sophia of Ochrida: preservation and restoration of the building and its frescoes.*
28 pages, 37 illustrations and maps, 1953 (also in French), out of print.

V *Manual of travelling exhibitions.*
112 pages, 18 diagrams, 70 illustrations, 1953 (also in French), out of print, see number X below.

VI *Lebanon: suggestions for the plan of Tripoli and for the surroundings of the Baalbeck Acropolis.*
48 pages, 1 map, 7 diagrams, 44 illustrations, 1954 (out of print).

VII *Syria: problems of preservation and presentation of sites and monuments.*
52 pages, 61 illustrations, 3 maps, 1954 (also in French and Arabic), out of print.

VIII *Protection of cultural property in the event of armed conflict.*
346 pages, 124 figures, 137 illustrations, 1958 (French edition is out of print).

IX *The organization of museum: practical advice.*
188 pages, 18 figures, 8 tables, 91 illustrations, 1959 (also in French).

X *Temporary and travelling exhibitions.*
123 pages, 23 figures, 88 illustrations, 1963 (also in French).

XI *The conservation of cultural property, with special reference to tropical conditions.*
Prepared in co-operation with
the International Centre for the Study of the Preservation and Restoration of Cultural Property, Rome, 341 pages, 60 figures, 43 illustrations, 1967 (also in French and Spanish).

XII *Field manual for museums.*
176 pages, 44 figures, 35 plates (also in French).

Field manual for museums

unesco

Published in 1970 by the United Nations
Educational, Scientific and Cultural Organization
Place de Fontenoy, 75 Paris-7e
Printed by Presses Centrales Lausanne S.A.

Printed in Switzerland
SHC.68/X.12/A

Foreword

Traditionally concerned with conservation, and quite recently with bringing art to the public, museums have also certain responsibilities towards scientific and technological research. Apart from other manifold duties in administration, conservation, education and the organization of cultural activities, museum staff must also be competent to handle all kinds of demands that may be made on them by the implications of scientific research today.

As far as museums are concerned, what is involved is twofold: (a) research on items in the collections capable of providing data vital to science, and likely to advance education and culture; (b) collecting of objects which will expand and enrich museum collections.

All museums have research concerns with their own collections, but not all museums or types of museum are as urgently concerned, or concerned in the same way, with collecting. Many collections are constituted once and for all; the possibility of new acquisitions is either non-existent or very slight, and in most cases does not depend on doing research.

However, the problem is different for newly-established museums in countries where research is very active, and where agencies responsible for research or for the protection of the cultural heritage are lacking or not strong enough. In such cases, all museum staff—curators, scientists, explorers, archaeologists, research personnel and all kinds of technical staff—may be called upon to participate, depending on the extent of the projects and the conditions under which they are to be carried out.

In co-operation with universities, scientific institutes and research centres, or, where these do not exist, by drawing on their own resources, museums must expand and enrich their collections with the products of their own field work carried out both locally and in other places and countries, near or far.

In the Unesco Museums and Monuments series, the present *Field Manual for Museums* is intended to provide museum staffs throughout the world with the basic information needed in organizing field work and adding to their collections.

After enlisting the support of eminent specialists in archaeology, ethnography and the natural sciences, Unesco invited them to describe the techniques and methods they have devised and successfully used themselves.

In thanking them, Unesco hopes that a wider knowledge of their working techniques and methods will help museums by stimulating research, and by encouraging research personnel to bring a rigorously scientific approach to their investigations, and so ensure that the light their discoveries throw on nature and on various cultures will be absolutely authentic.

Contents

List of illustrations

Plates

still exists. Boganda Museum. Department of Folk Art and Tradition. (Photo: B. Sullerot, Musée de l'Homme, Paris) (p. 117).

18. The horizontal loom used by Hausa weavers (Niger). Ethnographical Museum, Neuchâtel (Photo: J. Schoepflin, Neuchâtel) (p. 118).
19. The moulding of Tahoua pottery. Photograph exhibited in the Ethnographical Museum, Neuchâtel (p. 120).
20. Systematic air photography. The photographs are taken vertically, at regular intervals, so as to give the necessary coverage (Photo: Carl Zeiss, 7082, Oberkochen, Federal Republic of Germany) (p. 130).
21. This air photograph clearly shows an anticlinal geological structure with the closing of the fold towards the northern edge of the photograph. The axis of the fold runs approximately N 20° W. The correspondence between the massive sandstone series G, which form a very characteristic morphological element, can be seen on both sides of this axis. A limestone zone (A), only a few metres thick, shows up very clearly by photogeology, because its course is marked by a growth of euphorbia. A survey of this area could be limited to one major east-west traverse in the south and a few traverses in the north to find out the limits of the closure of the fold, the blurred outlines of which are shown here (p. 131).
22. This air photograph of a large equatorial forest clearly shows two folds running N-E. It will be understood that if the geologist has not seen and located these formations in advance from photographs, he can easily pass quite close to them, even a few hundred metres away, without suspecting the existence of these characteristic reliefs (p. 130).
23. The field geologist locates the outcrops by a stereoscopic examination of air photographs (Photo: Carl Zeiss, 7082, Oberkochen, Federal Republic of Germany) (p. 132).
24. (a) A field press showing carrying straps, straps to permit expansion, and closing straps. This press is made of mahogany; it measures about 30 × 45 cm (p. 145).
    (b) The same press opened out (p. 145).
    (c) Detail of closing strap (p. 146).
    (d) Detail of expansion strap (p. 146).
    (e) Detail of fastener used with closing strap (p. 146).
25. (a) One press board, size 30 × 45 cm.
    (b) Detail of construction of press board, the rivets are copper. The wood used in this case is hickory (p. 147).
26. An aluminium corrugate, size 30 × 45 cm (p. 148).
27. Sequence for press: press board, drier, corrugate, drier (plant), drier, etc., and finally a closing press board (p. 148).
28. Belly incision (p. 165).
29. Severing the legs at the knee-joint (p. 165).
30. Severing the tail (p. 166).
31. Severing the wing at the shoulder-joint (p. 166).
32. Exposing the head and cranium, removal of the eyes (p. 167).
33. A wooden stick wrapped in cotton wool is introduced into the skin (p. 167).
34. The skin is stuffed with a fibrous material (p. 168).
35. The legs are tied to the wooden stick, and the skin is wrapped in a paper bag. A label is attached (p. 168).

Figures

28. Measuring the strike and dip of geological strata (p. 138).
29. The labels illustrated were used for special collections and show our method of preparing labels:
    (a) A general label in which the country and collector are constant.
    (b) A special label for a specific project. All field data and names of collectors must be written in.
    (c) Labels completely printed out (p. 151).
30. Labels in which the majority of the data is printed on to the label. Numbers, scientific names, as well as specific data for each collection must be written in the spaces provided (p. 152).
31. Side view of a loaded press (p. 153).
32. A press board (p. 154).
33. A drier box, using electric bulbs as a source of heat (p. 154).
34. Drawing of the eye showing its diameter (18), the diameter of the pupil (7), and its colouring (p. 155).
35. View of the underside of a dead animal showing the three incisions in the skin. (a) Centre-line incision; (b) first crosswise incision; (c) rear crosswise incision (p. 156).
36. Line of cut for removing the hooves (p. 157).
37. Line of cut for removing claws and pads (p. 157).
38. Top view of the head showing the incisions in the skin around the horns (p. 157).
39. Line of cut on a monkey's hand for removing the skin from the skeleton of the hand (p. 158).
40. Measuring the skinned animal. Length measurements (p. 160).
41. Measuring the skinned animal. Circumference and diameter measurements (p. 161).
42. Measuring the head before skinning. Length and diameter measurements (p. 161).
43. Sexual organs of mammal. The cat: (a) female; (b) male (p. 170).
44. Sexual organs of a bird. The domestic fowl: (a) hen; (b) cock (p. 171).

The authors

ABDUL HAK, S. A.

Docteur ès lettres, University of Paris (1943). Diplomas of the Institut d'Art et d'Archéologie, the Institut d'Urbanisme, and the Ecole du Louvre, Paris. One-time Director and Chief Editor of the Annales archéologiques of Syria; Curator, National Museum, Damascus (1945-1950), Director-General of Antiquities and Museums of Syria (1950-1964), Chief, Section of Monuments and Museums, Unesco (since 1965). Publications: *Les sculpteurs des porches du transept de la Cathédrale de Chartres,* Paris 1943; *L'Art grec d'orient,* Damascus 1951; *Catalogue illustré du Musée national de Damas,* Damascus 1951; *Les aspects archéologiques de Damas,* Damascus 1953; *Rome et l'Orient romain,* Damascus 1958, etc.

BAHLER, René

Left Switzerland for Australia in 1949. Exploration of this country for 13 years, studying plant and animal life, and collecting specimens for various museums.

BREW, John Otis

A. B. in Fine Arts, Dartmouth College (1928). Student Harvard Graduate School of Arts and Sciences (1928-31). PH. D. Harvard, 1941. Fellow in archaeology University of Chicago expedition (1930). With Peabody Museum since 1930; assistant to director (1930-48); scientific director Claflin-Emerson expedition (1931); director Southeastern Utah expedition (1931-33); assistant to director Harvard Irish expedition, 1934; director Awatovi expedition field seasons (1935-39); Assistant-curator Southwest American Archaeology (1941-45); Curator North American Archaeology (1945-48); director since 1949. Engaged in archaeological reconnaissance for museums in New Mexico and Arizona (1946-47); Peabody professor of American archaeology and ethnography since 1949; member of the staff of Harvard Department of Anthropology (1937–); member of the Board of Syndics; member of the Massachusetts Historical Commission; chairman, advisory committee on Pre-Columbian Art, Dunbarton Oaks (1963–); chairman of the International committee for monuments, artistic and historic sites and archaeological excavations (1956–); chairman of the U.S. National Committee for the Preservation of the Monuments of Nubia. Author of articles in journals and papers of Peabody.

FORD, Brian J.

A.R.S.H., F.R.M.S., A.B.I.S.; independent research scientist who works from his laboratories in Cardiff, Wales. Has over 500 scientific publications to his name including essays, papers and technical articles which have been published in several languages. Editor, author and broadcaster in the scientific field. Acts regularly as a college lecturer in Wales.

Huber, Walter

Studied zoology at the University of Berne (1945), assistant at the Zoological Institute of the University of Berne. Doctorate of this University (1946). Research assistant at the Centre National de la Recherche Scientifique (CNRS) in the Laboratoire d'Embryologie expérimentale at Strasbourg University (France) (1947-50). Diplôme d'Etudes supérieures at Strasbourg University (1949). Curator at the Naturhistorisches Museum in Berne (1951-63); since 1964 its director. Lecturer at the University of Berne (1957-65); later professor of morphology and biology of vertebrates. Research journey to South Africa (1963). Museological expert in Zambia (1965). Research journey to Poland (1967). Field of study: Functional morphology; biometry and formation of the heads of mammals and birds; research on wild animals.

Küng, Kurt

Vocational training in the Natural History Museum, Berne. Attended the Kunstgewerbeschule (Arts and Crafts School) (1948-1952). Successor to Mr. Ruprecht, chief specimen preparer (1957). *Expeditions:* Norway (birds) (1956); Angola (big game) (1958); Norway (fish) (1960); Zambia (Consultant, Unesco mission) (1965); Nigeria (course leader, Unesco mission) (1966); Nigeria (ditto) (1967); Mission carried out for World Exhibition in Brussels: 14 mammals, including an okapi and a group of bonobos (1959). *Special field:* Preparation of dermoplastic model animals and of polyester bodies of animals. Construction of dioramas. Painting of backgrounds.

Ladmirant, Henri

Studies in geology at the University of Liège. Since 1956 has been attached to the Department of Geology and Mineralogy, Musée royal de l'Afrique centrale (Tervuren, Belgium) where he is concerned particularly with geological mapping, interpretation of air photographs, and petrology. Since 1960 responsible for a course in 'photo-geology' at the Faculty of Sciences at the Université Libre, Brussels. Also responsible for the teaching of 'photo-geology' in the training course for geological assistants for students from developing countries at the Musée royal de l'Afrique centrale.

Lerici, Carlo Maurilio

Degree of Mechanical Engineering, Turin Polytechnic (1913). Aeronautical Engineer during the first world war (1915-18). Specialized in the manufacture and commercial uses of stainless steel from 1924. Promoter of the Italian Cultural Institute, Stockholm (1941), of the Lerici Foundation at the Milan Polytechnic (1947), of the Archaeological Prospecting Centre in Rome (1955), and of the International Course on Archaeological Prospecting at Rome University (1964). Author of several publications on archaeological prospecting.

Linington, Richard Edgar

Honours degree in Physics, Oxford University (1960–). Faculty member—University of Pennsylvania, Philadelphia (1960-61). Lerici Foundation, Technical Director (1962). Active in both geophysical and archaeological fields. Directed several excavations in England and elsewhere (1958-60, Director of excavations for Oxford University and President of the Archaeological Society). Has undertaken work for the Foundation in several countries, including Spain, the United Arab Republic, Jordan, Bulgaria, Poland, Czechoslovakia, Federal Republic of Germany.

Has also worked in England, France, the United States of America and Guatemala. Author of various articles and specialist in research aspects of the application of scientific techniques to archaeology, including the use of electronic computers.

Lobsiger-Dellenbach, Marguerite

Docteur ès lettres, University of Grenoble (1935). Privat-docent, University of Geneva (1941-62). Director of the Musée et Institut d'Ethnographie, Geneva (1952-67). Prehistoric excavations in France (Dordogne); Two African expeditions (ethnographic and anthropological) in Kabylie and Niger (1948); Ethnographic and anthropological expedition in Nepal (1952); Specialist in reading of New Caledonian bamboo carvings (20 memoirs on the subject in collaboration with Georges Lobsiger). Publications (in addition to numerous articles): *La conquête du massif alpin par les populations préhistoriques* (Grenoble, 1935), *Recherches ethnologiques au Népal (Katmandu Valley)* (Geneva 1955), *Népal, catalogue descriptif de la collection d'ethnographie népalaise du Musée d'ethnographie de Genève* (Geneva 1954).

Michalowski, Kazimierz

Docteur ès lettres. Dr. h.c. (Strasbourg). Professor of Mediterranean Archaeology at the Faculty of Letters, Warsaw University. Member of the Praesidium of the Polish Academy of Sciences. Professor and Head of the Faculty of Mediterranean Archaeology at Warsaw University. Director of the Polish Archaeological Centre in Cairo. Director of the Institute of Mediterranean Archaeology of the Polish Academy of Sciences in Warsaw. Assistant Director of the Warsaw National Museum. Director of the Franco-Polish excavations at Edfu (Upper Egypt, 1936-39) and of the Polish excavations at Mirmaki (Crimea, 1956-58), Tell Atrib (Lower Egypt, from 1957), Palmyra (Syria, from 1959), Alexandria (from 1960), Dabot (Nubia, 1961), Deir el Bahari (Upper Egypt, from 1962), Faras (Sudan, 1961-64), Old Dongola (Sudan, from 1964), Paphos (Cyprus, from 1963). Vice-Chairman, meeting of experts of archaeological excavations (Palermo, 1956). Chairman of the Committee of archaeological experts and landscape architects for the salvage of Abu Simbel. Many scientific publications.

Oddon, Yvonne

Head of the Unesco-ICOM Museum Documentation Centre since its creation in 1947. Organizer of the ethnological library of the Musée de l'Homme, of which she was effective Director from 1929 to 1963.

Williams, Louis (Otho)

Systematic and Economic Botanist. Chief Curator, Botany, Field Museum Natural History, Chicago. B.S., M.S., Univ. Wyoming (1933); Ph.D. Washington Univ. (St. Louis, 1936). Twenty years field experience in American tropics. Research: Flora of Guatemala; Flora of central Central America; economic plants of Central America related to human cultures. Formerly: Research Associate, Harvard University; Botanist and Subdirector, Escuela Agricola Panamericana, Honduras; Botanist, U.S. Department of Agriculture.

Selim Abdul Hak

Introduction

I

SCIENTIFIC RESEARCH IN MUSEUMS

The broadening of the horizons of the various branches of science is one of the most striking features of our age. Knowledge is being perfected everywhere. Modern techniques are stimulating experiments, suggesting hypotheses and encouraging the formulation of new theories.

To help give human experience its true dimensions and to promote appreciation of universal values at the local, national and international levels, museums are tending more and more to become centres of research at the service of the community. The areas in which they can undertake research are many and depend on their nature and the category to which they belong. Museums exist precisely to preserve and improve their collections and to make them known, and justify their existence through the performance of those tasks.

In this connexion, it is worth mentioning that museums are contributing to scientific progress in two ways: by making a study of original items in their possession, and by trying to find and to acquire material that will complete their collections and make the information to be gleaned from them more useful and up to date.

It is often said that a museum must not be a repository of dead or dumb objects, or merely of curios. Indeed, every museum collection needs careful study. It is worth always to include specialists on the staff of even small museums, people who would have the opportunity of carrying out, either on their own or with the help of outside scholars, the type of academic and applied studies required in branches of science which are still in a state of constant development. The aim of this is to acquire a better knowledge of the exhibits and to establish classes, relationships, similarities, differences, varieties and divergencies. Equally important are the use, where necessary, of methods of technical analysis (chemical and physical), the carrying out of interdisciplinary comparative studies of the main cultural trends, the revision of accepted ideas in the light of critical inquiries, the formulation of conclusions and the communication of the results of studies to other museums and interested scientific institutions and their publication in bulletins, journals, specialist works, etc.

Such activities open up fresh perspectives for scientific and technical museum staff. Except in a fairly limited number of cases, museum collections are not assembled once and for all. Enriching them with new objects and material, filling in gaps and varying their composition are essential tasks, which must be attended to daily in the service of science and culture. For many categories of museums, scientific research in the field is still the main and most reliable source for obtaining a continuing supply of the material needed for their development.

The technological and methodological aspects of all research undertaken by museums to enrich their collections by appropriate means needs special emphasis, because the main and secondary techniques of each discipline would have to be applied rigorously and carefully by skilful, qualified workers if the specified objectives are to be achieved with the greatest possible degree of accuracy.

The main thing is to obtain as much scientific information as possible during and after each operation. Objects discovered, or yet to be discovered, are rich in meaning; they are often unique and highly precious items of evidence. Sometimes they have survived from a remote past, after being buried in the soil or existing in the environment of societies which were ignorant of their great value to science. Hence, their presence *in situ* may provide evidence as to the nature of their environment, past civilizations, events in which they have been involved and the customs of the peoples who used them. Utmost care is therefore to be recommended in collecting and recording all data capable of vitalizing the physical, archaeological, historical and ethnographic context and which are required to ensure that the discoveries are exploited scientifically to the best possible advantage.

It is important too that research workers should be able to ensure preservation of the discovered material while they are identifying the characteristics which locate it in time and space. Such material will have undergone a certain amount of change, depending on its specific resistance, the degree to which and the length of time for which it has been subjected to deterioration factors. Hence the need and the urgency for applying a provisional form of treatment immediately and for seeking, without delay, an appropriate laboratory method of ensuring permanent preservation.

It is likewise highly desirable to see that the sites and areas where research has been carried out are preserved, so that they can be used for further research, which may lead to possible new discoveries, or reserved as places where advantage might be taken of subsequent advances in techniques and knowledge for checking the accuracy of research data at some future time. Apart from that, the protection, maintenance and restoration of these sites for educational and cultural purposes have the great advantage of awakening and developing respect and admiration for the different values involved.

It is worth recalling that these considerations were at the root of the legal measures taken by many countries to protect their archaeological heritage and to safeguard their natural, historical, scientific and other sites. At the international level, similar considerations led to the drafting of two recommendations: the Recommendation on International Principles Applicable to Archaeological Excavations, adopted on 5 December 1956 by the General Conference of Unesco during its ninth session in New Delhi; and the Recommendation Concerning the Safeguarding of the Beauty and Character of Landscapes and Sites, adopted by the General Conference of Unesco on 11 December 1962 during its twelfth session in Paris.

Preventive and corrective measures have thus been drawn up at both the national and international levels to protect places where research may be conducted. The procedures to be followed for all investigations whose purpose is to discover objects have been clearly defined. It is to be hoped that research workers in all disciplines will observe the provisions of these protective measures, which are aimed solely at safeguarding important scientific and cultural interests.

SAFEGUARDING OF CULTURAL PROPERTY ENDANGERED BY PUBLIC AND PRIVATE WORKS AND BY RESEARCH IN THE FIELD

In the developed and developing countries alike, a very serious danger is today threatening thousands of natural, scientific, archaeological, historical and artistic sites and ethnological contexts because of the construction of great hydro-electric plants, dams, motorways, oil pipelines, pylons and power grids, intensive methods of farming, the urban explosion, urban development and renewal, the building of factories, aerodromes, railways, etc., all of which are nonetheless indispensable for bringing economic prosperity to all peoples.

Caught between these two conflicting claims—that of the need for economic development through technological progress and that of responsibility for preserving cultural property endangered by public and private works—our age has chosen a compromise, namely to save the threatened cultural treasures irrespective of cost.

Unesco is at present studying a draft international recommendation whose purpose is to provide reasonable solutions for this world-wide problem. This new international instrument would include provisions relating to legislative measures to be adopted, appropriate financing, the setting up of bodies for the protection of cultural property and also to the kinds of scientific research to promote and intensify. The significance which these latter activities could have for the knowledge and study of the cultural heritage of mankind cannot be overemphasized.

ORGANIZATION OF RESEARCH IN THE FIELD

If they are to carry out their scientific research duties properly, museums of all categories will have to tackle the essential tasks incumbent upon them as main or auxiliary centres indispensable for research. These tasks are, basically:

- to recruit and train the scientific staff who are to engage in research; to adopt and carry out research programmes at national level in accordance with the financial, technical and scientific resources at their disposal; to make energetic efforts to strengthen international co-operation in the sphere of research;
- to see to it that the products of research are used wisely, in the first instance for building up national collections and then as exchange material which will contribute to the development of science and culture in the world.

RECRUITMENT AND TRAINING OF STAFF TO UNDERTAKE RESEARCH IN MUSEUMS

In all countries, museums wishing to engage actively in research will have to have staff who are abreast of scientific progress in their fields and able to apply the techniques and methods of field research in the most effective way.

Ready availability of such staff is a goal to be achieved as many museums, even in the developed countries, are short of them. The task of preparing them to discharge their duties methodically raises problems in regard to the type of training to be given to curators, museologists and museum technicians. It is well known that these problems exist at the national level in many countries at the present time and are a major concern to Unesco and the International Council of Museums (ICOM).

In this connexion, it is principally the small and medium-sized museums, called upon to perform research, conservation and educational functions with only small staffs, that have difficulties. In their case, it is extremely important for the curator or curators to have had a fairly extensive scientific, technical and general training if they are to carry out their tasks properly. This diversification at the general cultural level will, however, have to be based on a specific specialization.

Accordingly, it is worth bearing in mind the need for having at the head of every museum, or of every department in a museum, a specialist in the subject to which the collection relates. This means that the scientific staff of museums will have had to have basic training in archaeology, history, geography, the fine arts, ethnography, anthropology, botany, zoology, etc. at a university, university college, or institute of higher studies.

A selection will have to be made from amongst those who have had such an academic training to find staff whose real vocation is research and who have the intellectual and physical capacity to undertake it. From then on it is the responsibility of the museums to ensure that their future research workers have the additional theoretical and practical knowledge they will require.

It is pointless to conceal the fact that very few museums have the time, the scientific staff and the necessary equipment to train new recruits successfully. With the inadequate facilities at their disposal, the staff of these institutions often only acquire a certain mastery of the subjects gradually in the course of a long career.

It is not wise for museums to set themselves up as independent bodies in order to speed up the scientific and technical training of their staff. This, and all problems of common interest to museums, are matters for museum directorates or associations. To provide suitable training for the research workers required by museums, short- and long-term programmes would have to be drawn up and put into operation within the framework of national possibilities and using all available facilities.

Nor must it be forgotten that this is a task best carried out in close co-operation with the universities, research institutes and centres and organizations for the protection of the cultural heritage, since, particularly in the field of research, the interests of the museums and of all these other institutions are parallel and complementary. Every research worker trained in any particular basic subject is an asset to a museum housing collections relating to that subject, and to any institution whose function it is to teach and advance knowledge of that subject, or to protect and safeguard relics having a bearing on it. It is logical, therefore, for the administrative department responsible for all the museums of a country to co-operate with all the other interested national institutions in organizing, periodically, comprehensive training programmes for research workers specializing in the same subjects, pooling their facilities so far as is nationally possible.

Theoretical and practical seminars on research might likewise be organized, preferably in museographical training centres (if they exist), for newly recruited staff and also for those already working in museums whose standard of training is insufficient. In this connexion, it is recommended that full use is made of the services of teachers and museum directors or curators who have a long experience of research, and that the lectures on archaeology generally given in universities and the courses of lectures or occasional public lectures given in archaeological, ethnographic and natural science museums are not overlooked.

Finally, it is worth while remembering that university museums often have methodically set out collections illustrating research done by members of the teaching staff, and a great many items in their storerooms. Together with university libraries, laboratories and research centres, they offer valuable facilities for the further training of research personnel.

ADOPTION AND IMPLEMENTATION OF NATIONAL RESEARCH PROGRAMMES

It is also desirable to extend this national co-operation for training museum research staff to the planning and implementation of programmes for research and the study of collections, since the immense horizons at present opening up in this field, although calling for a clear distinction between the respective functions and areas of competence of museums, university establishments and organizations for the protection of cultural heritage, make logical and coherent planning of all research to be undertaken in any of the basic disciplines indispensable.

There are many strong arguments in favour of the type of planning which involves a deliberate choice of a number of activities.

The most important things are to know what is being done in each discipline, to find out exactly what is known by the country's various scientific institutions, to pinpoint any gaps, to foresee future developments, to make a careful assessment of the possibilities of filling these gaps, to work out operational methods and techniques, to study the proposed programmes and projects in detail, to select, after studies, surveys, tests or provisional prospecting work, the topics and subjects for research and the areas and sites where the investigations are to take place, and to try to find and collect the objects indispensable or urgently needed for building up or enriching the museums' collections.

To enable science and culture to derive the maximum benefit from this research, it is likewise important to mobilize all possible skills, to co-ordinate the activities of scholars and specialists, archaeologists, ethnographers, geographers, geologists, botanists, epigraphers, preservation experts, site managers and camp directors in the light of the times at which they are available, to prepare the infrastructure for missions, and to set up interdisciplinary teams.

Lastly, it is of utmost importance that the best use is made of available funds, and that missions are provided with all necessary research equipment, reference books, geographical, geological and topographical maps, photogrammetric and surveying apparatus, laboratory equipment for the preservation and treatment of finds, transport vehicles etc.

In the developed countries, there are central bodies to promote, direct and initiate research in one or more disciplines. Individual museums, study centres, universities or bodies concerned with the protection of cultural property, even when their own facilities are very good, often call on outside specialists for assistance and use facilities of other institutions for their research.

Quite frequently, teachers from higher educational establishments participate in research carried out by museums and co-operate in the study of finds and in the publication of results. Similarly, the directors of scientific organizations or museum curators who have carried out research are, under various circumstances, appointed to teach the subject they have been studying.

In this way, universities make available to museums their rich specialist teaching resources and their continually improving methods, whilst the museums, for their part, provide the universities with material and problems capable of injecting fresh life into academic teaching.

This fruitful exchange is gradually becoming more common in other countries. In the Near and Middle East, museum directors and curators are taking an active part in the university teaching of history and archaeology. In return, university professors of history and archaeology are taking part in archaeological excavations carried out by museums or by organizations for the protection of the cultural heritage.

The same interrelationship also exists in Malaysia, where university professors base their research projects on objects preserved in the National Museum. Quite a close association is also being established for research purposes between universities and museums in India, Mongolia and Ceylon. In Japan, the museum is identified with and incorporated in the university and constitutes a highly effective teaching aid. Finally, in several Latin American countries, a number of museums are interested in research and are virtually university institutes.

It is worth pointing out, however, that although the interests of these two categories of institution coincide when it comes to promoting research, they cannot be completely identical in other fields. Each has its own particular part to play in the service of the community. There is no need to integrate them into a single system, for they can always, while remaining independent of each other, consult each other and make their own contributions to planning and carrying out archaeological, ethnographical and other research programmes within the limits of their respective functions.

POSSIBILITIES OF INTERNATIONAL CO-OPERATION IN RESEARCH

It is also possible to obtain international, bilateral and multilateral co-operation and the co-operation of appropriate international organizations for the methodological training of research workers and for the planning and implementation of research programmes.

Many developing countries are unable, because of a lack of institutions and of staff already trained in some discipline or another, to train future research workers on their own soil and with their own facilities. This could constitute a serious obstacle to undertaking work designed to enrich and develop their museums. In such cases, it is natural to think of making use of the many existing facilities which the developed countries and the international specialized organizations could make available to them.

First of all, it is worth drawing attention to the benefits museums in the developing countries can derive from the presence of foreign experts or teams of experts working temporarily or carrying out various types of archaeological, ethnographical or natural science projects of fairly long duration in their countries.

The staff of museums interested in the projects could make useful contacts in the field, they could familiarize themselves with working methods and techniques, study problems linked in some way with those being investigated, seek advice from the foreign experts and establish a close and profitable professional relationship with them which might become lasting.

Also, needless to say, national fellowships can be awarded with discretion to young people of particular merit to enable them to train abroad for careers connected with research. These fellowships must, of course, be for the type of training they are interested in and which can be obtained within general higher education courses offered at the major universities, specialized institutes and schools, research centres and laboratories attached to the large museums in some developed countries in Europe and America. This academic learning is best supplemented by a fairly long period of practical work in the latter institutions, as well as in the local or regional schools, institutes and research centres, set up by some of these developed countries in several Asian, African and Latin American countries, to develop on-the-spot research, in close liaison with institutions in their own countries, on one or several subjects of interdisciplinary interest relating to a particular region or continent. With a thorough training behind them, the new research workers can generally supplement their theoretical apprenticeship in the latter establishments by undertaking specialized work in the different basic disciplines and by bringing themselves up to date with current progress and with newly developed methods in specialized field research.

For a long time, countries with an eye to their cultural and scientific prestige have been offering, in the interest of international solidarity, a certain number of fellowships to young people from developing countries under a fairly wide range of bilateral agreements.

Under a variety of its programmes, Unesco, too, can, at the request of Member States, provide fellowships for training in institutes and research centres or through specialized national, regional and international courses. In this connexion, it is worth mentioning that, in co-operation with several Member States, Unesco has organized international courses and set up international study centres which could be used for the training of museum research workers. These include the specialized course in geology and applied micropalaeontology in Vienna; the Documentation and Study Centre for the History of the Art and Culture of Ancient Egypt in Cairo; the Regional Training Centre for Museum Technicians in Jos (Nigeria), which offers, among other subjects, a course in archaeology and African history; the Regional Centre for the Training of Specialists in Restoration of Cultural Property in Mexico, which also teaches the history of pre-Columbian and colonial period art; and the International Centre for the Study of the Preservation and Restoration of Cultural Property in Rome, which runs a post-graduate course for the supplementary training of specialists and organizes practical work, participation in excavations and training courses at various sites.

Lastly, any country planning field research programmes would be wise to think in terms of making wide use of international co-operation, since the very idea of such programmes being anything but regional and international undertakings is impossible to visualize. The contexts to which approaches, trends, perspectives, subjects etc. of research nowadays relate are becoming increasingly wide, and for this reason, the establishment of permanent, active contacts with the regional intergovernmental scientific institutions and with the specialized non-governmental organizations is virtually indispensable. Many of these latter organizations could be of great service to museums in research and other fields. Take for example, the International Council of Museums (ICOM) and its various international committees for archaeological history, ethnographical and natural sciences museums, the International Council for Monuments and Sites (ICOMOS), the International Union of Prehistoric and Protohistoric Sciences, the International Association for Classical Archaeology, the International Union of Orientalists, the various international organizations concerned with ethnography grouped together within the International Council for Philosophy and Humanistic Studies (ICPHS), the International Council of Scientific Unions (ICSU), the International Union for Conservation of Nature and Natural Resources (IUCN), the International Society of Soil Science, etc.

Relations with these organizations are very valuable for purposes of information, documentation, the adoption of working methods, project evaluation, and the planning of research and its detailed co-ordination.

Research carried out by foreign scientific missions in a country may also be regarded as a contribution to the implementation of its own programmes, in so much as the scientific objectives in view cannot but be of interest to both. It is natural therefore, to encourage this form of international scientific co-operation, which for a time experienced certain difficulties as a result of decolonization. The major museums and research and study centres have now resumed their activities, and their missions are scouring the continents, helping many countries to restore their cultural heritage.

It is recommended, however, that relationships between the countries where research is taking place and the missions carrying out that research should be firmly based on the international principles which have been adopted and be governed by bilateral or multilateral cultural contracts or agreements of mutual advantage to both or all parties and with no special conditions attached.

It is also worth noting that a new departure has been made in international scientific and cultural co-operation for carrying out large-scale projects of considerable scientific and cultural interest, requiring the expenditure of very substantial sums of money and the mobilization of a large number of specialists for a long period, thus making it beyond the capacity of one country to undertake them on its own. Like the projects on ecology, natural resources and oceanography, the study of the sahelian zone of Africa, the Chaco, the Indian Ocean, the tropical Atlantic etc., the international Campaign to Save the Monuments of Nubia, launched by Unesco in 1960, is an admirable example of multilateral co-operation. Archaeological missions from 24 Member States in four continents (Africa, America, Asia and Europe) have already carried out over 60 excavations along the 500 km of the valley of the Nubian Nile. The results of this research have been as important as the transfer of the monuments; they not only bear upon ethnography but shed new light on the whole history, from prehistoric times to the Arab civilization, of this meeting point of Central Africa and the Mediterranean countries.

In the current Unesco programme for 1967-68, this work is being carried a stage further by the launching of a project for studying the civilizations of Central Asia in co-operation with the relevant institutions in Afghanistan, India, Iran, Pakistan and several of the Soviet Central Asian Republics. A field work programme relating, in particular, to the archaeology and history of the Kushan Empire is at present being drawn up; it envisages the use of interdisciplinary approaches for co-ordinating the excavation work which will be undertaken.

In addition to carrying out research at home and in other countries under bilateral agreements, museums would also be wise to think in terms of participating, within the limits of their possibilities, in this type of multilateral research to be undertaken at the highest international level.

EXCHANGE OF OBJECTS BETWEEN MUSEUMS

It is a pity for a country's archaeological, historical, anthropological, ethnographical, natural science and other collections to remain dispersed because of the circumstances of their discovery and acquisition. On the contrary, it is worth assembling and distributing the products of research carefully so as to reflect the progress made in branches of science and to bring out the value of the country's cultural treasures.

The educational needs of our times call for the creation of multidisciplinary, specialized, regional, site and other museums. Different museums and categories of museums are increasingly basing their collections on an archaeological or artistic sequence, an overall historical perspective, or a geographical, ecological or other specialized classification. It is desirable, therefore, that national administrative departments responsible for museums should be able to effect any exchanges that would make the national collections more instructive and expressive and also enable particular museums to benefit from the fruits of research.

Whether collections are owned by the State, by local, public or private bodies, regulations governing exchanges, loans or the custody of objects are desirable in each country, so that collections can be built up and shared out among the museums and other public and private establishments. Such measures would help research and facilitate a rational use of funds earmarked for it, whilst at the same time eliminating the risks of rivalry and duplication.

Any action at national level in regard to exchanges of original objects between museums will have direct repercussions at the international level. The rational handling of the national heritage, by revealing the cultural wealth of a country, shows up the gaps in collections relating to other cultures: these gaps are often due to the absence or inadequate supply of foreign works or works representative of foreign countries in the national collections, and as a result may prevent the national heritage from being shown in its universal context.

To remedy this fault, the primary need is for original works from countries in the same geographical region or cultural area. These, in fact, are evidence of the existence through the ages of affinities or genuine spiritual families. Exchanges at regional level will thus help to explain the flourishing of the arts in a particular civilization, to clarify the various aspects of a culture, the various contributions to an aesthetic or a style, and to provide specimens and samples for the geographical, botanical, ecological or other kind of study of a region. Several regional intergovernmental organizations are taking these possibilities into account in the cultural programmes which they are preparing.

Exchanges of original objects can also serve broader aims at the international level proper, by helping to bring the works of distant civilizations or regions closer together. Mutual appreciation of cultural values began with the founding of the large museums of all categories which took upon themselves just such a task. Their work must continue and their example must be followed.

J. O. Brew

General remarks concerning the organization of expeditions

2

The various kinds of expeditions to be discussed in the main body of the text of this manual cover many branches of science. A multitude of different methods and techniques are involved. This is true even within a single subject. In geology, for example, an expedition to analyse the deposits of ancient lake sediments in southern Sweden and one to study sand dunes in the Algerian Sahara require different planning; and a survey of rock strata in the mountains of Nepal has needs radically different from the other two. Similarly, in archaeology, expeditions to excavate a large prehistoric Maya ceremonial centre in Guatemala, to explore a Palaeolithic rock-shelter in Tanzania, or to survey early Neolithic agricultural villages in north-eastern Syria, all demand greatly different preparation with regard to equipment, supplies, staff, and local arrangements. Expeditions vary in size from one man working alone collecting variations of an important medicinal plant on the tributaries of the Orinoco to fifteen or twenty scientists and technicians employing hundreds of labourers at a famous ancient city on the Indus or the Ganges.

Because of this extreme variation in size, aims, and locale, it is not possible in a general manual to provide the prospective expedition leader with an exact procedure. On the other hand, a number of highly important general principles apply to many, if not to most expeditions. This chapter will present these, and the leader can select those which fit his particular case. At first thought it might seem highly unlikely that there would be any similarity between an expedition to record solar radiation in the high Andes of Peru and one to study tree shrews in the jungles of Malaysia, but strangely enough the two have much in common.

EXPEDITION LEADER

Before we embark on a presentation of these general principles, it might be wise for us first to pause and consider the leader of the expedition himself. Ideally, this should be a man or woman with sound academic training in the subject of the expedition and previous experience in field work. No museums, however, have thoroughly trained people in all of the specialized branches of the various scientific disciplines. This is particularly true of new museums in countries which are undergoing rapid changes. In these countries it is especially important that collections in the anthropological and natural history fields be obtained as soon as possible while the materials needed are still available. Consequently, it is realized that situations may arise when it will appear necessary to send out an expedition even though the fully trained scientist to lead it is not available. Under such circumstances it is sometimes possible to solve the problem by obtaining such a person temporarily through an arrangement with another museum, a university, or a research institute, either within or outside the country in question. Co-operative agreements can be made with organizations or with individual scholars with a common interest. These usually involve the sharing of information and specimens collected, but such an arrangement can be a most practical investment and may also result in assistance for the publication of the results of the expedition.

If this proves impracticable, the leader must be drawn from the local staff. In small museums the director or one of his few assistants must do the job. If this person is ingenious and adaptable, has wide scientific sympathies, and designs a modest plan within the scope of his abilities and resources, the project should meet with success. The following suggestions are made with such a leader in mind.

OUTLINE OF ORGANIZATION

1. Clear definition of the expedition's objectives.
2. Marshalling and study of previous work in the area; (a) published material; (b) unpublished manuscripts and notes; (c) personal interviews.
3. Analysis of the physical features of the area: (a) maps; (b) meteorology and geology; flora and fauna;
4. Financial arrangements: (a) methods of financing; (b) guarantee of completion of field work; (c) guarantee of publication; (d) budget; (e) expense account.
5. Relations with present government and population: (a) permission to work; (b) local land tenure; (c) local attitude towards scientific work; (d) sources of labour and supplies; (e) local transport facilities; (f) local banking facilities.
6. Scientific ethics: (a) relations with local administrators and agencies; (b) relations with other institutions and scientists.
7. Assembling the expedition staff: (a) professional assistants; (b) technical assistants and skilled labour.
8. Assembling supplies and technical equipment.
9. Transport, packing and shipping: (a) types of transport; (b) packing and shipping.
10. Customs, passports, and health regulations.
11. Living arrangements in the field.
12. Conclusion of the field work.
13. Reports.

The items in this outline will now be discussed in some detail. They are general in nature and, although a number of them may prove more applicable to some fields than to others, they provide indications of procedures and types of information which it is hoped will be widely useful.

CLEAR DEFINITION OF OBJECTIVES OF THE EXPEDITION

The primary purpose of an expedition should obviously be to achieve its aims as efficiently and as completely as possible with the aid of all available scientific means. Many years ago Sir Flinders Petrie, one of the earliest exponents of good field methods, pointed out that unscientific methods had made museums 'ghastly charnel-houses of murdered evidence'. Since then progress in the disciplines with which this manual deals has been such that there is no excuse for bad expeditions. To come back from the field without clear and complete records, to neglect to catalogue and properly label objects deposited in museums, to fail to publish scientific findings is to destroy valuable evidence. It would be far better not to go into the field at all.

Of first importance in the planning of an expedition is a clear understanding of the purpose for which it is being undertaken. The party whose real motivation, if the truth were known, lies in the fact that the leader has always wanted to go 'on safari' into the big game country, desires to spend a summer in the Western Ghats, or is fascinated by the warlike history of the Apache Indians, is not likely to produce justifiable scientific results. The possible objectives are many and varied, but they should be specific and clearly stated.

For our purposes here the nature of the objective is not important. Be it to collect the rapidly disappearing elements of the material culture of a primitive tribe, to study its kinship system, to isolate a parasite which is destroying the sugar cane, or to plot tide action in the Straits of Magellan, the intention should be spelled out in detail and understood by all concerned. When this has been done, the expedition can then be properly planned.

MARSHALLING AND STUDY OF PREVIOUS WORK IN THE AREA

Published material. The objective having been defined, the first step is to survey all available previous knowledge of the subject. The most obvious source of such knowledge lies in published reports. All published works bearing on the field of the expedition should be read and abstracted. These may not be readily available locally, but much can now be done with interlibrary loans. It may be desirable for a member of the expedition staff to travel to some major centre where he can work for a period of time in an appropriate library.

Unpublished manuscripts and notes. Another important source lies in unpublished manuscripts and in the notes made by previous investigators in the field. When the names and addresses of such people can be obtained, much can be done through correspondence, Xerox or microfilm copies, etc. Sometimes a surprising amount of valuable information exists in unpublished form, and the custodians of such material are often willing to co-operate in making it available.

Personal interviews. Whenever possible, previous investigators in the field and others interested in the subject should be visited personally and notes taken of the interviews. Many important points are not included in published reports, particularly in relation to the logistic items described below, and often people who are very knowledgeable about an area have published or written down nothing at all. The latter group includes explorers, prospectors, retired administrators, traders, engineers, and others who have specialized, useful information about the area.

In this connexion, key books should be taken by the expedition into the field as well as notes and abstracts of the various unpublished materials and interviews.

ANALYSIS OF THE PHYSICAL FEATURES OF THE AREA

Maps. The late O. G. S. Crawford, who, perhaps more thoroughly than any other scientist, successfully combined the professions of cartography and archaeology, once wrote, 'Planning is naturally repugnant to many people'. Many expeditions, however, are heavily dependent upon maps, and the leader will be most remiss if he does not accumulate, before he goes into the field, as thorough a cartographic record of his territory as possible. This is usually not as easy as it seems at first glance. The British Ordnance Survey maps which present the entire United Kingdom at 50 inches to the mile, showing all known archaeological sites and even major boulders, are unfortunately unique. Some areas to which expeditions go have no satisfactory maps at all. Very seldom indeed will an expedition leader find a single map available which contains all the information he must or should have. His task will be to assemble all of the maps and other geographical information he can lay his hands on and, from them, construct his own master map.

A reasonable amount of research will often bring to light several types of special maps from each of which some of the necessary information for the master map can be obtained. All of the possibilities cannot be listed here, but examples are: geological maps, road maps, river and lake shore maps, mining maps, post office maps, forestry maps, etc. Inquiries should also be made about the existence of aerial maps and photographs of the area. Frequently, for military reasons, air photographs are 'restricted', but usually, with proper approaches, these can be provided for scientific use. Also, there are now commercial firms which do air photography on contract if permission for such activity can be obtained.

Meteorology and geology; flora and fauna. Knowledge of climate, ecology, vegetation, water-table, etc., is of varying utility to the different types of expeditions. To archaeological and ethnological studies, such information is necessary in as complete a form as possible in order to indicate the sources of food and water, building materials, minerals, metals, and stone for implements and ornaments, vegetable and mineral materials for paint, etc.

The sources for this kind of intelligence are to be found primarily in technical books, the publications of universities, museums, and governmental departments. These come under the headings of physiographic, hydrographic, and geological surveys, census, health bureau, and department of commerce reports, climatic and biological records, and various specialized reports of departments of natural resources, minerals, fish and wild life, agriculture, etc. Other useful sources are travel books, explorers' journals, and the technical reports of palaeontological, geological, botanical, oceanographic and zoological surveys, both official and private. Again, personal interviews with people knowledgeable on such subjects in the area can be extremely useful.

FINANCIAL ARRANGEMENTS

Methods of financing. Expeditions, whatever their character may be, must have funds on which to operate. If the institution conducting the expedition is a governmental department, this may not be a problem. But even then, the money available may not be sufficient to ensure a completely successful result. The leader of an expedition must be assured of sufficient funds, and this can be one of his most difficult problems. If he is a member of a sympathetic and understanding governmental department, he is indeed most fortunate. Often, however, other sources must be tapped to provide the necessary funds.

Although money for the support of scientific work is often difficult to obtain, there are still many possible sources. Private sources are still available in many countries. These range widely from a single large donor who provides all the funds, to a group of numerous contributors who are interested in the project and, in this last case, even though the individual donations are small, if enough of them are received the total can be significant. Scientific and eleemosynary foundations now exist in many countries, and these are some of the best sources for funds for scientific expeditions. Many of these foundations provide grants for work outside the confines of their own countries. Some of them operate on a 'matching fund' basis, in which case their grant has to be augmented by funds raised locally or elsewhere. Frequently, however, foundations work together to support a worthwhile scientific enterprise jointly.

Guarantee of completion of the field work. Before an expedition goes into the field, it *must* be assured of the requisite financial support to enable it to achieve its objective. There is an unfortunate record of a number of expeditions which have started out with inadequate finances and which have been forced to abandon their endeavours in midstream with no useful results. Work of this kind is merely destructive and serves no scientific purpose. It is essential that before an expedition starts out, it should have a guarantee of sufficient funds to permit it to complete its appointed task.

Guarantee of publication. For the most part expeditions are enterprises which attempt to add to the total of human knowledge. This aim can usually be achieved only by the publication of the results. Sometimes the leader of an expedition is attached to an institution where publication of his report is automatic, or he may have access to publication outlets. If this is not the case, for any research expedition, publication must be specifically arranged before it takes to the field. Otherwise the enterprise is simple vandalism.

The only exceptions to this are expeditions whose purpose is simply to collect specimens for exhibition in a museum or for laboratory analysis. Here the only scientific requirement is proper records of the field work and thorough labelling of the specimens when they are placed on exhibit or handed over to the laboratory. Even in such cases, a brief report of the material in an appropriate journal would be eminently desirable.

Budget. Budgetary regulations vary widely in different institutions. Even if a financial budget is not required, one should be made up. It is one of the essential elements in the planning of an expedition. This is the guide by which expenditures are governed. Made out in advance, it must of necessity be flexible. Divergencies from it are inevitable because of the exigencies of the field operations. Despite this, however, it is an indispensable guide-line as the expedition progresses through its season. Without it, the leader will not know how his funds are holding out or be able to conserve the money necessary for the concluding phases of the expedition.

Expense account. All monies spent on an expedition must be accounted for. This is not only ordinary economic procedure, it is a protection to the leader of the expedition, who is spending someone else's money. Accounts should be totaled up at least monthly and a complete accounting must be rendered at the conclusion of the expedition. This should include receipts for everything for which such documents can readily be obtained, including camp supplies and food, automotive expense, petrol and oil, salaries and wages, scientific and other equipment, medical, technical and office supplies, transportation and shipping expenses, etc. Records of minor expenses should be kept by all members of the expedition. These can be paid for out of expedition funds against a personal receipt.

RELATIONS WITH PRESENT GOVERNMENT AND POPULATION

The relationships between the expedition and the local officials and population are of great importance. Many expeditions have been hampered, and their efficiency cut down, through ignoring the precepts suggested in this and the following section. There are on the record failures of several expeditions through the thoughtlessness of the leader in not establishing a workable liaison with the local people, official and otherwise. Whether an expedition is heading for the Middle Atlas Mountains in Morocco, the southern tributaries of the Amazon, or the Murchison Range in the Northern Territory of Australia, it would be well advised to find out all that it can about the local controls of the area and to make contact in advance with regional government officials.

Permission to work. Although it is not true of all of them, many expeditions need to obtain official permission in order to carry out their work. We may assume that this will always be the case in a foreign country. Permits are sometimes necessary even when the expedition is sponsored by a branch of the national government. Regulations vary greatly from country to country. These should be studied carefully and, to avoid delay, applications for permits should be submitted well in advance. Foresight in this matter is particularly important when local permissions are involved. In addition to the official government permit it is frequently necessary to obtain the permission of private land owners or the administration of native reserves, forestry or animal reserves, provincial governments, etc. Such procedures can be very time-consuming. This is especially true of archaeological and palaeontological expeditions. Almost all countries now have antiquity laws, laws of treasure trove, laws protecting fossil deposits, etc. The texts of such laws should be obtained and copies of them carried by the expedition in the field. When dealing with private land owners it is important to get written permission, including a statement as to whether or not financial compensation is involved and, if so, how much.

Local land tenure. In connexion with permissions, it is necessary to know who actually owns and controls the land. Furthermore, one must know if the 'owner's' permission is sufficient or if permission must be secured from tenants as well. The importance of obtaining the consent, co-operation and interest of land owners, tenants, lessees, and occupants of the land cannot be overemphasized. Even in those countries where private land tenure is actually or theoretically abandoned, it is essential that working agreements be made with the people who live on and use the land. This is of particular importance to archaeological, palaeontological, and geological expeditions. On agricultural land, the question of crop compensation often arises. If land is to be taken out of production during the growing season, an agreement should be negotiated with the farmer based on current crop values.

Local attitude toward scientific work. The welcome afforded an expedition in the field ranges all the way from enthusiastic acceptance to armed resistance. It is important to know what to expect. Previous expeditions into the area are the best source of information. Members of those expeditions usually must be consulted personally, either by interview or by mail, as this kind of information is very rarely included in scientific reports. Letters of introduction from such people may be of use. 'Outsiders' often encounter suspicion and distrust, if not overt antagonism. The fact that the expedition comes from the national capital does not always allay those feelings.

Sources of labour and supplies. If the expedition has a capable local agent or foreman, the questions of labour and supplies can be left to him. This, however, is often not the case, particularly during the first season of an expedition. Reliable labourers are not always easy to obtain. There may be a seasonal factor involved. For example, in an agricultural region it is very difficult to obtain labour during the harvest season, whereas after harvest large numbers of men are available. Various types of local agencies may be able to supply labour. These include tribal chieftains, labour exchanges, county councils, police, local large employers, religious organizations, etc.

As for ordinary supplies, food, fuel, etc., it is desirable to purchase some of this locally, if possible. Feelings toward the expedition inevitably improve if it is spending money in the region. The problem for the leader is to find out just what is and what is not available locally in the way of supplies. If there is more than one supplier, of more or less equal merit, it is good policy to distribute the patronage among them. This has a dual effect: it establishes good will in a number of quarters, and it keeps the prices down through competition.

Local transport facilities. All possible information about roads, trails, navigable rivers, etc., should be gathered in advance. This is, obviously, one of the more important aspects of planning an expedition. The details will vary greatly with the nature of the terrain and of the expedition, and specific suggestions will be made later in this chapter.

Local banking facilities. Before starting into the field it is necessary to know what arrangements must be made for handling the funds of the expedition, making payments, etc. If there are banks in the region, the problem is relatively simple. In many places, however, banks do not exist and there are still areas where payments in money are of no use to the recipients. The problem in planning an expedition is then, first of all, to find out what the ordinary medium of exchange is. For instance, certain primitive Bushmen are still most interested in obtaining tobacco and other trade goods. At the opposite extreme, a Hopi Indian in north-eastern Arizona can be paid by a bank cheque. In any event, credit must be established either at a bank or with a trading company, local government post, mission, or whatever established agency is available. Whatever the method of exchange arrived at may be, payments should be made promptly.

SCIENTIFIC ETHICS

In the past, many expeditions have failed or encountered unnecessary difficulties through undiplomatic, thoughtless, or offensive behaviour on the part of the leader or members of the staff. Particularly at the start of an expedition, time spent on establishing good public relations will bring dividends and bear fruit in countless ways as the work goes on.

Relations with local administrators and agencies. Under certain circumstances a local chieftain, squire, or minor politician may be more important to the expedition than the great men in the capital or at the university. The leader of the expedition should get acquainted with the local people. It is highly desirable that important local officials have a sympathetic understanding of the aims of the expedition. Official 'red tape' may need considerable unwinding, and it is highly desirable that good relationships be established with the administrators of the immediate area in which the expedition proposes to work. The leader should take the time to make himself and his plans generally known to the regional, provincial, county, and municipal officials who may be able to assist in the many problems which will arise in connexion with the expedition. This includes the local judiciary, police and highway officials, and other legally constituted individuals. If a number of these people can be induced to become interested in the work, they may be able to render invaluable moral and practical support, providing manpower, earth-moving tools, and other emergency assistance, help in case of accidents, and aid in innumerable ways which will contribute to the success of the expedition.

Relations with other institutions and scientists. Although the expedition may be the only one operating in the area, it often happens that other scientists, in similar or related fields, are working simultaneously in the region. It is important that co-operative, friendly relationships be established with the leaders of such expeditions and local institutions. Despite professed high scientific aims, professional jealousies and competition have often in the past been known to give rise to many unpleasant situations. A diplomatic approach to neighbouring scientists is greatly to be desired and can eliminate many potential difficulties. As an example of the gain which can result when good co-operation has been established, one of the expeditions which recently had a concession to excavate pharaonic sites in Sudanese Nubia, in the area along the Nile to be flooded by the new Aswan Dam, unexpectedly encountered important palaeolithic remains and were able to borrow an expert specialist from a neighbouring prehistoric expedition. The work was then properly carried out, and a mutually satisfactory publication agreement was established.

ASSEMBLING THE EXPEDITION STAFF

Expeditions obviously vary greatly in the size and nature of their staffs. Planning for staff, equipment, and supplies can be broken down into two general categories according to the place of procurement: the home base or local sources.

Professional assistants. The specialized professional staff of an expedition must usually be recruited at the home base, drawn from major universities or museums. Sometimes it is necessary or desirable to obtain them from abroad. When a local research centre or institution of higher learning exists in the area in which the expedition plans to work, it may be useful to add a local scientist to the staff in order to take advantage of his knowledge of the region. In this connexion, we must not lose sight of the value of training local people through their association on the expedition with experienced and well-trained experts. Similarly, a field expedition offers an excellent opportunity for the training of students, both graduate and undergraduate, who can render valuable assistance to the professional aspects of the work.

Technical assistance and skilled labour. For the most part, specialized technical personnel must be recruited before the expedition takes to the field. Surveyors, topographers, draftsmen, skilled automotive mechanics, etc., ordinarily can be found only in major national, provincial, and university centres.

ASSEMBLING SUPPLIES AND TECHNICAL EQUIPMENT

Most, if not all, of the technical equipment must also be assembled before the expedition leaves for the field. This includes surveying equipment such as transits, alidades, leveling devices, site poles, stadia rods, measuring tapes, drafting instruments, drawing paper, inks, pencils, notebooks, cameras, film, medical and surgical supplies, office equipment, camp equipment, and even certain food items. Knowledge of what is available logically is extremely important in this connexion. Sometimes, for example, an expedition takes its entire food supply into the field. In other instances, a considerable amount of reliance can be placed on local resources. An archaeological expedition into the jungles of the Guatemalan Peten may well establish, through the agency of its caretaker and local staff, milpa vegetable gardens, poultry and other livestock farms, etc. There are a number of villages in Central America and Yucatan, some of which now have a population of several hundreds, which began as archaeological camps. The expedition may even employ a hunter who will provide fish and wild game. Again we must emphasize the importance of as thorough a knowledge as possible, in advance, of the region in which the expedition will operate. Mutual benefit will accrue from the utilization of these local resources, but the expedition leader must not rely upon them unless he has definite information that they will be available.

TRANSPORT, PACKING, AND SHIPPING

Problems of transport have been greatly simplified by modern technology. Unfortunately, however, expeditions have a tendency to operate in areas where transport is still at a primitive level. In lowland Central America, although airfields are now to be found at the major centres, most transport is still provided by dugout canoe and jungle trails. The dugout canoe may now have an outboard motor, but its carrying capacity is very limited.

This is another aspect in which advance knowledge of the area where the work is to be carried out is of utmost importance. The first point to be established is whether transport can be obtained locally or whether vehicles, outboard motors, helicopters, etc., must be brought in by the expedition. The problem is to provide adequate food, living and working equipment with a minimum outlay of money, time, and trouble for transport. Transport of personnel must also be considered, as must the shipment out of the area of the material collected by the expedition. Not only the cost but also the mobility, convenience, and safety of the people and material to be transported must be considered. Outside of developed areas equipment for living usually bulks larger than equipment for working. In remote regions equipment must be kept to a minimum because expense and trouble increase rapidly with the amount to be transported.

Transport must be considered in five categories: porters, animal pack trains, wheeled vehicles, water transport, and air transport.

Porters—human transport. The simplest and cheapest form of transport is for the scientist to carry his equipment on his own back. This is possible in cases of certain botanical, geological, palaeontological, or archaeological reconnaissance expeditions. Usually, however, help is needed. The advantages of human transport are considerable. The entire outfit can go where one man can go, so that there is complete independence of roads or even of trails. The porters also provide abundant labour in camp. Men are less bother than animals, for they can look after themselves, whereas animals have to be cared for. They also may be more easily recruited and dismissed, providing greater flexibility in transport organization, and, when released, they can go home by themselves, which animals cannot do.

One disadvantage of human transport is that food must be carried for the men. This limits the area of operations to about a two weeks' march. Beyond that the porters must carry more food for themselves than expedition baggage. In addition, the likelihood of sickness or fighting among the porters increases directly in proportion to the number of men. Normally, for long distances, upwards of forty men are needed to carry a ton of goods. This makes human transport very expensive, even though the rate per man per day may seem low. Sometimes, however, this is the only form of transport which is practical.

Animal pack trains. In various parts of the world the following animals may be used to carry goods: horses, mules, donkeys, camels, bullocks, yaks, elephants, and llamas. Except for llamas, animals can be expected to carry heavier loads than men. Except for camels, they are generally, like porters, independent of roads and established trails. The disadvantages are that they have to be fed and cared for; experienced handlers are therefore required. For sustained hard marching, twenty to thirty miles a day, grain feeding is usually necessary, and this food must be carried as the animals cannot keep up their strength without ample time to graze. If the expedition is moving slowly, a grazing diet may be sufficient. The ability of the man in charge of the pack train is of great importance and, when possible, he should be engaged in advance upon good advice. One man can care for two to five horses or mules to carry 400 to 1000 pounds, or seven to ten camels transporting over a ton of goods. This, however, applies only to men and animals used to the work. Members of the expedition can assist the wranglers in the packing and handling of the beasts, but the importance of a good man in charge of the pack train cannot be overemphasized. Procurement should also include good riding animals for the members of the staff.

If animal transport is to be used, the arrangement of the loads must be carefully calculated. The loads must be evenly balanced and must be planned so that no one package exceeds half a load for the animal. Loading will take longer in the morning than for other forms of transport, and again assistance from the staff will expedite movement considerably. The leader of the expedition must also see that the animals are properly shod for the terrain that is to be crossed and that spare shoes and the equipment for applying them are provided. This cannot be left entirely as a responsibility of the handlers, but should be carefully checked before the expedition starts out.

Wheeled vehicles. This category includes trains, wagons, and carts, and various forms of automotive vehicles. Train transport is one of the standard ways of approaching the area of an expedition. This normally presents no problems, but it should be remembered that railroads that penetrate primitive regions are subject to frequent washouts and other disasters where baggage must be carried around a break in the line. In such cases, arrangement of the equipment into packages which can be carried by one man may prove worthwhile.

Although the use of automotive equipment has recently spread widely throughout the world, there are still regions where vehicles drawn by animals are commonly used. It is true that a given number of animals can move many times the amount of material in a wagon or cart than they can in packs on their backs. Wagons can move over very bad roads and in some types of country where there are no roads at all. Loading is rapid and easy and, as with automotive transport, the size and shape of the packages are less important than with most other forms of transport. On very bad roads there is some danger of breakage of equipment through jolting and overturning, and this should be prepared for in the packing.

The most common form of transport at present is the automobile, ranging from ordinary passenger cars and trucks to specialized vehicles such as Jeeps, Land Rovers, Power Wagons, and six-wheel trucks. The choice of vehicle depends on the nature of the terrain to be traversed. Except in regions with good roads and towns and cities no great distance apart, motor transport should never be undertaken without a competent mechanic, either amateur or professional. This factor should be considered in recruiting expedition personnel. Photographers and topographers often possess sufficient skills for all ordinary emergencies. For work in remote and rough countries, however, professional mechanics are necessary. For example, if equipment has to be ferried across a river in small boats or rafts, it may be necessary to dismantle and reassemble the vehicles. In such country a full inventory of spare parts is needed, as extensive repairs often have to be made. For the same reason, special attention must be given to the tool kit, and each vehicle should be fully equipped at all times.

In many areas where expeditions operate, safety and success demand more than one vehicle, and long trips must never be undertaken except in convoy. At least one of the vehicles in the convoy should be equipped with a winch. Before starting out on a trip, a thorough check must be made to ensure that extra water, oil, petrol, spare parts, tools, tow ropes, shovels, etc., are present.

In motor transport, packing is less of a problem than in other forms. It is often desirable to have special boxes permanently built into the vehicles. Care must be taken, however, that tools, spare tyres, and all other items that may be needed during the course of the trip are readily available so that the truck does not have to be unloaded in order to get at them. Whenever possible, individual packages should not weigh more than fifty to sixty pounds.

Water transport. In general, water transport is the cheapest, safest, and least laborious means for moving goods and personnel. Except for canoes and other small boats, packages can be of any size. For primitive water transport the size of packages must be related to the smallest boats to be used. When portages are involved, between lakes or around rapids or falls in rivers, packages should be restricted to weights easily carried. For small boat travel, certain types of equipment and supplies should be in watertight containers.

Air transport. The advantages of air transport for scientific work are threefold. The first is speed; even small planes and helicopters can travel faster than any other form of transport. Second, for reconnaissance and photography, great areas of country can be surveyed quickly; when modern techniques o photogrammetry are used, accurate maps can rapidly be made. Third, the aeroplane is independent of differences in terrain, both land and water, and distances can be traversed quickly in a single vehicle that otherwise would call for shifting from one to another of a number of different types of surface transport. This is however, in general, the most costly form of transport. It demands highly skilled operators and mechanics. Also, although floats and skis can be substituted for wheels in the landing gear, except for helicopters the places where the craft can land are strictly limited. Under certain circumstances it is a most desirable form of transport and has enabled a number of expeditions to achieve results which would not otherwise have been possible.

Packing and shipping. Every form of trave has its fixed routine and it is necessary to pack for that routine. The size and shape of packages should be designed for the most primitive type of transport that the expedition will encounter. Things that are to be used together should be packed together, such as cooking utensils, photographic developing materials, etc. Things wanted at a given time can then be found in definitely known packages in a specific place in the baggage. This will save much time and confusion. All packages should be numbered and the contents indicated. The leader of the expedition should have a complete record of the contents of the packages, and a list of the contents should be placed inside each package. Reserve supplies should be packed in separate balanced units. If the expedition is to be divided into two or more parties when it arrives at the scene of operations, much time and difficulty will be saved if this is foreseen in the make-up of the packages.

In packing and shipping, the four chief dangers to guard against are breakage, water damage, theft, and loss. The most frequent cause of breakage is the shifting of the contents in the packages. This is best prevented by tight packing, interior partitions and cleats, and special containers within the packages for all fragile and delicate objects. Other causes of breakage are falls, blows and the strain of pack ropes. The strength of the container is in general the only safeguard against this kind of damage. Water damage may be caused by rain or by immersion during river crossings, floods, or as a result of the capsizing of small boats. Important and expensive equipment should be packed in waterproof containers, and waterproof canvas tarpaulins will protect the load from rain.

The most effective protection against theft is vigilance. Valuable equipment should be kept in padlocked boxes, preferably unlocked by the same key or by a master key. Padlocks are better than built-in locks, as they can be filed off if the key is lost or the mechanism ruined by dust or rust. Extra padlocks should be carried.

Against loss, theft, or breakage, duplicates of important materials such as essential scientific instruments, medicines, etc., should be provided. All shipments should be insured, but the precautions outlined above should be taken because insurance coverage will be of no immediate use to the expedition if it arrives in the field to find essential equipment missing or broken.

Shipment of specimens. If the expedition plans to collect and send home scientific specimens, thought must be given to this when the expedition is being planned. In some regions, packing materials, boxes, etc., may be obtained locally, but often that is not the case. Specialized containers, for botanical specimens, etc., will naturally be brought from the home base, but provision must often be made for gross shipments. The containers used to transport certain supplies, such as food and expendable equipment, will gradually become available during the course of the expedition, but these often will not be sufficient. Cardboard cartons in flat form for assembly, foam rubber, plastic boxes, cloth or paper bags, etc., should be part of the expedition's baggage. If the expedition is situated so that it receives mail regularly, subscriptions to a number of newspapers will provide good packing material.

All specimens shipped must be well labelled in such a way that the label cannot be lost or obliterated in transit. All containers of specimens should bear labels on both the outside and the inside. With certain types of specimens it is desirable to write a field catalogue number on the object itself. For fragile objects, such as pottery and plant specimens, it is wise to use double packing, that is to place the carton containing the specimens inside a somewhat larger carton or wooden box with a cushion of newspapers, grass, or other material between the two.

CUSTOMS, PASSPORTS AND HEALTH REGULATIONS

If the expedition is to operate in a foreign country, there are a number of factors to be considered in addition to whatever scientific permits are necessary. In most countries, if the proper approach is made, it is possible to bring in scientific equipment and expedition supplies free of local customs duties. Negotiations for such exemptions should be initiated as far in advance as possible as they are often complicated. This is particularly the case when the equipment has to pass through one or more other countries before it arrives in the country where the work is to be done. If arrangements for such passage through customs are not made, distressing delays may occur. It is also possible for the expedition to obtain exemptions from certain local taxes, such as the petrol tax, and even free transport of equipment, or at least a favourable rate on the local railroads and air lines. The expedition leader should familiarize himself with all local regulations pertaining to these matters and get in touch with competent officials in the countries concerned. He must also see that the members of his staff are equipped with passports and all necessary visas and that they obtain the injections and vaccinations needed to immunize them against the prevalent diseases of the region.

LIVING ARRANGEMENTS IN THE FIELD

The arrangements for living in the field vary greatly depending on the nature of the expedition, its size, and the region in which it plans to work. In settled countries, expedition members may live in hotels or as paying guests in country houses or farm houses. Often, however, it is necessary to establish a camp or a series of camps.

The requirements are so varied that we cannot go into the details of expedition camps within the confines of this introductory chapter. Certain generalizations, however, can be offered. The task of the expedition leader is to design a camp which will provide for comfort, safety, and health, and permit his staff to conduct their work in the best possible manner. Certain hardships must be endured, but every effort should be made to keep these at a minimum.

The selection of the site of the camp is of first importance. It should take full advantage of whatever amenities the environment offers and protect against storms, floods, snow avalanches, etc. Water is a most important consideration. Whenever possible the camp should be close to a good water supply.

38

Sometimes, however, no good water supply exists where the work of the expedition is being done. In that case the decision must be made whether to camp by the water supply and transport men, equipment, and specimens to and from the work or to camp at the site and haul the water. Food is another important factor upon which the morale of the camp is highly dependent. It is axiomatic that one of the most valuable members of a camp is a good cook.

CONCLUSION OF THE EXPEDITION

At the end of the field work, the leader of the expedition must be sure that enough time and thought is given to the concluding phases. If excavations have been made, the land should be left according to the wishes of the owner or occupier. Farmers usually want the land to be restored as nearly as possible to its original condition. In the case of archaeological excavations, however, the local people sometimes want the site left open for visitors to see. It is also possible that restoration may have been stipulated in the official permit, and occasionally the site may be preserved as a historic monument. For the benefit of future expeditions and in case the leader may wish to return at some future date for further work in the area, it is essential that the expedition leave a good impression behind it, that local officials be properly thanked and that all obligations, financial and otherwise, be met.

REPORTS

The final responsibility of an expedition is the scientific report. In most cases the work will have been of little or no value unless a detailed report is published for the world of scholarship. After the field work has been accomplished, the various members of an expedition often scatter far and wide, and it is sometimes difficult to assemble their several reports. It is the duty of the leader to see that this report is written and published.

Yvonne Oddon

Standard methods of field documentation 3

SIGNIFICANCE OF IDENTIFICATION RECORDS

Whether casually discovered, systematically collected in the field by a scientific expedition, bought at a dealer's shop or accepted as a gift at the museum, each object should be accurately identified before being formally added to a museum's collection.

A museum's collection includes all acquisitions made through finds, purchases, gifts, bequests and exchanges, excluding, of course, temporary loans and the questionable long-term deposits.

It does not necessarily follow that an object once registered should be kept forever in a museum's collection. It might indeed, according to the institution's policy, interest or legal possibilities, be exchanged or even sold. Nevertheless, it is essential that it should be, at all times, accompanied by its correct identification: an object, when unidentified, is usually worthless for purposes of conservation, scientific research, exhibition or education, whatever may be the main activity of the museum.

Records bearing fragmentary or inaccurate information and objects erroneously numbered also have little value. Registers bearing illegible entries, or which have been lost or are undecipherable because entries have been made on a single copy or on low-grade paper, are also responsible for hours and days of disheartening labour. Museum curators all over the world have frequently been faced with a tremendous task of reorganization owing either to neglect or to ignorance of the proper methods to be followed.

As a rule, unidentified objects are not discarded but are put aside for careful investigation with the help of the museum reference library, or else are sent to a specialized museum or to an expert in the particular branch of knowledge involved. Whatever the case, this causes loss of time and often extra expense.

This is why the establishment of a set of regulations using a satisfactory system of records is one of the most important responsibilities of a museum.

The basic elements include the following:

- Identification or acquisition record (temporary, or 'transmission' label and accompanying notes).
- Accession records (Registration).
- Descriptive catalogue (Scientific catalogue cards with accessory indexes and cross-references).
- Location records (Place of objects within the museum; movement of the collections in or out of the museum).
- Collection file, or 'historic' file (Folders for individual objects or for collections, containing details on origin and acquisition, field notes, correspondence, photographs, bibliographical notes, etc.).
- Iconographic and photographic records.
- Records on the condition of the object and of its treatment.
- Loan record.

The first of these records, the identification record, is the master-key to all the others.

Fig. 1.
Field identification label

Museum N° Field inventory N°

Designation

Object found [ ] received [ ] bought [ ] From

Place

Date when found or bought Collector's Name

Field trip or Expedition Price paid

Origin

Maker

Ethnic group, or Species

Material & Technique

Function or use

Museum photo N° Negative N° Field photo N°

Description and Condition of object

Measurements

Remarks

Collection file N°

Attached to the object at the moment of its acquisition, it should not be removed until final numbering and cataloguing, and even then, it can be used for other purposes (see below, p. 55).

In small museums, the identification record, which is transmitted to the registrar or written by the curator himself, often provides the only information the museum will ever have about the object. Hence it is all the more important to prepare identification forms, multigraphed or printed, for distribution to museum staff in charge of collecting, buying or receiving objects or specimens.

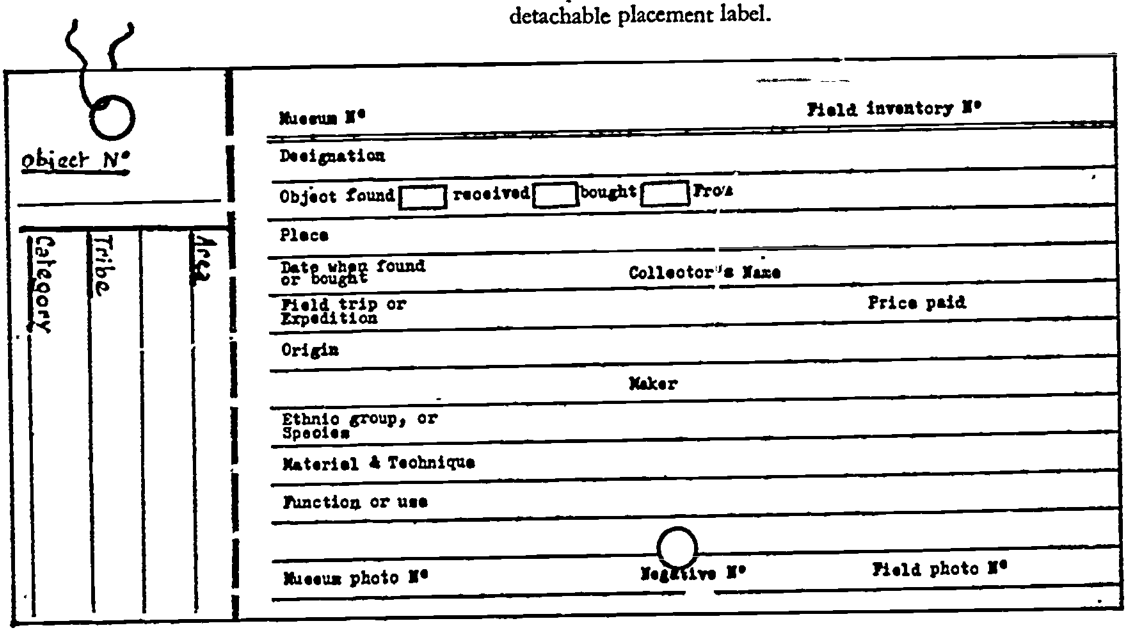
Specialized museums or large departmentalized museums generally have different forms according to the category of the collection in question. Small general and regional museums, however, although dealing with various kinds of collections, cannot afford to use complicated methods and different types of forms.

Any identification record, however, regardless of the category and size of the museum, should include at least the following basic information: provisional number identifying the object when collected during field work; name or designation of the object; mode of acquisition; source (name of person or expedition responsible for the acquisition) price paid (if any); place of origin and period if known; short description, measurements and condition of the object; photographic identification number; remarks on condition of acquisition, etc.

Such abridged data can easily be fitted on to a Bristol card label of library size (Figs. 1, 2), with all other relevant information being recorded on sheets of paper or preferably on detachable pages of a notebook.

Identification records established by collectors in the course of their field-work constitute the most reliable type of documentation. There should be no problem when they are written in person by specialists in search of

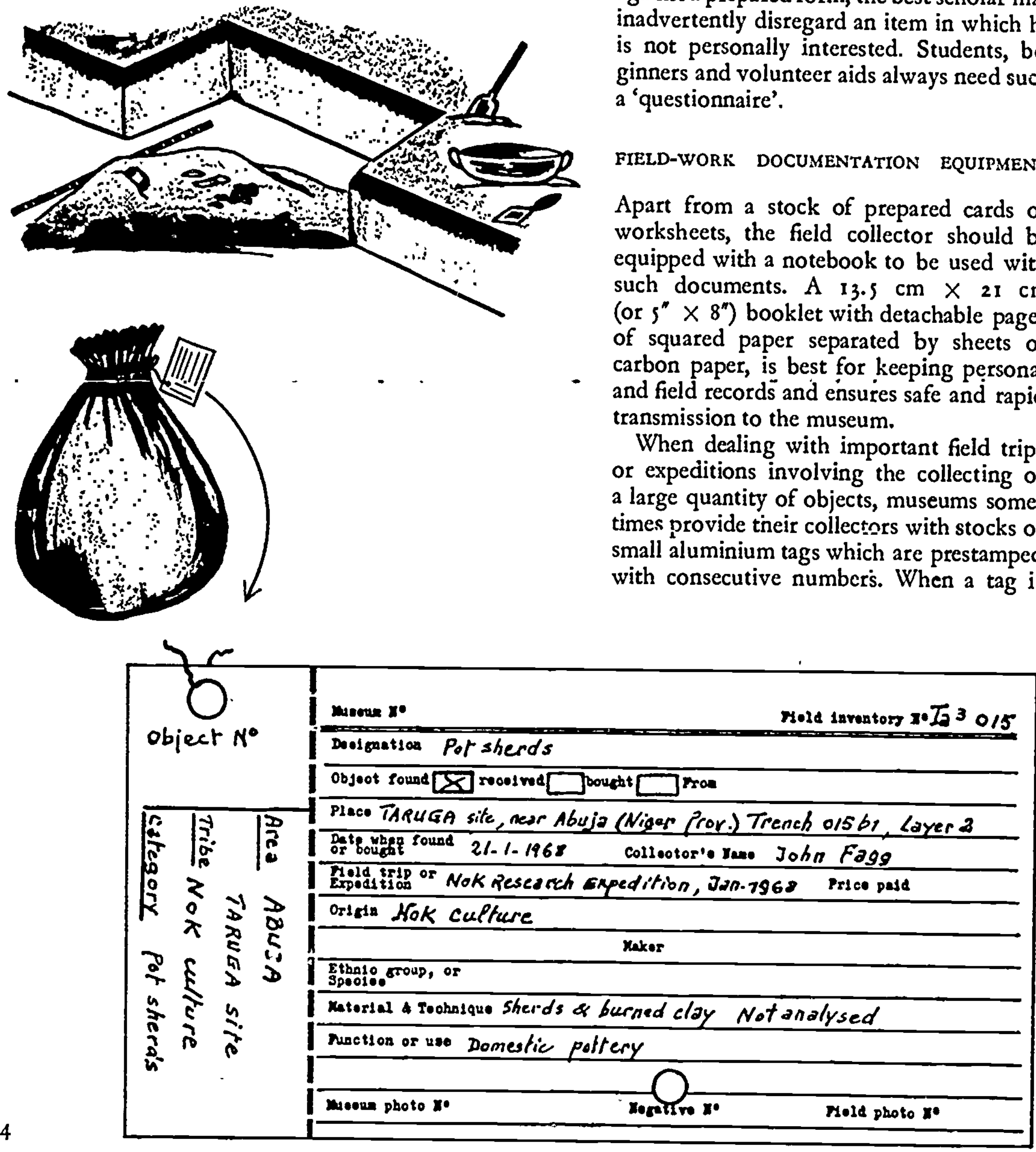
Fig. 2.
Example of an identification card with a detachable placement label.


Object N°

Category | Tribe | Area

Museum N° — Field inventory N°
Designation
Object found [ ] received [ ] bought [ ] From
Place
Date when found or bought — Collector's Name
Field trip or Expedition — Price paid
Origin
Maker
Ethnic group, or Species
Material & Technique
Function or use
Museum photo N° — Negative N° — Field photo N°

Fig. 3.
Field identification: pottery fragments. All the finds in a particular layer of excavation are sent to the museum with a single identification card.



facts and eager to note every scrap of information which might be helpful later on for further studies. Nevertheless it often happens that unless he can check the data required against a prepared form, the best scholar may inadvertently disregard an item in which he is not personally interested. Students, beginners and volunteer aids always need such a 'questionnaire'.

FIELD-WORK DOCUMENTATION EQUIPMENT

Apart from a stock of prepared cards or worksheets, the field collector should be equipped with a notebook to be used with such documents. A 13.5 cm × 21 cm (or 5″ × 8″) booklet with detachable pages of squared paper separated by sheets of carbon paper, is best for keeping personal and field records and ensures safe and rapid transmission to the museum.

When dealing with important field trips or expeditions involving the collecting of a large quantity of objects, museums sometimes provide their collectors with stocks of small aluminium tags which are prestamped with consecutive numbers. When a tag is fastened to the object, the number is immediately recorded in the field notebook and the corresponding identification entry is made.

However, if the collector's notes do not reach the museum at the same time as the labelled objects, the task of the registrar will be complicated. In order to avoid this, the collector should record all entries in a special field label-book made up of duplicate standard identification forms, one of which, made of good quality or cloth-reinforced paper, can be detached and tied to the object or enclosed in the box or parcel of finds sent to the museum (Fig. 3).

Needless to say, the use of good quality labels is particularly advocated for tropical climates, where protection against insect pests or fungi (such as spraying with a solution of three parts of ethylene dichloride to one part of carbon tetrachloride, or other suitable products) is also advisable.

Indelible pencils and, if necessary, indian ink or similar products, should be used. Labels can be slipped into a plastic envelope before being tied to the object.[1]

Permanent marking directly on the objects is a task for the museum since it involves the use of different techniques according to the various types of materials. It is a task rarely undertaken in the field, where objects are usually allocated temporary numbers on removable labels.

A tape-measure (preferably with metric marking) should not be forgotten, and portable scales might turn out to be useful.

Photographic equipment is, of course, indispensable, as possibly also a battery tape-recorder and, if required by the type of survey, a cine-camera (see also below, p. 55).

The collector should have an official local survey map and have access to a good standard dictionary. A few specialized textbooks and vernacular vocabularies will be required, depending on the type of fieldwork he is engaged in.

The museum should, of course, supply field-workers with glue, tape and light, strong cord (avoiding rubber bands, which deteriorate, and common adhesive tape, which might 'run'), and with labels or tags bearing the institution's name and address.

GENERAL RECOMMENDATIONS

Although the primary rules of documentation procedure need not be elaborate, the following are basic:
- Never postpone the task of writing down information in the field-book. Even if it is only hastily scribbled, it is safer than committing it to memory.
- Keep objects in separate lots according to the places where they were found. Do not, for instance, mix archaeological pieces obtained from different locations; assign a special number or code to each lot, tray or bag.
- As far as possible, complete the identification label on the spot and tie it to the object, or if the find consists of fragmentary pieces or a biological specimen, place it in the container or envelope, or around the vial, etc.
- Do not use abbreviations: spell all names in full.
- Be sure to number every object at the time of identification, repeating the same 'field-inventory number' on all records pertaining to the same object.
- Keep records of operations in a chronological sequence, possibly using marks or symbols for future systematization.
- Use notebook also as a diary: many apparently insignificant details might become of importance in the future. A duplicate carbon copy should be kept for the museum's collection file.

1. Permanent labels to be placed in vials can be prepared later on in the museum's laboratory. They are usually typed on special parchment paper using a minuscule-type typewriter equipped with an acetate carbon ribbon.

– Remember that the scientific value of an object depends on precise information. Information can be concise, but the 'history' of an object is never too complete.

COMPLETING IDENTIFICATION RECORDS

We shall not attempt to give examples of elaborate collecting or survey questionnaires, but rather, using the simple standard label shown on page 42 as a basis, point out the kind of information which should not be overlooked when dealing with a given category of collection.

1. *Museum No.* Space left blank by the collector, to be filled in later by the museum's registrar when the object is assigned its permanent accession number.[1]

2. *Field inventory No.* The collector's own recording number, as entered in his field notebook. This may consist of numbers of two or three units, the first giving the two last digits of the current year, the second being a serial number referring to the place or site of the find, and the last referring to the individual object or batch of fragmentary pieces. If a field survey is carried out over a period of several years, the two first numbers may be reversed.

   The collector may also want to include letters to designate particular categories of collections or the nature of an object, for instance *P* for Pottery, *S* for Sculpture, *O* for Ornament, or any other subject-matter serving his own purpose.

3. *Designation.* Record the name of the object or specimen, first in the terminology used in the museum, then, if at all possible, in the local vernacular. Identify the language and use a standard phonetic notation.

   Numerous textbooks set out to provide a rapid means of identification for many different categories of objects or specimens. Should they be trusted implicitly?

   Archaeologists and ethnologists are well aware of the difficulty of assigning a proper name to objects not pertaining to their own special field of study. Names commonly used are often misleading and should always be supplemented by a correct description under the corresponding heading.

   Nevertheless, it should be remembered that he who refers, for instance, to a musical instrument by any name or description he pleases, being unaware of the points which matter, will cause more confusion than if he had left it altogether unnoticed.... Ethnological literature teams with ambiguous or misleading terms for instruments, and in museums, where the field-collector's report has the last say, the most senseless terms may be perpetuated on the labels.[2]

   The name given to the object by its users and the name by which it is known in the area of its origin, is more precise than a guess at a technical term.

   What is true for musicology is true for the whole field of ethnology whose terminology is by no means firmly established. Objects are closely associated with cultural traits which, through confusion of terms, may easily be misinterpreted.

   In case of doubt and when it is not possible to use a plain universal appellation such as 'sandal', 'comb', 'axe', 'basket', etc., it is better to leave a blank (see also below para. 13).

   Natural science specimens, unless correctly identified, should also be entered at this first stage under their common

1. Number of two units when the accession is one object, and three units when the accession consists of several objects.

2. E. von Hornbostel and Curt Sachs, Classification of Musical Instruments, *The Galpin Society Journal*, London, no. 14, March 1961. Translated by A. Baines and K. P. Wachsman.

name, followed by the vernacular term. The sex of animals should, however, be indicated (Fig. 4).

Type-specimens, when recognized as such, should of course be specially mentioned.

4. *Mode of acquisition.* Mention whether locally found or excavated, received as a gift, or purchased. Give the name of the donor or dealer.

Information such as names and addresses of informants, owner of site, etc., should be entered fully in the field notebook (see also below under para. 7).

Note also the techniques used to obtain the object, for example, an underwater find was obtained through grabing, dredging, trawling, etc.

5. *Place where found or bought.* Locality, district or area, province or region, country.

Locate the exact site on an official map (preferably a government survey map provided with a grid system). In the case of archaeological excavation, it is essential that the field notebook should contain a precise record of the position of objects when found (Field grid number, layer, measurements in depth and horizontal plan), stratigraphical information, and *notes about any objects found in association* (see also paras. 12 and 17).

Submarine sites should be identified with latitude, longitude, depths, and distance from the nearest inhabitated locality.

In the case of zoological and botanical collections, details of the habitat are of primary importance: it is therefore necessary to indicate the altitude of the location, and details of local climatic and soil conditions in the-field book. All environmental data, even when thought to be of secondary interest, should be noted on the spot. If this is not done, the information may be lost for ever; and it may be found later that it was important for research. As has been said by a museum zoologist, 'nowadays the success of an expedition should be measured more by the number of notebooks that are filled than by the number of specimens brought back'.[1]

Geological specimens should be located in relation to the topography, with notes about local vegetation and the presence of fossils.

6. *Date when found or acquired.* The season, month and time of day or night, are also of significance when dealing with the capture of animals (particularly insects) and the uprooting of plants.

7. *Collector's name.* Name the person, or persons, responsible for the find or the purchase of the object.

If obtained from a former collection, this should be specified under the heading 'remarks' on the reverse side of the label (see below para. 19).

Enter every known fact in the notebook. This, associated with the information entered under para. 10, will make it possible to draft a 'case history' of the object later on.

8. *Field-trip or expedition.* Give name and dates of special individual trips or of a scientific expedition. If a sea voyage is involved, give name of the ship.

9. *Price paid.* In case of a purchase, give the price in the currency in which the object was paid. Specify also the mode of payment.

The price paid for an object in the field by a collector may later on constitute an interesting element for a survey of relative values.

1. R. F. Inger, Expeditions as a Research Function of Natural History Museums, *Museum News*, Washington, Vol. 45, No. 2, Oct. 1966, p. 28-30.

It also provides a basis for calculating the cost of replacement or insurance coverage, in case of theft or loss.

10. *Origin*. State briefly whether the object is known to belong to the area where found or whether it has been borrowed or imported from another region. If the latter is the case, give the name of the place of origin.

    Indicate the date, age or period of the object and its manner of production together with the maker's or artist's name, when known (see also below under paras. 12 and 13).

    Do not include doubtful information on the identification label, but give all significant facts in the field notebook, using such wording as: 'said to have been made at ... by ...', etc.

    Anthropological surveys are dependent on such information, and cultural contacts which may be inferred from it are important facts for the ethnologists.

    The same precaution should be observed when dealing with chronological evaluation if absolute dates cannot be assigned.

    Geological specimens as well as prehistoric finds are dated through stratigraphical information. Prehistoric finds, furthermore, can be dated with the help of several relatively accurate techniques, such as radio-active or magnetic dating.

    Historical and art objects can be dated by mentioning the century, a historical period or a dynasty.

    If an object has been associated with a known personality or with a historical event, this should be noted here. The usefulness of such information is by no means restricted to historical collections.

11. *Ethnic group* or culture to which the object may be related should be entered here, or alternatively, the name of species.

    Give names according to the museum's practice, and add vernacular name of tribe, clan, etc.

    Specific place of a natural history specimen in the relevant scientific hierarchical classification need not be indicated here unless known with certainty. Non-specialists should not attempt to guess, but leave the task of determining phylum, class, order, family, genus and species, to the museum research staff.

12. *Material and technique*. Material or materials from which the object is made, and main techniques or media used in its making. Status and sex of the maker.

    Though necessarily concise on the identification label, this information should be recorded *in extenso* in the field notebook.

    Sketches illustrating for instance, the successive stages of manufacture of an object may well supplement descriptions and photographic records (see also p. 55).

    Names of materials in the vernacular language and typical local expressions should be noted, as well as information about the availability of the materials in the locality or about the manner in which they were transported.

    Details about the raw material or about the manufacturing technique or the style of an object, may also help in retracing the object's origin or suggest its age.

13. *Function of use*. When and by whom the object is used or was used; how and where; time; status and sex of the user; specific places and occasions.

    Whether collecting agricultural implements in a farming region, artifacts in a suburban district, costumes in some provincial European community or ritual paraphernalia at the outskirts of a tropical forest, the problem is basically identical.

Object N°

Category | Tribe | Area

Museum N° | Field inventory N°

Designation Crested porcupine (Hausa: "Beguwa")

Object found ☐ received ☐ bought ☒ from a hunter

Place Shendam, Jos div., Plateau prov., NIGERIA

Date when found or bought 22-11-61 | Collector's Name Miss S.K. Sikes

Field trip or Expedition | Price paid 12 s

Origin Plateau prov., NIGERIA

Maker

Ethnic group, or Species Rodent: Hystrix cristata

Material & Technique Sex: fem

Function or use Locally hunted for food

Museum photo N° | Negative N° | Field photo N°

Description and Condition of object Long, sharp black & white quills on back, crest of long, rather softer but still wiry bristles on neck and shoulders

Measurements Total L: 75 cm L. of quills: between 20 & 50 cm

Remarks Caught by evening time when emerging from burrow - with net.

Brought to Museum already prepared. Conservation to be checked

Collection file N°

Fig. 4.
Brief identification of a zoological specimen.
The label is filled in at the time
of recording the specimen.

Plate 1.

Field work (for the Boganda Museum at Bangui, Central African Republic). Acquisition of objects and investigation among the nomadic Babenzélé Pygmies tribe.
Basket, wooden box, cross-bow, traps, assegais, and so on. High-Sanga Region, 1965 (Photo: H. Doré).

Plate 2.

Identification on photographic plan of one square metre of palaeolithic ground, Pincevent, Seine et Marne, 1964 (Photo: Musée de l'Homme, Paris).

Plate 3.

Recording and filming a local shepherd playing the hurdy-gurdy, Tillos (Gironde), June 1965 (the musical instrument has been described and photographed separately) (Photo: Musée des arts et traditions populaires, Cl. Marcel-Dubois).

Objects are related traditionally to some aspect or phase of life. Some masks, for instance, are worn either for village or intertribal festivities and dances, others for funeral ceremonies, and a large number are used for ritual or magic purposes; some should be carried above the head, some others on the shoulders; they may be endowed with a personality, including a genealogy, and be given a proper name; children or women may not be allowed to see or touch them, etc. Drums also can be males or females, carrying their own visible or invisible symbolism.

Quite independent of their original purpose, similar objects can be put to many a different use or be treated in varied specific manners. A small stone vessel has been found in a North African kitchen; its present undeterminate use as a container does not preclude its former utilization, centuries ago, as a lamp, a mortar or a censer....

It is essential that field notes should, as far as possible, contain this kind of cultural data, although the task of obtaining it is often fraught with difficulties, and requires sagacious, tactful and patient cross-questioning.

Accordingly, questionnaires currently used by ethnologists and, in general, by students of traditional life and customs, draw attention to such facts, many of which could pass unnoticed. It is indeed important to pay attention to the handling and the carrying of an object, to its place when not in use, to its possible destruction and to how it could be replaced, and, in particular to its association with local, religious, economic and social structures (*Plate 1*).

When dealing with collections of animals or plants, the same attention should be paid to their connexion with local life and customs. A plant may be used for food or drink, or valued for its medical or magical powers; its fibres may be used for making musical instruments or be twined into mats or baskets, and its fruit may be made into household utensils....

When collected at the same time, vernacular and local terms help to determine ideas, concepts or myths hidden behind visible shapes.

14, 15 and 16. *Photographic identification.* The collector assigns his own photograph records numbers, leaving space, where indicated, for numbers to be assigned later by the museum for its own photographic and negative files (see also below p. 55).

17. *Description* and *Condition of object.* This paragraph and the next one, given on the reverse of our standard label, are meant to help in the identification of an object which has already been examined and defined.

A few words are sufficient to specify the general shape, colour, decoration and size of an object or a specimen, and to provide information as to the physical condition in which it was found.

In large or specialized museums, curators responsible for cataloguing the collections under their charge know the particular nomenclature to be used for describing objects or specimens and the sequence to be followed in entering the information.

Unlike identification records, the museum catalogue is a scientific document which will be consulted for research, and also a reference tool which will be needed for the production of printed exhibition catalogues. Moreover, the completeness and accuracy of its contents could facilitate the organization of data into retrieval forms at some future date for processing by computers.

However, field collectors do not as a rule spend a long time writing down elaborate descriptions, their task being mainly to point to the distinctive traits or qualities of an object which make it different from others in the same category.

Professional training in museology includes at least a short course on object handling, naming and describing, according to the nature of its objects concerned. The collector should be able to say, for instance, if an object represents a human figure, a deity, an animal or a plant whether it is of single manufacture or composed of several parts; whether a vessel is spherical, hemispherical, cylindrical, etc., whether it is shallow or deep, has or has not a cover, a handle, a neck or a foot, and whether it shows inscriptions or a maker's mark. He should, in addition, indicate whether the object is carved, painted, varnished, dyed, etc. Decorative motifs should be defined as being, for instance, rectilinear, curvilinear or dotted, natural, symbolic, stylized, or a combination of several types.

The field notebook, besides, ought to lay stress upon direct observations which might be difficult to supply later on: for instance whether the decoration is made by the manufacturer himself and involves some traditional procedure.

The state of conservation of the object or the specimen, even if briefly noted on the identification label, ought to be more specifically described in the fieldbook: is the material showing some weakness? Has the object been broken, corroded, stained or discoloured, or has it been damaged by pests? Has it been repaired? Does it show a natural patina?

18. *Measurements*. Provided also as a help towards identification, measurements should always give the maximum dimensions and be taken in the same order: height, width, depth; or length, width, thickness; or height, diameter.

If a base or a cover are integral parts of an object, they should be included in the height.

Natural science specimens should be measured according to their categories. For instance, for animals: give total length, length of the tail, length of the legs and of the ears, width of the body and of the head, etc.

The use of the metric system is recommended.

The dimensions of a picture should be given free from the frame.

If the object or the specimen has a complicated shape, diagrammatic sketches in the notebook offer a short cut to intricate explanations.

It has been found useful to weigh objects which might be mixed with pieces of similar appearance, for instance prehistoric flint implements.

Zoological specimens should be weighed before any preparation has taken place.

19. *Remarks*. This heading is used to complete information when needed, and is of course restricted to field comments which should be supplied on the spot.

The collector should for instance point out whether an object has been exchanged more than once, or whether it has been made for sale or for export; who is in charge of the sale, when and where it is to take place.

Indication as to the frequency of appearance of the object locally is also of interest.

Details should be given about the treatment given to specimens during the field expedition, such as the provisional preparation of animals, the cleaning of fossils and skeletal pieces and the drying of botanical specimens.

Indicate also whether samples have been tested and what kind of tests have been applied.

20. *Collection file.* Indicate by a check or sign whether field-notes, photographs, etc. will be sent to the museum in addition to the identification record.

Information dealing with a single collection or an expedition, or with individual objects of particular importance, is kept by the museum in its 'Collection' or 'Historic' files. The duplicate page of the collector's field notebook are of course of paramount and permanent interest.

MUSEUM USE OF IDENTIFICATION LABELS

When the label has fulfilled its task of identification and the object has been accessioned and numbered, it can still, being of library size, be used in different ways as a museum record:

- as a source record, if filed according to the collector's name or the name of the field expedition;
- as a location record if filed according to the object accession number, under the specific storage or exhibition place where it is located;
- as a subject index if filed according, for instance, to tribal name, name of material or technique, name of species, etc.

AUDIO-VISUAL DOCUMENTATION

However thorough, field documentation alone is seldom complete enough for research purposes, and should be supplemented by photographs, films or sound recordings.

Photographs

Although the making of rough sketches at the time of identification are rightly considered as routine tasks, a photograph of each object or specimen should be taken, and sets of photographs when dealing with objects of particular interest.

It is of course important to take photographs of the locality surveyed or of the excavation site and, in the latter case, photos of the objects position before removal. White tags or precut arrows made of aluminium or of white painted wood placed near the important finds help to locate them on the photos. Alternatively, photographic plans might be used *(Plate 2)*.

In any case, and whenever possible, objects and specimens should be shown in their original setting.

A graduated measure or any implement or object in common use may be placed next to the subject to indicate scale.

Note that it is better at this stage to get a plain and candid picture than to look for artistic effects.

Besides the photograph number of each identified object entered on the label (see p. 13, paras. 14-16), the field notebook should include information about the date, hour, condition of light, and give the name of the photographer, if different from that of the collector identified on the label.

For any survey of historical significance it should be noted that photographs obtained from the collections of local photographers often prove to be invaluable.

Sound recording

Collections connected with music, language or sound in general, involve the use of a recording device. Portable battery tape-recorders are easy to operate and high fidelity portable instruments can now be obtained. Care should be taken, however, to mark successive recordings distinctly, as is done for film records.

Photos or films taken at the same time often provide supplementary information, if sound films are not available *(Plate 3)*.

Film records

Field collectors are more and more frequently being instructed in the use of cine-camera apparatus, as cine records provide a kind of dynamic documentation, whose value can never be over-estimated.

For professional use 16 mm cameras are usually recommended. It is possible, however, that, in the not too distant future, 8 mm cine cameras will be designed to meet professional requirements, with consequent savings in weight, costs and films.

Care should be taken to record information about each film sequence accurately and immediately in the notebook, following of course the general information about place, date, hour and operator.

The showing of animals in their environment and the difficulties of doing so with the necessary discretion are important aspects of film records.

Discretion is not to be neglected either when taking pictures of human activities; the taking of even a single photograph often involves delicate negotiation. There is, however, no better way of illustrating the intimate relationship of objects to human beings, or between people.

When investigating, for instance, the building and the use of boats in a fishing community, and assuming that typical crafts and accessory implements are being collected, what is the task of the cameraman?

First of all, to define the place of the boat-builders in the social organization, then to give a true picture of their technical knowledge. Their gestures and movements should be recorded as well as the tools used for measurement, or the arrangement of the different parts of the boat. Are sails or oars kept in special places or under specific conditions? Is there a ceremony involved in the first launching? Moreover, nothing but a film can illustrate the rowing rhythms and the behaviour of the boatmen in their daily life.

CONCLUSION

Although the precise and time-consuming tasks of field documentation may seem tedious in comparison with the pleasures of discovery or the adventures of collecting, they undoubtedly bring their own satisfaction.

The collector should remember that:

- an object is never just an object, but a witness to some human activity or achievement, and should be truly regarded as a historical fact;
- a natural science specimen is never just a dead specimen, but a visible element in the evolutionary history of nature;
- reliable identification records are not just labels, but the first means which will enable the museum to keep its collections alive and useful.

BIBLIOGRAPHY

BORHEGYI, Stephan F. de. 1965. Field manual or cataloguing guide. (*Museum News*, Washington, vol. 43, no. 5, Jan. 1965, pp. 38-40).

BRUCKNER. Geraldine. 1968. A standard terminology for describing objects in a museum of anthropology. (In: Dudley, D. H. & Bezold Wilkinson, I. *Museum registration methods*. Washington, pp. 224-239).

BURNS, Ned J. 1941. *Field manual for museums*. Washington, U.S. Govt. Print. Off.

DUDLEY, Dorothy H. & Bezold Wilkinson, Irma. 1968. *Museum registration methods*. Washington, American Association of Museums and the Smithsonian Institution, VIII, 294 p. ill.

Institut français d'Afrique Noire. 1953. *Conseils aux chercheurs*. 4e éd. Dakar, IFAN.

JEWEL, C. A. Brief guide for collectors. 1960. In: *Report of the Museum of English Rural Life*, Reading the Museum.

MEIGHAM, Clement W. 1961. *The archaeologist's note book*. San Francisco, Chandler.

MURDOCK, George P., FORD, C. S. *et al.* 1965. *Outline of cultural materials*. 4th rev. ed.,

2d print. New Haven, Human Relations Area Files (Behavior Science Outlines, vol. 1).
MUSÉE DE L'HOMME. 1931. *Instructions sommaires pour les collecteurs d'objets ethnographiques.* Paris, Musée d'Ethnographie.
ROYAL ANTHROPOLOGICAL INSTITUTE. 1951. *Notes and queries on anthropology.* 6th ed. London, Routledge & Kegan Paul.
WHEELER, Sir Mortimer. 1954. *Archaeology from the earth.* Oxford, Clarendon Press, 1954 & Baltimore, Penguin Books, 1962.

A few specialized manuals or monographs

DORIAN, A. F. 1965. *Textile dictionary* [In 6 languages] Amsterdam, Elsevier. 3 vol.
GOLSTEIN, Kenneth S. 1964. *A guide for field workers in folklore.* Hatboro, Penn., American Folklore Society & Folklore Associates.
HAGGAR, Reginald G. 1962. *A dictionary of art terms ...* New York, Hawthorn Books.
HIGGS, J. W. Y. 1963. *Folk life collection and classification.* London, The Museums Association. (Handbook for museum curators, pt. C, sect. 6.)
LEROI-GOURHAN, André; BAILLOUD, Gérard *et al.* 1966. Problèmes méthodologiques. (In: *La Préhistoire.* Paris, Presses Univ. de France.)
MUSÉE DE LA VIE WALLONNE. 1964. Rubriques de notre catalogue systématique. (*Enquêtes du Musée de la vie wallonne*, Liège, t. 10, n[os] 113-116, janv.-déc. 1964, pp. 194-236).
RÉAU, Louis. 1953. *Dictionnaire polyglotte des termes d'art et d'archéologie.* Paris, Presses Univ. de France.
SHEPARD, Anna O. 1956. *Ceramics for the archaeologist.* Washington, Carnegie Institution of Washington (Publication no. 609).
STEWART, James Smith. 1960. *An archaeological guide and glossary.* 2d rev. ed. London, Phoenix House.
STOUTENBURGH, John L. ed. 1956. *Dictionary of arts and crafts.* New York, Philosophical Library.
STURTEVANT, W. C. 1967. Guide to field collecting of ethnographic specimens. Washington Smithsonian Institution, Museum of Natural History, 41 p. (*Information leaflet* 503).
WHITE, Margaret E. 1952. *A glossary of ceramic terms.* Newark, N.J., The Newark Museum.

Kazimierz Michalowski

The techniques of archaeological excavation

4

INTRODUCTION

Archaeology is a history discipline, but has its own research techniques, which make it akin to philology. Just as the philologist studies a text, so does the archaeologist study a monument. The aim of both is to decipher a portion of historical truth from the fragment which has been conserved, and to make a critical study of the past.

The basic technique of archaeological research which enables the research worker to obtain his study material is excavation. This is not the sole technique used by modern archaeology, for there are many others. Present research is complex in nature, and the choice of technique depends largely on the site, on the nature of the finds and on many other factors. It would take too long and serve little practical purpose to consider all the possibilities open to the researcher. For it has to be remembered that archaeological excavation is not a discipline on its own, but one among other research methods aimed at the scientific interpretation of history. On the other hand, there are undoubtedly certain categories of archaeological excavation from which any person of education, who finds himself called upon to uncover or preserve a relic of the past, can derive practical information.

The fact that excavation techniques are not taught at universities is not due to lack of basic rules, methods or systems of excavation, but because, as already stated, excavation is not an independent field, but an often complex set of actions which vary widely according to the geographical and demographic contect, type of terrain, etc. The only way of learning excavation techniques is by practice, and not by studying in libraries. We shall therefore confine ourselves here to presenting practical recommendations based on experience.

ACCIDENTAL FINDS

It often happens that extremely valuable relics of the past are accidentally found in the course of agricultural work, pipe-laying, the construction of foundations or the building of roads, or even by a passer-by scratching the ground with his cane. The question then arises of preserving chance finds of this type and, if they are transportable —sculptures, receptacles, etc.—of placing them in the nearest museum, museum store or other safe place, such as a school, administrative building and so on, so that they can be thoroughly studied by specialists under proper conditions.

Again, the find may not be a single transportable object but a whole group of objects, the discovery of one item on the site heralding that of many other similar vestiges of the past. A vessel turned up while tilling the soil may form part of a group of objects belonging to a tomb or an entire cemetery of perhaps major scientific importance, or a piece of old brick-work or worked stone turned up when laying foundations may be the remnants of an old building whose presence there had been entirely unsuspected.

What should be done, therefore, when a discovery of this kind has been reported?

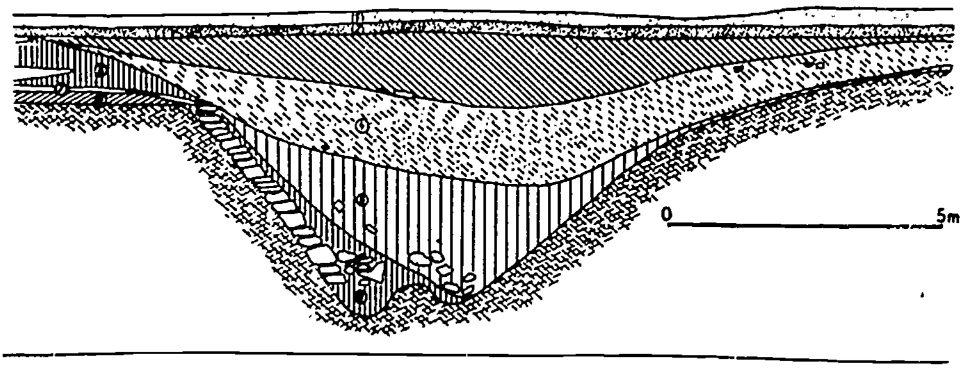
Study and protection of the site

The main thing is to make a detailed observation of all the ostensibly secondary factors which accompany the unearthing of the find. Next, the scene of the discovery has to be protected. Whereas the first operation involves simple actions, usually requiring nothing more than a camera, a ruler, a notebook and a pencil, protecting the site may often present serious problems as far as the administrative regulations of the country are concerned. In most countries, however, there are special regulations for safeguarding monuments which authorize the stoppage of work, even in progress, if the chance find has important scientific and historical implications.

The first thing to be done, on arriving at the scene of the find, is to photograph the object in its existing state, placing a ruler beside it in order to record its dimensions. At least two photographs should be taken —a close-up, and another showing the position of the object in relation to its surroundings. After that, the depth at which the object was found has to be measured, the seriation of the soil levels which cover or covered the object and are still visible in the trench has to be recorded in the notebook by means, say, of a rough sketch, and the sequence of layers beneath the object has to be indicated, if at all possible (Fig. 5).

Where the object has not simply been taken up (from sand, for example) the type of layer must be carefully noted. It soon becomes evident, when digging a trench, that the quality of the soil at a certain depth is not uniform, either as regards earth colouring or clay content. Traces of lime, ash of other substance are sometimes found to be present, for the object is usually found in a 'cultural layer' which was once the soil on which people lived. There will thus be fragments of ordinary earthenware, or sometimes rubbish, charcoal, ashes from domestic fires, and so on. All this should be noted as accurately as possible. If there is a building, road or other notable feature in the vicinity, the position of the find in relation to these visible and more or less permanent surface features should be meas-

Fig. 5. Profile of a tomb, Iwanowee, Poland.



ured. In addition, a lay-out plan should be made.

A not infrequent occurrence is for the chance find, such as a large vessel or fragment of sculpture, to be extracted by inquisitive onlookers before the person responsible for its conservation arrives. This is regrettable, for a chance find is as important, for the archaeologist, as the discovery of a murder is for the criminologist. It is common knowledge that if anyone finds a corpse in circumstances which point to murder, he should beware of moving it before the arrival of the police, whose job it is to take the photographs and measurements which are of vital importance for the investigation. The same applies to archaeological monuments. Archaeological methods resemble methods of criminal investigation, except that their object is to discover, not a murderer, but the historical setting of which the find is at once the expression and the evidence. And often the conditions under which it has been conserved up to the present are more important than the fingerprints found at the scene of a crime.

Where notification of the find arrives after its extraction, the same measurements, descriptions and photographs as specified earlier must be made *post factum*, with a specification of the point where the object was found. After that, check soundings must be made round about in order to ascertain whether the find is an isolated one or the first of a larger series of monuments, for, as already stated, the vessel, say, may be an item of funerary furniture or a vestige of an ancient habitation which the finder has come upon by chance.

Check soundings

The check soundings must be made with deliberation and close attention, particular note being taken, in the manner mentioned above, of the arrangement of the soil layers.

In the case of surface finds turned up by ploughmen, there is no need to make check soundings at any depth: a 50 cm trench might be all that is necessary. If the find is made during trenching, the sounding should go down to a considerably lower depth than the trench. It should be borne in mind, incidentally, that check soundings are essential even when it is the archaeologist himself who duly extracts the object after notification of its discovery.

Extraction and care of the objects

The extraction must be done with the utmost care. To keep a cracked vessel in shape, for example, use has to be made of paraffin wax, spreading it over the visible parts of the object before trying to separate the latter from the soil with the aid of a knife or spatula.

Objects that have been lying in the soil are usually impregnated with salt, and are therefore very liable to deteriorate when exposed to the atmosphere. Suitable boxes padded with shavings or cotton-wool must therefore be prepared in advance for encasing fragile objects after their removal from the soil. Each object removed should be immediately measured and recorded in the notebook in the order of discovery. An object may occasionally fall to pieces during removal, but where the earth is firm an imprint of its shape may sometimes remain. Where this happens, plaster casts are made of the negative imprint in the soil. It is desirable to have extracted objects photographed forthwith, even before cleaning, which as a general rule should be done in suitable premises. Once all the objects in the find have been extracted, the site should be carefully cleaned with a broom and re-photographed. All photographs of the site should include a graduated ruler.

The transport of the objects, even if only to a temporary museum store, should be effected with great care, avoiding any jolting.

But where the object found is a non-transportable monument, such as a mosaic forming part of a building, its extraction has to be carried out on the spot, exact measurements recorded, photographs taken and a detailed description made, for example, of the ornamentation or of the scene represented on the mosaic. In the case of architectural fragments, precise note must be taken of the state of preservation of the building of which they form part.

With non-transportable objects, of course, the utmost pains must be taken to conserve them on site, it being necessary, very often, to employ guardians to keep watch over them. The chance find of a non-transportable monument is often the prelude to systematic excavations of the site.

The steps to be taken on unearthing a monument of this kind are accordingly described in the following section of our recommendations, concerning excavations proper. In either case, once the chance find has been conserved, a detailed report should be drawn up giving full results of the observations and measurements made and a copy of it sent to the higher authority concerned. The report should also include an exact inventory of the objects found, together with a brief description of them and particulars of their dimensions and composition.

The present practice is to use colour photography as far as possible for photographic documentation, and modelling clay and latex for casts. When extracting fragile vessels made of bronze, acetone is used for cleaning surfaces and vinavyl for reinforcing the parts uncovered prior to extraction.

EXCAVATIONS

Prospection

As stated above, a chance find may give rise to systematic excavations, although this is not always the case. Very often, the choice of excavation sites is based on other indications. Take, for example, that cradle of mighty civilizations of the past, the Mediterranean basin, concerning which the information given by ancient authors, later literary tradition and fragmentary inscriptions containing geographical names are important pointers to the location of a bygone human settlement which has disappeared from surface level. In order to choose the site effectively and begin systematic excavations, the site has to be 'prospected', this operation comprising two phases: (a) observation of the surface; and (b) check soundings. It is usually possible, on the basis of the data thus collected, to determine broadly the area of the soil covering the ancient ruins.

The results of this first operation can never be definite or decisive, for ancient towns, settlements and even groups of religious buildings have undergone repeated changes during the centuries, and the area used by man has expanded and contracted in turn. Usually, the likelihood is, after prospecting, that a number of layers—urban ones, for example—will be found on the site, each of them sometimes representing several centuries of occupation.

Aerial photography

Prospecting is greatly facilitated by aerial photography. Taking photographs from an aeroplane, and on occasion from a captive balloon, makes it possible to correct the data obtained by surface observation and soundings. But aerial photography also makes it possible to reconnoitre places of which there is no historical mention, groups of ruins, settlements or cemeteries. It is sufficient to recall the discovery, by this method, of large numbers of Etruscan tumuli in Italy, or ancient settlements in North Africa. For it is well known that at a certain altitude, and if the sun's rays make an appropriate angle of lighting with the ground, the remnants of ancient walls, ditches etc. which are invisible at ground level are rendered highly visible in photographs by differences in vegetation or sand coverage.

Before beginning excavations on the site generally defined by prospecting, detailed topographical documentation has to be prepared with the aid of a theodolite. A contour map of a scale of 1 : 50,000 or 1 : 100,000 is drawn up, depending on the extent of the area which is of interest to the archaeologist, with indications of the elements visible on the surface, such as existing structures, clumps of trees, or even surface ruins. It is true that all these may disappear as the excavation work proceeds, but during the first phase of site operations they may constitute important markers. A few photographs should also be taken of the complete site so that they can be co-ordinated with the contour map—i.e., so that the corresponding secti ~~ of the latter can be found and identifieu on them. Where the site is level and not covered by large-scale ruins, with ancient structures buried beneath débris and sand only, the contour map should be immediately marked by a grid (usually 20 × 20 m), which will serve for pinpointing the ruins or objects subsequently discovered.

Geological analysis

The second preliminary operation is the geological analysis of the soil. Advantage can be taken, in this connexion, of the check soundings already made, with a study being made of the profile of the soil layers. This kind of preliminary study is specially important for prehistorical excavations. In any case, the archaeologist starting to excavate should be completely familiar with the nature of the soil covering the relics buried underground. The technique will not be the same for excavations in driftsand of the desert as for those in 'sebakh', or the powdered organic products of old middens containing a high proportion of nitrogenous compounds. Similarly, the measures to be taken will differ according to whether the ruins are covered by river silt due to flooding, or whether humus is present. In North Africa, rock débris due to erosion is also a frequent occurrence. Finally, the method to be followed will be quite different if the site is filled with débris from vaults and walls.

The preliminary analysis of the soil is also important for establishing the thickness of the sterile overburden (archaeologically speaking) covering the monuments. By this is meant a layer of soil containing neither potsherds, nor tool fragments, pieces of wall, etc.—in short, anything testifying to human activity and capable of serving as an index for designating the cultural stratum *(Plate 4)*.

Excavation techniques

Once it has been established that down to a certain depth, which may sometimes be only a few centimetres, the soil covering the ruins is not in the nature of a cultural stratum, and after subjecting it to a geological analysis, the process of clearance can be expedited by using machines of the bulldozer or excavator type in order to remove the surface layer from the archaeological site. Great circumspection must be exercised, and there are sites on which the use of such equipment is neither possible nor desirable. But an experienced archaeologist tagging along behind the bulldozer and regulating the levelling depth runs less risk of damaging the cultural layer than if he had to supervise several dozen excavation workers. This excavation technique is commonly used in the Soviet Union; it is very effective, and makes the clearing process much quicker.

One of the most important decisions the archaeologist has to take when beginning the excavation work is to select the place for dumping the spoil. This is no easy matter. In principle, it should be dumped at a point where no further trenching will be done —away, that is, from the actual archaeological site previously studied by soundings. The aim is to avoid the unnecessary work of shifting earth from one place to another. Unfortunately, it is not always possible to keep to this programme completely. It depends on the size of the archaeological site and on the technical aid available. In the case of large-scale excavations, the earth is shifted by means of tubs or tip-wagons. For smaller-scale excavations where suitable equipment is lacking, other arrangements need to be made, such as the use of rock-beds or natural reservoirs (for example ponds, lakes, the sea and even rivers, like the Nile).

And what of the nature of the excavation itself? As stated at the outset, there is no technique which is applicable in all cases; techniques are legion, and the choice of method depends on the nature of the monuments and sites. In the case of the remains of structures made of such materials as wood or beaten earth, great care must be taken once the first cultural layer has been removed.

Grid method

We have already referred to the grid made on the contour map. Sometimes this grid is first traced on the site itself and then transferred to the map. The 20 m squares are then divided into smaller ones. Mention may be made, in this context, of the grid method successfully used by Sir Mortimer Wheeler. The site divided into miniature squares is excavated in such a way as to leave the baulks separating the squares intact, the thickness of these virgin baulks depending on the solidity of the soil. As the excavation of the site within the squares progresses, the surface will begin to look like a large furnace grate. Another advantage of this method is to facilitate stratigraphic studies in the individual squares.

Within these, the earth is removed with a spatula and a knife, instead of a shovel, and observations and notes of all the soil tints are made on the spot, using coloured pencils, once the cleared surface has been cleaned with a brush. These tints also provide an indication of the texture of the soil, for a layer of beaten earth, for example, differs in appearance from one of driftsand or silt. The charred remains of wood are unlike the crumbled débris of walls of buildings, and the remains of piles, ditches, wells and so on are different again.

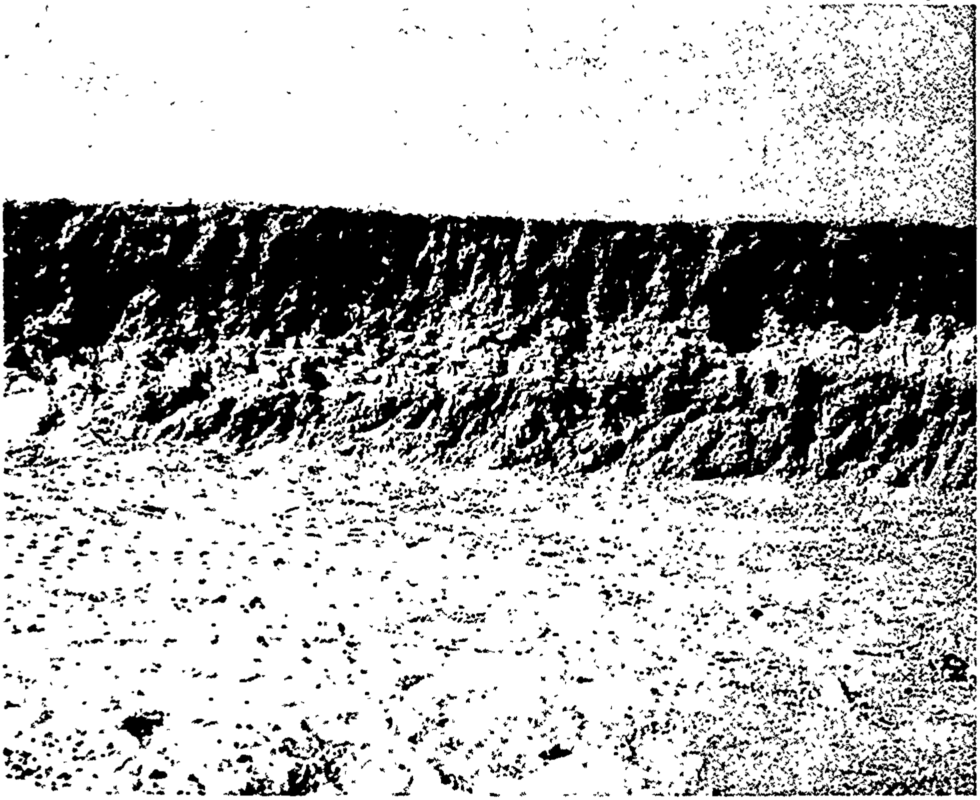
The position of every object found should be measured both horizontally and vertically. Only strict documentation and very exact observation of the location of the horizontal layers can provide a basis for archaeologically sound interpretations. The objects found will be treated in the same way as when preserving chance finds (see above).

Stratigraphy

As the work advances and exact observation proceeds, a picture of the causes of the destruction of the edifice in question (fire, earthquake, etc.) will emerge with increasing clarity. As the digging goes deeper, the outline of the cultural layers begins to appear on the profile of the excavated square. In this way, excavation by layers provides us with a very clear picture of the stratigraphy of the site. It now becomes a question of being able to date each level in an adequate manner. To that end, use is made of the objects found and their correlation with the superposed ones. The finds may consist of intersecting walls separated by a layer of alluvium, food remains or bones of animals dating from the periods of human occupation of the site. The history of archaeological excavations provides us with numerous examples of the superposition of several cultures on a single site: an experienced archaeologist can sometimes identify more than twenty down to a depth of 20 m.

If, even at only a few levels, objects are found which are not difficult to date, such as coins or fragments of vases which can be chronologically placed with complete certainty, it will be possible, by carefully noting the position of the levels, to establish a hypothetical chronology having a high degree of probability, even for levels not containing precisely dated objects.

For the archaeologist, the carefully cleaned profile of the excavated sector will constitute a chronological table, as it were, of the site.



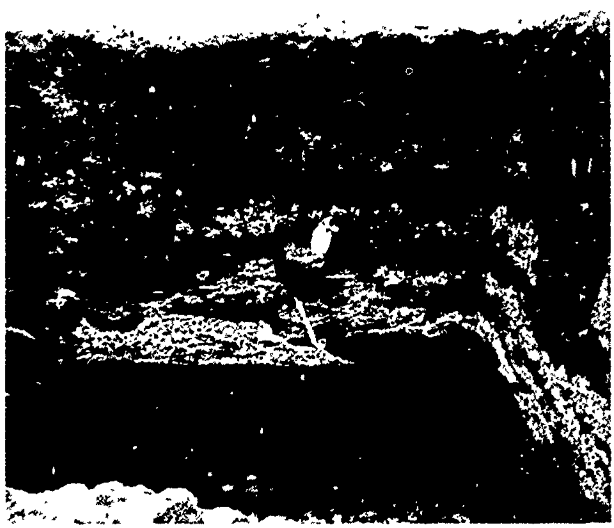


Plate 4.

Layer of lime, dating from the middle of the third century, on the forum of Diocletian's camp, Palmyra.

Plate 5.

Composition of the strata, Serock, Poland.

Plate 6.

Unearthing a first-century oven in Diocletian's camp, Palmyra.

Plate 7.

Cleaning out a second-century lime kiln, Tell Atrib.

Plate 8.
Classifying pottery, Palmyra.

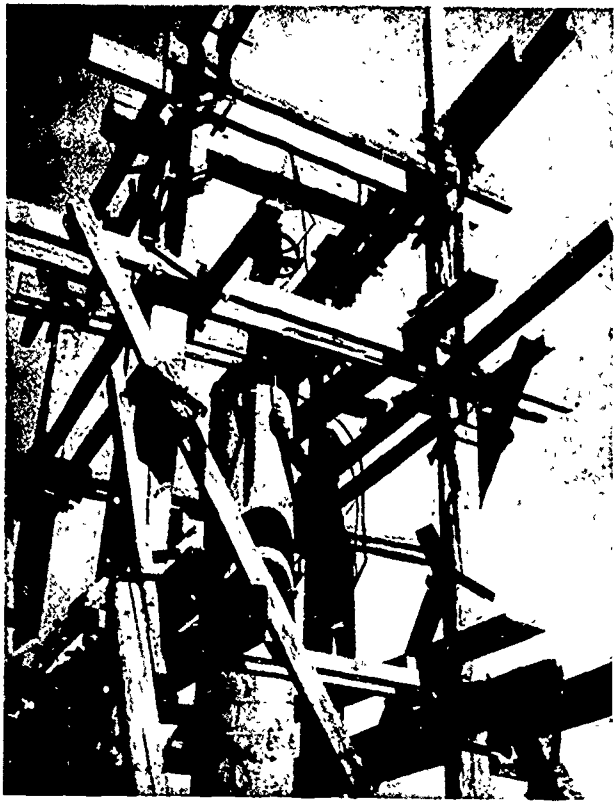


Plate 9.
Reinforcing a third-century column in Diocletian's camp, Palmyra.

Plate 10.
The conservation expert Gazy cutting out a fresco in the great cathedral, Faras.

Where stratigraphical dating is concerned, however, it must not be forgotten that objects in upper layers may sometimes have been subject to transfer to lower layers through the action of burrowing animals or by some other cause. For this reason, scrupulous observation is necessary as regards the stratification of an archaeological site. It should be remembered, in this connexion, that 'comparative stratigraphy', or the study of analogies between the stratigraphies of different sites, is a very useful aid to the archaeologist. Claude Schaeffer's work, *Stratigraphie Comparée et Chronologie de l'Asie Occidentale (III^e et II^e Millénaires)* is a good example. Stratigraphy is of manifest value at the present time in conducting archaeological research on large numbers of excavation sites. It should nevertheless be noted that stratigraphy was first applied in the case of prehistory discoveries, especially in caves and grottoes, which means that it was used for studying periods for which we have neither the coinage nor the epigraphic material which make the dating of cultural levels so very much easier. All that the experts specializing in the most ancient epochs could apply was a relative chronology based on a very careful study of layers of food remains, of certain tools often covered by a layer of silt, or refuse stemming from later human activity. It was thereby possible to specify different periods of utilization of the 'shelter', abandoned by man for a certain period and then re-used *(Plate 5)*.

Documentation

But taken together, our methods of archaeological documentation, even the most modern, such as precise measurement, detailed photography, chemical analysis of soil and monuments, dating with radioactive carbon C^{14}, the use of radio-isotopes for photographs of the X-ray type, an analysis of the animal or human bone remains and organic products carbonized or impressed into the soil, are simply the application of the advances made by science at a specific historical stage in its evolution.

The archaeologists of past generations were also convinced that the documentation they were using was completely methodical. But just as today we pass severe judgement on the shortcomings of former documentation procedures, so we can confidently expect that future generations of research workers will have much to criticize us for. The present shortcomings can be partially offset by leaving 'control' plots on the excavation site, i.e., plots protected from erosion and left untouched by the shovel or spatula, and covering, perhaps, 10 m^2 or even less, depending on the nature of the archaeological complex. Almost a century ago, Heinrich Schliemann, the discoverer of Troy, left control plots of this kind on the mound of Hissarlik, and it is thanks to them that the merican Aarchaeologist Blegen was able, in the 1940's, to establish a more precise chronology of the results of the excavations made by his illustrious predecessor.

Specific cases

We have given an example of only one method of conducting excavations. But if it was proposed, say, to use that method for work on large groups of ruins in the Mediterranean world, such as those of Palmyra, it would be tantamount to entering a large scientific or even specialized library containing thousands of books and setting about reading all of them, beginning with the first book on the top shelf on the left. In cases like the above, a different method of excavation has to be applied, for if great heaps of rubble comprising large architectural blocks of decorated stone, inscribed slabs and so on had to be removed in layers, the results would be nil; apart from which any kind of excavation work would be rendered impossible.

In the case of monumental architecture, observation of soil colourings beyond a depth of a few centimetres is completely pointless. Other criteria for soil stratigraphy must therefore be used in order to determine the process and period of construction of the edifice, and to decipher its history. In clearing groups of ruins covered by débris and piles of earth, usually of alluvial origin, a study must be made of the composition of the débris itself, of the traces of deposits on the walls of the edifice, and of surface or buried blocks. It is often possible to deduce therefrom the cause of the collapse of the building and to determine, by means of smaller finds, the date of the catastrophe; and by noting later changes and the nature of the wall structure of additional parts built on, it is often possible to make a fairly accurate reconstitution of an historical phenomenon. This is not to say, however, that while clearing a room, for instance, or a well belonging to the group of monumental ruins studied, a more precise stratigraphy of the site would not be useful; and in such cases the application of the method described above might well be desirable.

Necessary destruction; reconstitutions

Hardly a day passes without the archaeologist directing excavations finding himself faced with the necessity of taking decisions of extreme importance. To reach the lower levels or to clear a room which had at a later stage been sealed by a wall, he has to dismantle the wall and hence destroy the whole or part of a structure, of ancient origin, indeed, but later than the building as first designed. He sometimes has to take the decision to dismantle an entire section of an ancient town constructed on the walls of dwellings dating from an even earlier period. In other cases, it may be road pavings that are superposed. Occasionally, the decision may concern a fine building, itself ancient and fairly well preserved, but topping an older building *(Plate 6)*.

In difficult situations like this, the findings of an international committee of experts are essential, as in the case, for example, of the famous Roman theatre at Bosra, in Syria, which was later converted into a mosque. But in practice, as stated, the archaeologist himself has to make the decision about destroying a relic of the past, not only from day to day but sometimes even from hour to hour.

What, then, should be done?

Apart from compiling architechtonic documentation and making special plans and sections, descriptions must be made of the piece of wall or entire building to be eliminated and must be included in the general site plan. When dismantling walls, care should be taken to make sure that they are not composed of blocks derived from even older buildings, for it is quite possible that these may have been used for the reconstruction of a major monument. It was common, in ancient days, to use components of older and disused buildings for construction purposes. How many fine sculptures and inscribed stones have been found incorporated in walls which at first sight seemed all of a piece, or embedded in the foundations of ancient buildings! The Egyptian pharaohs of the New Kingdom made use, in building the pylons of their temples, of materials from the older temples of the Middle Kingdom, which were probably partially in ruins at that time or were deliberately destroyed in order to serve their new purpose The material thus disengaged is sometimes so abundant as to permit the reconstruction of an ancient monument which at a late stage was used as a quarry (as at Karnak, in Upper Egypt).

But in the ancient world, buildings were made not only of stone. In areas where there were no stone quarries, the principal material used was unbaked brick. This was the case, specifically in the Nile delta, and especially in other parts of Egypt and in Mesopotamia, where fortifications several metres high as well as forts and palaces were built of unbaked brick. Where these structures have been covered with alluvial mud, an additional difficulty arises during excavation: it is sometimes almost impossible to distinguish between the brickwork and the earth cover. In this case, it is necessary, after digging a deep trench, to wait until the sun's rays have dried out the profile of the trench, and the difference between the wall and the mud then becomes apparent. Where deep trenches are dug in wet soil, it is sometimes necessary to use pumps which at least make it possible to disengage the structure quickly so that measurements can be taken and documentation prepared. On dry sites, the present practice is to use an inclined conveyor belt in order to remove rubble and earth from deep trenches.

Excavation methods

We have referred here to two diametrically opposite methods of excavation work. But there are many other methods in between. The system of deep wide trenches is sometimes used in order to make what might be called extended soundings. This makes it possible not only to work out the stratigraphy of the site, but also to study the position of certain structures whose nature and state of conservation do not justify total clearance and detailed exploration.

Another method that is sometimes used is for clearing tumuli. These are usually in the form of a hemisphere; the latter is divided into four quadrants, two of which, on opposite arcs of the circle, are cleared in the initial operation, for it may prove to be not worth while clearing the other two.

In clearing cemeteries, all the abovementioned methods may be used, provided that a separate inventory of finds and complete photographic survey documentation are prepared for each grave. It is extremely important, when clearing graves, to take accurate note of the position of the skeleton and the arrangement of the funerary furniture—i.e., the vessels and other objects placed beside the body.

In the case of the large underground tombs known as hypogea, the utmost care must be taken in clearing the underground corridors, which are liable to collapse as the penetration of the tomb advances; and props are therefore used, as in mines. Speaking of safety measures during excavations, it should be borne in mind that old walls cleared of sand and earth are also liable to collapse. In particular, when dismantling latter-day walls which block access to earlier structures, all the necessary safety rules should be observed, especially if the walls are built on sand.

Inventorizing

The archaeologist should never be without his notebook, ruler and camera on the site. But his work does not end when the day's work on the site is done, for its completion leaves him and his colleagues free to begin the actual listing of the objects which were found during the day and which will be transported to the temporary storehouse as the work proceeds.

The techniques of inventorizing have already been discussed in respect to chance finds. There are certain monuments which call for rapid cleaning and conservation operations *(Plate 7)*. At present, casts and prints are made of inscriptions so that they can be given a first reading. Similarly, coins and metal objects are given a first cleaning with a diluted mixture of soda lye and zinc. But before the archaeologist's heavy day is finished, he has yet another task to fulfil —completion of the excavation log in which he records the major finds, the decisions taken and his preliminary (and sometimes mistaken) conclusions, which he will correct in due course.

In addition, the archaeologist making excavations on a Mediterranean site is obliged, at regular intervals, to carry out another operation from which his colleagues excavating in, say, Central or Northern Europe are normally exempt. He has to classify thousands of potsherds, turned up in hundreds every day. It would be irrational to try to inventorize and describe every one of them, as with isolated finds or as in excavations made in Europe, where pottery is often the only archaeological document available. Here, again, the example to be cited is that of the research worker in the library: the archaeologist has to know where and how to look, and what is important for his research, and be able to place documents in order of their priority significance. To try to retain everything is to retain nothing. The archaeologist therefore has to classify the earthenware objects, this being done in two stages.

The first stage will cover a single area, not too large, such as one room of a building. Among the hundreds of shards found, the archaeologist selects those which he adjudges to be pieces of a vessel and which he thinks will help in its reconstruction, those characterized by striking ornaments and those characterized by a particular type of clay or by an unusual mode of firing *(Plate 8)*. The material thus separated into two groups—as a rule, there are twice as many rejected shards as there are retained for the next grading—should be stored away in a suitable place (not necessarily a store-room) with an indication of the date and place of the find. On completion of the excavation work in a given section, for example, after clearing an entire structure or collection of graves, the archaeologist proceeds to the second stage of classification of the previously selected shards. Once again, a large proportion of the material is discarded and the only pieces kept are those which constitute valuable and important documents from the historical or artistic point of view. They are then inventorized. Obviously, the classification of pottery requires a certain amount of experience and a good knowledge of the site. The tiniest fragment of a black-varnished Attic vase, which would be of little value in Greece, will be carefully listed if it turns up in excavations in Egypt.

Conservation of walls and frescoes on the site

As the excavation proceeds, the archaeologist must give thought to the state in which the excavated site has to be conserved. The problem, where cultures are superposed, is not easy to solve. The archaeologist has to try to conserve what is most important and constitutes a definite group of relics of the past. Before the season ends, the excavated walls have to be conserved so as to secure them from deterioration by rain. Only in Upper Egypt are archaeologists spared this worry.

To consolidate excavated walls, cement is used in blends carefully worked out so as not to detract from the original nature of the structure. In some cases, a certain amount of consolidation has to be done as the excavation work proceeds. There are occasions when the archaeologist has to see to the anastylosis of a column or pillar as part of excavation work *(Plate 9)*. Clearly, all these are makeshift processes. Conservation proper, accompanied by partial reconstruction of the archaeological assemblage, is a field on its own.

Mention should be made here, perhaps, of the methods used to conserve on site the fragments of mural paintings unearthed in the excavation area. The process recently developed by the Polish mission at Faras, during the archaeological work conducted in Nubia under Unesco's auspices, was as follows. After cleaning the frescoes, one or two layers of Japanese vellum were applied by ironing it on, together with a mixture of beeswax, rosin and turpentine, suitably blended after several experiments made on the spot. Once the surface was covered with the paper, a second sheet, this time of gauze, of larger size than the mural, was applied with a hot iron and wax mixture, as before. After that, the painting thus preserved had only to be protected from the sun. To remove the paintings, special saws were used to saw them away from the wall. (In general, if the sawing is done by a skilled operator, there is no risk of paintings being damaged *(Plate 10)*. Before removal of the paintings from the wall, a wooden scaffolding shaped like a sledge was backed on to the wall by means of ropes tied to the upper edge of the cloth projecting beyond the mural. Each sawn-out fresco was then deposited slowly on the scaffolding and the latter placed in a horizontal position, after which the fresco was shifted on to a plank, using the same ropes, and the parts of the wall and rough-cast weighting down the back of the fresco were filed off so as to leave a smooth surface. For transport, the frescoes were packed in special cases with inside quilting.

Report

The archaeologist's last task, after completing the excavation, is to prepare a detailed report on his finds. In theory, for each excavation site there is a basic library collection enabling a first comparative analysis of the finds to be made. Apart from a full inventory, the report should include a tentative historical interpretation of the archaeological assemblage discovered. It is quite useless to specify that an object was found at such and such a depth, or at such and such a point in a given square of the grid (with an indication of its number): this type of information tells nothing to anyone, and even the discoverer himself will find it meaningless after the lapse of a few years. To include particulars of this kind under the catalogue entry for the selected objects may indeed serve some purpose, but to include them in the report is completely pointless, and, worse still, makes attempts at interpretation more difficult.

The archaeologist, like all research workers, may be mistaken in evaluating his finds. Just as, in his excavation log, he corrects the errors of the preceding days, so the succeeding excavation seasons enable him to develop earlier hypotheses. His report should not only be an account of his activities, but should also constitute an attempt to draw conclusions from the investigation of a specific segment of history, for which the documents used are archaeological monuments. And above all, in preparing his report on the work of the excavation season, the archaeologist should always remember that excavation is not an art in itself, but only one of the main research methods of that branch of historical science.

BIBLIOGRAPHY

ATKINSON, R. J. C. 1946. *Field Archaeology*. Methuen, London.

DAUX, Georges. 1958. Les étapes de l'archéologie. *Que sais-je* nº 54. Paris, Presse Univ. de France.

DE LAET, Siegfried J. 1954. *L'archéologie et ses problèmes*. Bruxelles, Berchem.

DU MESNIL DU BUISSON, R. 1934. *La technique des fouilles archéologiques; les principes généraux*. Librairie Orientaliste P. Geuthner, Paris.

HEIZER, Robert F. 1954. *The archaeologist at work*. Harper, New York.

LAMING, Annette. 1952. *La découverte du passé*. Picard, Paris.

LEROI-GOURHAN, André. 1950. Les fouilles préhistoriques. *Techniques et méthodes*. Picard, Paris.

LEROI-GOURHAN, André. 1939. *Manuel de la technique des fouilles archéologiques*. Paris, Office International des Musées.

——. 1964. *Restaurierung und Konservierung*. Berlin, BJV Ergänzungsband.

SCHAEFFER, Claude F. A. 1948. *Stratigraphie comparée et chronologie de l'Asie occidentale (IIIe et IIe millénaires)*. Oxford University Press.

WHEELER, Sir Mortimer. 1954. *Archaeology from the earth*. Oxford, Clarendon Press.

WOOLLEY, Sir Leonard. 1954. *Digging up the past*. Harmondsworth, Middlesex, Eng., Penguin Books Ltd.

Carlo M. Lerici and Richard E. Linington

Prospecting methods in archaeology

5

INTRODUCTION

Archaeological exploration in our modern world, while retaining intact the traditional aims of this humanistic discipline striving to discover the evidence of ancient civilisation, cannot on the other hand fail to be affected by the great changes taking place in all aspects of human life as a result of the extraordinary developments of science and technology.

These changes contribute to the stressing of the interdependence of all human activities, just as in the field of culture there is an increasingly marked trend towards an integration of knowledge, overcoming the differences and misunderstandings which in the past have divided the humanistic disciplines from those of science and technology. Today, the 'sealed compartments' are no longer acceptable.

Till recent years, archaeological exploration was one of these 'compartments': unchanged over the centuries, using processes based on proud traditions, carried out by a continuing succession of eminent archaeologists, whom we must remember with gratitude.

Their teaching is still alive, even though the new exploration methods are profoundly affecting the traditional methods. These new techniques are virtually still in the initial stage of their application, but the results already achieved suggest that they will necessarily become established everywhere, not only in relation to the immediate goals of exploration, but also because of their interconnections with other activities, outside of the realm of archaeology, which today cannot be ignored by the followers of this discipline.

At this point it seems suitable to introduce the major factors which, at present, are involved in archaeological exploration, specifying for each of them the nature of their co-relation with the very purposes of exploration.

This knowledge is indispensable for an understanding of the discussion made in the following sections on the choice of methods, their description and the conduct of the operations.

MAJOR FACTORS AFFECTING ARCHAEOLOGICAL RESEARCH

We must naturally give first place to the cultural factors, as reflected in the increasing interest attached to investigation of the past. This interest seems to express man's wish to combine his achievements towards the civilisation of the future with a better knowledge of the more remote and obscure events of his part history.

Till very recently this cultural motivation was practically the only one, or at least the most important of the factors underlying archaeological exploration activities.

Over the last few decades other factors have come into the picture and should be taken into proper account, for they are those which today can exert the greatest influence on new exploration activities. They appeared in the early years of this century, and their importance has been growing at a progressively accelerating rate, which can now be determined on the basis of statistical information.

The expansion of urban centres

It is a known fact that industrial growth induces in all nations a movement of people from the land into the towns and cities, which thus tend to grow larger and larger, particularly when they are located in the industrial centres attracting labour forces away from the farms. A tremendous amount of damage has already been caused by this invasion in the archaeological areas around all historical centres, and it is evidently necessary to remedy this situation by locating any archaeological formations which may still lie buried.

Land reclamation

In all nations the tremendous population growth demands the intensive exploitation of all arable land where crops can be grown with modern cultivation and fertilization methods. Thus, if only in the historical centres of the Mediterranean area, hundreds of thousands of acres of archaeological areas are being ravaged by deep ploughing, irrigation ditching and by the use of fertilizers which help accelerate the decay of the still buried archaeological material.

Air contamination and water pollution

Over the last few decades, the expansion of the industrial centres, especially in the vicinity of historical areas, the growth of motorization and the increasing use of solid and gaseous fuels, have all contributed to a frightening extent to contaminating the atmosphere with combustion residues containing extremely harmful elements, which cause a progressively increasing destruction of the archaeological resources.

As it is known, several international conferences have called attention to the seriousness of this process, which threatens not only the wealth of art and history on view in the historical centres and in public and private collections, but also the material still buried underground, which is subject to the same deterioration as a result of polluted underground waters and atmospheric contaminating agents carried into the soil by rainfall.

Expansion of roads, railroads and public works

This is a consequence of industrial growth; there are too many reported cases of damage done to unknown archaeological formations by the movement of earth required for these projects. The problem of the monuments of the Egyptian and Sudanese Nubia which were threatened by the new Aswan High Dam comes under this heading, just as many thousands of other cases, less known or even unknown, which unfortunately occur in all countries where ancient civilizations have existed.

Development of tourism

This is one factor which, in the present picture of the development of archaeological areas, constitutes an economic element of decisive importance in the planning of any new archaeological exploration activity.

Up to the end of the last century this was a practically negligible factor, and nobody would have dreamed of its being in corelation with the problems of archaeological exploration.

The statistics for the last 50 years offer indications of extraordinary importance for the assessment of this factor, which in certain historical countries of the Mediterranean area has even become the most important among those of direct concern to archaeology. Over the next few years, tourism will register an unprecedented growth, due to the advent of new and faster means of transport which will shorten the distances between continents, to the expected reductions in travel costs, to the introduction of 'work weeks' as short as four days in connexion with the spreading of automation. This will enable hundreds of millions of people to enjoy travelling and other forms of tourism on an unprecedented scale. The development of a historical centre and its integration into the plans of international tourism will be a decisive factor in promoting and orienting new archaeological exploration campaigns.

This picture which we have outlined in its essential elements suggests the rules which will have to be followed in organizing any new archaeological campaign. They will necessarily take into account the new scientific methods of investigation which we will describe in the following sections. The use of these methods will result in a more 'dynamic' approach than that followed in the past, for the new instruments now made available to the archaeologist by science and technology are subject to continuous changes as a result of the unprecedented evolutionary process taking place in the applications deriving from the advances of science in the fields of nuclear physics and electronics.

It is evident from these brief considerations that archaeological exploration is no longer a 'sealed compartment', but rather one field in the general framework of scientific progress in all disciplines.

The experience acquired from past applications of the prospecting methods, particularly in Italy during the last decade, makes it possible to lay down some general rules to be followed in organizing an archaeological exploration campaign.

ORGANIZATION OF THE PROSPECTION

First of all it should be borne in mind that all prospecting methods must be regarded as complementary one to another. In addition, any archaeological campaign should make use of all the information available. This includes historical sources, previous discoveries, both accidental and as a result of deliberate research and, in particular, any previous air photographs of the area. In certain regions detailed archaeological surveys already exist, in others use can still be made of surveys taken for military, cadastral, forestry, public works and other purposes.

In the areas where the land has undergone land reclamation work, now so frequent in many countries, because of the necessity for a high degree of farm mechanisation, valuable help can be provided by aerial surveys made before the land was subjected to deep ploughing, which turn it into a uniform surface and erase all signs which once could disclose the presence of archaeological formations at shallow depths in the soil. In many areas considerable numbers of air photographs have been taken for military purposes, especially during the last world war; these often offer a very valuable source of information.

INFORMATION OF VALUE IN PLANNING ANY PROSPECTING CAMPAIGN

Information from the local antiquities and public works authorities

- historical information concerning the area to be explored;
- information on past excavations or chance findings;
- cadastral maps showing property boundaries and roads;
- crop maps;
- information on surveys made in connexion with public works; the drilling of wells, tunnels, etc.;

- geological map of the area;
- aerial surveys, when available;
- any geochemical soil surveys;
- presumed nature and depth of the existing archaeological formations;
- existence of AC and DC power lines.

Information of a general nature

- permission to enter the areas to be explored;
- facilities for the exploration team: quarters, food, transport, etc.;
- local labour availability and wage scales;
- location of the nearest motor vehicle repair shop;
- responsibility for payment of any damage to crops;
- water, fuel, oil and power (voltage and frequency) supplies.

All of the information listed above is important for the programming of the exploration work under the most favourable conditions, i.e. ensuring the most economical employment of personnel and equipment. The very choice of prospecting means is conditional upon the geological characteristics of the ground and upon the anticipated nature of the archaeological formations to be explored.

In the case of an exploration campaign of major importance in terms of area to be covered and time required, it is generally wise to have a specialized expert run a preliminary survey, which in no cases will take more than one week.

The preliminary surveys of this kind so far conducted in several countries have proved their worth. Their cost is largely offset by the fact that they make it possible to reduce to the essential minimum the exploration equipment needed, and to determine from the very beginning which prospecting method is best suited to the area.

THE CHOICE OF THE PROSPECTING METHOD

Generally speaking, the choice of the prospecting method depends upon the following factors:

(a) nature of the ground to be explored;
(b) presumed nature of the existing archaeological formations;
(c) presumed average depth of the formations;
(d) area to be covered;
(e) purpose of the prospecting work, e.g. intended to determine whether archaeological formations are present or absent, so that the land can be released for uses such as residential or industrial building, public works, etc.

There are of course other factors to be taken into consideration in each case, since every campaign can be affected by seasonal conditions, by the presence of certain crops, by access difficulties, by the presence of power lines which may induce alterations in the local magnetic field, by the difficulty in obtaining an adequate water supply for stratigraphic drilling, etc.

It is readily evident from these brief considerations that in all cases the preliminary survey conducted by a prospecting expert will be of great help in choosing the most appropriate method and techniques, not only with a view to ensuring a positive result, but also in order to obtain the most rational utilization of the men and equipment employed in the campaign, that is, the most economical use of the funds available.

These considerations give us an opportunity of pointing out that every prospecting campaign carried out with the means and processes made available by science and technology, while on the one hand enabling the archaeologist to achieve the desired results rapidly, will, on the other hand, prove apparently more expensive than the conventional methods, due to the high cost of the prospecting equipment and of the skilled personnel required.

We said 'apparently', for a 10-year experience with these applications at many archaeological sites and for different purposes has shown that the rational use of the new methods of prospecting will result in substantial savings entirely comparable with those effected by the use of aerial photography for planimetric surveys, the cost of which is one fourth of that of ground surveys carried out by teams using conventional equipment.

It will be understood that this explains why isolated exploration projects, limited excessively both in space and in time, may prove uneconomical, particularly when the nature of the soil and of the buried archaeological formations requires the use of several prospecting methods. These can involve the employment of costly scientific and technical equipment, which may be used but partially, often for a small fraction of the time spent on the campaign.

It is understandable too that the larger the area to be explored or the larger the number of different surveys that can be undertaken, the more rational will be the use of equipment and personnel, since it can be possible to keep several teams at work at the same time using the same equipment which would have been needed by one team alone.

The description of the campaigns carried out in the past, and reported on in several publications, can help in giving archaeologists indications for the planning of any new exploration.

DESCRIPTION OF THE METHODS

From the considerations set forth in the preceding sections it appears evident that the choice of methods depends upon many factors which may vary from case to case, and that only a practical experience of some years will enable the explorers to choose with certainty the best solution to be adopted. Fortunately today, the technical literature already offers a substantial body of case histories concerning numerous applications, which have been reported on in several

Prospecting methods

Surface effects		"Sampling techniques"		Geophysical surveying	
Air photography	Surface surveys	Samples taken	No samples	'Active'	'Passive'
Overall cover	Collection of material	Core sample	Probing	Seismic	Magnetic
Low level photography	Soil differences	Drilling for samples	Simple drilling	Electrical	Gravity
	Vegetation cover	Pollen analysis		Electro-magnetic	
		Geochemical methods (phosphate analysis)		Minor methods	

Fig. 6. Diagram showing the division of the various prospecting methods.

countries. Thus, the rapidity of communications and the expansion of cultural exchanges now enable each country to adopt the latest techniques and to benefit from the continuing progress being made in this field. In addition, a close contact has been maintained between the major centres in the field and this has done much to aid the development of the subject.

The various prospecting methods can now be outlined, with the assistance of the overall schematic diagram in Fig. 6. In addition to the various methods, two basic approaches may be defined as follows:

1. The location of evidence suggesting the existence of buried archaeological features, the nature of which remain uncertain. Supplementary survey work or excavation is thus necessary.
2. The location and investigation of buried archaeological features to a sufficient degree that a reasonable interpretation of their nature and extent can be made. Supplementary work is thus either not necessary or will be very limited in amount.

Those methods for which both approaches are applicable are shown starred in the figure, whilst all the others are covered by approach 1 only.

SURFACE EFFECTS

The first group of prospecting methods are those that record the effects visible on the modern surface. Apart from the continued existence of above surface remains, the presence of a buried archaeological site can be revealed by the occurrence of fragments of constructional material or artifacts, normally brought up from the underlying deposits by farming operations, especially ploughing. An accurate survey of the amount and position of these fragments, although somewhat laborious, can give useful information. In addition to the presence of actual archaeological material, the surface soil may also show differences in colour or in texture. Ploughed out banks and tumulus mounds are but two examples of where this can occur.

Such effects as mentioned above are only likely to occur were the soil cover is relatively thin, and can of course only give information about the very top part of the buried deposits. Also objects and soil types are only likely to be noticeable where the vegetation cover is scanty or absent. Grass, in particular, will probably conceal all traces. This is, of course, one of the reasons why, in many regions, far more archaeological sites are known from arable areas than from those that are predominately pasture.

The presence of a vegetation cover is however not always a disadvantage, as both the type of vegetation, and variations in its development, are often dependent on buried archaeological feature. For the features can affect the moisture distribution in the soil and even the amount of soil available. By plotting the distribution of certain plants, or those areas where plant growth is either retarded or advanced, something can often be deduced as to the possible existence of archaeological features. Changes in ripening grain crops can be particularly useful and important.

AERIAL PHOTOGRAPHY

The main difficulty of all these methods is that they tend to be rather too vague and subjective. Indications are often tantalizingly uncertain. On many occasions some sort of pattern will seem to occur, thus suggesting the existence of a buried site, and then it will prove impossible to deduce anything further of definite value. It is here that aerial photography can be of use by providing a more objective overall view of the apparent pattern. Normally the great value of aerial photography is thus not that of revealing anything new that was not already visible on the ground, but in enabling a sufficiently distant view to be taken so that some sort of order and sense may be brought into an otherwise impossibly confused situation. In practice, the value of this new viewpoint is twofold. Firstly, existing fragmentary remains can be elucidated in terms of a general plan, and secondly, the less permanent effects mentioned above for ground survey methods can be recorded. Strictly speaking, it is only this second use that constitutes a prospection method.

The main, and most obvious, advantages of aerial photography are that large areas can be covered, and that a wide range of features can be shown. Thus, in taking one photograph, work equivalent to weeks, if not months, of ground survey can be achieved. Against this, it is unfortunately often found that occasions for the taking of the one vital aerial photograph may be rare, or even non-existent. Since much of such aerial photography relies on differences in the vegetation cover, which in turn express the form and nature of the underlying archaeological features, both local conditions and climate are very important. Often the number of days per year that the differences can be photographed is very limited, whilst crucial areas may never have a satisfactory vegetation cover.

Finally, partly because of the above limitations, aerial photography is both a long-term and an expensive operation. Thus for any one particular site, unless a suitable aerial photograph happens to exist, other survey methods are likely to be of greater immediate use. In addition to these practical difficulties over time and opportunity, aerial photography will also be of use mainly only for relatively shallow and uncomplicated sites.

Aerial photography can also be of use even in areas where no surface traces occur, in giving a general idea of the nature of the region, especially when coupled with topographical and geological information. Thus, for example, it may be possible to delimit those areas where alluvial deposits may cover buried settlements. On the other hand, a general aerial survey of an even larger area may well give decisive clues to more limited problems. Thus the overall pattern of traces of ancient roads and water supplies might well help towards locating archaeological sites, even though no indications occur of the sites themselves. In Fig. 6 two methods are given for aerial photography; overall cover and low level photography. In regions where relatively little field archaeology has been undertaken, much can be learnt from an overall photographic cover. Such cover will, however, probably be on a fairly small scale, so that details of the sites may not be at all clear. Also the time of day and period of the year will not be suitable for all types of possible markings. Experience has shown that much additional information, including many new discoveries, can be gained from special flights under a series of different climatic conditions. On such flights, individual sites can be searched for and, when found, photographed from a relatively low level. Both vertical and oblique photographs are of value. It is such work, although of very great value, that can make aerial photography a specialized and expensive operation.

SAMPLING TECHNIQUES

Prospecting methods forming the second main group necessitate some disturbance of the deposits. Normally this disturbance is made in order to obtain samples from the deposits; hence the title 'sampling techniques'. For completeness, two other possible methods are included which also involve disturbance, but do not actually produce any samples.

Before continuing, it is wise to consider the size of the disturbance caused. For, to suggest the use of a method such as drilling for samples, is liable to meet with violent, even if somewhat illogical, response from some archaeological circles. Normally the maximum size of a drill hole will be about 10 cm in diameter giving a cross sectional area of about 80 cm^2. For convenience, the zone of disturbance can be taken as 100 cm^2. Next, even if drilling was undertaken on a grid with only 10 metres between drill holes, a very close spacing indeed, this means a disturbance of 100 cm^2 every 100 m^2 (1,000,000 cm^2). That is, the disturbance represents only one hundredth of 1 per cent of the whole area, or 1 part in 10,000. This can be compared with the use of test excavation, a normal archaeological practice. Here small test pits are dug across the area, often fairly rapidly and without the possibility of such accurate control as for larger excavations. Some damage is thus unadvoidable. The smallest size for such a test pit is about 1 metre square. Then test pits every 10 m represent a removal of 1 m^2 in every 100 m^2, that is 1 per cent of the whole area, or 1 part in 100. One is thus faced with one hundred times the disturbance, often to gain almost the same amount of information.

The simplest methods within the general group of 'sampling techniques' are, as mentioned above, those that do not give any samples. Firstly, there is the use of probing; by this is meant the testing of soil depths by using a pointed rod, normally of steel. Such work is limited to relatively shallow deposits of a predominately earthy character. Where the deposit is more variable, especially where fragments of stone or rock occur, simple drilling can give equivalent results.

The disadvantages of both these methods are obvious; not only is there the disturbance, but also the results are likely to be highly subjective, even when taken on a regular grid system. Thus, in general, they are not of any real use in prospecting and cannot be recommended. Under special circumstances they may be of use, for example as in the drilling of Etruscan chamber tombs as developed by the Lerici Foundation. It must be stressed however that in this case, the drilling does not form part of the prospecting methods as such, but rather is a way of helping the investigation of known features found by other methods. The value of the drilling is in fact in avoiding further disturbance within the tombs, whilst at the same time forming part of a more efficient overall operation.

The methods that produce samples are of greater possible application. Simple core sampling, where a cylinder of deposit is removed, can normally only be used for fairly uniform earthy deposits. This can however be of value in many sedimentary situations where the archaeological deposit of interest may consist of only a thin horizon of material. Where the deposits are more varied, certain types of drilling equipment can be of use, as long as the material removed is not greatly broken up by the drilling process. In particular, it would be of interest not only to discover the rough nature and depth of the deposits, but also to recover small fragments of archaeological artifacts, specially pottery sherds. This is possible with modern specialized drilling equipment.

Fig. 7 shows a diagram illustrating such a system. The drill unit is mounted on a small truck or jeep and is powered by the motor of the vehicle. Circulating water under pressure is used to help liberate the soil deposits and thus minimise the damage from the drill head. The water also brings the liberated material to the surface thus allowing an idea to be gained of the different deposits encountered. Normally the fragments of archaeological material are of sufficient size to enable identification and dating. In practice, unless a water supply is available very close to the drilling point, a subsidiary water truck will also be necessary.

The final methods are pollen analysis and the group of geochemical methods, of which phosphate analysis is the most important. These rely on the further laboratory investigation of soil samples, and are thus likely to be both more complex, and more laborious, than the other methods. In practice, although interesting results can be obtained, it would seem that the effort

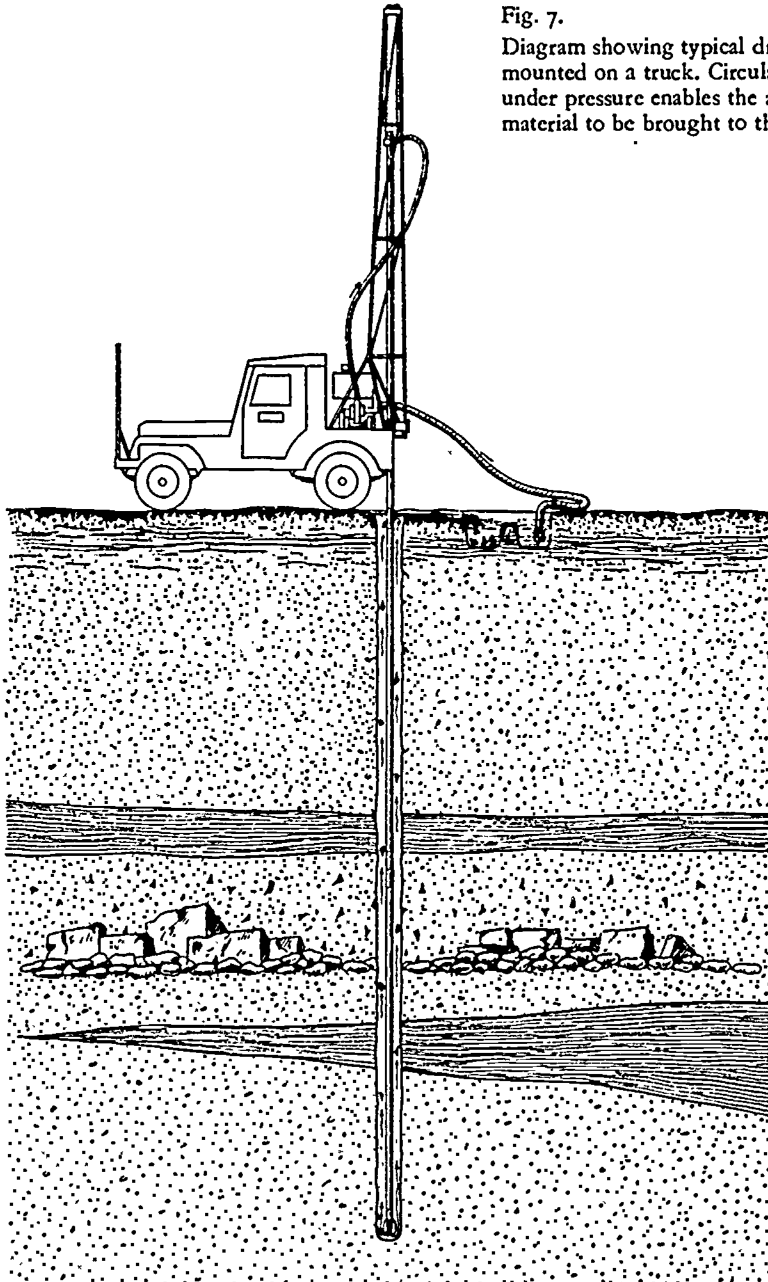


Fig. 7.
Diagram showing typical drilling equipment mounted on a truck. Circulating water under pressure enables the archaeological material to be brought to the surface.

involved normally renders them less suitable for routine prospecting. However, under special circumstances, and in connexion with accurate excavation, they can be of great value.

GEOPHYSICAL SURVEYING

The third, and final group of prospecting methods are those of geophysical surveying. They all use the same basic approach, which is the measurement of a physical property at points along, or above, the modern ground surface. Then it is hoped that the way these measurements vary allow an interpretation to be made as to the possible presence, and even the nature, of the buried archaeological features. For this to be possible, meaningful contrasts must occur between the physical characteristics of the different elements of the archaeological deposits. This condition is fundamental to the application of geopl .ical methods.

Luckily in many cases such contrasts exist, due either to the presence of man-made materials of from the juxtaposition of different natural substances. For example, brick-built walling buried in earth deposits or a pit cut out from the rock and filled with earth can both give marked physical contrasts. However, it is always possible that whilst a difference can occur in one set of physical properties, a corresponding difference may not occur in other properties. Thus any one geophysical method will not be of universal application.

The main methods of geophysical surveying have been shown in Fig. 6. It will be seen that they have been sub-divided into two groups; 'active' and 'passive' methods. These terms are perhaps not very suitable, but they do serve to distinguish two different approaches. In the first, the 'active' methods, a disturbance is introduced into the ground, and the effect produced is measured, whilst, in the second case, the passive methods involve a direct measurement of existing physical values. It is thus to be expected that the first type of method can be more flexible, but will also probably be more complicated to use than the second.

Of the various methods, at present only two can be considered as being of real use in archaeological surveying; these are magnetic and electrical surveying. It is hoped, however, that some, at least, of the other methods will ultimately be of value.

ELECTRICAL RESISTIVITY SURVEYING

The first geophysical method to be adapted to archaeology was that of resistivity surveying. Variations in the electrical resistance of the ground are found by applying a known voltage across the region of interest and measuring the current flow produced. A direct measurement between two points is, however, not possible, as both contact effects at the points of current entry and the interference of natural earth currents can cause large errors. To overcome these difficulties the normal system used is shown in Fig. 8(a). Four contacts are placed in a straight line, a resistance value can then be obtained from the current flowing between the outer contacts AA' and the voltage drop produced across the inner pair BB'. This system, although removing the contact difficulties, results in complicated relationships between the measured resistance and that of the ground. The situation is slightly less complex if a symmetrical system is used, as shown. This leaves two possible variables, the distances 'a' and 'b'. For archaeological work, these distances must be kept fairly short in order to concentrate current flow into the near surface region; practical values for 'a' and 'b' normally fall in the range of from 1 to 5 m.

A buried archaeological feature, as at F in the figure, can be searched for by observing variations in the measured resistance values at various points along the surface of the ground. It is generally more convenient to take lines or readings, in which case an equi-spaced array, $a = 3b$ has some advantage in allowing a succession of readings to be made with the minimum movement of the contacts. Against this enhanced convenience of operation, the interpretation of the results from other spacing systems is often simpler. A practical difficulty of some significance can arise from the size of the spacings used, in that spacing errors become important, and, to a lesser extent, so do the depths of insertion of the contacts.

A factor of great importance in archaeological work is the dependence of measured resistance values on moisture distribution. Even quite small quantities of moisture in unconsolidated deposits will greatly reduce their apparent resistivity. Sample values in ohm-cm are: limestone rock, 5.10^4, dry soil 2.10^5, wet soil (20 per cent moisture) 50, and salt water 5. Thus local conditions affecting the groundwater distribution will be of great moment. Other possible sources of variation in the resistance readings, apart from archaeological features, will be geological features, surface contour variations, and climatic conditions, especially seasonal variations.

In addition to the basic system given above, several other electrical methods have been used in commercial geophysics, such as the plotting of equipotential lines between fixed arrays of contacts. Also, electromagnetic methods using variable frequency alternating current sources have found some use; here both the resistivity and the equivalent inductance of the deposits are of importance. These other methods have not as yet received much application in archaeology, and many are unlikely to be of very great use for the problems of the size and complexity likely to be encountered. Electromagnetic methods in particular, however, would seem to offer some hope of avoiding the difficulties and time involved in the simple four contact method, although the interpretation of the results may well be somewhat more difficult.

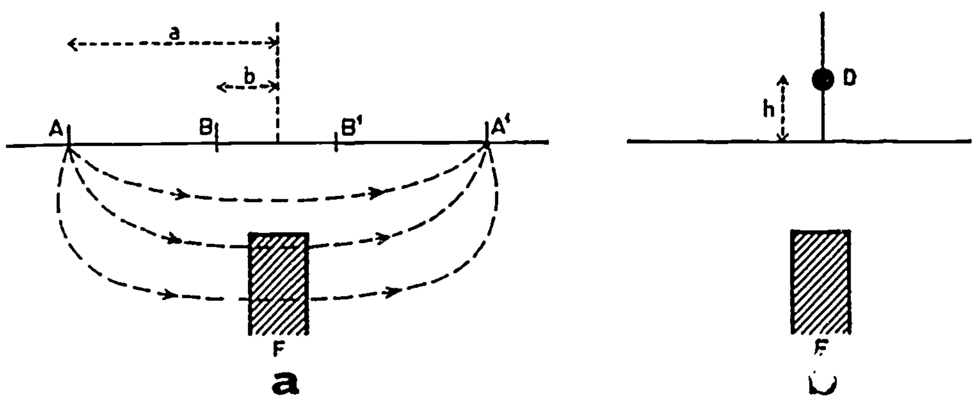


Fig. 8.
The two main methods of geophysical prospecting: (a) electrical resistivity and (b) magnetic.

METAL DETECTOR

Electro-magnetic methods have another application in forming the basis of most metal detectors. Until recently these seemed to be of little practical application in archaeology in that they are limited to very short distances. However improved measurement techniques have been developed which should enable more suitable instruments to be made. Such equipment would seem to be most useful in connexion with certain problems during excavation; they could also often be of use in disturbed areas for clearing the ground of superficial iron scrap prior to a magnetic survey.

MAGNETIC SURVEYING

A method that has proved to be of even greater value in archaeology than that of the resisting system is that of magnetic surveying. As the contrasts in magnetic susceptibilities normally found are extremely small, it has only been with the development of new instruments, especially the proton resonance magnetometer, that any useful work could be attempted.

The method of survey consists of making magnetic measurements across the area to be surveyed; as the detection device only records the total magnetic field at a point, it does not have to make physical contact with the ground being surveyed. In practice it is convenient to mount the detector on a rod so that it is always at a fixed height above the ground surface, namely as in Fig. 8(b). The only possible variable, apart from horizontal movement, is thus in the detector height D.

Apart from its value in locating kilns, furnaces and other features exhibiting remanent magnetism as a result of heating, the magnetic method of survey is of application on a wide range of archaeological sites. This is because the magnetic susceptibility of humus and of soils associated with occupation debris is generally markedly higher than that of other deposits. Direct location of the deposits of greatest potential archaeological interest is thus often possible. As with the resistivity method, however, serious practical difficulties can occur. In particular, the interference from objects of metallic iron and from sources of varying magnetic field, such as electric cables, can be very large. Magnetic surveying has, however, the great advantage over resistivity in that measurement at a point gives much more flexibility of operation as well as being considerably faster.

OTHER GEOPHYSICAL METHODS

Other possible geophysical methods include those of seismic and gravity surveying. Unfortunately, the special difficulties encountered make these methods much less suitable for archaeological sites. Although some experimental work has been carried out, at present neither method can be said to be of any practical use in archaeology. However, there is always the possibility that in the future further research will change the situation.

AUXILIARY EQUIPMENT

For any practical surveying campaign it is quite probable that some auxiliary equipment will be necessary. Apart from the question of transport and other general services, as have been mentioned previously in connexion with the organization of a prospecting campaign, other more specialized equipment may be necessary. Whilst much will depend on the individual circumstances, in general the auxiliary equipment can be subdivided as below:

(i) measuring equipment for laying out the necessary lines or grids for drilling or geophysical prospecting;
(ii) special equipment for certain definite problems, such as:
  - the drilling equipment for controlling the nature of the anomalies,

- the *periscope* for the inspection of underground cavities, as, for instance, chamber tombs,
- the *photographic probe* for taking pictures in the cavities in order to determine their nature and condition;

(iii) a certain minimum of equipment necessary for the checking and field servicing of the geophysical equipment.

COMPARISON BETWEEN THE DIFFERENT PROSPECTING METHODS AND GENERAL CONCLUSIONS ON THEIR USE

Fig. 9 attempts, in tabular form, to summarize and compare the various prospecting methods. In addition, several general conclusions seem worth stressing.

1. For the general search of large areas (of the order of several square kilometres) aerial photography and certain sampling methods seem to be most suitable.
   For more detailed work (several hectares) aerial photography or geophysical prospecting are liable to be preferable. In cases of emergency, namely where some information is required quickly, then only sampling and geophysical methods can give immediate results. Of course, in all cases, all other evidence should be taken into consideration, including historical sources, past records of discovery, archaeological remains or material still visible on the modern surface, etc.
2. Most prospecting methods require a fairly high degree of specialized knowledge, personnel and equipment. This is especially true of aerial photography and geophysical methods. Thus a fairly complex organization will normally be necessary. In particular, a special note of warning should be given over the possible use of geophysical methods. It is not enough just to purchase the equipment in the hope that non-specialists will be able to obtain useful results; what is really required is a specialist full-time group free to deal only with the problems of prospecting. If this is not possible, then it is much better to start by applying for help to an existing centre rather than risk wasting time and expense.
3. Prospecting methods are likely to be most successful on the simpler types of archaeological site. Here they can offer many advantages, especially in giving information much more quickly than by more conventional methods. Thus, it is in such cases they should be applied, rather than to the very difficult problems often suggested.
4. Whilst organizations exist in most countries for air photography, often as an official adjunct to the normal archaeological services, the situation for geophysical prospecting is markedly different. The recent date of much of the work, together with the specialized nature of the subject, when added to practical difficulties, often of a bureaucratic or financial nature, have all tended to limit the practical application of the methods. Indeed, the biggest single shortcoming of the present situation is the lack of organizations capable of applying the methods. Probably the most important general conclusion is that there is a real, and even urgent, need for official help in setting up centres for the application of the methods. Whilst more experimental work is still necessary, the methods have already proved their worth in archaeology. However, they cannot and will not be of any real value unless the means exist to apply them. One would thus like to take the opportunity offered by this important handbook, of stressing once again the need for official action, both through the existing centres mentioned below and through new organizations whose creation is demanded by the development of the subject.

Fig. 9.
A comparison between the different prospecting methods.

Method	Air photography		Surface surveys
	overall cover	low level photography	
Principal applications	discovery of new sites	details of sites	discovery and qualitative ideas on sites
Type of information obtained	photographs of crop or soil markings		distribution of material or of crop or soil marks
Archaeological conclusions	existence, nature and plan of sites		existence and rough idea of nature of sites
Difficulties	dependent on soil use and time of year		normally too subjective
Limitations	fairly shallow sites		mainly shallow sites on arable land
Interpretation of results	relatively simple		difficult as results normally inconclusive
Cost of equipment	relatively high		none
Cost of use	high		low
Speed	individual work fast but only as part of long term work		relatively fast
Disturbance to deposits	none		none

RESEARCH CENTRES FOR GEOPHYSICAL PROSPECTING

As mentioned above, the centres active in the field of geophysical prospecting are so few in number that it is worthwhile listing them. Almost all the serious work has been done in Europe, where the main centres are:

- Fondazione C. M. Lerici, Roma, Italy (address: Via Veneto 108, Roma). Active in all aspects of ground prospecting methods, and the only centre to undertake regular prospecting campaigns on a large scale.
- Laboratory for Archaeology, Oxford University, Oxford, England (address: 6 Keble Road, Oxford). A research laboratory which also concerns itself with prospecting problems.
- Research Laboratory for Field Archaeology, Rheinisches Landesmuseum, German Federal Republic, Bonn, (address: Colmanstrasse 16, Bonn). Mainly, of necessity, limited to problems within the Rhineland. However, its work has a wider general interest.

Other work has been accomplished in France, the United Kingdom and in Poland. However, so far this has tended to represent individual activity rather than that of more organized centres. Outside of Europe, some work has also been done in the United

Sampling techniques			Geophysical methods		
core samples	drilling	analysis	magnetic	electrical	others
discovery of new sites rapid checking of areas		investigation of known sites	investigation of known sites		
core of material from the deposits	objects and overall nature of deposits	variations in chemical or botanical substances	variations in geophysical measurements		
existence and type of sites		additional information on nature of sites	nature and plan of sites		
limited to earth-type deposits collection and classification of samples necessary		additional laboratory work necessary	liable to severe interference from modern sources	dependent to large degree on moisture variations	not of practical use at present
samples give information at single points only			relatively shallow sites		
direct evidence on type and nature of site			fairly difficult		
very low	moderate to high	low (but laboratory facilities necessary)	moderate to high	fairly low to moderate	probably moderate to high
low	moderate	moderate	moderate	moderate	uncertain
moderate to fast	moderate to fast	relatively slow	moderate	moderate to slow	uncertain
slight disturbance necessary			none	none	probably none

States, in particular at the University Museum, University of Pennsylvania, Philadelphia.

PUBLICATIONS AND COURSES OF INSTRUCTION

At present the only general course of instruction on prospecting methods is that organized by the Lerici Foundation and held annually at the University of Rome. This aims to give a general introduction to all the main methods, in terms suitable for both specialists and a general archaeological audience.

As for the centres active in the field, the number of publications dealing with ground prospecting techniques is somewhat limited. Three publications of a periodical nature exist. These are:

- *Archaeometry,* published by the Research Laboratory for Archaeology, Oxford University. This deals with both general research problems and prospecting methods. Normally it is an annual publication, 7 volumes having been issued up to mid-1966.
- *Prospezioni Archeologiche,* published by the Fondazione Lerici. A new publication, the first number of which was issued in 1966. It aims to concentrate on all the diverse aspects of prospecting. An average of from one to two numbers a year are planned.

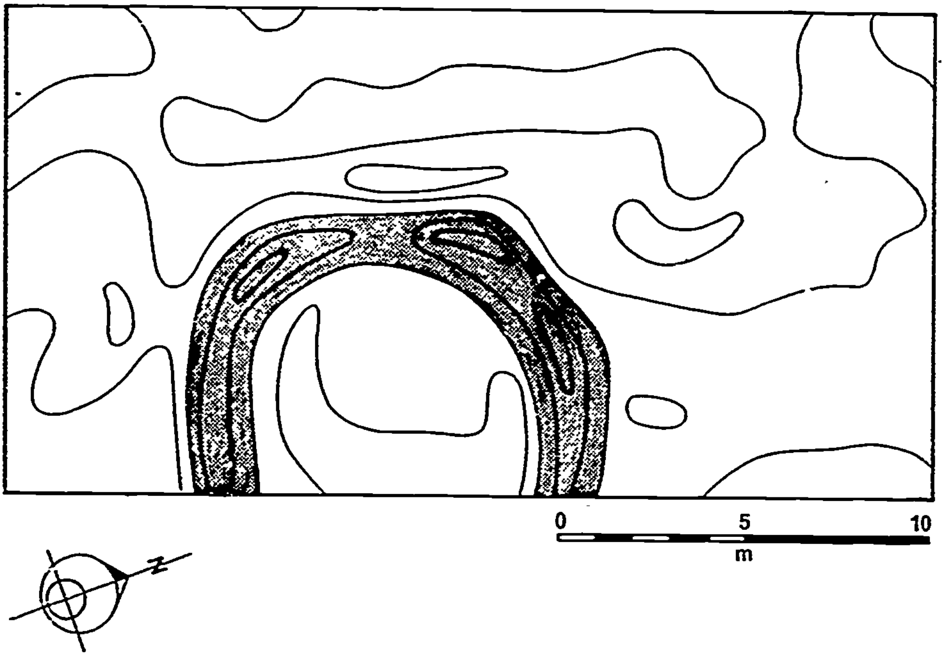
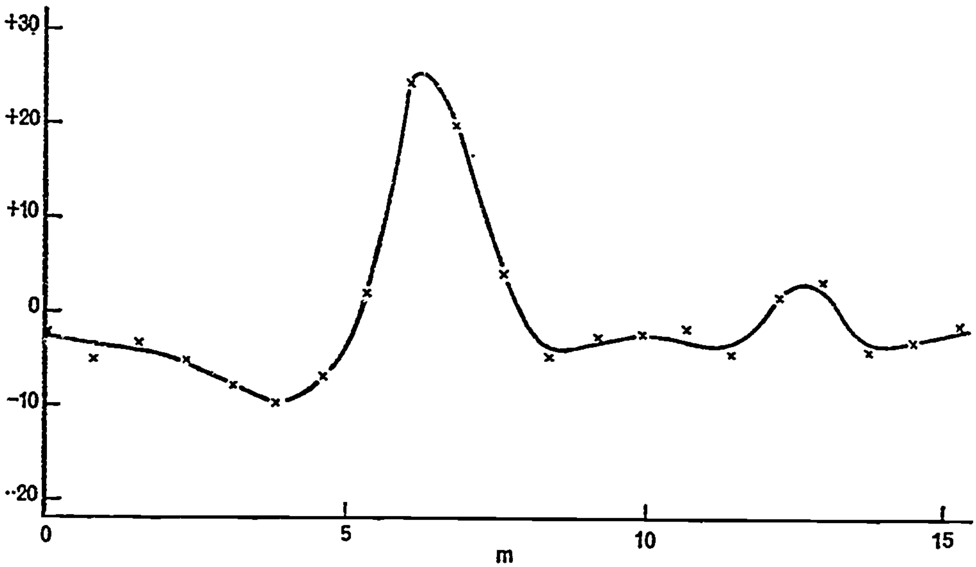


Fig. 10.
Magnetic survey of a ring ditch at
Stanton Harcourt, England.



- *Archaeo-physika,* published by the Rheinisches Landesmuseum, Bonn. A semi-periodical publication, including articles on prospecting methods. Volumes are to be issued as appears convenient. So far one volume has been published (1965).

As far as other works are concerned, a select bibliography is given below.

- AITKEN, M. J. *Physics and archaeology,* London Interscience Press, 1961.
- FONDAZIONE C. M. LERICI. Various publications both on general aspects and on particular prospecting campaigns.
- LERICI, C. M. *Alla scoperta delle Civiltà Sepolte,* Milano, Lerici Editore, 1960.
- LININGTON, R. E. (American Scientist, vol. 51, no. 1, March 1963) reprinted in the Bobbs-Merrill series of the Social Sciences.

APPENDIX

EXAMPLES OF GEOPHYSICAL SURVEYING

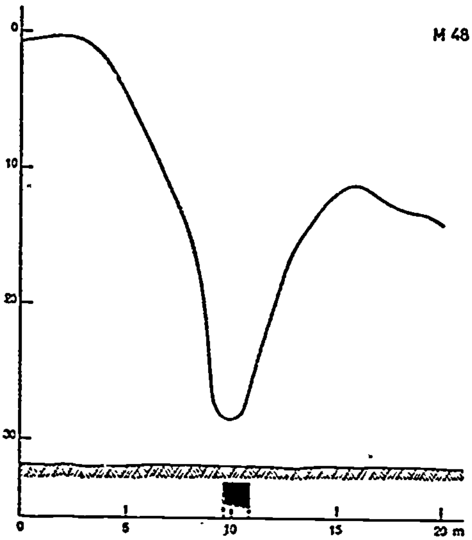
Air photography has now become a well established method in archaeological prospecting and nearly everyone has an idea of the type of results that can be obtained. However this is still not true in the case of the geophysical methods of prospecting. It has thus been thought worthwhile including this short appendix, which gives a few examples of practical surveys, in the hope that these may help show both something of the nature of the methods and their possible use.

1. *Stanton Harcourt, England*

Fig. 10 shows the results of a small magnetic survey on a Bronze Age ring ditch. The archaeological feature of interest consisted of a shallow ditch cut down into the natural gravel and filled with mixed gravel and loamy earth deposits. The higher magnetic susceptibilities of the earth compared to the gravel resulted in the ditch giving a marked magnetic anomaly as shown by the graph in the lower part of the figure. An area survey enabled the exact position of the ring ditch to be found; as shown by the contour diagram in the upper part of the figure. This example shows how the methods can be of great use on the simpler types of archaeological site, especially those where ditch systems occur, such as some types of habitation, fortified enclosures, etc.

2. *Sybaris, Italy*

Another fairly simple example is shown in Figs. 11 and 12. Fig. 11 gives a sample magnetic profile across a buried stone wall. The presence of the wall causes a magnetic anomaly because of the contrast between the stone of the wall and the more magnetic earth deposits on either side. That is the reverse effect to that of the first example. As the wall was both massive in size and formed a single isolated feature, it gave a particularly large and clear anomaly. It was thus possible to follow the wall fairly easily by means of a series of transverse lines, some of which are shown in Fig. 12; for each line, the magnetic anomalies are shown in black. It can be seen that the course of the wall,



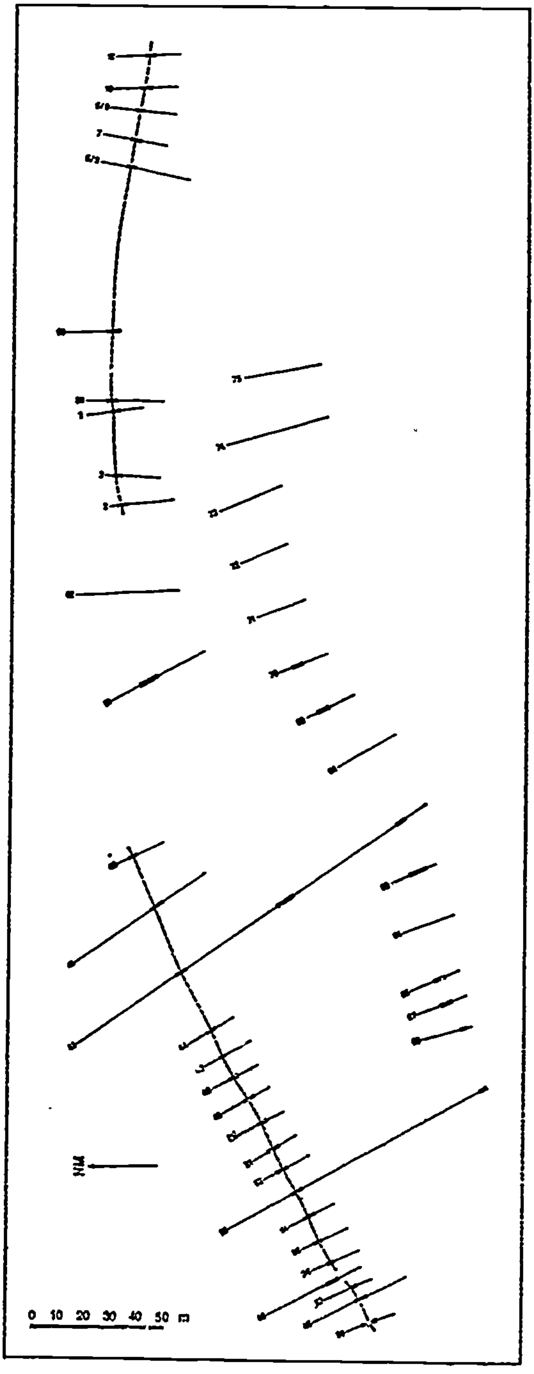
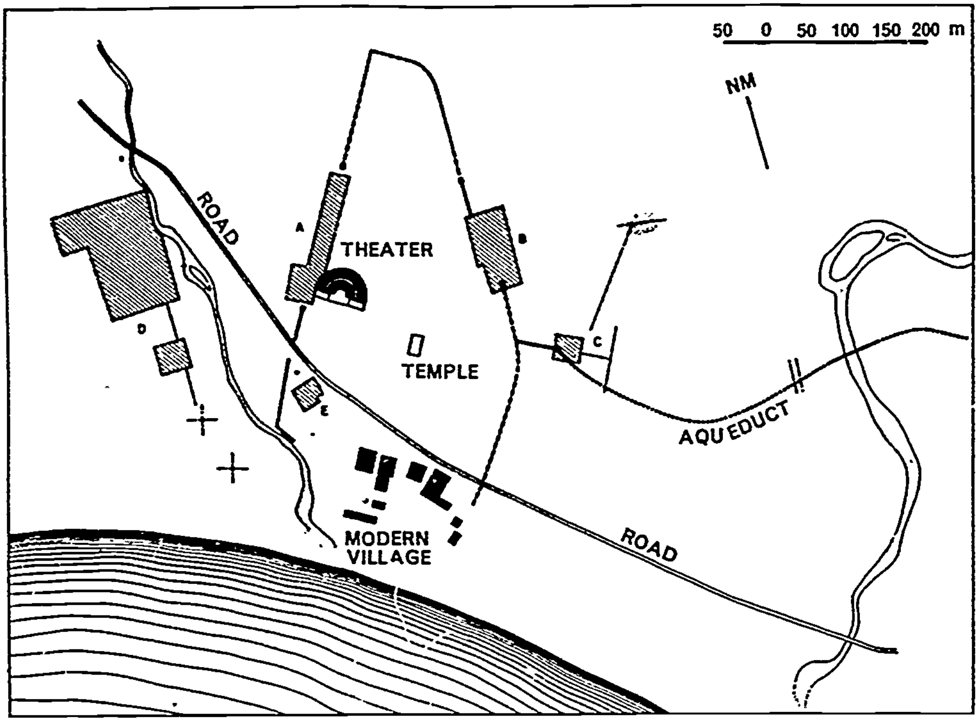


Fig. 11.
Magnetic anomaly for a large buried wall at Sybaris, Italy.

Fig. 12.
Plan of part of the survey of the wall shown in Fig. 11.



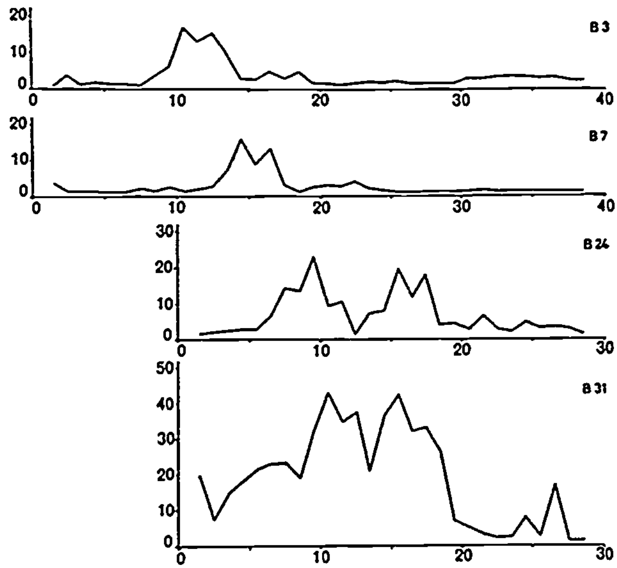


Fig. 13.
Plan of the archaeological zone at Bolonia, Spain, showing the areas surveyed.

Fig. 14.
Sample graphs of the electrical resistivity variations from zone B at Bolonia.

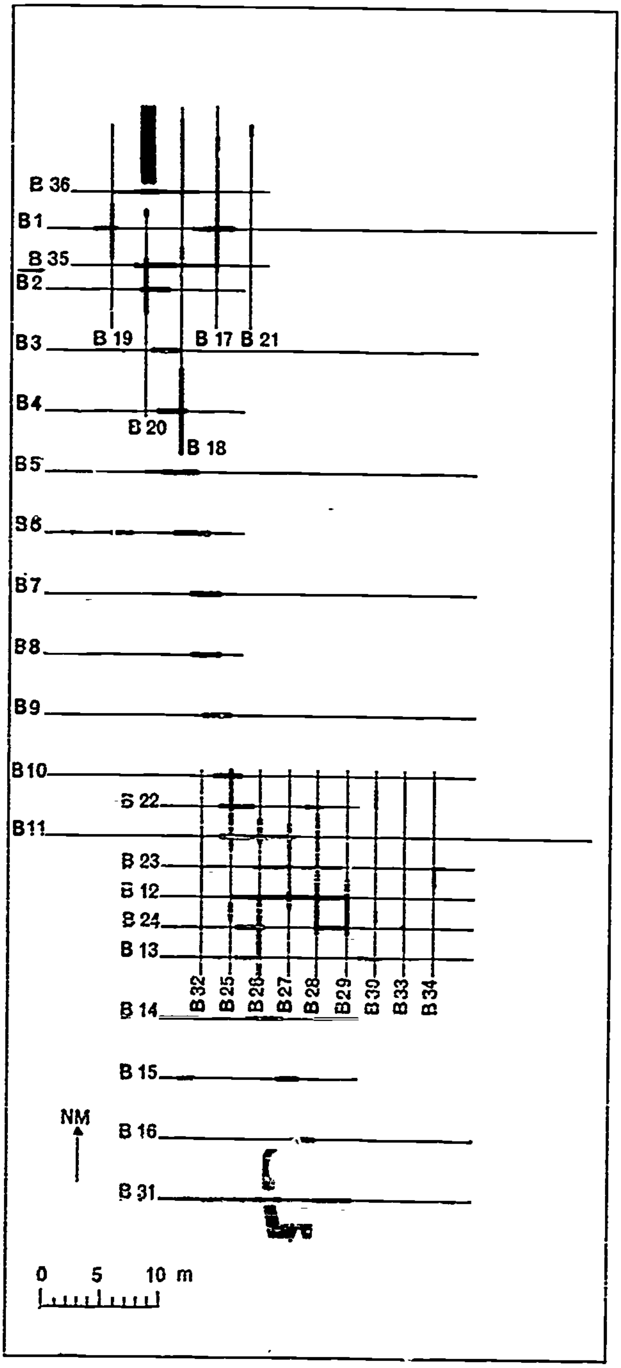


Fig. 15.
Plan of the surveyed lines in zone B, at Bolonia.

shown dashed in the figure, is quite clear over most of its length and can easily be distinguished from the other anomalies, which are probably due to other archaeological features in the adjacent areas. Whilst the present example concerns that of a wall, similar results could be obtained for many other types of linear archaeological feature.

3. *Bolonia, Spain*

Figs. 13 to 16 show the results of an electrical resistivity survey on the site of a Roman city in southern Spain. The survey was undertaken in order to check on the nature and limits of the archaeological zone in connexion with a project for the construction of a tourist village on the site. Fig. 13 gives a general plan of the area showing the areas surveyed (shaded). It will be noted that a fair amount of the city walls could still be traced from surface indications, even if badly damaged in places (shown in heavy line on the plan). In area B, no traces occurred and it was thought that possibly nothing remained in this area. However, a series of electrical traverses revealed marked anomalies on the presumed line of the wall, as for example lines B3 and B7 in Fig. 14. Fig. 15 shows a plan of the surveyed traverses in area B with the electrical anomalies added, whilst Fig. 16 gives an interpretation of the results in terms of the presumed archaeological features. It can be seen that the city wall could be traced throughout the uncertain area, whilst in addition, interesting details such as a tower and a probable gateway were also revealed. It was thus possible to change the construction plans to avoid disturbing the buried archaeological features.

4. *Pyrgi (Santa Severa), Italy*

The above three examples have all been of relatively simple cases which are typical of many archaeological sites. Clear results were obtained very quickly and without any disturbance of the archaeological deposits. The last two examples show how information can often still be obtained even under much more complex conditions. Fig. 17 shows a symbol diagram of the magnetic survey undertaken at Pyrgi on the site of a small Etruscan port. Previous excavations, in the rectangular area towards the top left hand corner of the figure, had revealed a large temple structure. It was thought that the adjacent area to the south of the temple was probably archaeologically sterile; however, as a check, a geophysical survey was undertaken. This revealed the complex pattern of results shown in the figure. Despite their complexity, it still seemed possible to undertake an interpretation; this is shown in Fig. 18. It should be stressed that this interpretation was made directly after the geoph; sical work and before any

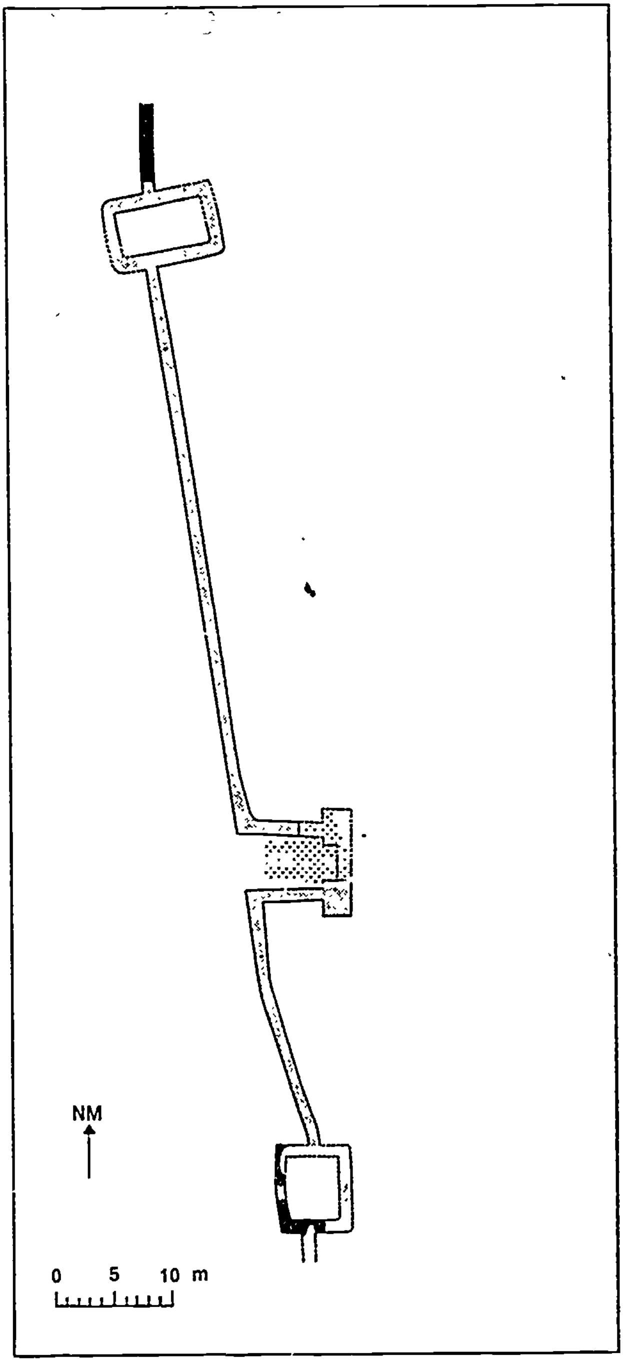


Fig. 16.
Interpretation of the survey shown in Fig. 15.

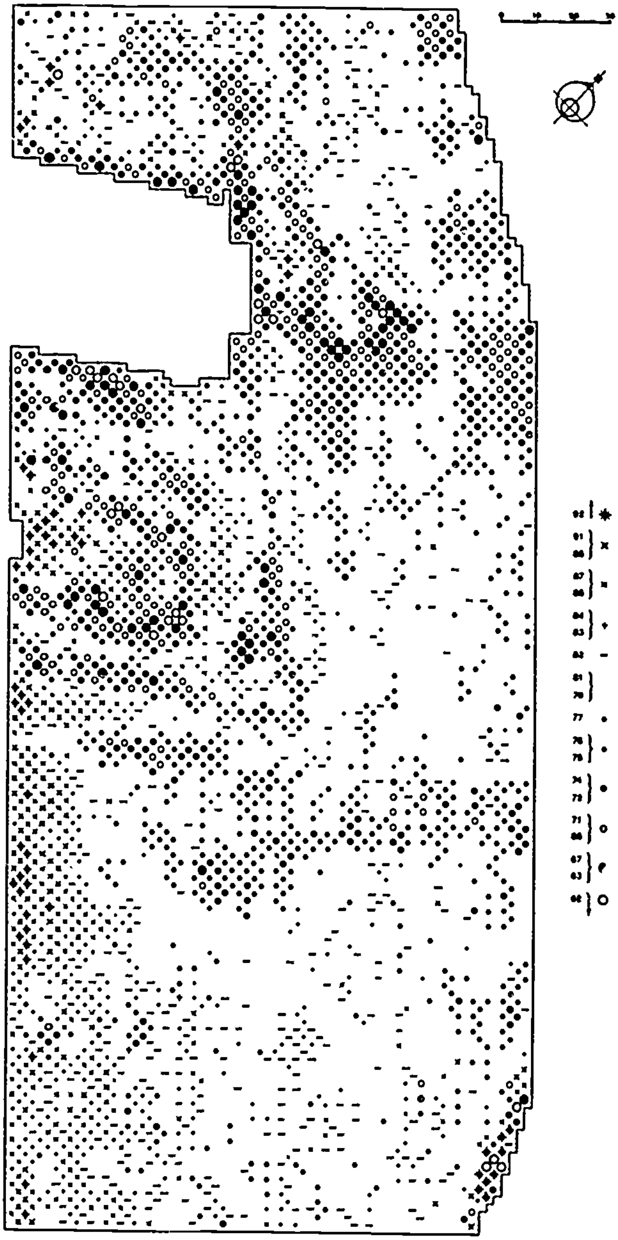


Fig. 17.
Symbol diagram of a magnetic survey at Pyrgi (Santa Severa), Italy.

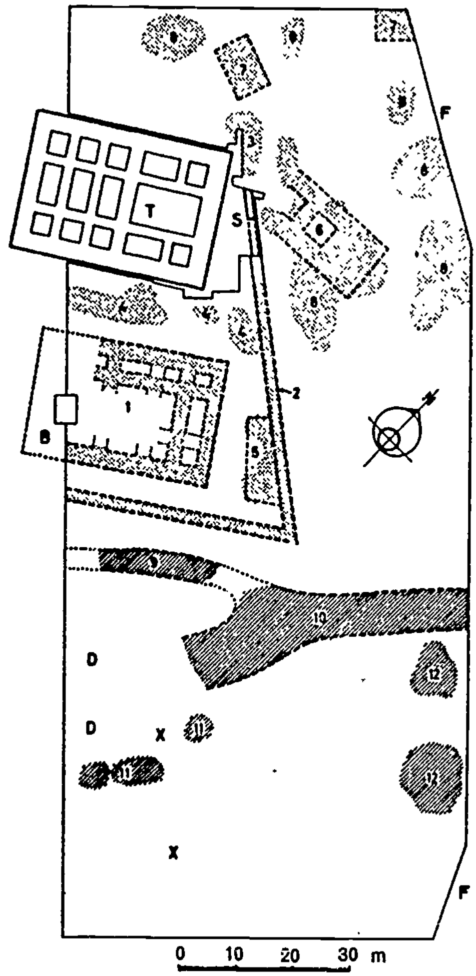


Fig. 18.
Interpretation of the results shown in Fig. 17.

further excavation had been undertaken. The most important feature forecast was that of a large structure, number 1 in the figure, which seemed to be a further temple. Indeed, subsequent excavation proved this to be the case, as shown by the plan of Fig. 19. An extra unexpected addition to the general success of the survey work was that, in testing a further anomaly (feature 4) lying between the two temples, the excavators discovered the remains of a small shrine in which were found three scrolls of thin gold sheet covered with inscriptions in Etruscan and in Punic.

5. *Cerveteri, Italy*

The final example is that of a survey on the Etruscan necropolis of Cerveteri. Fig. 20 gives a magnetic contour diagram of the survey results. Although very complex, this does show various features. In the case of chamber tombs, one would expect that the contrast between the air space in the tombs and the fairly highly magnetic tufa rock would cause marked anomalies associated with a decrease in the magnetic field intensity. A detailed study of the results, coupled with theoretical calculations of the type and form of the anomalies to be expected, showed that the results were probably due to a series of rows of chamber tombs, with the tombs in each row being fairly close one to another. It can be seen from the plan of the tombs, given in Fig. 21, that the subsequent excavation proved that the interpretation was quite exact in that four rows of tombs were found. In fact, it was possible to locate the majority of the tombs before any excavation took place. Although at first sight the results may seem to be impossibly complex, even here it proved possible to discover information of considerable value from the geophysical survey. Thus there can still often be some use for the methods even on fairly complex sites, although much will depend on the individual circumstances.

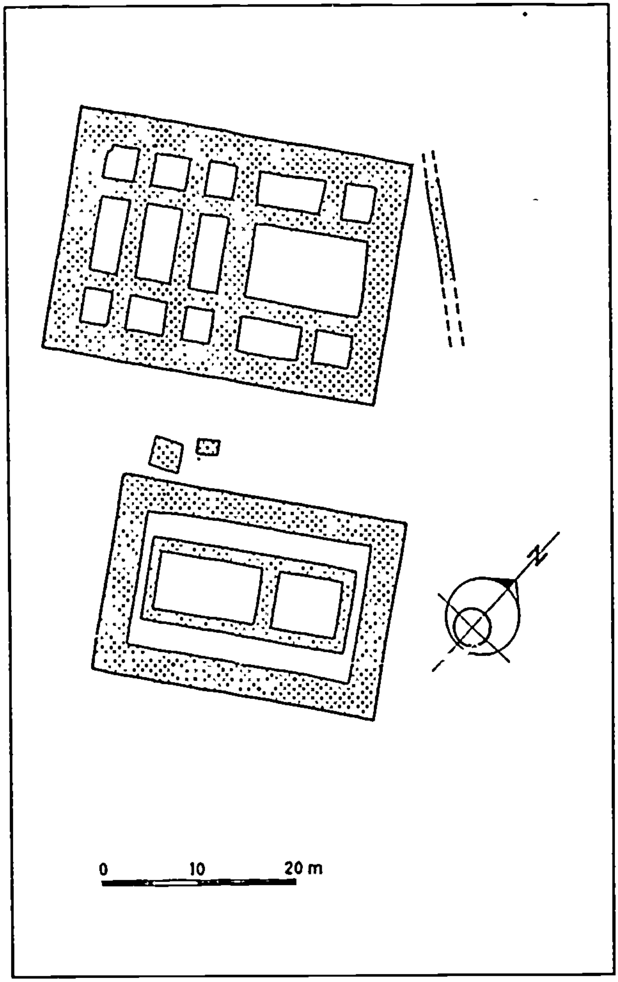
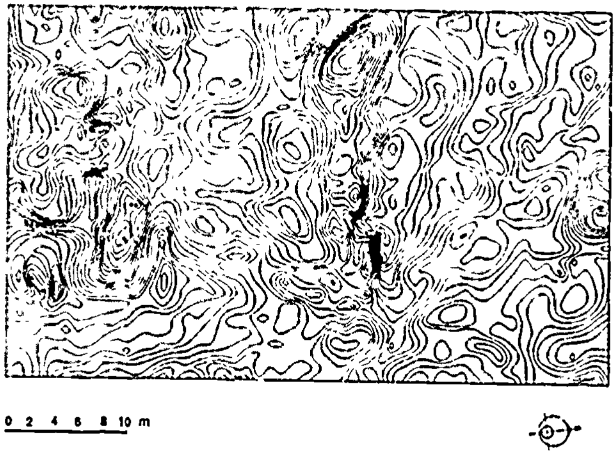


Fig. 19.
Sketch plan of the excavated features within the area shown in Fig. 17.



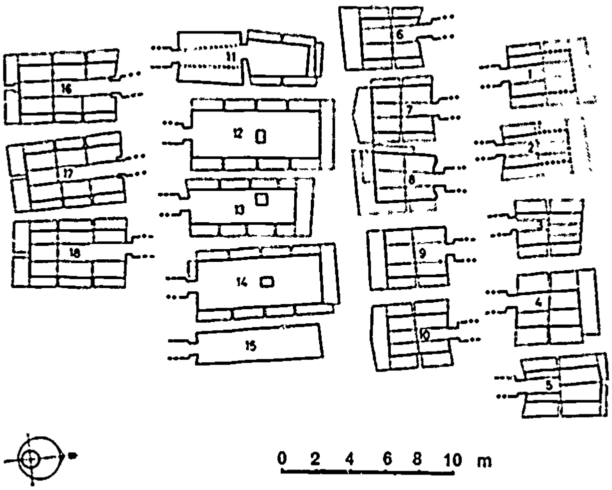


Fig. 20.

Magnetic contour diagram of part of the necropolis of Cerveteri, Italy.

Fig. 21.

Plan of the tombs found on excavating the area shown in Fig. 20.

Brian J. Ford

The recovery, removal and reconstruction of skeletal remains—some new techniques

6

The great rate of post-war redevelopment has led to wholesale excavations for purposes of civil engineering, and rebuilding has encouraged a growth in archaeology to preserve and record a thorough account of remains before they are permanently destroyed. The techniques of excavation and documentation that such sites require are well known in many cases, yet in one respect they are inadequate. This is in the field of human remains, which, though they can reveal considerable data of paramount importance to the archaeologist and historian, and even, occasionally, to the medico-legal expert, are often ineptly handled and analysed, with the inevitable result that signs are destroyed, and so the final record cannot be effectively completed. Museum collections are often replete with fragmentary human skeletons, partly held together with primitive glues or strips of adhesive paper, or partly filled with massive unsightly areas of brillant white plaster-of-paris. Many of the techniques mentioned in the literature are repeated without the benefit of newer methods, such as the use of polymerising plastic materials, and others still advocate inefficient, untidy handling methodology. A recent account (Adams, 1966) describes the delicate excision of vertebral fragments from a 2,700-year-old mummy of Egyptian origin: the subsequent restoration of the remains was carried out by using plaster-of paris and paraffin wax. It is unfortunate that such techniques are still used to supplement an otherwise delicate and precise programme of analytical work. The techniques outlined here, some of which have been described elsewhere (Ford, 1966), involve the application of polyesters to this specialized field; the plastics show themselves to be of great applicability to this kind of work.

Utilizing these newer materials, it has been possible to develop an entire scheme of general applicability to the discipline, which makes it possible to carry out an excavation and analysis with a greater amount of assurance, that the maximum amount of information may be satisfactorily derived. However, it is necessary to consider first what criteria any such scheme must satisfy. These criteria are:

1. That the remains, whether well or badly preserved in the earth, must be amenable to handling through the means advocated in the scheme; the concepts must be of general, and not limited, applicability.
2. That the techniques described must be uncomplicated, repeatable, and effective; the use of toxic, volatile or unstable materials and liquids should be excluded, and only a small number of basic requirements should be involved.
3. That the reconstruction work which permits the most thorough reassembly of the remains must not impede subsequent analytical examination, nor must the procedures used distort the general appearance of the remains.

4. That the final reconstruction must be as thorough as possible and enable the remains to be restored as nearly as possible to their original state.

We will now consider the handling of the remains through the various stages of excavation and reconstruction.

EXCAVATION

No doubt any excavation will be part of a recorded site examination, and details of exact location, depth and relative position of associated objects (walls, ditches etc.) will be noted in the normal excavation report. However, it is necessary to ensure the proper annotation of these data, as they may be of prime importance in interpreting the remains, and it is easy for them to be overlooked.

Skeletons of individuals interred casually (plague-pit burials, battle-field victims, entombment in alluvial or volcanic deposits) are usually supine and may show signs of *post-mortem* dislocation. Those of individuals buried according to rite vary considerably, and may be considered under the following headings:

1. *Extended burial.* The body is laid supine, with many different attitudes for the limbs (there may be poor correspondence between skeletons even within a given group), possibly with a preferential orientation (e.g. east/west), and often in association with tokens or weapons buried at the same time.

2. *Flexed burial.* The remains are laid on one side, as though sleeping.

3. *Contorted burials.* Skeletons show atypical attitudes, possibly due to casual interment, or occasionally resulting from ritual crouching or (as in some African systems) the binding of the body in an attitude compatible with its presumed 'after-life'.

4. *Fragmented burials.* The remains may be found in the form of bodily fragments in a container, chamber or urn; or as cremated skeletons. Cremation may result in the presence of many different signs; high temperatures lead to distortion of the charred bones, whereas a low temperature cremation, though instrumental in causing heavy calcination of the bones, may leave few traces of distortion. Occasionally the remains may show peripheral charring coincident with transverse fracture in which the charring is seen in section. This is evidence that the bones were broken after cremation. It is also necessary to find evidence of the purpose of the cremation, which may be accidental or ritual; even fragments of charred bone may be of use in radiocarbon dating.

Once an area of bone has been uncovered, a further judicious clearing of the area by careful use of trowel and brush will allow the orientation of the skeleton to be seen. By following articulations logically, the position of the burial can be readily inferred. Settling of the surrounding earth may lead to dislocation and radical distortion in the positions of limbs; the occurrence of lesser changes, such as the sinking of the mandible down towards the chest, is almost invariable when the remains are at all decomposed. Recent remains are subject to legislation in some countries, and it may be necessary before proceeding further to obtain the consent of the authorities (United Kingdom, Home Office, 1964) in order to avoid statutory penalties. The clearing of soil from the remains must be done with care. If the end of a partly-covered long-bone is lifted before it is properly cleared, transverse fracture will inevitably occur. It is especially important to make sure that the skull is cleared *in toto* before it is removed from the

Plate 11.

A typical excavation of human remains (Photo: Thomson House, Cardiff).

Plate 12.

Radiograph of remains reconstructed with polymer; reconstructed areas (arrowed) clearly visible due to transparency of polyesters to X-rays.

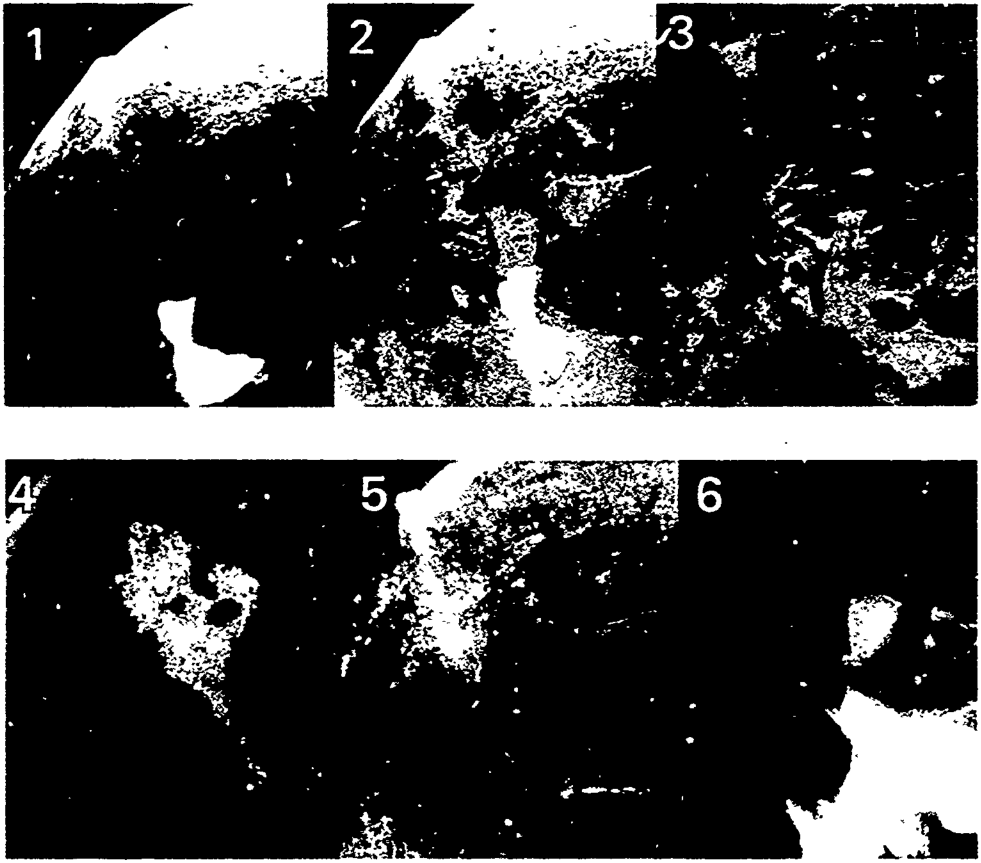


Plate 13.

Reconstruction of area missing from skull:

1. The damaged area;
2. Glass fibre cut to size is cemented with drops of Cataloy blend (C);
3. Cataloy blend (A) is roughly used to fill the cavity;
4. The area is first levelled with a sanding disc;
5. Final smoothing is carried out with the aid of abrasive paper;
6. The transparency of the repair is shown under X-rays (note a rotation of + 15° of (6) relative to the other photographs in this series).

Plate 14.

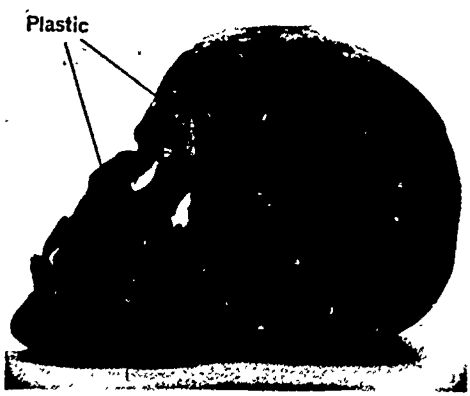
Prosthetic replacement of missing coronoid and condyloid processes of mandible.

Plate 15

Vertebra with artificial arch.

Plate 16.

A reconstructed skull: areas of plastic indicated by dashes.



earth if breakage is to be avoided. However, in the case of softened or badly decomposed skeletons, it is advisable to remove the bones with surrounding soil *en bloc* for later cleansing in the laboratory. In the case of separated bones, these may be gently restored to their original positions during the excavation process, so that accurate measurements and photographs may be taken of the skeleton before removal takes place. A typical excavation with which the author has been concerned is shown in *Plate 11*.

REMOVAL

Removal commences with the gentle separation of the bones from the substratum of soil. Not until the bones have been so separated can lifting commence. The bones of the hands and feet are lifted first, and are placed in polyethylene bags with a small label of identification; the bags are then sealed with staples or wire and packed with newspaper packing into boxes.

Lifted next are the ribs, commencing with the structures nearest the pectoral girdle. Where entire ribs can be removed, albeit piece by piece, it is advisable to place them in individual plastic bags with annotated labels; in other cases is it possible to place merely the right and left rib cage separately into bags. It is obviously essential to insist on clear, unambiguous labelling of parts at this stage. The labels should bear the following information:

Excavation reference number, which will enable the exact location, date and particulars of the excavation to be located in the record; side of body (L or R); area represented. Thus the bones of the left foot from the skeleton shown in *Plate 11* were inserted into a bag with a label reading:

'BVAG/2/L foot'

This form of annotation can be made within a few seconds, yet it enables complete recovery of relevant details later.

The sternum is then removed, and is usually found in a collapsed and decayed state. It should be placed in bags in the order in which the fragments are lifted, numbered from proximal to distal, a convention used universally in the scheme. Thus the fragments of the skeleton in question were labelled:

'BVAG/2/stern. 1' etc.

The mandible is then lifted, along with associated teeth from the lower jaw. A search is made for the hyoid; often this is most difficult to find, whether through decay or simply through inadequate searching.

The bones of the skull are then carefully removed. The facial structures particularly are liable to fracture or even total disintegration during this process so great care is needed. Only the heavier cranial structures are lifted; attempts to lift the facial bones by themselves are usually disastrous.

When the skeleton lies face-downwards, it has been found that the most satisfactory way of lifting facial structures is by removing them complete with the mass of soil in which they lie; this will be dictated largely by individual circumstances.

The long-bones of the legs are then raised, followed by those of the arms. These are packed carefully in long bags; in well-preserved examples, the entire limbs from a skeleton may be lifted and transferred together to a box; the bony structures are sufficiently unambiguous for pooled storage of this kind to be applied to the long-bones from an individual skeleton, though it is inadvisable to use the principle elsewhere.

The pectoral girdle is raised next, the two halves being retained in separate containers; then the pelvis may be lifted. This is a difficult structure to lift in one piece, and it may help to transfer the various segments of the girdle (for convenience they may be known as 'left', 'right', and 'central', being the regions of the ilium/ischium/os pubis mass, and the central vertebral arrangement of the coccyx respectively) separately.

Finally the vertebral column can be raised and, in view of the ambiguity which may be incurred, it is best to place each individual vertebra in a separately annotated bag (labelled C1-7, including the atlas and axis as C1 and C2 respectively, T1-12, L1-5).

Cardboard packing cases are perhaps best adapted to the task of removal. The remains may be packed in these with wood-straw or newspaper, as necessary, to ensure stability during transfer back to the laboratory. A manual of skeletal structures, such as the handbook written by D. R. Brothwell, can be useful in interpreting remains; however, an anatomical text used in conjunction with extensive practical work is best, since a thorough acquaintance with bones is necessary for efficient work; Gray's *Anatomy of the Human Body* or Gérard's *Manuel d'Anatomie Humaine* are examples of study material.

RECONSTRUCTION

Washing of bones frequently results in damage to them; the use of polyester materials to strengthen them is advisable, and has been found to be eminently practicable. 'Cataloy' compound, supplied by Messrs Holts (Croydon, England), has been found to be well adapted for this purpose. Wooden dowel rods inserted in the lumen of long-bones have been advocated (Brothwell, 1963), but this practice is unwise. Later drying of the bone, combined with relative moistening (and therefore swelling) of the wooden rod merely leads to rupture of the medullary cavity and splitting or disintegration of the bone. However if the lumen is gently cleared of soil (which may be retained for pollen analysis), the cavity may be filled with a fairly thin paste of the polyester material which, after setting, allows the cleansing of the outside of the bone to be completed with ease. It has been possible in the laboratory to undertake trial comparisons of bones with and without this kind of support and to demonstrate conclusively the benefit of such reinforcement. It is necessary to attempt washing small fragments in order to ascertain their strength and resistance to the process; if successful, washing can then be completed with warm (not hot) water containing no detergent or soap: the latter are both superfluous and may hinder later work. A technique of pressure-impregnating bones of a brittle nature has been described (Purves and Martin, 1950; Angel, 1943) in which the matrix of the bone is permeated with a solution of a plastic material such as Alvar; however, many such bones can be spared this kind of impregnation, which precludes later analysis of the matrix region by micro-chemical tests, by the use of a core of the polyester material. Cataloy paste, which is sticky or viscous in form, contains both 'filler' and 'hardener'. Cataloy powder, however, is also available. It is supplied with a liquid, and by varying their relative proportions, a whole range of consistencies, from a pourable liquid to a firm paste, may be made as the occasion demands. The proportions of components which produce normally used consistencies are outlined below; others may be found by interpolation.

Consistency of mixture	Parts by volume of:	
	powder	liquid
A stiff paste	3	2
B medium paste	2	1
C thin paste (may be applied with brush)	3	4

The mixture (C) is suitable for reinforcing long-bones as described; (B) is applied to fractured bones as an adhesive, and as such is ideally adaptable for skull reconstruction. The opacity of the solidified polymer to X-rays is low, as is shown in *Plate 12*, and so the areas that are rebuilt are easily visible on an X-ray plate. Utilizing glass fibre sheets, it is possible to prepare prostheses with which to make good missing parts of the skeleton. This is a procedure outlined in *Plate 13*; the glass fibre mat is used to occlude the damaged area, and the application of a paste made to the specifications of (B) above enables the area to be rebuilt. The final contour is restored using progressively finer grades of abrasive paper; even delicate and badly preserved skulls are amenable to repair in this way, the plastic, indeed, greatly increasing the structural integrity of the reconstructed bone. Cylinders of glass fibre, prepared with blend (C) above, may be filled with paste (B) and united to bony fragments with the stiff paste (A) in order to replace missing elements: *Plate 14* shows a successful repair of a jaw articulation by this method. It is also possible to construct an artificial vertebral arch *(Plate 15)* to ease rebuilding of the final skeleton.

The advantages of the technique are as follows:

(a) The bones, even if in a damaged or fragmentary state, can be speedily and accurately repaired with a repeatable method;

(b) The maximum amount of information can be gained from the reconstruction for, even if, for example, sutures are obscured, the hidden detail is revealed simply by X-ray examination, though it is naturally advisable to ensure that such detail is not obscured in the reconstruction procedure;

(c) Only two components and the minimum of apparatus is needed; the technique can be used in the field;

(d) The repair is permanent, and adds considerably to the strength of the reconstruction;

(e) The artificially-introduced areas are clearly visible because they differ in colour from the native bone, though the tone of the plastic blends pleasingly and unobtrusively with the bony structures themselves *(Plate 16)*; the remains are thus ideally adapted for later exhibition.

(f) Bones for radio-carbon or palaeoserological analysis may be excised from the skeleton since the bone is not materially altered during reconstruction.

SUMMARY

Skeletons must be carefully exposed, the bones cleared of all obstruction before lifting, and the remains, when packed, securely labelled and separated. Washing and drying must be carried out with great care and after trials of method. Polymerising materials, such as polyester paste, have been shown to provide a great deal of reinforcement for damaged bones during cleaning. Finally, the use of these plastics enables a thoroughly reliable and permanent repair of the skeleton to be achieved.

ACKNOWLEDGEMENT

I am indebted to Mr. G. Hinde for his co-operation at a radiological examination carried out at the Royal Infirmary, Cardiff.

BIBLIOGRAPHY

ADAMS, C. V. A. 1966. Surgery on Shepenmut, *Medical News, London*, 195 (c); 3.

ANGEL J. L. 1943. The treatment of archaeological skulls, *Anthropological Briefs*, (3) 3, New York.

BROTHWELL, D. R. 1963. *Digging up bones*. London, British Museum.

FORD, B. J. 1966. Das Ausgraben und Restaurieren menschlicher Skelette, *Der Präparator. Zeitschrift für Museums-Technik*, Bonn, vol. 12, nº 4, Okt. 1966, pp. 106-110.

FORD, B. J. 1967. A 12th century murder. *Medical News, London*, 262, 10.

FRAZER, J. E. 1958. (Ed. Braethnach A. S.) *Anatomy of human skeleton*, 5th ed. London, Churchill.

PURVES, P. E.; MARTIN, R. S. 1950. Some developments in the use of plastics in museum technology. *Museums Journal, London*, vol. 49, no. 293.

SIMPSON, K. 1954. *Forensic Medicine*, 5th ed. London, Arnold.

UNITED KINGDOM. HOME OFFICE. 1964. Licence to remove human remains issued to the author, Burial Act of 1857, section 25.

Marguerite Lobsiger-Dellenbach

Hints for ethnographers

7

INTRODUCTION

This chapter could not cover all the disciplines that ethnology embraces and will deal only with ethnography proper i.e. the rational search for objects, and the necessary documentation on their identification and origin. A region or a human group cannot be ethnologically studied in a few weeks. A survey, to be comprehensive, if not exhaustive, demands several visits; the area must be seen and lived in at all seasons and in all its extremes of cold, heat, damp, drought. The actual collecting of objects takes less time; if scientifically done, it provides the ethnologist with valuable information, necessarily revealing human data, especially about techniques, which he has not always had the time or opportunity to study in the field. The idea that only the beautiful or unusual is worth bringing back to the museum is out of date; the 'humble toil of these anonymous groups that go to make up societies' (Levi-Strauss) often produces objects that are just as interesting as the unusual, or perhaps even more so.

Thirty years ago, a museum could still acquire a mask, a drum, a pendant, a vessel, and know only its geographical origin. Now, probably only the amateur collector will buy if the identity is doubtful or unknown.

Whether the items be modest or outstanding, crude or perfect, lay or religious, an ethnographic collection is primarily a working instrument, a document in the raw for investigation during the study.

A feature of our own times is the extraordinary mixing of populations, contacts between civilizations which penetrate and destroy one another to rebuild anew, and the ethnographic object very quickly becomes a museum piece or a document for the archives, because the community, perhaps, did not come to know writing early enough, or simply rejects what belonged to its forbears.

In the present overthrow of traditions which most peoples prefer to ignore, reject disdainfully or are sometimes even ashamed of, the ethnographic object loses its normal significance as its power of evocation increases.

Up until the beginning of the twentieth century, people in many parts of Europe, in Alpine areas for example, lived by centuries-old traditions that the 1914-18 war suddenly upset. Improved roads and the opening up of valleys brought new ideas of comfort and new beliefs; new techniques and ideas often led people, somewhat ungratefully, to a total rejection of the past. Here and there, fortunately, there were collectors who saved, if not all, at least a part of the old heritage, who collected everyday objects and implements and recorded old beliefs and legends. The objects, luckily, are now in museums. But not all have been saved. Thousands of the relics of science disappeared, bought up by dealers interested only in making money, or simply destroyed. The Bethmale Valley in the Pyrenees offers one of many examples of a life that has been completely transformed. In forty years of patient research Mr. Jacques Begouen has collected much of the remaining evidence of the culture of a people 'isolated by the very formation of these high valleys, lacking all means of communication... developing as a self-sufficient unit, making everything by itself, for itself; a pure creativity, artistically evolved from its own very distinctive imagination. Having nothing to imitate, its imaginative reactions continued to be entirely creative, and this it is that makes them sublime'.[1]

Vandals, they are alas everywhere, make forays into the most remote villages and sell their plunder on every market. In 1965, African dealers arrived at the Geneva Museum and showed us masks from Mali, coolly informing us that they were for wearing on 14 July...

Vandalism can never be condemned fiercely enough. By giving an unlettered people who know nothing of machines the rudiments of hygiene, literacy and mechanics, we obtain no right thereby to despise, plunder and despoil them. I have particularly in mind an Australian example. The *churinga*[2] plays a very important part in the life of the aboriginal, representing the place where his spirit, even his totemic ancestor, dwells; hence its sacred value to him, his great care of it, the strength he derives from it and his ingenious hiding-places for it. Yet vandals, regardless of the disastrous consequences of their crime, have managed to discover these hiding-places and steal their sacred contents. Some district-officers now keep these *churingas* locked up in their offices out of the reach of criminals but at the disposal of their owners who have placed the objects in their care and who, from time to time, come to meditate before the *churingas*, brought out from the official safes for the occasion.

Museums are increasing in number, and pride of place should be taken by ethnography museums, for they are the reflection of civilizations, whether or not technically advanced. 'Modern industrial and economic development, although its benefits cannot be denied, must nevertheless endanger the natural and cultural heritage indispensable to the equilibrium and happiness of mankind'.[3]

The ethnography museum, contributing to the knowledge and the reciprocal knowledge of peoples, is the repository of this heritage, a tangible inventory of immense importance. While there is still time, such museums should be set up everywhere. Every government should want to preserve the full picture of its land, the manners and customs, the old crafts and ancient beliefs. The ethnography museum will alone provide subsequently a measure of change since the advent of new techniques and ideas, allow the changes and experiments to be evaluated and the profit and loss account to be drawn up.

Those who had the good fortune to travel and bring back evidence from all over the world of the ways in which people live and deposit it in ethnography museums, have permanently guaranteed this material against destruction. They have been the pioneers. Unfortunately, they often forgot about documentation, with the result that sometimes whole sections of museums resemble collections of bric-à-brac.

Museum records contain description like this: 'Primitive weapon, brought back by Mr. X.' If the item is interesting, it may repay research. Who was this Mr. X? Perhaps his descendants can be traced. And then it is discovered that he was never abroad, probably found the stone axe described as a primitive weapon during an outing to a lake or at the bottom of his garden, and that it is neolithic! We often

1. Jacques Begouen: 'La Vallée de Bethmale, Ariège, Pyrénées', *Bulletin de la Société Ariégeoise des Sciences, Lettres et Arts*, Vol. 21, 1965.
2. Stone amulet of the Arunta tribe.
3. *ICOM News*, Feb. 1966, p. 30.

have to publish descriptions of items without pedigrees in the specialized journals, on the off-chance that some expert may be able to identify them. It would be a great advantage to have a more widely circulated-version of the famous *Intermédiaire des Chercheurs et des Curieux*[1] to centralize such research, cause of so much worry to directors of ethnography museums, and so eliminate the practice, usually unsatisfactory in any case, of sending photographs to museums and to overworked specialists. Publication after successful identification would help museums to a better understanding of peoples whose mentality is a complex and many-sided puzzle that has been the object of much scrutiny; and to little avail.

FIELD RESEARCH

Field research does not always lend itself to standardization. As Marcel Griaule rightly says 'a search, even if methodical, must permit a thousand variations that cannot be codified'. Alfred Métraux goes even further, affirming that 'a taste for the formula and for classifying is one of the worst dangers to the new science of man'. But we must get rid of the empiricism, source of the vandalism mentioned above. Museum collections must be built up by methodical prospecting on the basis of precise questions, not by the random local forays of irresponsible people with no idea of ethnography.

Anyone who has not worked in an ethnography museum should have a good knowledge of the human sciences before undertaking field work. This, obviously, is not always possible. If it were, these recommendations would be pointless, since they are primarily intended for people who have no special training but who are nevertheless really interested in human life and have an eye for the significant detail that leads to an authentic object; they must also be both persevering and tactful, for the ethnographer can easily make himself 'absurd and even detestable' (Marcel Griaule).

Indiscretion is always round the corner. Anyone preparing an ethnological expedition would do well to consult Griaule's *Méthode de l'Ethnographie*,[2] or Notes and Queries on Anthropology.[3]

A distinction must at once be made between the field collector and the expert. The first skims the surface; the second works in depth, but can do so only if the collector first provides the raw material, chosen with knowledge and care.

The many young people who today are interested in going exploring should read François Balsan's latest book (*Les Explorateurs*, Paris, 1966) and Sturtevant's *Guide to Field Collecting of Ethnographic Collections*.[4] Most lose this first enthusiasm. A few remain (we know some) who feel they have a vocation and an ideal. These are the ones who will go out and are capable of bringing back real ethnographic documentation even after a very brief training, once they have a plan to follow. Only those 'who bring back something the first time and who persevere' should be kept on (Balsan, op. cit. p. 11).

Marcel Griaule recommends two field methods, intensive and extensive. They can both be followed by the collector, but as he will remain less time in the field than will the ethnologist (who is, in addition, concerned with social structures and all that derives from them: religion, law, techniques, history, institutions, and so on), the extensive method will suit him better.

On the job, he must have patience, waiting until he is known, liked, accepted

1. *L'Intermédiaire des Chercheurs et des Curieux*, Mensuel de questions et réponses historiques, littéraires, artistiques et sur toutes autres curiosités, 16 rue Montpensier, Paris-1er.
2. Paris, Presses Universitaires de France, 1957.
3. London, Routledge & Kegan Paul, for the Royal Anthropological Institute, 6th edition, 1951.
4. Washington, Smithsonian Institution, Museum of Natural History, 1967.

by the local people. On no account must he rush things. The first weeks of gradual contacts will also be useful in enabling him to get used to a different way of life, to acquire a feeling for the objects he is to bring back to his museum and so be able to document them better. Markets and bazaars can be live museums in places like Fez, Cairo, Damascus and Aleppo, where he can not only see what people come to buy, but can actually see the craftsmen at work and the objects being made.

Once I wished to bring back for our own museum objects that can be found today in a home in Nepal—pots, dishes, chests, bins for food and grain, drinking vessels, and so on. I had noticed that it was often the men who bought the pots and brass vessels. I went with a local to some Kathmandu dealers, where we bought what I would describe as a set of kitchen utensils. My reputation, already dim because of the purchase a few days earlier of a leaky pot, suffered still further; the story went round that the country I came from was so poor that I had to go as far as Kathmandu to find myself household goods!

There is nothing wrong with buying a repaired object, and it is an excellent idea to buy articles as they are actually being made if the opportunity is offered, so that the manufacturing techniques used can be studied. Having several specimens of the same object allows the museum to display the item under several guises (matter, form, technique, use, and so on) in different sections. Moreover, one sample can be reserved for an analysis of the materials and techniques: the alloy welding, hammering, turning, moulding, sewing, and so on.

Ethnography encompasses so much that it is impossible to tell the collector exactly what he should bring back. It would need a survey of the entire earth, with its own glossary for each region and civilization (nomad, semi-nomad, pastoral, sedentary, agricultural, etc.); and a survey of all the crafts—which will not necessarily be practised in the same way everywhere (the African smith certainly does not use the same methods or tools as the Asian—nor does the African weaver, the sculptor, tanner and so on). Clothing and ornaments vary not only from continent to continent but from tribe to tribe and according to occasion (ceremonies, rites, mourning). Two books by A. Leroi-Gourhan (*L'Homme et la Matière*, 1943; *Milieu et Techniques*, 1945) and *Notes and Queries* (op. cit.) give plenty of sketches of items worth collecting, and many helpful comments.

In the following pages we shall refer only to essentials. The collector's problems are always complex; we can therefore only offer suggestions, while trying nevertheless to pinpoint the problems as accurately as possible.

The collector must at all costs concentrate, not on the letter of the suggestions but on their spirit; keep his eyes and his ears wide open, be forever on the lookout, and try to adapt what is suggested here to his chosen area with all the tact and intelligence of one who loves his fellow men and wants to preserve as faithful an image as possible of a dying or changing civilization and at the same time enrich his own museum.

His harvest can be enhanced through the study and care he devotes to illustrations by photograph, sketch and drawing. On returning home, the objects should be brought to life by placing them in a realistic display showing how and for what they are used (Fig. 22). Black-and-white photography lends itself better to enlargement, is easier to handle in the museum and more accurate than colour photography *(Plate 17)*. But colour, too, is necessary, and it is a good idea to take a separate camera for each purpose.

CARE AND IDENTIFICATION OF OBJECTS

Each object should be numbered as it is acquired by means of a piece of sticking-plaster, or by means of a small metal-framed cardboard label attached by string. The number should be entered in a flexible notebook that will fit in the pocket. The data to be entered will of course vary, but should always include the name of the place and tribe or group; a description of the object, its native name, purpose, and uses; the time of year; whether used mainly by men or by women; the constituent material; the fullest possible details regarding fabrication; whether made more particularly by women or by men; whether made for personal use or for barter, trade or export; whether common or not. The price paid should be entered in a separate column.

Museums being scientific establishments, their collections must be backed by documentation whose reliability is guaranteed by the strict criteria observed by the collector.

As items accumulate in his camp, tent, room or premises provided by some kindly authority, he must number and take care of them—clean them if necessary (he will always find a rag but should take brushes with him), and dust or spray with an insecticide. Spraying is obviously easiest; there are DDT and xylophene sprays on the market that he should take with him. This conservation is provisional, the rest will be done in the museum; field equipment is necessarily rudimentary and there is no point in wasting time, energy and money on full laboratory facilities.

The final packing often presents problems, and the possibilities should be investigated beforehand. In some places, practically nothing is available, neither packing cases, nails or paper. Materials must therefore be sent on ahead, including Indian ink or paint, and brushes for writing addresses on the packets. Straw or dry grass can nearly always be found, to wedge between objects and stop them from knocking against each other. Items should first be wrapped, if possible, in crepe paper or newspaper, which has been sent on ahead; if paintings on glass are wanted, it is necessary to take rolls of adhesive paper to protect the glass by strips stuck diagonally across the surface.

Fragile objects must of course be packed separately, and earthenware should not be packed with stone or metal implements. Packing, it is worth emphasizing, deserves special care, for on it, too, will depend the success of the mission.

In short, the collector who sets out to assemble a collection must equip himself beforehand with patience, kindliness, consideration and respect for others; and with notebooks, handy registers, pens and pencils, drawing paper, measuring tapes, cameras, films, tie-on labels, brushes, insecticides, adhesive paper, sticking plaster and packing material. Keenness, observation and finesse will look after the rest.

DWELLINGS

Dwellings have much to offer the ethnographer, who will find in them a rich and varied source of material for his collections.

They can include anything from a hut of simple bark (Australia) or branches (African pygmy or Fuegian); stone or wood cottages, middle-class architect-designed homes, one-storied pisé dwellings without foundations, two-storied wooden-frame pisé dwellings, log-cabins, and so on; or tents, varying in materials and construction.

Some general features can be noted which will be useful later: plans, layout, building materials, favourite sites, village formation (concentric, linear, scattered), and so on. Lots of photographs should be taken, inside and out, to facilitate realistic reconstruction in the museum. All accessories should be noted:

1. *Comfort:* seats, beds, blankets, head-rests, back-rests, pillows, cradles, movable partitions, lighting, heating, etc.

2. *Storage:* chests, shelves, cupboards, baskets, bags, jars, brooms, hangers, etc.

3. *Cooking:* the fire (it may be outside) and how it is made, stove, brazier, fuel, fan or blower (possibly horn or bamboo tube); the utensils: pots, jars, dishes, saucers, bowls, spoons, cups, goblets, mortars, pestles, grinders, spice-boxes, ladles, scoops, graters, skimming-ladles, churns, everything in short, that is used in cooking, eating and drinking, preserving and washing, and everything used to keep and carry water.

Position of the objects in the kitchen, living-room or other quarters should be carefully marked on a sketch (Fig. 23) in case it is decided later to make a partial or complete reconstruction in the museum.

The constituent materials should be investigated on the spot, as it is sometimes very difficult to do so later in the museum.

Ridge ornaments, ridge- or corner-tiles, gargoyles, painted or carved wooden shutters, doors, joists, locks, bolts, padlocks and tent-pegs are useful outside samples to bring back.

All types of roofing should be studied, and the means of holding it in place.

If roofs are thatched, it is worth watching a roof being thatched, even to lend a hand, to observe and photograph the ridge (often intricate and artistically plaited), and to bring back the implements used.

If there is a loft, permission should be obtained to go there and sketch it, for it affords the best view of the structure of the truss (i.e. the assembly of tie-beams, principal rafters and purlins) that forms the roof.

CLOTHING, ORNAMENTS AND ACCESSORIES

Clothing worn by men, women and children should be studied in detail, from head to foot.

Head-gear is unknown in some parts of the world, being replaced by ornaments such as headbands, diadems, crowns. Head-gear or ornaments may differ for everyday wear or for ceremonies, and according to activity (e.g. some peoples wear crowns only for hunting), according to sex, and sometimes even age. The range is infinite, from a simple veil or cloth to the huge screw-pine hat of Southern Asia, and including the skull-cap, turban, woven cap and the fur-lined Eskimo hood.

Shoulder covering varies too: shawls may cover the shoulders only or go down to the waist; ponchos; capes may be short or reach down to the ground, enveloping the body; shirts and blouses, plain or embroidered, long or short; waistcoats, coats and overcoats.

Many different means are employed to carry children—headbands, slings, straps, belts . . .

Items fastened at the waist include belts, sarongs, trousers, skirts, pagnes and loincloths, worn by men and women.

Lastly, footwear, so varied that it can take up a whole section without boring the museum visitor.

It is interesting to see how clothing is cared for and cleaned. Investigating the way different articles are made will inevitably lead the collector on to different crafts (weaving, basket-making, tanning), that we shall review briefly later.

Careful note should be made of the significance of colours, which may vary according to whether the wearer is single, engaged, married, or widowed, and according to festivals or ceremonies. Ornamentation by embroidery, painting, ribbons, and so on, may also have a special significance.

A fairly large number of ornaments and accessories must be collected.

Hair ornaments are relatively few: pins, combs, slides and ribbons. Brushes and combs are needed to keep the hair tidy. Face adornment or shaving should be observed, and everything used in the process should be collected (kohl or kohl cases, nose-rings, labrets, eyebrow tweezers, toothbrushes, dentifrice, make-up). People blow their noses and clean out their ears; the objects used for these purposes are interesting too, and sometimes are very original.

Ear-rings, rings, necklaces, reliquaries, pendants, bracelets and anklets (and how much more besides) are not always just ornaments, but may imply protection, wealth, status (single, married, widowed), rank or calling. This should always be checked.

Painting and tattooing the body are other forms of ornamentation that should be recorded, and the implements used acquired.

We can also include in this section umbrellas, sunshades, walking-sticks, sceptres, fly-whisks, fans, and so on. Some ornamental accessories are reserved for widows or priests. For each item, we repeat, the native word should be noted.

CRAFTS

Smith, metal-worker, goldsmith

Metallurgy is as old as history, and widely practised. The smith may command profound respect and even inspire fear; he may also be despised. 'In African mystical thinking the forge is a holy place, a sanctuary of earth forces that are feared but essential to the proper functioning of human society' (B. Holas, *Industries et Cultures en Côte-d'Ivoire*, 1965). 'Different kinds of magic charms are necessary to "transform" ore into metal' (K. Birket-Smith, *Histoire de la Civilisation*, Paris, Payot, 1955). For the Yakuts, 'smiths and sorcerers hatch from the same nest'. In these circumstances, it will not always be easy to get hold of the tools and instruments of metal-working.

To brighten the fire, a fan or blow-pipe is used by metal-workers and goldsmiths (found among all peoples skilled in the working of gold and silver), a bellows by smelters and smiths (skin bags open at the top, ending in a nozzle, enclosed in an earthenware or wooden case fitted with a crude valve; bellows with a single or double, vertical or horizontal piston made of wood, bamboo, etc.) As kilns and furnaces are not transportable, good photographs and sketches to scale must serve instead.

The smith's tools are many (fire-iron, tongs, crucible tongs, mortar, crucible, anvil, hammer, anvil-tongs, soapstone or earthenware moulds).

Those of the goldsmith are finer: auger, die, bone, hardwood, or metal stamps chasing-chisel, gravers, small hammers, files, moulds, cooling tubs; roughly the same tools will be used by the metal-worker. Specimens of these crafts should be collected as well as the tools.

The lost wax process does not require many tools. It would be interesting to bring back, for demonstration, a specimen that could be shown at different stages of fabrication.

Tanning

Animal skins are widely used for clothing, containers and other objects (bags, satchels, coca bags, belts, amulet cases, scabbards, quivers, wallets, prayer skins, drumheads, and so on), even cannons, used by the Chinese during the Nepal campaign at the end of the eighteenth century.

In some places the skin is used still covered with its hair or coat and merely dried or tanned; or the hair may be taken off, thinned down and the skin made more flexible. Scrapers or slickers which vary from place to place, cutting-boards, cutting tools and awls are the main tools. Tanning needs supports and vats which it will often be impossible to bring back; photographs and sketches must serve instead.

Sculpture

Achievements in sculpture have been magnificent and are well-known: Congolese and Melanesian wood-carvings, Indian wood-carvings along the north-west coast of America, Nepalese wood-carvings, ivory carvings in China and Japan, stone in Peru, Mexico, India and southern Asia.

The sculptor is included in this section because he is often considered as craftsman rather than artist. His craft is not always clearly defined and may be just the sideline of a moderately skilled artisan. Sometimes the smith is also a wood-carver. Going more deeply into the matter it is found, however—as A. A. Gerbrands did in New Guinea for example—that sculpture may be the major occupation and that the artist, no longer the craftsman, is recognized as such within a given group.

In most cases, the fundamental purpose of the sculpture is liturgical.

Axes, adzes of varying size, chisels, gouges, knives, abrasives and saws are practically the only instruments used. It is essential to photograph the sculptor at different stages of his work and to bring back partly completed items. Obtain, for example, a mask barely roughed out with the axe, then make the artist start again and stop when he has finished with the adzes, and obtain specimens similarly at the gouge and the knife stages.

Weaving

In this section we include basket-making, which is mostly done by women. A specimen or two of each type of basket, container and so on should be brought back with photographs illustrating their fabrication and uses.

The same recommendation applies in the case of rope and string (nets, bags, clothing, matting, and so on) made of hemp, raffia, esparto, jute, grass, palm fibre and leaves, rattan, animal or even human hair. All these materials receive treatment, which should be observed, and are pounded, steeped, carded and rippled, operations that require special equipment which should likewise be collected.

In some places which have no woven materials as such, 'tapa' (pounded bark) is made; special beaters are used, and calibers in the decoration. The making of felt should also be observed.

Looms, upright and horizontal, range from the very simple to the very complicated, and the collector must adapt his arrangements accordingly.

Before leaving for an area where weaving is highly skilled, he should do some preliminary study. As suggested earlier, he might also lend a hand, which is the easiest way of getting to know the equipment (cards, heddles, battens, bobbins, pulleys, shuttles, weights, and so on). A complete loom should, if possible, be reconstructed in the museum, and brought to life by using plenty of photographs of the original location; or even better, a loom in operation with a piece of work still on it *(Plate 18)* should be acquired.

The preparation of woollen or cotton thread involves equipment worth collecting (whorls, distaffs, spools, spinning-wheels, and so on).

Pottery

Domestic pottery-making, now dying out, recalls one of the most common and oldest crafts in the world, and merits thorough study. 'The extension of pottery-making is readily explained by the presence of clay deposits. Pottery was sold nearly everywhere, and quite far away. Research should start with an inventory of domestic and religious objects' (Mauss, *Manuel d'Ethnographie*, Paris, 1947). That inventory can begin in the market-place and gradually penetrate more and more deeply into everyday life. Subsequent investigation, possibly at the museum itself, should determine how far the clay-bed is from the place of manufacture, and whether its choice derives from some ancient belief (clay is sometimes dug fairly far from the place of manufacture, although there are beds nearby because, for religious or other reasons, the nearer beds are regarded as less propitious). The place of extraction and the transport used to take the clay to the place of manufacture should be observed and photographed.

Plate 17.

The image and the object. In the exhibition galleries, the photograph explains either the manufacturing or the utilization of the exhibit. It is a useful substitute to explanatory notices in countries where illiteracy still exists. Boganda Museum. Department of Folk Art and Tradition. (Photo: B. Sullerot, Musée de l'Homme, Paris).

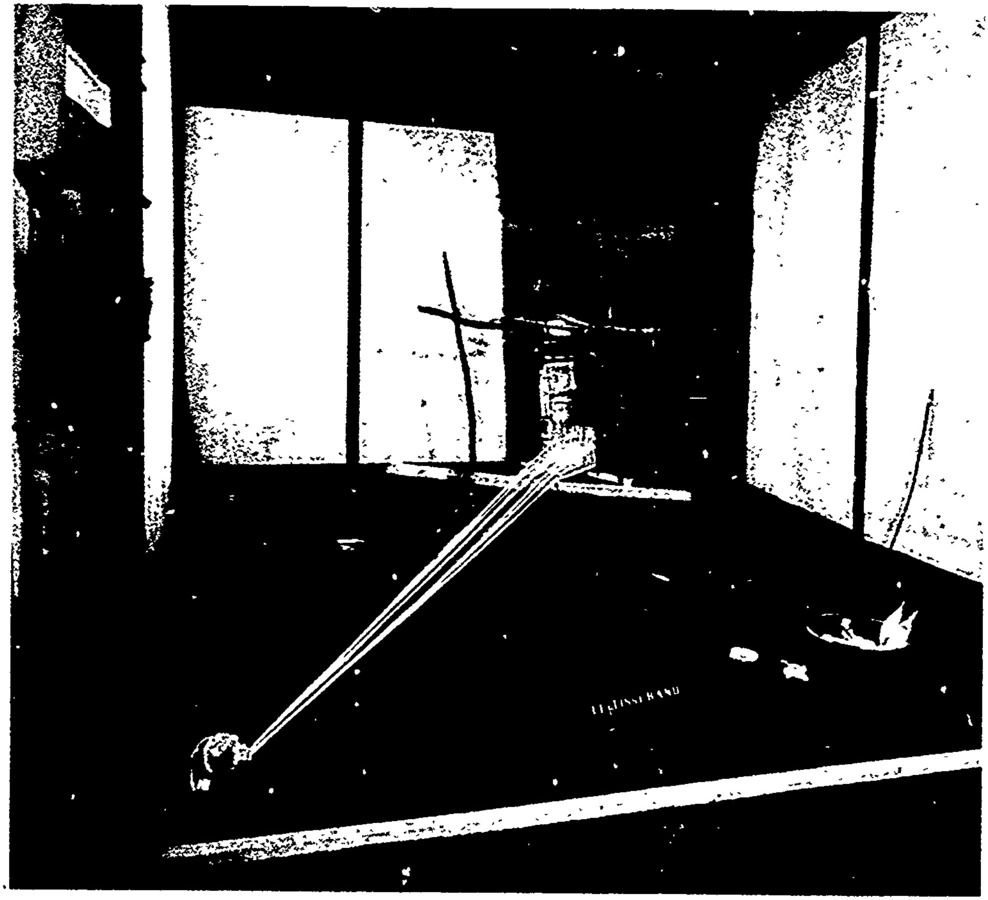
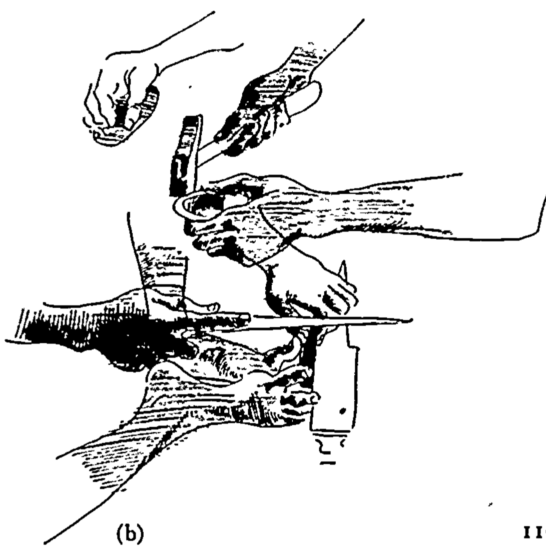


Plate 18.

The horizontal loom used by Hausa weavers (Niger). Ethnographical Museum, Neuchatel. (Photo: J. Schoepflin, Neuchatel).

(a)



(b)

Fig. 22.

Drawings by Hans Erni for the Ethnographical Museum of Neuchatel:
(a) the apprentice blacksmith's: first job making an awl;
(b) analysis of movements hand.

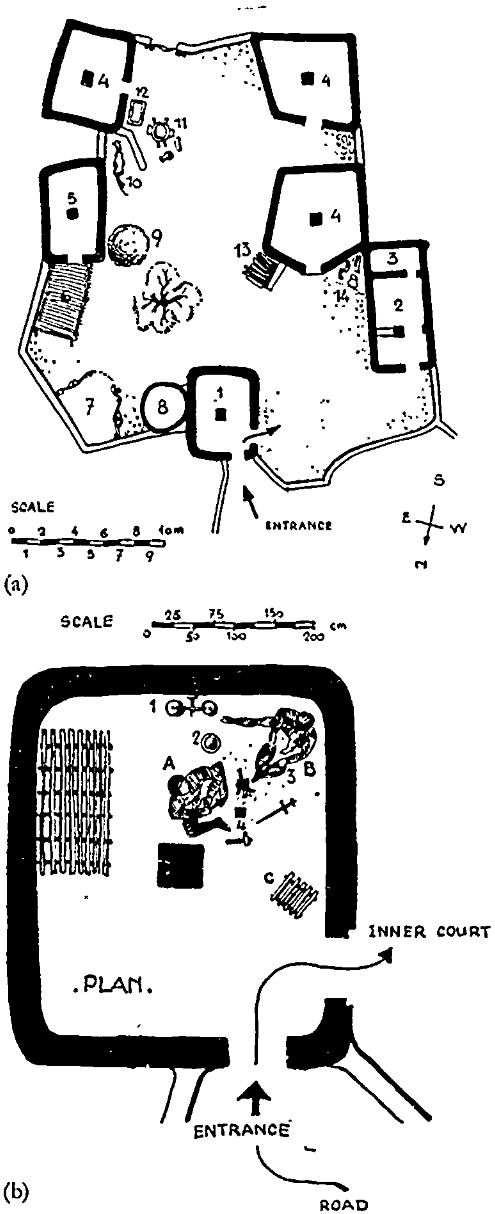


Fig. 23.

Sketch of the living quarters and workshop of the smith Captini, at Tahoua

(a) The living quarters. 1, the *machiera* (workshop); 2, the *chigura* (living quarters); 3, store-room; 4, house for the women; 5, chief's house; 6, *zaouri* (parlour); 7, goat pen; 8, millet silo; 9, banco; 10, horse enclosure; 11, kitchen; 12, water container; 13, wood pile; 14, tools and utensils.

(b) The workshop: A. the smith; B. an apprentice; C. visitor's mat; 1, scales; 2, water; 3, bellows; 4, the anvil and the hearth (sketch by Raoul Gabus for the Ethnographical Museum of Neuchatel).

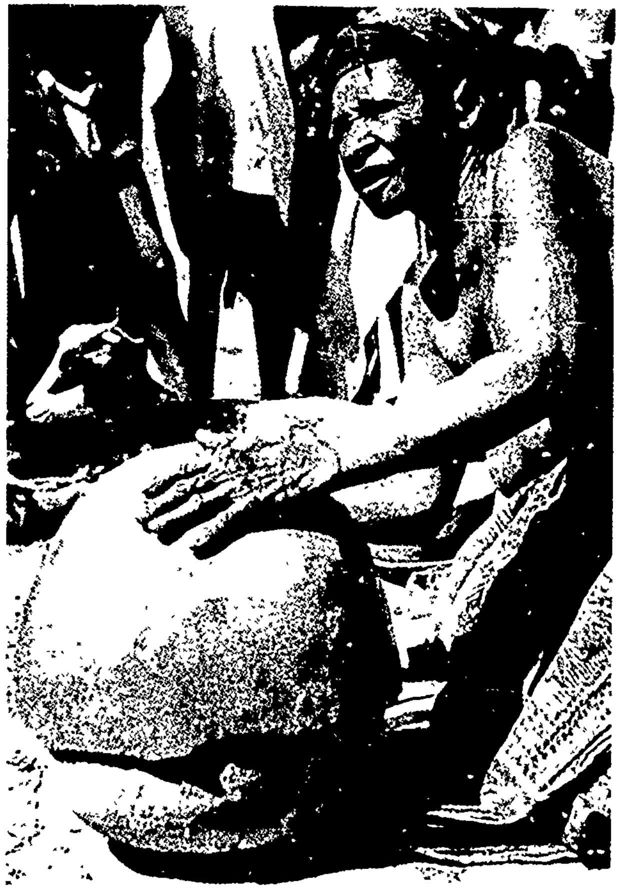


Plate 19.

The moulding of Tahoua pottery. Photograph exhibited in the Ethnographical Museum, Neuchatel.

For a proper understanding of the fabrication, it is necessary to watch: (1) working over of the clay by hand, foot, or machines; mixing with other materials (gravel, straw, reed, etc.); (2) modelling (hand, wheel, moulds) *(Plate 19)*; (3) drying (duration, place; sun or shade); (4) firing (in open, kiln; duration, number of firings); (5) joining (handles, spouts); decoration.

The potter's implements are comparatively few: wooden or other beaters; bamboo, reed or wooden knives; smoothing-tools (shells, stones, bone, ivory, strips of wood); rudimentary stamps and brushes for the decoration.

Objects of baked, or dried, clay can be broadly divided according to purpose into three main groups: (1) *food:* cooking (pots, etc.), eating (dishes, plates, etc.) storage (jugs, bowls of all sizes, lids); (2) *drink:* carrying (jugs, jars, vases, etc.), storage (containers of all shapes and sizes), drinking (bottles, bowls, goblets, cups, etc.); (3) *furniture and architecture:* small stoves, flower vases, building bricks (often of dried and unbaked clay), irrigation pipes, tiles (also often dried and unbaked), chimney cowls, wash basins, etc.)

The following points specifically concern pottery but can refer to nearly all objects collected. Who makes the tools or other utensils? There is often a local specialization by sex. Sometimes it is the woman and not the man who works the clay. If the woman is the potter, can the husband sell objects made by his wife? Or does she alone sell? Does she receive the proceeds of the sale? It will similarly be interesting to know whether the pottery (or other object) is produced by the family, an individual, or the community, or whether it is made industrially; whether a potter makes some objects but not others (some specialize in making only jugs or granary urns, and so on); how is the pottery marketed: market, shop, door to door, to order, locally, elsewhere; what are the conditions of sale or barter: special season, special street, square, quarter?

STOCK-RAISING, AGRICULTURE, HUNTING AND FISHING

Sedentary peoples and nomads or semi-nomads alike keep animals, with obvious differences in the degree of domestication, and in the objects that can be collected. Apart from bridles and halters, yokes, sometimes admirably carved, and collars (not forgetting large blue beads to ward off the evil eye) should be collected, and muzzles, bits, blinkers, wooden or metal bells (some may already have been found at the metal-worker's or carver's), pack-saddles, saddles and side-saddles, saddle-cloths, stirrups, spurs, riding whips, goads and whips; shearing, branding and bleeding tools, watering-troughs, curry-combs; milk-pails, butter-churns, cheese-tubs and butter-prints. In some places, special milking-stools can be found.

Stables, cattle-sheds and pasturages may repay observation and even yield collection pieces such as carved stakes, and perhaps amulets, for which an explanation should be sought.

There is little variety in agricultural implements throughout the world. It needs a fairly lengthy stay in any one place to witness all the different stages of crop-growing there—tilling, breaking, digging, sowing, harrowing, ridging, harvesting—and to see all the implements in use, but an attempt should be made to acquire as many as possible. In many places there are special markets or fairs, with a great array of agricultural equipment but, above all, try barter with the local growers. Implements will also be found at the smith's. During the ploughing and sowing season, hoes, swing-ploughs, ploughs, spades, harrows, clod-crushers and so on can be seen in action; irrigation channels will be repaired, fertilizers collected, prepared and spread, scarecrows put up.

The harvest season will bring out a whole range of sickles and scythes, and be sure to see the threshing and winnowing (winnowing-baskets, flails, tribula). Grain brings us to the granaries, silos and storage containers of every description. The transformation of grain into flour involves millstones, pestles, rudimentary mills; flour leads to the baker's, with its bread-bins, tallies, scales, and so on. The different means of conveyance merit attention, and complete the picture.

Miniature implements made to amuse the children and also to enable them to help in work on the land should not be overlooked.

Very few populations now live solely by hunting and fishing, but many sedentary and semi-nomadic peoples, farmers and animal breeders hunt and fish, this often constituting an important aspect of the local economy. A large variety of weapons are involved (clubs, daggers, spears, javelins, bows, arrows, blow-pipes, slings, spear-throwers, boomerangs, harpoons, fish-spears and so on) which can be collected over a period, together with canoes and boats—or at any rate the main parts (prows, poops, decorations, oars, boat-hooks). Traps, numerous and very cunning, are not always easy to observe, as hunters and fishermen are loath to reveal their secrets. In many cases, poisonous substances are used, and their preparation needs implements that should be collected if possible.

CEREMONIES, AMUSEMENTS

Here, the collector must be left a free hand. No ethnographer, collecting material for exhibition later in museum showcases, can possibly hope to make at the same time a precise and elaborate survey of the many ceremonies that he will have occasion to attend. This is a job for the ethnologist—and a very long-term one.

While studying dwellings, for example, the field-worker may come upon household gods that are accorded rites, with offerings made in special vessels, and have censors swung before them. He will attend sowing and harvest, funeral and marriage ceremonies with their particular masks, statues, disguises, ornaments and accessories—all material he should try to acquire.

Amusements, too, vary considerably from one people to another. Many games—dice, cards, and so on—have been invented, from string games to chess. Ball games and tops are practically universal. Dolls and carved model animals are often made by the children who play with them. This is a vast sector, difficult to explore; and there are no short cuts.

The virtually universal pipe, and percussion, wind, string and other musical instruments can also be included under this heading.

The above seems to cover most human activities that can be illustrated by museum objects. If prospected in the manner suggested in this guide, any region can be accurately and comprehensively represented.

H. Ladmirant

Field work techniques in geology and mineralogy[1]

8

There are two different approaches to the collection of geological specimens for a museum:

- the specimens can be assembled to illustrate the geology of a region, or
- representative specimens can be assembled, selected for their intrinsic interest, their beauty or the extent to which they will enrich the museum's collection.

In the following pages we shall concentrate on the techniques relating to the first of these approaches, but it is obvious that they can be applied to the second approach too.

PRINCIPLES

Field geology, which is based on observation and induction, is the study of rocks *in situ*. It deals with their nature, their geographical location, their relationship to neighbouring rocks, their age, the conditions in which they were formed, and their evolution. With a knowledge of all these factors, it is possible to reconstruct the geographical and geological history of the region and to forecast the nature and characteristics of the rocks lying beneath the surface. The surface information is assembled on the geological map, which is the basic document used in prospecting for natural mineral resources.

Although there have been rapid developments in certain techniques such as photogeology and airborne geophysical surveying, and although, broadly speaking, the ratio of field work to laboratory work is growing less, it is obvious that the basic and decisive information can only be obtained by investigation in the field.

The field worker must be capable of observing, describing and taking measurements which are precise, complete and capable of being understood both by himself and by others. He must give the most careful attention to the collection of specimens, in view of the variety of investigations which may subsequently be carried out on them in the laboratory.

Except in certain countries with an arid or glacial climate, in which erosion systems may expose the rocks over large unbroken areas, the geologist generally has only a limited number of outcrops to work on, the remainder of the rock being hidden by a weathered layer of varying thickness, by loose material of recent origin, or by the formation of a soil carrying dense vegetation. The outcrops are not individual isolated phenomena; they are the visible parts of rock formations which continue in the sub-soil.

The general principle of geological map-making is relatively simple: by studying a certain number of points in detail, the geologist has to reconstruct a picture of a surface with such accuracy that it can yield information concerning the third dimension, i.e. the depth.

---

1. It is a pleasure to express my gratitude to Messrs. L. Cahen and J. Lepersonne who have given me the benefit of their advice on the drafting of this chapter.

Geologists are often taught that the outcrop must be studied and described so thoroughly that there will never be any need to come back to it. But this is a counsel of perfection, which can rarely be followed. Instead of wasting hours in describing the rocks by amassing pages of indiscriminate detail, the geologist should begin by asking himself what information is vital and what details can be ignored. The essential point is that he should understand the purpose of his work.

Unlike private firms and some government departments, whose activities are intended to achieve practical and immediate results, the geological department of a museum is normally concerned with basic geological problems and with comprehensive studies.

The scope for geological research in any country is tremendous, and it would be idle to attempt to do everything at once. Research institutions are so expensive, and there is such a shortage of specialists that the problems to be studied must be selected with great care. Some of the many problems which, for various reasons, cannot be tackled immediately, will probably be dealt with later on, perhaps in a few years, perhaps in twenty years' time. It is therefore essential to adopt a short-term approach, but to bear in mind the possibility of subsequent developments and to attempt to foresee them as far as possible. When carrying out surveys in the field, for instance, it is advisable to include among the specimens of granitic rocks a few well-chosen large pieces, weighing 50 kg or thereabouts, which can be used later on for geochronological measurements by means of the zircon dating method, even though the department may not at the moment have its own geochronological laboratory and cannot afford to have these studies carried out in outside laboratories. There is little difficulty in collecting such specimens if this is done as part of a systematic survey, but much time and money will be wasted if a special expedition has to be arranged at a later date to collect a few specimens.

Not only must full and factual records be kept at all times when the field work is being carried out, but these records must be filed and stored, as they come in, in such a way that any research worker can have access to them and consult them at any time.

In the developing countries, particularly in large countries where the geological map of scale 1:200,000 is in course of production, the museum should collaborate with the country's geological survey department, if one exists, in the initial preparation of this important basic document.

PRELIMINARY STUDIES AND PREPARATION

(a) *Selecting the region*

Choosing a region for study is not something which can be undertaken lightly; those who are responsible for a research programme must always bear in mind a number of factors which are likely to influence the quality of the results and the time required to achieve those results. Both scientific and practical factors have to be taken into consideration.

Any existing and accessible general geological and geographical information about the region and about adjacent regions or countries will help to determine which areas are of interest and what precisely is to be studied.

Generally speaking, air photography can yield so much information that it would be almost unthinkable nowadays to undertake a regional geological survey without making use of photogeology. Hence the existence of air photo coverage will be a decisive factor in the choice of a region.

The area to be studied cannot follow arbitrary geographical boundaries; it must be based on the shape and size of the geological formations. The choice will also depend on the specialized knowledge of the staff and the scientific equipment available in the laboratories. Newly established museums will be well advised to choose clearly defined projects which can be carried out in a relatively short time; three years for instance. An assessment should be made of all the difficulties which are likely to arise in connexion with the programme, the survey team and the possible follow-up work, in order to avoid starting on a project which is beyond the scientific and financial resources of the museum concerned.

In addition to the administrative problems of organization, and possibly also of co-ordination with the activities of other authorities, a number of practical factors are involved, of which the most important are: accessibility, topography, condition and density of the communications network, amount of vegetation, climatic conditions and supply situation.

(b) *Preliminary studies*

Field work begins in the laboratory. Before starting out for the field, the geologist must assemble and study all the existing documentation. This will include geological, geographical and photographic date. All too frequently, geologists embark on a new survey project without studying previous work on the subject. In so doing, they lose the benefit of a body of knowledge which has been acquired at the cost of considerable effort and is often extensive and of high quality. This attitude also leads to a duplication of itineraries. One of the major tasks of a museum is precisely to assemble and keep up to date all the published and unpublished documentation concerning the country itself and the neighbouring regions.

Geological documents. Many regions have already been the subject of isolated geological surveys which are so varied in their approach and interpretation that they cannot be assembled into a coherent pattern. This applies in particular to developing countries in which only a few main exploration routes have been mapped, some detailed local surveys have been made for mining purposes and the first small-scale geological sketch plans have been made.

The main items of documentation concerned are reports made by exploration teams, prospectors' notes, copies of geological reports and commentaries made by mining companies and governmental authorities, published and unpublished works, old geological maps and collections of specimens of rocks and minerals. Any information about the terrain which can be gleaned from these documents should be systematically marked up on the maps in the form of a dot with a serial number together with any available information concerning the strike and dip of the strata. The maps should be accompanied by a register, in which the name of the observer, the source of the information and a summary of the original description should be entered against the corresponding number. It is often a very laborious task to transfer the old itineraries, owing to the vagueness of the old topographical maps. It will often be necessary to refer to aerial photographs in order to pinpoint a particular place.

Cartographical material. The basic tool for all field work is a geographical map of good quality on which every fact observed should be carefully located. The geologist should not forget to consult old maps, which can often provide valuable information concerning place names.

In economically developed countries, maps are generally available on a scale of 1:50,000 or even larger—sometimes up to 1:10,000—with contours marked in. For surveys in new countries, planimetric maps on a scale of 1:100,000 or preferably of 1:50,000 are adequate, provided that they are of good quality. It is the task of the national geographical services to prepare the standard map of the country. Nowadays cartography is usually based on aerial photography. But although aerial mapping is quicker

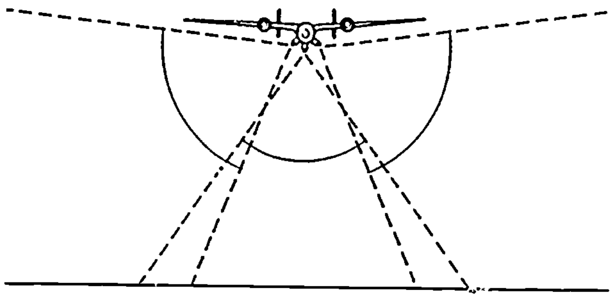


Fig. 24.
The three-camera system of aerial photography, known as Trimetrogon. The three photographs, taken simultaneously, cover a strip of ground from one horizon to the other.

than traditional map-making methods, it always involves a large-scale operation which has to be spread over many years. It may be, therefore, that maps covering the area which are of interest to the geologist have not yet been prepared. In this case, the museum must be provided with a minimum of equipment and a minimum of personnel competent to produce planimetric maps on a scale of 1:50,000 from aerial photographs. The geologist may have to take part in this work, and he should be familiar with the techniques involved.

The most suitable method, giving sufficient accuracy at low cost, is that of aerotriangulation by the assembly of slotted templates, followed by the transfer of the photographic interpretation by means of a camera lucida. A good way of drawing planimetric maps of areas with average relief displacement is to use the radial planimetric plotter. Readers who are interested in these techniques will find full information in the works listed in the bibliography.

Photographic documents. Photographic documents include aerial photographs, flight maps and photographic mosaics. Flight maps are small-scale planimetric diagrams showing the flight bands or flights lines; they are indispensable for locating and positioning aerial photographs.

An assembly of a number of aerial photographs, normally between 10 and 100, which are re-photographed to form one large photograph, is called a mosaic. Mosaics are similar in size to topographic maps. There are various types of mosaic, differing in quality and accuracy, according to the method of assembly.

Nowadays aerial photographs are of great importance both in reconnaissance mapping and in detailed survey work; they have largely replaced the traditional prospector's plane table.

There are several different types of aerial photograph, depending on the position of the camera when the photographs are taken.

Much the commonest type is the vertical photograph, which is taken with the camera positioned vertically, whereas oblique photographs are taken with the camera inclined at an angle, sometimes at such an angle that the horizon is included.

For photographing large areas which are isolated and sparsely populated, the three camera system is sometimes employed. This system, called Trimetrogon photography, employs a vertical camera in the centre and two other cameras placed symmetrically one on each side of it, so that the full width of the terrain is photographed as far as the horizon. Thus the three photographs, which are taken simultaneously, cover a strip of ground from one horizon to the other (Fig. 24). This system has the advantage of covering a very large area with a minimum amount of flying, but it has the disadvantage of restricting the scale of the photograph. It should also be mentioned that the 'distant' half of the oblique photograph is unusable owing to the very small scale, the large number of blind angles in hilly ground and the effect of mist.

In the great majority of cases systematic coverage by aerial photography is carried out by means of vertical photographs. High quality photography is required, which is provided by the majority of modern cameras, and strict standards have to be observed: the axis of the camera must be within 3 degrees of the vertical, the scale must be between 1:30,000 and 1:50,000, the photographs must be in large format—either 18 cm × 18 cm or 23 cm × 23 cm—they must be taken along rectilinear and parallel flight bands or flight lines, there must be an overlap of at least 60 per cent between two consecutive photographs in the same strip and an overlap of about 10 per cent between the photographs in two consecutive strips *(Plate 20)*.

All these photographs are made in black and white. Colour photography appears to be ruled out at the present owing to the prohibitive cost and the often inadequate quality.

A vertical aerial photograph is not an orthogonal projection of the ground and cannot be used as a map. Differences of altitude cause distortions, which are sometimes substantial, in the representation of the ground, and a geologist who is embarking on the interpretation of aerial photographs should make himself familiar with the particular characteristics of the medium.

With the aid of photogeology, which is based on the study of relief features, drainage patterns, type and distribution of vegetation and shape and distribution of tones, it is often possible to obtain a rough picture of the lithology and structure of an area.

It is impossible to deal here with the principles of photo-interpretation; our bibliography mentions several very well-illustrated books which cover this subject very thoroughly.

We must stress the importance not only of studying the drainage pattern but also of observing the details of the shape of rivers. Falls, narrowings of the channel and sharp bends are almost always related to geological causes (Fig. 25).

Every observed detail which appears to have geological significance should be marked directly onto the photograph with the aid of special wax pencils. These data are then transferred to the control point map. The method of transfer depends on the difference in scale between the photograph and the map and on the amount of detail shown on the map: it may be done simply with the aid of proportional compasses or by a camera lucida or by photographic projection. This preliminary photogeological study can show up outcrops, geological strata with their strike and dip, contacts between different kinds of rock, folds, faults, joints, schists, intrusive masses, dikes, and discordances.

It also enables the geologist to familiarize himself with the area to be visited.

(c) *Making preparations for a field project*

Three factors are involved in the preparation of a field project, none of which must be overlooked: human, geological and technical.

The human factor. The responsible authority must show great psychological insight in selecting a team which, for several months on end, will have to share the same life, and put up with physical conditions which may often be difficult. Any clash of personalities or of temperament is likely to be a serious handicap to the harmonious execution of the project. It is now taken for granted that a reasonable standard of comfort and appropriate food are essential prerequisites for efficiency. The geologist should undergo a general medical examination, receive any dental treatment which may be required, and undergo the necessary inoculations. It is important that the team should not feel cut off from the rest of the world and, in particular, that they should know what steps to take in case of accident or serious illness. If the field project is being carried out in uninhabited countries, the team should be equipped with a handbook of first aid and an emergency medical kit.

Geological factors. In most cases it will be possible to determine from the preliminary study which areas are to be given priority for survey purposes, and hence to decide exactly what problems are to be tackled. If the photogeological survey has shown that the region is formed of regularly folded sedimentary rocks of regular synanticlinal type, it will be easy to plan a series of traverses crossing these folds at right angles *(Plate 21)*. In the case of uniform crystalline formations—granites and migmatites—the traverses will be arranged so as to carry out a series of observations at regular intervals throughout the area, with a more detailed examination of the contacts which are assumed to exist between such geological units. It would be a great waste of time to carry out a series of observations like this on a plateau formed of horizontal or sub-horizontal sedimentary strata, and in this case it will only be necessary to cut a few sections along water courses or, better still, in a cliff.

Aerial photographs, again, will enable the traverse to be planned in the light of the location of outcrops, the relief of the area *(Plate 22)*, the adequacy of the means of communication and the state of the bridges. A complete programme should be drawn up for the field work, but some flexibility should be allowed in carrying it out. It is useless to attempt to draw up an excessively detailed programme, setting out the work to be done and the route to be followed every day. A programme of this kind would soon be disrupted by the many incidents which beset the geologist in the field: a member of the party may be injured, a vehicle may break down, there may be several days of storm, sometimes an interesting and unexpected geological discovery may justify delay.

The technical element. The plans for any field project will be conditioned by the funds, the time, and the number and competence of staff available. The leader will begin by gathering information from people who know the area well. This information should cover climatic conditions, the length of the good season, the average, maximum and minimum temperatures, the distribution and amount of rainfall; these factors will determine the type of clothing and camping material to be taken. It is essential to know the pattern of population and the location of populous centres with their facilities for the supply of food and fuel. If there is plenty of big game, this may be a help in recruiting temporary native labour. If a motor vehicle is to be used, account should be taken of the varying conditions in which it will have to operate, and provision should be made for replacement tyres and spare parts.

Field work often involves camping. It would take up too much space to deal here with the type of equipment required and the method of organizing camp life; readers are referred to the book by J. W. Low (1957) in which some thirty pages are devoted to basic hints on safety and to innumerable practical details of camp life.

The following equipment will be required for geological field work: geological hammer, sledge hammer, chisel, compasses, magnifying glass, watch, altimeter, camera, steel tape, drawing material, notebooks, scissors, adhesive plaster, collecting bags, enamel paint, topographical maps, air photographs, pocket stereoscope; and possibly also surveying equipment: plane table, alidade, and stadia rods. In some cases more sophisticated equipment, such as a radiation counter, may be required.

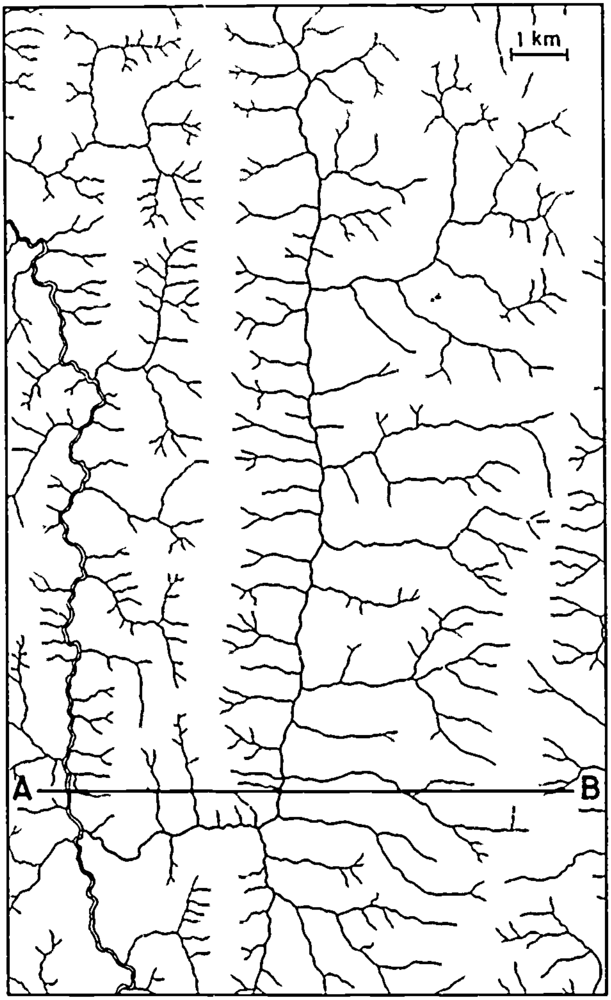
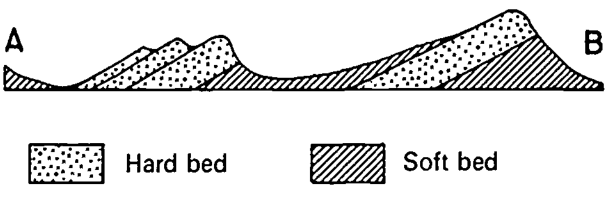


Fig. 25.

This drawing is taken from a topographical map of Africa, showing the drainage system only. The diagrammatic section A-B can be drawn solely from a study of the shape of the drainage pattern.



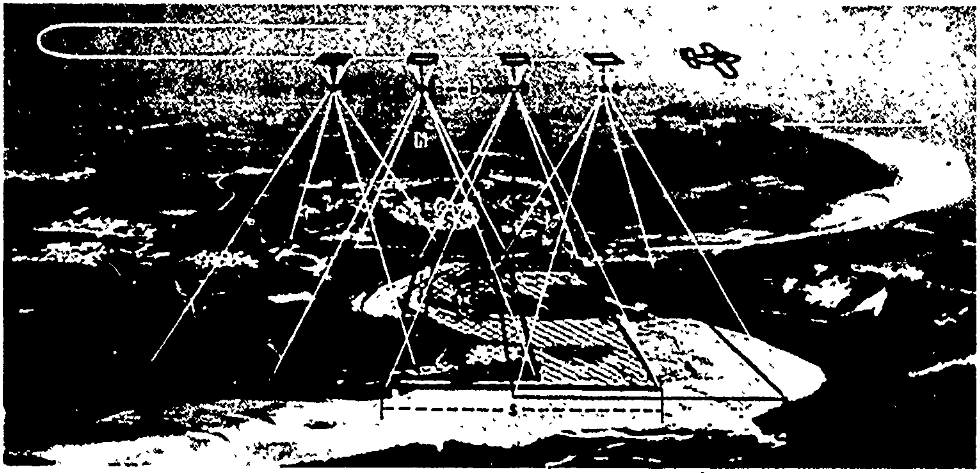


Plate 20.

Systematic air photography. The photographs are taken vertically, at regular intervals, so as to give the necessary coverage (Photo. Carl Zeiss, 7082, Oberkochen, Federal Republic of Germany).

Plate 22.

This air photograph of a large equatorial forest clearly shows two folds running N-E. It will be understood that if the geologist has not seen and located these formations in advance from photographs, he can easily pass quite close to them, even a few hundred metres away, without suspecting the existence of these characteristic reliefs.

Plate 21.

This air photograph clearly shows an anticlinal geological structure with the closing of the fold towards the northern edge of the photograph. The axis of the fold runs approximately N 20° W. The correspondence the massive sandstone series G, which form a very characteristic morphological element, can be seen on both sides of this axis.

A limestone zone (A), only a few metres thick, shows up very clearly by photogeology, because its course is marked by a growth of euphorbia. A survey of this area could be limited to one major east-west traverse in the south and a few traverses in the north to find out the limits of the closure of the fold, the blurred outlines of which are shown here.

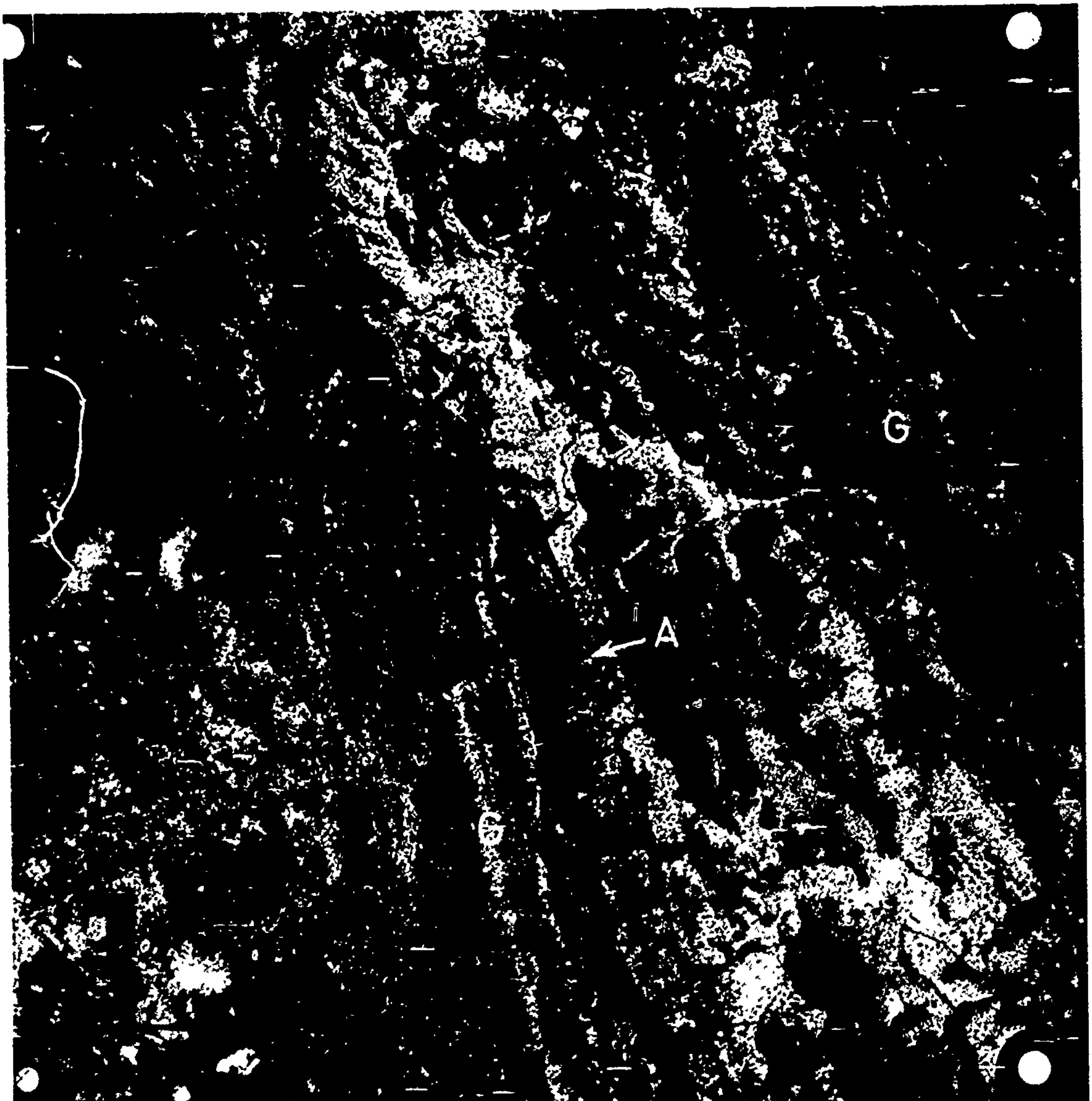


Plate 23.

The field geologist locates the outcrops by a stereoscopic examination of air photographs (Photo: Carl Zeiss, 7082, Oberkochen, Federal Republic of Germany).

WORK IN THE FIELD

(a) *Planning the work*

For large-scale projects, lasting a year or more and involving several geologists or prospectors, two types of camp will be required. A permanent or semi-permanent base camp should be set up for several months, preferably in a centre of population. This camp will be the meeting point for the geologists; specimens will be collected here and packed up for transfer to the museum. Equipment and provisions will be stored here. The camp should provide, in addition to a modicum of personal comfort, such aids to work as a typewriter and equipment for reproducing maps on ozalid paper. It is essential that this camp should be established at a place where there are facilities for communicating with the museum, so that reports can be sent back every fortnight and instructions received from the museum.

When out on survey expeditions, the geologists should set up 'fly' camps which will be used for one or two nights.

The areas to be visited by the various teams should be divided up equitably, taking into account distance, difficulty of access, geological complexity and the experience of the geologists concerned. It will be found useful to have a small-scale topographical plan on which the squares of the grid can be shaded in to show how the work is going from week to week and to give an up-to-date picture of progress (Fig. 26).

When in the field, the geologist will normally devote the latter part of the day to putting his notes in order, completing a sketch, classifying his specimens and studying air photographs of the area to be covered on the following day.

In principle, the geologist should prepare a weekly report and a monthly report, with a final report at the end of the project.

The weekly report should give a factual summary of the work done; it should be purely descriptive and enumerative, and it is therefore advisable to use a standard form.

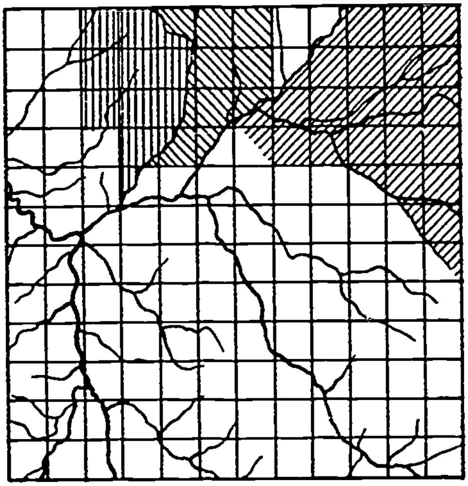


Fig. 26.
Extract from a small-scale plan marked to show the progress of surveys being made by three teams.

The monthly report should be fuller. It should include a copy of the geologist's notes on observations made and a map showing the observation points used; the latter can frequently be replaced by an outline tracing of the air photograph on which the drainage pattern and the reference points have been marked in. A copy of this tracing should be made on ozalid paper and the geological interpretation drawn in with coloured pencils. In the body of his report, the geologist should set out in summary form his ideas on the geology of the area concerned and put forward any suggestions he may have for his future programme, if new data seem to justify a modification of the programme. One copy of these reports should be kept at the base camp, and the other copy sent regularly to the museum.

It is better to mark in the whole line of the traverse on the map or photograph rather than merely plot the observation points.

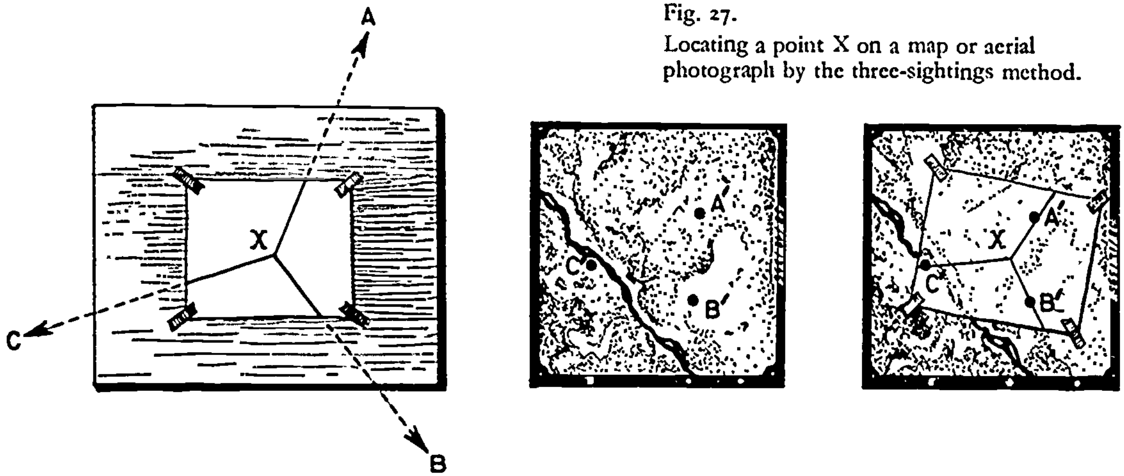


Fig. 27.
Locating a point X on a map or aerial photograph by the three-sightings method.

The three big items which are of immediate concern to the geologist in the field are: to plot his exact position on the map or photograph, give a correct description of the outcrop and collect representative specimens.

Locating one's position. In systematic geological mapping, the degree of accuracy required in locating the observation points will depend on the scale of the map which is to be prepared. For instance, when maps are being prepared on the scale of 1:200,000 locations should be plotted to the nearest 50 m. Plotting one's exact position on a map or photograph is by no means as easy as is generally assumed. Owing to the wealth of details and reference points which they provide, aerial photographs are much more useful than geographical maps.

When carrying out a geological survey without any simultaneous topographical survey, the geologist should consult the aerial photograph constantly, from the moment he leaves his camp, and check his movements on it regularly *(Plate 23)*.

To locate a point on a featureless surface which has no landmarks such as a solitary tree, the edge of a field, etc., the following simple and rapid method can be used: from the point to be located, note the horizontal sightings of three easily identifiable points in the landscape (A, B, C), using a sighting compass or a small theodolite. The angles between the sightings should be wide, not less than 90°. Accuracy can be checked by calculating the three angles, which should add up to 360°.

The three sightings are then drawn finely on a piece of tracing paper, which is laid over the photograph or map and adjusted so that the three lines pass over the points (A', B', C') corresponding to the points sighted upon. The point which is to be located will automatically lie at the intersection of the three lines, and it can be marked on the photograph by pricking through with the point of a needle (Fig. 27).

This method can be employed equally satisfactorily with maps or aerial photographs. If photographs are being used, and if the area exhibits much surface relief, i.e. if the contours exceed 50 m, the distortions which are inevitable in photographic representation (conic perspective) will make it necessary to sight upon points which are at about the same altitude as the point to be located.

Observations. The term 'outcrop' includes not merely rock formations which are naturally or artificially exposed, but also the bedrocks in prospect holes; a study of displaced rocks can also help to explain the geology of the region. The best places for finding well-exposed rocks can often be located in advance on aerial photographs and topographical maps, which normally show quarries and road and rail embankments. In addition to the items mentioned above, the geologist should keep a watch for various indications which are likely to be of geological importance, including: the morphological details of a cliff face, a small rise in the ground, some particular feature of a river, the shape of a sink hole, the appearance of the vegetation and the type and colour of soil exposed on tracks.

Every useful item of information should be entered in a notebook. Squared paper will be a help in setting out certain data and is very useful for sketches and sections. A duplicate notebook, with carbon paper, should be used. Each notebook should open with the observer's name, a sketch of the compass used, showing the type of graduation, the local magnetic variation, and a list of abbreviations used.

The observation point should be marked on the photograph by pricking it with the point of a needle. On the back of the photograph, the needle hole should be surrounded by a small circle, about three millimetres in diameter, and a reference number should be written alongside this.

Every observation should be given a number. The work of several geologists may be identified by placing the observer's initials before the numbers: for instance, J. D. 873 will indicate observation point 873 recorded by Jules Durand.

When using maps on a scale of 1:50,000, adjacent observations referring to the same landmark should be grouped under the same number if they refer to outcrops lying within a radius of about 250 m of the landmark. If they are separate features, at least 50 m apart, and clearly identifiable on the photograph, they should be pricked separately and marked by small letters, e.g. 1834 a.

In the case of very big outcrops, the points to be marked are those at which specimens have been collected or measurements made. An indication should be given of the area involved, and, if necessary, a large-scale plan should be attached, showing the relative position of the observation points.

In the course of his surveys, the geologist should ask the local inhabitants or his guide for the names of rivers or villages, which should then be marked directly on the map. When starting a traverse, he should always make a note of the date, the place and time of departure and the direction followed.

On reaching an outcrop, he should begin with a general examination to determine its size and shape and the amount of weathering to which it has been subjected. He should also make sure that the outcrop consists of firm rocks and not of loose boulders. Each outcrop should be given a fresh reference number, accompanied by the time, the number of the air photograph on which the outcrop has been marked, and the sheet number of the map concerned. The features of the outcrop should always be listed in the same order, following a prearranged plan. This list should be drawn up in accordance with the categories of rocks encountered: it will obviously be subject to modifications, additions and deletions, in the light of the progress of work. In order to ensure that no important feature is overlooked, this list should be placed at the front of the notebook.

All descriptions should be purely factual, any theories or interpretations being recorded in quite separate paragraphs. The notes should be full and accurate (but not verbose); the geologist should never rely on his memory.

The description of an outcrop should begin with general features, passing on to details at the end.

We give below, for guidance, a list, which is not intended to be exhaustive, of the main features to be taken into consideration in the case of an outcrop of sedimentary rocks:

- general appearance, shape, dimensions,
- presentation and thickness of beds,
- nature and thickness of interbeds,
- description of the rock: name – identifiable minerals – coherence – hardness – granularity – colour of the weathered surface and of freshly-broken rock,
- sedimentological features: nature, size and distribution of detrital elements, cross-bedding – graded bedding – ripple marks – desiccation fissures – lenticular arrangement – banding – criteria indicating the normal and overturned position – nodules – inclusions – geodes – marker beds,
- tectonic features: folding – microfolding – joints – schistosities – faults,
- presence of fossils, their nature and position,
- contacts between different kinds of rock,
- special features of weathering of metamorphism,
- modification on contact of eruptive rocks,
- mineralization.

If a detailed study of a large section is required, it is advisable to describe the beds starting from the stratigraphic base and working up towards the top.

Photography. Photographs are an excellent means of illustrating observations; they also help the geologist to recall certain aspects of an outcrop and of the landscape.

The geologist's equipment should therefore include a small high-quality camera, preferably a miniature camera equipped with three standard lenses and an exposure meter. A wide-angle or panoramic lens is essential in order to obtain an extensive view of the landscape or to photograph a complete outcrop which has to be taken close-up, as in the case of a gorge or mountain pass. The telephoto lens is used to take large views of the detail of a conglomerate or contact, fossils, sedimentation figures, inclusions, etc.

Colour is an important geological feature in rocks; it can be reproduced most faithfully by means of good quality colour transparencies. If only one camera is available, it should be loaded with colour film, from which black and white prints can always be made if required. The ideal arrangement is to have two cameras, one for colour and the other for black and white. There are now cameras on the market with interchangeable backs which make it possible to change over from colour to black and white or vice versa at a moment's notice. The use of colour filters demands some experience of photographic techniques, and the geologist who is not accustomed to them would do well to avoid their use.

It is not easy to photograph rocks, as they generally lack any sharp colour contrast. The photographer cannot control his lighting, and statistics show that half of the surfaces to be photographed are in shadow. When this is the case, flash photography can be used for close subjects (at a distance of a few metres). Always remember to indicate the scale of the objects being photographed by laying on the rocks a familiar object, such as a hammer, compass or pen, the size of which is well known.

The geologist should endeavour to make his photographs attractive pictures as well as valuable documents, by selecting the angle from which he takes the photograph, by giving the picture a foreground and by paying attention to composition. The number of each photograph should be recorded in a notebook and it is often useful to add a few words describing some characteristic of the object photographed, so that it can be identified subsequently without any fear of confusion.

The photographic technique which can give the best results is the one advocated by L. W. Le Roy under the title of 'photo-stratigraphy'. This technique consists merely in taking a series of four or five photographs of one outcrop, reducing the distance each time. The first photograph puts the outcrop in its setting; the second shows the complete outcrop; the third covers part of it; and the fourth, taken at a distance of 1 or 1.50 m, brings out certain details.

Stereoscopic photography can be of great service in some cases, particularly in bringing out irregularities in badly-lit surfaces without any shadows. There are special cameras on the market designed to take two photographs simultaneously. They are relatively expensive, as they have twin lenses, besides which they add to the bulk of the field geologist's equipment. With a little experience, however, it is possible to take 'stereopairs', for stereoscopic viewing, with a single-lens camera. A 'stereopair' consists of two photographs of the same object taken from different but neighbouring camera stations so that they will be on the same scale. The procedure is as follows:

- take the first exposure, making an exact note of the picture area covered:
- roll the film on for the next exposure,
- move the camera sideways to right or left,
- point the camera at the same object, ensuring that the picture area is the same as in the first exposure,
- take the second exposure.

The distance between the two camera stations is called the base. The rule to be remembered is that the wider the base, the greater will be the exaggeration of distance along the axis of the camera, i.e. the greater will be the impression of depth when the photographs are viewed through a stereoscope. When photographing at relatively short distances — up to 20 or 30 m — the photographer stands at the same place and merely bends his body slightly so that the camera is moved about 10 cm to the left or right. For landscapes, the sideways movement should be about one pace. It is advisable, however, to begin by making several tests using different lenses.

Measurements. The correct surveying of a traverse, with accurate measurements of angles and lengths, comes under the heading of topography, and it would take up too much space to describe the methods here. It may be of interest, however, to mention the simple cyclometer method. The equipment consists of the front forks of a bicycle, complete with wheel and handlebars. A small cyclometer is fitted to the wheel, and this is used to measure the distance covered. The angles can be measured with reasonable accuracy by means of a compass fitted with small sights. The traverses made by this procedure must either be closed, i.e. terminating at the starting point, or they must be based on two fixed points.

At least one of the instrument stations should be a position which can easily be identified on an aerial photograph or map, if possible a geodetic point.

It should also be mentioned that simple, light and portable instruments are available consisting of a compass with sights, clinometer, telemeter with stadia rod, and alidade.

It is essential that the description of an outcrop should be accompanied by the following measurements:

- dimensions of the outcrop, thickness of beds and veins, size of enclosures, boulders, etc.,
- direction of strata, veins, contacts, faults, fractures, schistosities,
- inclination of the above,
- altitude of the outcrops.

The dimensions listed above are normally measured with a two-metre steel tape.

Measurement of the strike—generally of the bedding plane—is carried out with the aid of the geologist's compass. The first step is to examine the outcrop and find a true bedding plane, making sure that it is a typical one; it is always possible that there

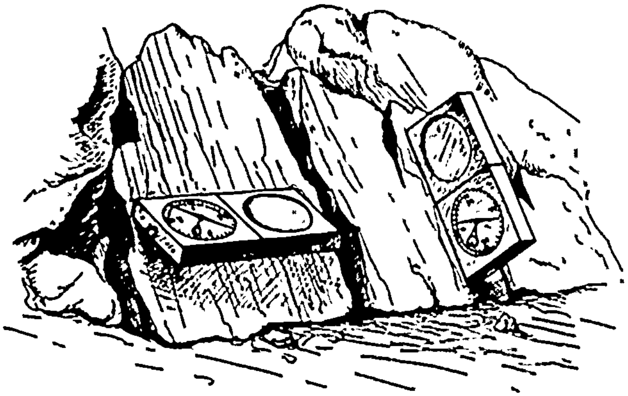


Fig. 28.
Measuring the strike and dip of geological strata.

may be a small irregularity in the bedding. The simplest, but least accurate, method of measuring is the contact method. The compass is held horizontally (this can be checked by means of the little spirit level which is built into the compass case) and placed on the surface which is to be measured so that the edge of the compass which is parallel to the north-south line is in close contact with the surface. It is then only necessary to wait until the needle comes to rest and to read off from the dial the bearing indicated by the blued point (Fig. 28).

When dealing with large solid beds such as quartzite strata several metres or dozens of metres thick, surrounded by soft schistose material, great care must be taken to ensure that the planes marked as bedding planes are in fact bed surfaces and not joints. This is a frequent source of error.

An important precaution, which should always be taken when measuring the strike, is to move one's hammer at least three metres away. The compass needle is also liable to be affected by the close proximity of metal posts, railway lines or a motor vehicle.

The geologist's compass incorporates a clinometer; this is a small pendulum, the free end of which moves along a graduated arc. When measuring dip, the compass is held vertically, perpendicular to the strike. To make sure that the compass is in the correct position, it should be tilted slightly, when the correct angle of dip will always correspond to the highest reading on the clinometer.

When the surface being studied is extensively exposed, greater precision in measurement can be attained by employing the 'indirect' method, i.e. by moving a short distance away from the outcrop and aligning the edge of the compass with the plane by sighting instead of contact. This gives an overall measurement which is not affected by small surface irregularities.

When recording observations in the notebook, the strike should be indicated first, followed by the dip. The clearest way of recording this is:

s: N 40° W; d: 27° SW

It is not advisable to make an immediate correction for magnetic deviation and quote the angle of strike by reference to true north, because awkward mistakes can be made if this is overlooked, which is always liable to happen. Always indicate clearly what these measurements refer to (bedding, schistosity, etc.).

An altimeter is an instrument working on the principle of the measurement of atmospheric pressure; there are some compact models on the market. If the measurement is being made by direct reading, however, a series of corrections will always have to be made afterwards; for details the reader is referred to the manufacturer's instructions. Certain precautions must be taken at the outset to deal with one important correction, namely that for variations of atmospheric pressure. A base station, less than 100 km away, should be equipped with a recording barometer or an altimeter, the readings of which should be noted every hour.

If it is not possible to provide a control station of this kind, it will be necessary to use the theoretical barometric pressure curve based on the observations of the local meteorological service. If this information is not available, the geologist must check the pressure variation curve himself, by taking frequent readings whenever he is able to stop at the same place for twenty-four hours or more. Altimeter recordings should always be accompanied by an indication of the time.

It often happens that soft or loose formations of relatively recent origin, either horizontal or sub-horizontal, partially cover a developed and more or less peneplain substratum. In such regions, measurements of altitude are the only means of reconstructing the position of the surface of unconformity and of calculating the strike and dip of the overburden. The geologist also needs to know the altitude in order to be able to determine and correlate the peneplains and terraces.

(b) *Collecting specimens*

The purpose of specimens is:
- to illustrate and support geological observations,
- to illustrate the stratigraphic scale,
- to indicate exactly the composition of marker beds, define the metamorphism, study the nature of the eruptive rocks, etc.,
- to enable fossils to be investigated and identified,
- to enable various studies to be carried out, including the determination of isotope relationships (absolute geochronology by means of radiation measurement) and traditional chemical analysis,
- to enrich the museum's collection of rocks, minerals and fossils.

In principle, every observation should be illustrated by a specimen. In practice, however, this procedure would involve collecting an excessively large number of specimens, and the geologist should therefore limit their number, bearing in mind their probable degree of usefulness; he should not, however, be afraid to increase the number, as it is always better to do this than to collect too few and to have to return to the field later.

Rock specimens should generally be between eight and fifteen centimetres in each of the three dimensions. Each specimen should bear the number of the observation point. If several specimens are taken from the same point, they should be given subsidiary numbers thus:

J. S. 827/1 or J. S. 1224/3.

Where the material is of a heterogeneous nature--ptygmatic folds, rough conglomerates, contacts—larger specimens will be required. As far as possible, all specimens should be taken in duplicate, so that one can remain at the base camp for reference while the other is sent to the museum. The reference number should be marked on the sample indelibly with enamel paint and also written on a label to go with the specimen in its bag.

An easy way of provisionally numbering the specimen is to attach a piece of adhesive tape to the surface (which must be completely dry) and write the number on it, either with a ball-point pen or, better still with an indelible pencil. Specimens of hard rock should be put in linen bags, and soft, friable and loose materials should be placed in plastic bags.

It is advisable to indicate the orientation of all samples, i.e. to record their position so that this can be reconstructed in the laboratory. The normal procedure is as follows: a piece of adhesive tape is attached to the chosen face of the outcrop; the strike and dip of this face are measured, and the information written on the adhesive tape; the piece of rock is then detached from the rock-face. Specimens marked to show the orientation should be taken whenever they are likely to be required for structural or stratigraphic studies. In the case of specimens of sedimentary rocks, it may be sufficient merely to mark the top and the bottom in relation to the stratification. This relative orientation can easily be indicated by the sign + or — used to indicate the top and the bottom respectively.

Particular care is required in packing the specimens. To prevent movement during transport, they should be tightly wedged with paper or some other packing material, because any rubbing or jolting is likely not merely to damage the samples, but also to spoil the labels on them, or even make them illegible.

Some minerals which are highly fragile (needles), or soluble in water, should be packed first of all in thin paper (tissue paper or similar) and then in cotton. Wood shavings or paraffin wax can also be used to pack the box.

Some fossils, such as ammonites which have suffered epigenesis by marcasite or pyrite, must be protected from damp. Fragile specimens can be strengthened by coating them with a binding material such as gum arabic, dissolved in a little water.

A final point: no attempt should be made in the field to remove fossils from the rock specimen; this is delicate work, which often takes a long time and needs special equipment.

Rock and mineral specimens intended mainly to add to the museum's collections should comply with the general conditions indicated above, but they should be selected not only as representative samples but also for their intrinsic interest (rarity, beauty or, in general, any feature which distinguishes them from normal specimens).

BIBLIOGRAPHY

AMERICAN SOCIETY OF PHOTOGRAMMETRY. 1952. *Manual of photogrammetry*, 2nd ed., 876 p.

BANDAT, H. F. von. 1962. *Aerogeology*. Houston, Texas, Gulf Publishing Co. 342 p.

COLWELL, R. N. 1960. *Manual of photograph interpretation*. American Society of Photogrammetry. 868 p. (Very extensive bibliography.)

FURON, R. 1962. *Formulaire du géologue*, 2nd ed., Paris, Paul Lechevalier. 228 p.

GERARDS, J.; LADMIRANT, H. 1963. *La photogéologie au service des travaux préliminaires à la mise en valeur des ressources minérales*. Memorandum on item A. 5.2.1. Geneva, United Nations Conference on the Application of Science and Technology for Development. (oc. E./Conf. 39/A/86.)

HURAULT, J. 1956. *Manuel de photogrammétrie*. Paris, Institut Géographique National. 2 vols., 435 p.

LAHEE, F. H. 1961. *Field geology*, 6th ed., New York and London, McGraw-Hill. 925 p.

LOW, J. W. 1952. *Plane table mapping*. New York, Harper Brothers.

——. 1957. *Geology field methods*. New York. 390 p. (Harper's geoscience series.)

MILLER, V. C. 1961. *Photogeology*. New York, McGraw-Hill. 231 p.

RAISZ, E. 1962. *Principles of cartography*. London, McGraw-Hill. 315 p.

SEIGNOBOSC, H. 1948. *Cours de topographie générale*. Paris, Charles-Lavauzelle. 560 p., 422 illus.

SMITH, H. T. U. 1943. *Aerial photographs and their applications*. New York, Appleton-Century-Crofts. (An excellent introduction to aerial photography.)

UNITED NATIONS. 1960. *Proceedings of the United Nations aerial survey methods and equipment*. 167 p. (ECAFE, Mineral Resources Development Series, no. 12.)

L. O. Williams

Field work techniques in botany

9

INTRODUCTION

The primary purpose of field work is to prepare voucher specimens for subsequent examination in the course of floristic, ecological or other studies of a region for which knowledge of the vegetation is required. These specimens should eventually be stored in an herbarium, where they will be available to students who may wish to restudy them and where they can be preserved for all time.

In addition to the work of gathering the actual specimens, adequate field data concerning these specimens should also be compiled. This data should be recorded on labels to accompany not only the original specimens, but also such duplicates as may be collected at the same place and at the same time. Usually, such field data is first written into a field book at the time of collection, the labels being prepared later from the data in this book. After the work of preparing the labels is completed, the field book should be deposited at the institution of the collector.

The careful selection and preparation of specimens in the field and the preparation of adequate field data for these specimens is essential if the work is to be of permanent value. Poorly prepared or inadequate specimens with poor field data are practically worthless. If they have to be sent to a specialist for determination they may be refused, or determination satisfactory to the project may prove to be impossible.

PRELIMINARY CONDITIONS AND PREPARATIONS

The choice of the region to work on is normally dictated by the purpose of the study. If, for example, it is desired to do field work related to a floristic study of the vegetation of a country, then the basic region to be studied will be quite different from that selected if the object is to investigate the ecology of sheep-raising in that same country, or to carry out a forest survey,

The time involved in a study will also be limited or controlled by the type of study and the size of the region. A forest survey of a mountain in Wyoming may take one botanist from a few days to a few weeks. A forest survey of Peruvian Amazonia, on the other hand, may take a group of botanists, foresters and collectors twenty or thirty years. The size and complexity of the study to be made should be carefully assessed as far as possible in advance so that provision can be made for adequate finance to complete the work.

Obviously, the more accessible the region is to the person making the study, the more easily he will be able to carry out the various field programmes involved. A botanist working in Liberia, for example, will find it easier and more profitable to work on the multitude of problems that his own country presents than to spread himself and his resources over too large an area. Each particular problem studied will give an indication as to what portion of the country should be worked next and what material will be required.

Many field studies, however, especially in the tropics, are undertaken by men and institutions far away. This may be dictated by the research interests of that institution and the men who staff it. An example of this is the writer's institution, where certain regions of the neotropics have been under study since the end of the nineteenth century and where one of the finest research collections for that part of the tropics has been accumulated.

Preliminary studies to field work on the region selected may be simple or complicated. A forest survey of a mountain in Wyoming may involve nothing more complicated than getting some collecting materials together, loading them into a field car, going to the mountains to make the collections and observations necessary to the study and then going home. The preliminary studies for a forest survey of such a region as Amazonian Peru may take a good deal of library study, consultation with people acquainted with the region, making arrangements for staying in the region, and movement and use of the material once the team is in the region to be studied. A preliminary trip into the region by the person doing the planning can be very useful for making contacts upon which the success of the project may depend.

The preparation of an expedition may be very easy (most are) or difficult, depending on the region. If one is working from headquarters where all the facilities are available, it may simply be a matter of going out to the place to be worked, gathering the specimens, then coming back in and preparing the material collected.

The preparation of a long expedition, or a continuing one to little known regions where transportation and other facilities are notable by their scarcity, may require considerable thought and preparation.

In expeditions to foreign countries, we have found it desirable, where possibel, to co-operate with an institution in the country being studied. The advantages are mutual. The national institution will get through the expeditions materials that might be difficult to secure with its own resources. The local scientists will have at their disposal facilities, political and others, that may be invaluable to the success of the expedition. They may also have facilities available in remote regions where it is hoped to work. A most valuable asset that the local scientist is likely to have is the basic knowledge of the country.

The preparation of an expedition to a remote area must be carefully done. If most of the materials to be used are to come from another country, which is often the case, then these must be procured and shipped well in advance so that they are available when needed. Everything that is needed must go in this advance shipment, for once the expedition is in the field, something forgotten will cause difficulties.

Scientists have a habit of planning expeditions that may stretch to the limit the financial backing available. While it is commendable to try to get as much material as possible, in complicated expeditions it may be wise to limit the field work to what may reasonably be done with funds available.

FIELD WORK

Work plan. There are as many work plans for collecting botanical specimens as there are botanists. The work plan will be dictated to a considerable extent by whether the work is being done at some distance or near to headquarters or a semi-permanent base camp. The kind of country being worked and the weather and climate conditions likely to be experienced will have a very important influence on planning.

If the weather permits drying by sun heat, then materials can be collected and brought from the field and put immediately

(a)

(b)

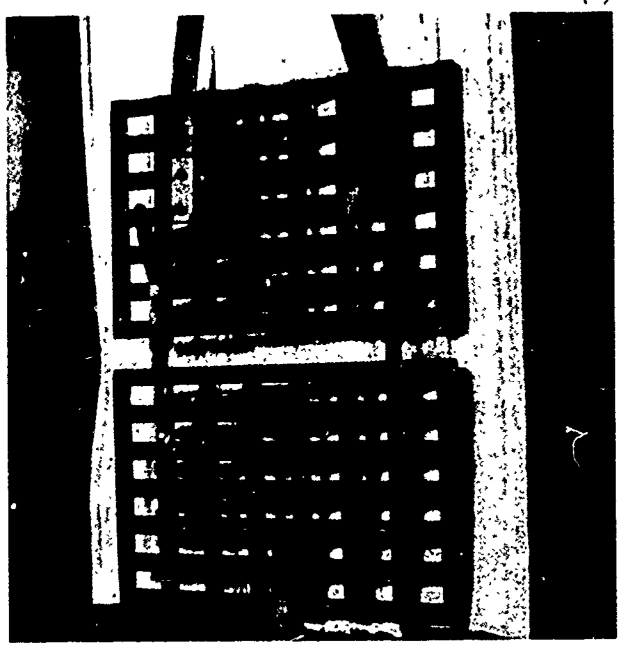
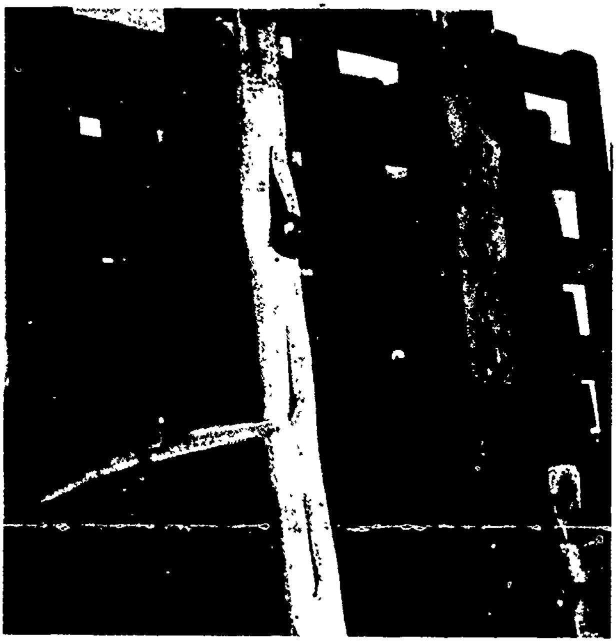


Plate 24.

(*a*) A field press showing carrying straps, straps to permit expansion, and closing straps. This press is made of mahogany; it measures about 30 × 45 cm.

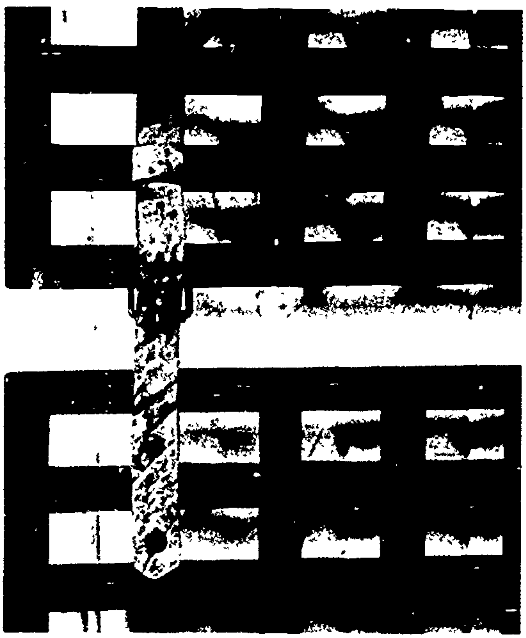
(*b*) The same press opened out.

(c)

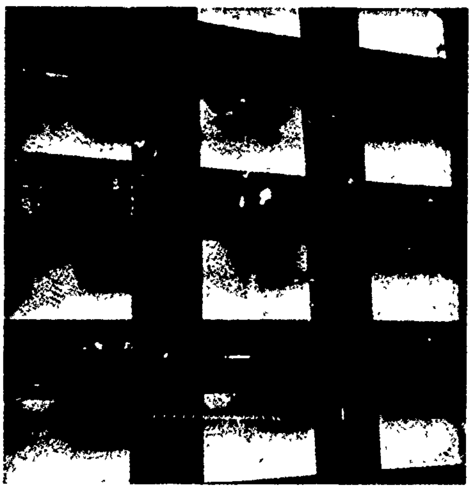


(c) Detail of closing strap.
(d) Detail of expansion strap.
(e) Detail of fastener used with closing strap.

(d)



(e)



(a)

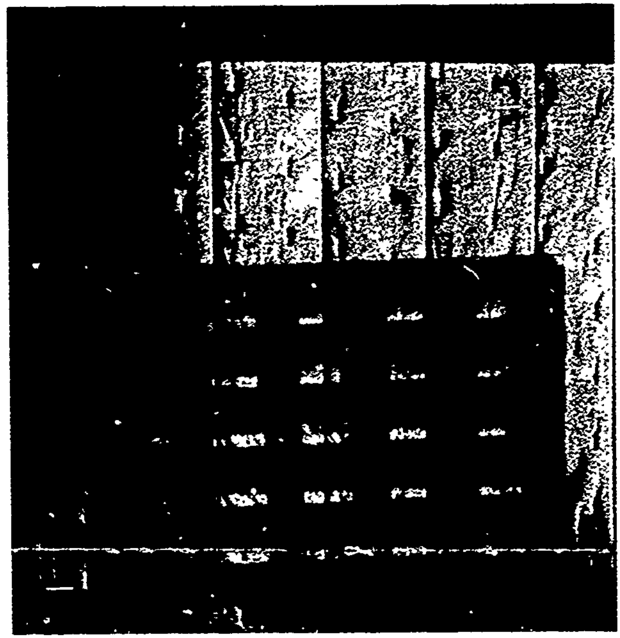
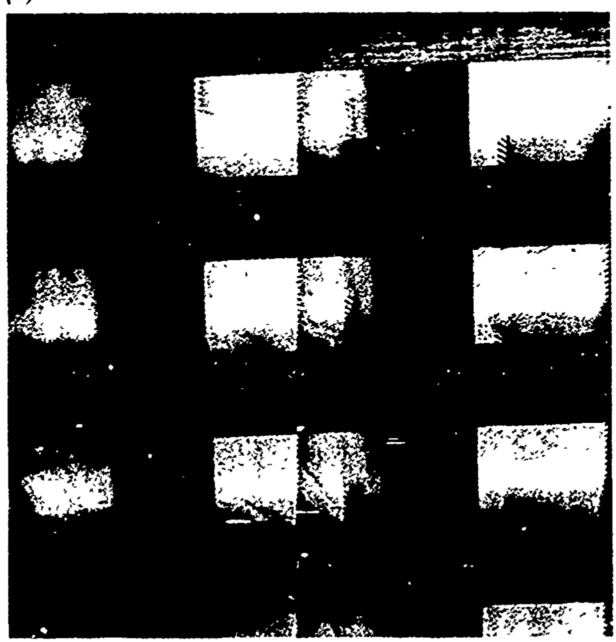


Plate 25.

(a) One press board, size 30 × 45 cm.

(b) Detail of construction of press board, the rivets are copper. The wood used in this case is hickory.

(b)



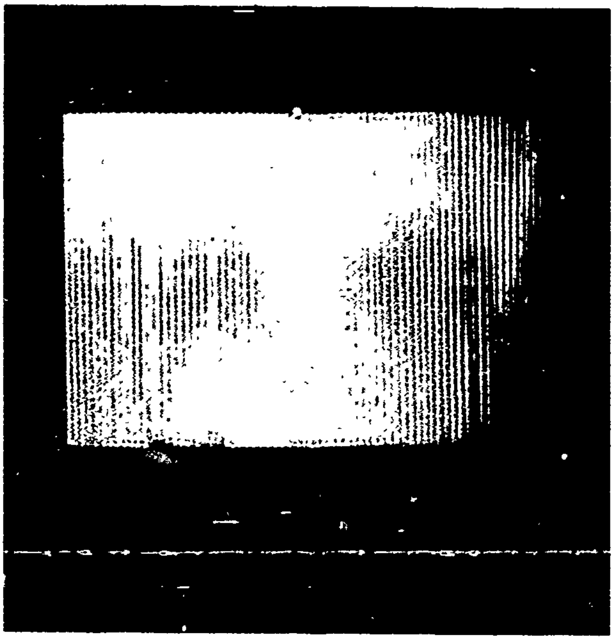


Plate 26.
An aluminium corrugate, size 30 × 45 cm.

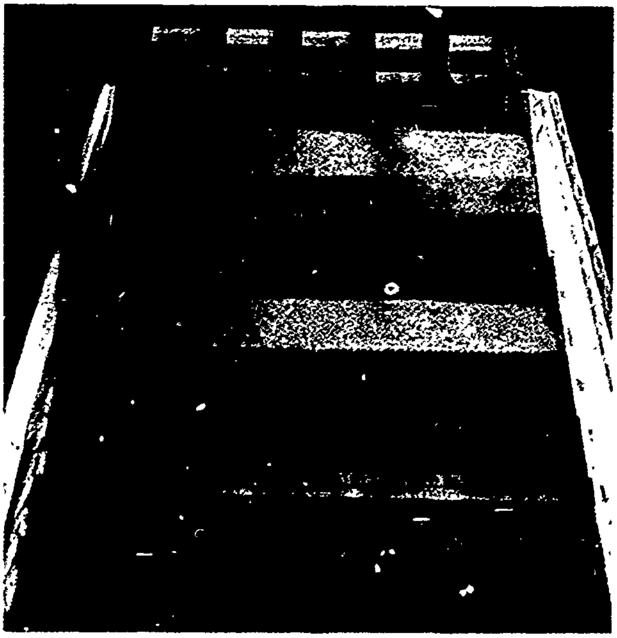


Plate 27.
Sequence for press: press board, drier, corrugate, drier (plant), drier, etc., and finally a closing press board.

into press and dried. Depending upon materials and temperature, drying may take from two to four days. If one returns to headquarters or to a good base camp each day, where artificial heat is available, then again it is advisable to put material into presses and begin drying at once.

When one is away from headquarters, and especially if drying conditions are difficult or slow, it is perhaps best to preserve the material in formalin until returning to headquarters. This is especially true if one is working in humid forest areas. However, if it is necessary to dry in the field, it is easy to devise a method using the materials at hand. Presses may be filled in the usual manner and the heat applied to these. Open fire may be used, but continual care must be taken not to burn equipment and specimens. When it is known that conditions will be damp, kerosene lanterns, lamps or stoves, gasoline lanterns, or other types of heaters, may be taken into the field. Little else is needed besides the ordinary presses with some skirts to help direct the heat and a framework on which to set the presses.

When one is working in humid areas a long way in distance or time from headquarters, drying may be so slow that within a short time, all the available drying equipment is tied up. Valuable time will then be lost waiting for material to come out of the press so that more can be put in. Under such conditions it is usually preferable to collect as great a representation of the vegetation as possible to avoid using field time in the routine of caring for the presses and keeping the heaters going. We have come to the conclusion that if we are to be away from headquarters more than a day, then all material goes into formalin and is dried at headquarters at leisure. The collectors thus spend most of their time collecting rather than in the relatively unproductive operation of drying while in the field. This system increases the 'take' considerably.

Methods of collecting botanical specimens vary from collector to collector and may also vary according to the materials being collected. If a general collection for floristic studies is being made, then it is well to take everything that is in determinable condition. Even if a plant is a common species, it is still best to take it, for no one can carry all the details of a flora in his head, especially in tropical regions, where the number of species, and often related species, is very great and frequently not well known.

The actual procurement of specimens is usually not difficult. Small trees, shrubs or herbs present no problem. In tropical forests the procurement of specimens from the forest giants, however, may be a less simple matter. It is sometimes impossible to tell from the ground if a tree is in flower. And if it is in flower, how can the flowers be obtained? The time involved in felling a tree is so great that it is rarely practised. Often a length of cotton clothes line with a rock tied on the end can be entangled in branches and these broken off. One situation that should never be passed by is a clearing operation where trees are being felled. This will make available the tree tops and all the epiphytes and other plants that grow on and among these branches.

What should actually be taken? Everything for which there is a reasonable expectation of determination. If something sterile is important in a study, then take it and hope that it can be determined. If the study is a special one, then the collector may limit his collections to those plants which he wants.

The selection of specimens should be critical. If a herbaceous plant is being collected, then be as sure as reasonably possible that all the plants collected and put under one field number are all the same thing. This problem is relatively easier when shrubs or trees are being collected. Branches from a single shrub or tree will usually supply enough specimens to make up the number of duplicates desired.

The actual tools used to collect with may vary from collector to collector. The writer uses a fairly heavy machete as an all-purpose tool. It can be used to dig, to cut or to chop. Trowels are often used; a geologist's hammer is a useful tool in hard or rocky ground; a pair of pruning shears is an excellent tool for use in collecting woody material; a good quality pocket knife is always useful; a good cotton clothes line with a rock or stick attached is a handy means of breaking down branches that are too high to reach; saws or cutters on long, extensible handles are useful in special situations.

Field presses or other devices to hold the day's accumulation are necessary. Field presses should themselves be light in weight so as not to add to the load excessively (*Plates 24-27*). They should open and close by a simple device and be extensible as they become fuller and fuller. Newsprint may be used in these presses to hold each collection and to keep the materials separated. We have found that large plastic bags are eminently useful when collecting in the wet forest or where it is rainy. They are not so good to use in dry sunny regions because of the heat which they trap. Coffee sacks are also useful in some situations. The old vasculum is still used and is useful in dry regions where specimens may be small. In most circumstances, however, they are too small, or if large enough, too heavy for use in tropical regions where material piles up rapidly.

FIELD DOCUMENTATION

Data must be kept for all collections and should be written down in a field book as soon as possible after the collection is made. Every collector should number his collections serially and should never repeat his collection numbers. These numbers should go on all labels, the same number being used for all duplicate specimens of one collection.

Characteristics of the plant should be recorded where these are not obvious from the specimen. Flower colour should be mentioned for it is fugaceous. If the plant is a shrub this should be recorded, as it is often impossible to tell from a specimen whether it was from a tree or a shrub. The size of the plant should be given if it is not obvious from the specimen. If the plant is an epiphyte, a parasite, a saprophyte, this should be recorded. For trees it is well to give diameter of the trunk at breast height (DBH) or above the buttresses. The habitat of the plant should be accurately given (for example 'pine savannas', 'primary rain forest'). Geographical data should be given with care, and in remote regions where the names of geographical features are not well fixed, it is not unreasonable to give position by latitude and longitude. Elevations are often essential and are given for preference in metres. Major political divisions should be given for all collections.

In the preparation of labels for collections the data from the field books are transposed in proper order. It is customary to put at the head of the label the name of the major political entity where the collection was made, for example 'Peru', not 'Plants of Peru', for we may assume that the person using the specimen knows it is a plant. Following 'Peru' in smaller type, may be the name of the institutions sponsoring the expedition (Fig. 29). This has been referred to as 'the commercial'. The collection number may be put at any convenient place, usually following the name of the collector or preceding the scientific name. The scientific name should follow, or a space should be left for it if it was not known when the label was prepared. If the material was determined by a specialist, it is customary to add this information after the scientific name—*det. Wurdack, 1966* or *Wurdack, 1966* is usually sufficient. The native name may also be given at the beginning of the main body of information if it is known. If this name is in an indigenous dialect the name of the people or dialect should be given. Then there may follow the data mentioned above in field notes, first describing the plant (i.e. forest tree to 28 m, 1.5 m DBH); then flower or fruits; then habitat; then geographical location; then the elevation and date. The name of the collector or collectors should be the last item on the label. However, there are as many formats for labels as there are persons who prepare them: the main requirement is to ensure that all essential information is entered on the label. Something that may be common knowledge to you may not be known to someone else. If the specimens are vouchers for a special study, put this on the label, perhaps at the base.

Labels are not usually prepared in the field for it is not a good use of available field time; any convenient time after returning will do. It will be found that much time may be saved if as much of the field data can be printed as possible (Figs. 29, 30). If field work was carried on, say, at the confluence of the Ucayali and Pachitea rivers, in a certain province, near a certain village, at such and such longitude and latitude, for several days, then this information at least will be applicable to a large number of collections and had just as well be printed. The paper used for labels should be of good quality. Information written on paper that crumbles with time is lost for ever and the specimen that it accompanied becomes essentially valueless.

PERU (a)

Field Museum of Natural History

José Schunke V.

TREES OF PERU (b)

U. S. Forest Products Laboratory
Chicago Natural History Museum

[This tree, given field number   , was visited periodically to obtain complete herbarium material which was determined and distributed by Chicago Natural History Museum. The tree was then felled to obtain wood specimens for testing and distribution by U. S. Forest Products Laboratory. The material was all collected under U. S. Public Law 480, Proj. S8-FS-1, by Servicio Forestal y de Caza, Lima, Peru.]

HONDURAS (c)

Chicago Natural History Museum

23288

Valeriana urticaefolia HBK.

Flowers white; scattered over moist slopes in oak-pine forest area in the mountains between Montaña Uyuca and La Montañita, about 15 km. east of Tegucigalpa, department of Morazán, alt. 1,500 meters.

January 3, 1963.

Louis O. Williams
Terua P. Williams

Fig. 29.
The labels illustrated were used for special collections and show our method of preparing labels:
(a) A general label in which the country and collector are constant.
(b) A special label for a specific project. All field data and names of collectors must be written in.
(c) Labels completely printed out.

COSTA RICA
Chicago Natural History Museum
Escuela Agrícola Panamericana

Cut-over cloud forest area near El Cañón, 40 km. south of Cartago, province of Cartago, Cordillera de Talamanca, alt. 2500 m., January 26, 1965.

Louis O. Williams, Antonio Molina R., Terua P. Williams, Dorothy N. Gibson.

GUATEMALA
Chicago Natural History Museum
Escuela Agrícola Panamericana

Montane cloud forest area on outer slopes of Tajumulco Volcano, Sierra Madre Mountains about 8–10 km. west of San Marcos, department of San Marcos, alt. ±2300 m., December 31, 1964–January 1, 1965.

Louis O. Williams, Antonio Molina R., Terua P. Williams, Dorothy N. Gibson, and Chester Laskowski.

NICARAGUA
Chicago Natural History Museum
Escuela Agrícola Panamericana

Cut-over hills about 15 km. northeast of Matagalpa along Río Las Cañas, Department of Matagalpa, alt. ±700-800 m., January 14, 1965.

Louis O. Williams, Antonio Molina R., Terua P. Williams, Dorothy N. Gibson, and Chester Laskowski.

Fig. 30.
Labels in which the majority of the data is printed on to the label.
Numbers, scientific names, as well as specific data for each collection must be written in the spaces provided.

STABILIZATION OF BOTANICAL MATERIAL IN THE FIELD

If the field work is being done near headquarters where major drying apparatus is available, or at a field camp set up for drying in the field, then drying may be started the same day the collection is made or at most the following day. This is the ideal situation and specimens are perhaps best prepared in this way, using artificial heat to hurry the drying.

The specimens are laid out on newsprint, the number of the collection written on each sheet *in pencil* (some 'modern' pens use inks that are unstable) and absorbent drier paper, a corrugate and another drier placed on it. The procedure is then repeated until the stack is 60-90 cm tall. The stack is then placed between press boards and tightened down, using good cotton clothes line or web straps for the purpose (clothes line is cheaper and perhaps better) (Fig. 31). The press is then put over the heaters. It will become slack and need tightening after 15-20 hours. Specimens should not be dried so fast that they become brittle or discoloured. Specimens dry at different rates; two to four days is normal. Fleshy plants may take a week or two.

When working away from headquarters we have devised and used over the years a system that will permit us to preserve specimens for up to six weeks before we get back to headquarters and dry them out. The system is simple, safe and rapid. In twenty years we have lost a few specimens by mould, but so few as not to be significant.

The specimens are prepared between newsprint just as though they were to be put into press immediately. The newsprint is first 'painted' with formalin, the specimen put in and arranged, the top half of the newsprint closed and painted with formalin. The next piece of newsprint is placed on top (it will stick because of the formalin on the sheet below) and 'painted', the next specimen is placed and arranged, and so on. When the bundle is 15-20 cm thick it should be wrapped up tightly in a piece of plastic about 1 × 1.50 m, tied securely with string and stored in a cool place. If desired, a newspaper can be put on either side of the bundle, before it is put into the plastic, and wetted with formalin. This gives a little more protection to the bundles.

If the specimens are to be put into press within a week, the formalin used may be 5 per cent. Up to two weeks before drying use 10 per cent. Formalin of 15 per cent concentration will hold the specimens for as much as six weeks.

The disadvantage of this system is the resultant discoloration of the specimens. Advantages are that the specimens dry quickly (in about 2 days) and are apparently bug-proof, perhaps permanently.[1]

Whether specimens are dried from fresh material or from material preserved in formalin they should be taken from the press as soon as they are dry and not left until they become brittle.

Standard drier (blotter) paper may be obtained from several firms. Cardboard corrugates may be used in the presses to permit circulation of hot air. These usually collapse and become inefficient in a short time. Aluminium corrugates are much superior and last for years. The only supplier of these known to the writer is General Biological Supply House, 8200 S. Hoyne Ave., Chicago, Ill. 60620. Their 1966 catalogue lists them at $80.00 per hundred.

Suitable newsprint can usually be had from the local newspaper, or by buying old papers in the market.

---

1. A much more detailed account of the preparation of herbarium material, care of herbaria and many special techniques will be found in F. Raymond Fosberg, and Marie-Hélène Sachet *Manual For tropical Herbaria*, Reg. Veg. 39, 1965, p. 1-132, illus. Obtainable from International Bureau of Plant Taxonomy, 106 Lange, Nieuwstraat, Utrecht (Netherlands).

Fig. 31.
Side view of a loaded press.

Press boards can be made by any carpenter. They should be about 60 × 45 × 1.25 cm and have two cross braces to strengthen them and to carry the straps or ropes (Fig. 32).

Cotton rope (6 mm) is excellent for tying presses and is cheap. Any other rope or web straps will also serve.

A drier box using electric light bulbs can also be made by any carpenter and wired by an electrician (Fig. 33). The presses should rest on top of the drier, *not inside* it. The box is made to join tightly at the ends, sides and bottom; three bulb holders are fixed on the bottom and not more than six 2 cm holes are drilled around each holder. Air is drawn through these holes past the hot bulbs and is heated and continues upward through the presses. Bulbs of 200 watts may be used on the first day, then replaced by 100 watt bulbs for slower drying or to avoid brittleness in the specimens.

Specimens may be taken from the press as soon as they are dry. A simple test is to 'feel' the specimen for moisture. A finger nail drawn across a leaf will leave a track lighter than the leaf surface if the leaf is dry, but darker if the leaf is not dry.

Dry specimens should be tied into bundles and stored where moisture or insects cannot damage them until such time as they are ready to be studied and prepared for labelling and distribution.

The shipment of specimens from one country to another may be regulated or require permits, such as export or sanitation permits. Most countries do not prohibit, tax or collect duties from import of scientific materials. Regulations, if any, may vary from country to country.

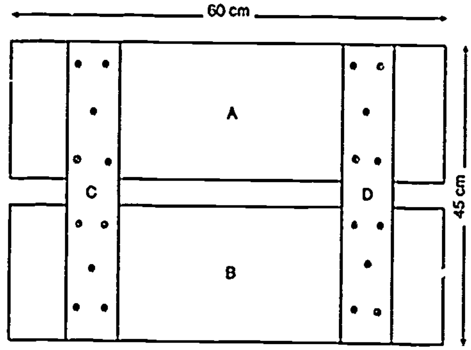
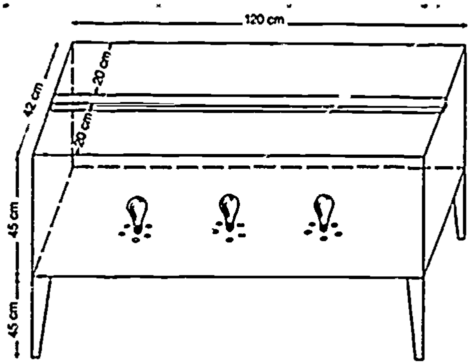


Fig. 32.
A press board.

Fig. 33.
A drier box, using electric bulbs as a source of heat.



BIBLIOGRAPHY

International code of botanical nomenclature adopted by the International Botanical Congress (9th.) Montreal, 1959. Utrecht, International Bureau for Plant Taxonomy and Nomenclature, 1961.

USHER, G. *A dictionary of botany, including terms used in biochemistry, soil science, and statistics.* Princeton, N.J., Van Nostrand, 1966.

Field work techniques in zoology

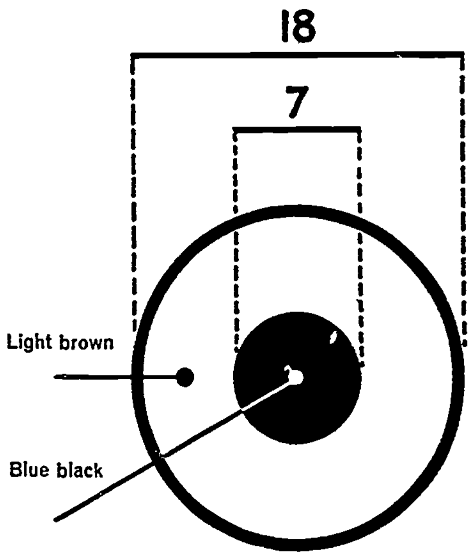


Fig. 34.
Drawing of the eye showing its diameter (18), the diameter of the pupil (7), and its colouring.

A. THE SKINNING OF LARGE MAMMALS IN THE FIELD

1. *Preliminary remarks about shooting*

When it comes to shooting large mammals, in order to turn them into specimens that are worth exhibiting, care must be taken to see that they are shot cleanly and with the proper ammunition. The point is, firstly, to spare them unnecessary suffering and, secondly, to obtain skins that are not unnecessarily damaged by the shot. Large exit holes may make a skin unusable. If the preparator is not himself a good shot, he should leave the shooting to someone who is, and attend solely to the skinning of the animals and to the preparation in the field of the skins and such other parts of their bodies as are required.

2. *The work of the preparator*

The first thing is to photograph the animal that has been killed. Here, detailed photographs of the head and other parts of the body which are difficult to copy come in very useful later on. Sketches and notes to complete the photographic material are highly desirable. In this connexion, a coloured sketch should be made showing, in particular the size, shape and colour of the eye and the diameter and shape of the pupil (Fig. 34). Coloured sketches of bare parts of the skin, as for example on monkey's heads, are also necessary, as these parts nearly always have to be coloured in afterwards on the dried skin of the animal. If an

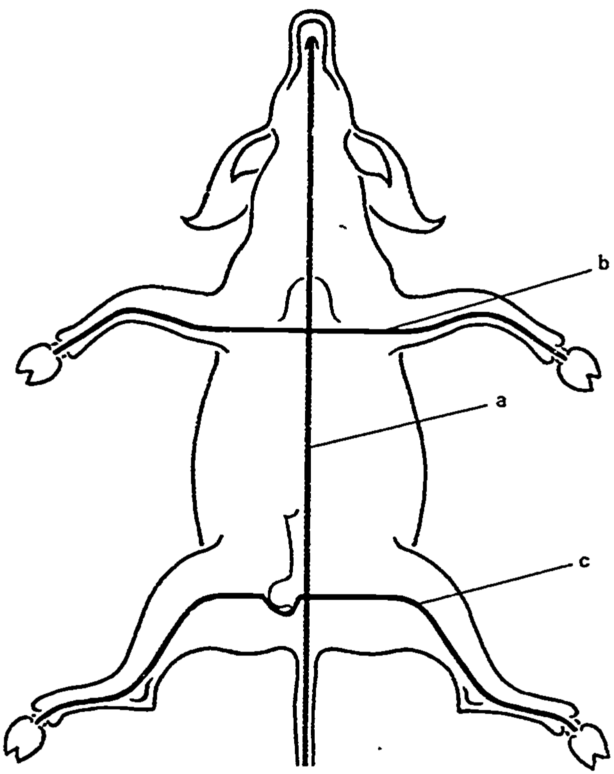


Fig. 35.
View of the underside of a dead animal showing the three incisions in the skin: (a) centre-line incision; (b) first crosswise incision; (c) rear crosswise incision.

animal is to be shown later in a diorama, it is recommended that coloured photographs be taken of its habitat.

The skinning should be started as soon as possible. The preparation process is as follows:

(a) *Slitting open the skin* (Fig. 35). The animal —in our illustration a red buffalo—is laid on its back. Then the skin is slit straight from the lower jaw to the tip of the tail, passing to one side of the penis and testicles in the case of males. Care should be taken to see that only the skin is cut through and not the muscles underneath. This is best achieved if the knife is not pulled but pushed with the cutting edge facing upwards in the cutting direction. After the lengthwise cut, the two cross cuts are made. The cuts are begun below the dew-claws or, in the case of beasts of prey, in the centre of the palm or the sole of the foot (Figs. 36, 37) and are taken, initially, as far as the carpus or the tarsus, as the case may be. From here, the skin is opened on the *inside* from the forearm and upper arm or the leg or thigh right to the centre of the belly or the breast.

Additionally, in the case of animals with horns or antlers, the skin is cut on the upper side, as shown in Fig. 38. It is cut through round the horns and backwards at an angle to the centre of the head and from there a little further along the centre-line over the back of the head and the neck. The

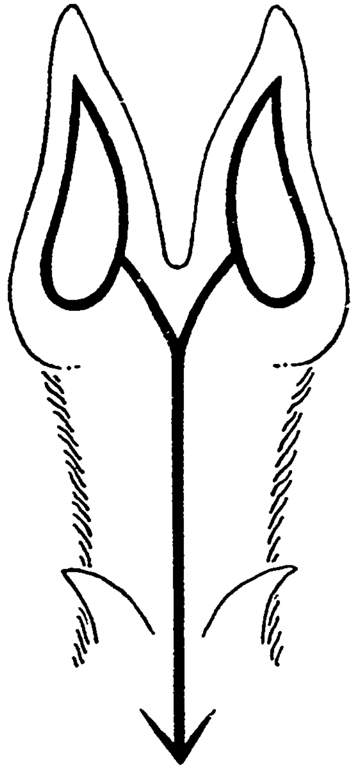


Fig. 36.
Line of cut for removing the hooves.

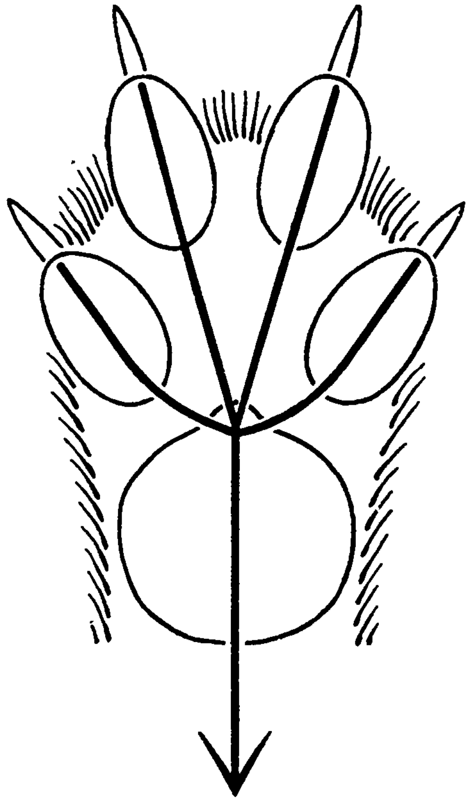


Fig. 37.
Line of cut for removing claws and pads.

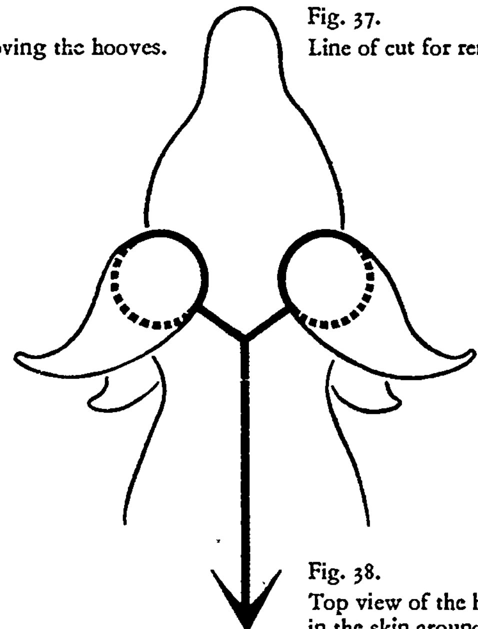
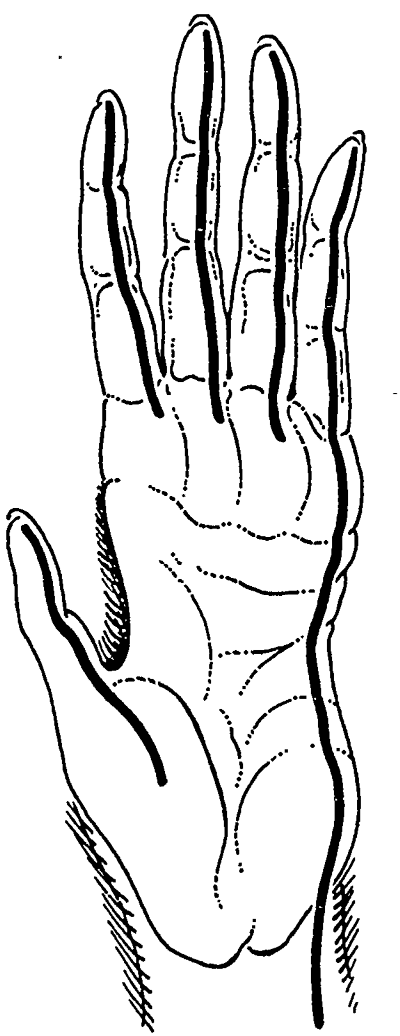


Fig. 38.
Top view of the head showing the incisions in the skin around the horns.

Fig. 39.
Line of cut on a monkey's hand for removing the skin from the skeleton of the hand.



length of this centre-line cut depends on the size of the horns over which the skin has to be pulled.

(b) *Skinning*. The skinning is begun in the region of the breast. The edges of the cut are lifted by hand and the connective tissue between the underside of the skin and the muscles is carefully cut through with a knife. In this way, one slowly works one's way forward towards the back and towards the outside of the extremities. This work requires some practice, as it is important not to tear any holes in the skin. In order to detach the skin from the hind legs and from the tail, where it connects up with the rectum and also, in females, with the genital orifice, it must be cut through as deeply as possible. Special care must be taken in detaching hooves, claws or nails from the foremost phalanges. *These horny formations are part of the skin and must remain attached to it.* The cutting lines are shown in Figs. 36, 37 and 39 for hooves, paws and for a monkey's hand. As on the body, the skin here is also detached, starting from the cuts, from all around the phalanges.

The most difficult thing, which is not easy to describe, is the preparation of the ears, eyelids and lips. In the case of the ears, the skin must be cut out as deeply as possible in the auditory canal. Then the external ear is turned inside out like a glove, by detaching its skin on the outside from the cartilaginous sustentacular tissue. The ear cartilage therefore remains attached to the underside of the skin of the external ear and is not, as might be expected, removed. Now the skin can be removed right down to the eyes. The fragile eyelids must be separated from the cranium as far down as possible in the orbits. Once this has been done, the cranium can be skinned right down to the lips. They should be detached from the skin of the mouth along the jaws and inside the visible edge of the lips where they fold under. Once the upper lip has been cut through, it is detached from the inside as far as the nasal cartilage, which is then cut through. Only then, i.e. when the skin has been completely detached from the cranium, is it carefully separated from the nose membrane.

To put it briefly, the dead beast is therefore skinned by working from the belly-side towards the back and from the tail towards the head.

(c) *Preservation of the skin in the field.* Scissors and a knife are used to remove any remaining flesh and adipose tissue from the skin. Blood stains should be cleaned with cold water. Then the skin is laid out on the ground with the hair side underneath, a mixture of two parts of common salt (NaCl) and one part of potash alum ($K\,Al\,SO_4$) is rubbed into the inner side and it is finally covered with a layer of this salt compound. This both draws water from it and preserves it sufficiently to prevent decomposition from setting in for some considerable time, even in a damp state. Time and circumstances permitting, it is recommended to lay the skins out over a makeshift wooden lattice frame so that the air can also get at the hair side. To protect it against insects, it should be treated on both sides with an insecticide. Skins should never be left to dry in the sun, as this destroys the fibres in the leather layer.

(d) *Measuring the skinned animal.* Accurate measurements are necessary for the subsequent reconstruction of the animal's body. It is laid on its side with its legs and head in as natural a position as possible, and two outline drawings of it are made, on which the measurements shown in Figs. 40, 41 are put in. In Fig. 40, these are straightline measurements. If by any chance a measurement is made over a curve, a special note of this should be made. The measurements given in Fig. 41 are circumference measurements of the neck, body and extremities, and also measurements taken horizontal to the symmetry plane, which are called diameters. These measurements should be sufficient to reconstruct an animal's body with the necessary accuracy. It should be noted, however, that they cannot record the finer details concerning the shape of the body. They are simply to help the preparator to determine the rough shape, as it were, of an animal and its proportions. The preparator, who has to prepare specimens, cannot get by without a good knowledge of anatomy. In addition, it is always advisable to note down or photograph any special features of the structure of the body.

If the complete skeleton of the animal is not going to be preserved, just the cranium and a foreleg or a hind leg should be prepared. The cranium serves later as the basis for modelling the head, of which a special drawing should be made showing its measurements (Fig. 42), and the foreleg or the hind leg serves to determine exactly the position of the articulations. These parts of the skeleton are separated from the body at the shoulder or at the pelvic joint and are freed from muscular fat as cleanly as possible. The cranium is severed from the first cervical vertebra and the brain is remooved through the foramen magnum. The bone material is rubbed thoroughly with salt, treated with an insecticide and powdered.

(e) *Marking the material.* So that items do not get mixed up, all the preserved parts of an animal—the skin, cranium and leg bones—must bear the same number. Metal tags, with the number engraved on them and which are tied on with wire, are the best solution. The corresponding measurement drawings must, of course, bear the same number and also state where and when the animal was killed. This requirement may seem very obvious, but unfortunately it is very often disregarded and cannot therefore be stressed enough.

(f) *Packing and carrying.* With the hair side inwards, the dreid skin should be folded in such a way that there are no sharp creases. On the other hand, the bundle of skin must be sufficiently compact for the parts of the skin lying on top of one another not to rub, otherwise this easily leads to chafing. The packing material and mode of transport used depend on the climate. Skins must above all be protected against damp. Strong plastic bags serve the purpose very well. If only for the sake of cleanliness, the bone material is also packed in the same way.

3. *Expedition equipment for hunting large mammals*

Equipment for this purpose should include a portable medicine chest, photographic equipment, field-glasses, drawing materials, coloured pencils, metal tags (numbered), a tape-measure, callipers, large and small knives, a steel, a small whetstone, scissors of different sizes, a hammer, nails, wire, pincers, tweezers, a saw, an axe, bush-knives, string and rope, strong plastic bags, thread, needles, soap, towels, common salt (NaCl), potash alum ($KAlSO_4$), and insecticide (DDT).

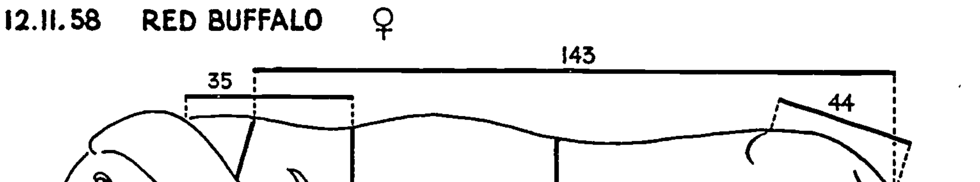


Fig. 40.
Measuring the skinned animal.
Length measurements.

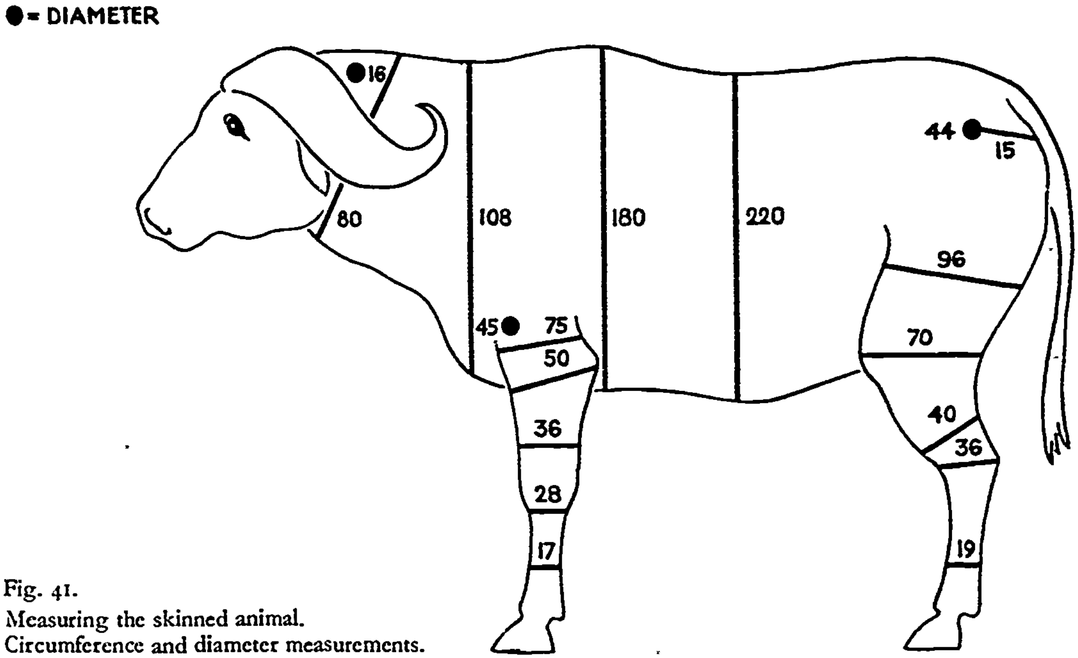


Fig. 41.
Measuring the skinned animal.
Circumference and diameter measurements.

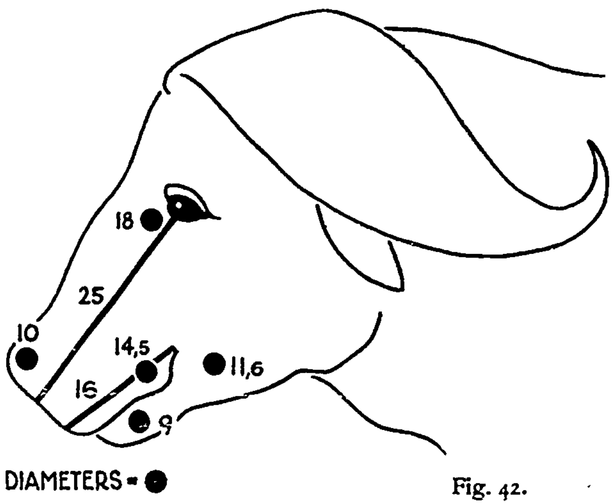


Fig. 42.
Measuring the head before skinning. Length and diameter measurements.

B. PREPARATION OF BIRDS AND SMALL MAMMALS

1. *Preliminary rema.ks about shooting and trapping*

While birds are generally killed with a shotgun, various small mammals are caught with traps. This is not the place to describe the various methods of catching specimens or the different types of traps used. The setting of traps requires specialized knowledge also of animals' habits. The responsible preparator will use only traps that cause the animal no suffering. He must therefore limit his choice to types that either kill the animal cleanly or catch it without causing any injury. If the animal is caught alive, it is the trapper's duty to kill it humanely. With the larger animals this can be done with a well-aimed shot using a suitable weapon. In the case of small mammals such as mice, a powerful—i.e. lethal—anaesthetic is recommended. The animal, with or without the trap, is put into a container which closes tightly and into which a wad of cotton wool impregnated with chloroform or sulphuric ether has been placed.

Small and tiny mammals, unlike the large ones, are not skinned, but stuffed like birds. It is now proposed to describe in detail how birds are stuffed and then to discuss briefly the difference between the stuffing of birds and the stuffing of mammals.

2. *The stuffing of birds*

The process consists of the following stages: (a) *slitting of the belly;* (b) *severing of the legs;* (c) *removal of the tail;* (d) *removal of the wings;* (e) *laying bare of the neck and cranium;* (f) *cleaning and poisoning of the skin;* (g) *stuffing and sewing up of the skin.*

(a) *Slitting of the belly (Plate 28).* The dead bird is laid on its back and the feathers on its breast and belly are parted so as to lay bare the skin. Then its skin is slit open with a sharp scalpel from the tip of the breast-bone right down to the anus and the skin is detached from the muscles sideways.

(b) *Severing of the legs (Plate 29).* When the skin has been detached sufficiently to show the thighs, they are pulled as far as possible out of the enveloping skin and the legs are severed at the knee-joints (N.B. not between shanks and feet). The muscular thighs therefore remain attached to the body.

(c) *Removal of the tail (Plate 30).* Now the skin is carefully detached right down to the base of the body, and the exposed caudal vertebral column, which carries the tail feathers, is severed as close as possible to the body.

(d) *Removal of the wings (Plate 31).* By detaching the skin on the breast, which is carefully eased back and not, as might be expected, slit open, the upper arms are now exposed and, like the thighs, are drawn out of their enveloping skin and severed from the body at the shoulder joint. Next, the muscles of the upper arm are removed. The muscle of the forearm and the hand must also be cut away. In the case of large birds, the skin on the underside of the wing between the radius and the ulna is slit open and the muscles are drawn out with a pair of tweezers. With small birds, it is enough to cut away the muscles of the forearm. With practice, they can be pulled out from the elbow joint. The skin of the wing should on no account be detached from the forearm, as the setting of the secondary feathers is otherwise destroyed.

(e) *Laying bare of the neck and cranium (Plate 32).* This operation requires a great deal of care and practice. The skin is loosened round the neck and the latter is pulled back rather like a finger being pulled out of a glove. When the head has been bared as far as the ears, the middle ear is pulled out of the cranium with the tweezers. Then the skin is turned back further inside out as far as the eyes and it is separated from the cranium as deep as possible in the orbits, without damaging the eyelids. Next the skin is detached as far as the root of the beak. The eyes, which are now exposed, are lifted out of their orbits and removed. Lastly, the muscles of the head are cut away, the cranium is severed from the neck, the tongue is cut out and the brain is drawn out through the foramen magnum. Thus, the body, together with the neck and thighs, has been removed from the skin and can be taken away. It will now be used for preparing a measurement drawing and, if necessary, for determining the bird's sex (see below, p. 171). Throughout the operation, the different parts of the body, as and when they are exposed, should be powdered with starch-flour. The object of this is to bind the blood, tissue fluid and fat, as these substances otherwise easily stain the feathers.

(f) *Cleaning and poisoning of the skin.* During the process of skinning, the skin is naturally turned inside out. Before the skin can be turned right side out again, it must be stripped of all muscle and fat, and the contents of the uropygial gland must be removed. Then it is given a thorough poisoning treatment with arsenic solution ($Na_3A_sO_3$). This poison must be handled with the utmost precaution. Nowadays an arsenic substitute is frequently used instead.

(g) *Stuffing and sewing up of the skin (Plates 33-35).* After it has been poisoned, the skin is turned right side out. To give it a little firmness, it is fitted with a wooden stick which, with the top part wrapped in cotton wool and inserted into the cranial cavity *(Plate 33)*, projects a few centimetres beyond the tip of the tail. Next the skin is packed loosely with cotton wool, or a similar stuffing material and then the belly incision is sewn up *(Plate 34)*. Lastly, the legs are tied to the wooden stick. Before the skin is placed in a paper bag to dry, with the wings carefully arranged in their resting position, the feathers must be meticulously smoothed out.

3. *General information*

It is always possible to turn carefully prepared bird skins into items that can be exhibited. This involves reproducing the shape of the bird's body. It is therefore advisable to make a drawing showing its most important measurements and, more especially, the length of the thighs and the position of the hip and shoulder-joints. Also to be noted are the diameters of the eye and iris, eye colouring, the colour of the beak and feet and, if necessary, of bare parts of the skin. If the skin is to be of any scientific use, there should, of course, be an indication of where and when the bird was killed and of its sex (see p. 170).

4. *Preparing skins of mammals*

The skins of small mammals are prepared basically in the same way as bird skins. The difference is simply that the skeleton of the front and rear extremities remains completely attached to the skin, and that the rear extremities are severed from the body not at the knee-joint, as in the case of birds, but at the hip-joint. To remove the muscles, the skin can be turned back as far as the carpus or the tarsus, and in the case of larger animals, if necessary, as far as the phalanges. Muscular fat should be removed as cleanly as possible and the bones of the extremities should be treated with arsenic solution or arsenic substitute before the skin is turned back again.

In the case of skins which are later to be fashioned into stuffed animals worthy of being exhibited, the cranium is left in, as in the case of birds. Here too, of course, the head muscles and brain must be carefully removed. If, however, skins are required for scientific purposes, the cranium, which together with its teeth is important for taxonomic investigations, should be removed completely. This is done in the same way as with the larger mammals. Once the cranium has been isolated, the cranium muscles, tongue and other soft parts are removed as cleanly as possible. The brain should be removed with a spatula or with a needle through the foramen magnum. If possible, it is desirable to leave the cranium, which has been cleaned, in water over night, in order to soak out any haemoglobin, which easily penetrates the bony tissue and is difficult to remove afterwards. Before the skull is packed away, it is dried and salted. of course given a tag which bears the same number as the skin to which it belongs. Craniums which have been treated thus are later soaked, degreased and bleached in the laboratory.

5. *Preservation of dead creatures when being brought in in large numbers*

It is not always possible to find time to skin the birds or small mammals which have been killed, either because too many are coming in at the same time or because field conditions do not enable the immediate preparatory work to be done. In such cases, the dead creatures must be kept fresh and at the same time protected against decomposition. The best course is to slit the abdominal cavity lengthways, remove the entrails and to line the cavity with cotton wool that has been impregnated with alcohol 70 per cent. An impregnated pad of cotton wool should also be stuffed into the mouth. Great care should be taken to see that skin or feathers do not get stained with blood. To prevent this, the edges of the opened abdominal wall must be sprinkled with a drying agent such as starch, potato-flour or powder. Then the skin or feathers are sprayed with DDT or another insecticide, and the dead creatures are placed in plastic bags of the right size. Here they are well protected against desiccation and, provided they are stored at as cool a temperature as possible, will keep from one to two days even in high summer temperatures.

6. *Equipment for the preparation of birds and small mammals*

Preparation equipment includes the following items: portable medicine chest, photographic equipment, nets and traps, drawing materials, coloured pencils, a tape-measure or ruler, tags, an injection syringe, a few brushes for poisoning and powdering, scalpels and knives, a steel, a small whetstone, dissecting scissors, round-nosed scissors, tweezers, assorted spatulas for skinning and for removing the brain, sewing silk and needles, twine, stuffing material (cotton wool, kapok, fine wood fibre, tow), wooden sticks of varying thickness and length, thin cardboard, pins, a small brush for drying washed skins with starch, packing material, chemicals: starch, arsenic solution, saturated or arsenic substitute; as a preservative, if necessary, formalin and alcohol 70 per cent.

The preparation of arsenic substitute: Chop up 50 g of white soap and dissolve in 500 g of hot water. After cooling, add 20 g of alum, 10 g of camphor and 5 g of potassium tartrate and mix the solution with kaolin until it is of a syrupy consistence and can be applied with a brush.

C. PRESERVATION OF FISH, AMPHIBIANS AND REPTILES

1. *Preliminary remarks about catching*

The catching of fish and amphibians presents no special difficulties and need not be described here. The catching of reptiles is more difficult; it is something that has to be learnt. Anyone who is inexperienced should not try dangerous experiments, especially with poisonous snakes, but let himself be guided by a snake-catcher who knows his job.

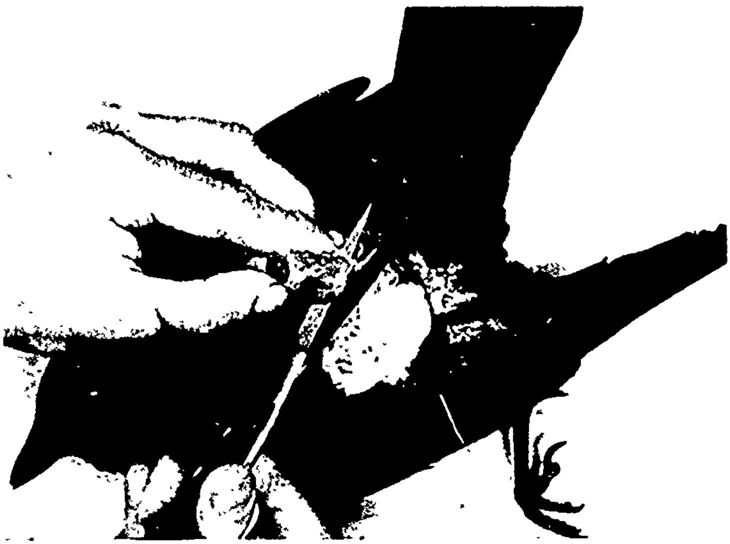


Plate 28.
Belly incision.

Plate 29.
Severing the legs at the knee-joint.

Plate 30.
Severing the tail.

Plate 31.
Severing the wing at the shoulder-joint.

Plate 32.

Exposing the head and cranium, removal of the eyes.

Plate 33.

A wooden stick wrapped in cotton wool is introduced into the skin.

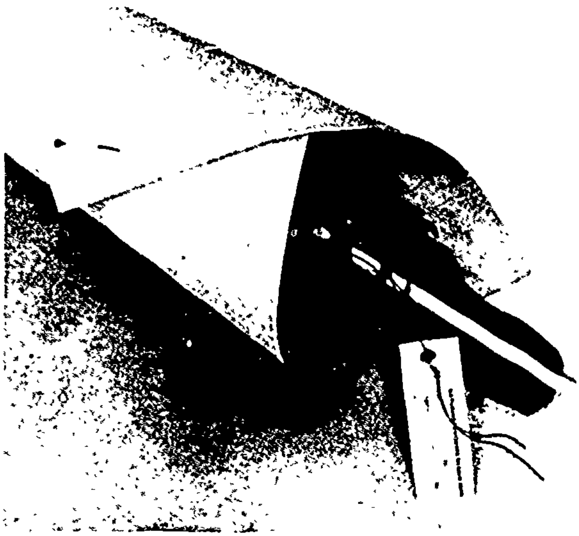


Plate 34.
The skin is stuffed with a fibrous material.

Plate 35.
The legs are tied to the wooden stick,
and the skin is wrapped in a paper bag.
A label is attached.

For killing fish, acetone chloroform (trichlorbutyl tertiary alcohol) is used. The fish is wrapped in a damp piece of gauze or other tissue and laid flat in a vessel filled with water, into which the killing agent is then poured.

Amphibians and reptiles are killed in a closed vessel, the bottom of which is lined with cotton wool or cellulose impregnated with chloroform and sulphuric ether in equal parts. The creatures very quickly cease to move but it takes some time before they die. They should be left for about an hour in the vessel in which they have been anaesthetized.

When travelling, it is simpler to take along nicotine in the form in which it is sold as a plant-protective agent. A few drops of this odourless poison squeezed in the mouth are sufficient to kill the animal. Very large reptiles such as crocodiles must, of course, be shot with a rifle. Nowadays, it is also possible to use an anaesthetizing gun for crocodiles and large snakes, after which they are killed by being injected with a suitable poison.

2. *Preserving whole animals*.

Fish, amphibians and reptiles are generally preserved whole in formalin, alcohol or chinosol.

Ethyl alcohol (Spirit of wine), which can be denatured, is the most common preservative, even though the object shrinks fairly appreciably. It is available commercially in a concentration of approximately 95 per cent and must be diluted. To keep shrinkage to a minimum, the animals should first be laid in a 40 per cent solution. For their final preservation they are then transferred into a 70-80 per cent solution. So that the tissues can fix quickly, a short incision should be made in the side of the belly. If it is desired to obtain fully intact animals, alcohol can be injected into the abdominal cavity.

Formalin is a good fixative and has the advantage of shrinking the tissues less than alcohol. It is not to be recommended for permanent preservation as it dissolves the calcium in the bones. For fixing, a 10 per cent hydrous solution, i.e. one part of commercial 40 per cent formalin to three parts of water, is used. Then, for permanent preservation, a 4 per cent solution is sufficient (one part of formalin to 9 parts of water).

The disadvantage of alcohol and formalin is that they have to be carried in liquid form and in sufficient quantity. As a preservative and also as a good disinfectant, it is therefore simpler to use *chinosol*. It can be obtained in tablet form and is used as a 15-20 per cent hydrous solution. Chinosol produces only slight shrinkage of the animals. It also preserves the natural colours much longer than alcohol or formalin.

3. *Preserving skins*

For practical reasons, generally only the skin of large reptiles is preserved. As a rule they are skinned in exactly the same way as large mammals (see p. 155). The inside of the skin is carefully stripped of fat and is rubbed with a preservative containing arsenic (see below). It can then be put to dry or preserved in alcohol. If there is no preservative handy, the skin can be salted and dried like the skin of a mammal. It is also possible to preserve and transport it temporarily in a concentrated solution of common salt (two parts) and alum (one part) or in a solution of dioxane.

4. *Equipment for the preservation of fish, amphibians and reptiles*

Items under this heading include: Fishing-tackle, fishing-nets for catching amphibians in water; silk thread or fishing-line for making snares to catch lizards; special tongs for catching snakes; acetone chloroform, sulphuric ether, nicotine; ethyl alcohol,

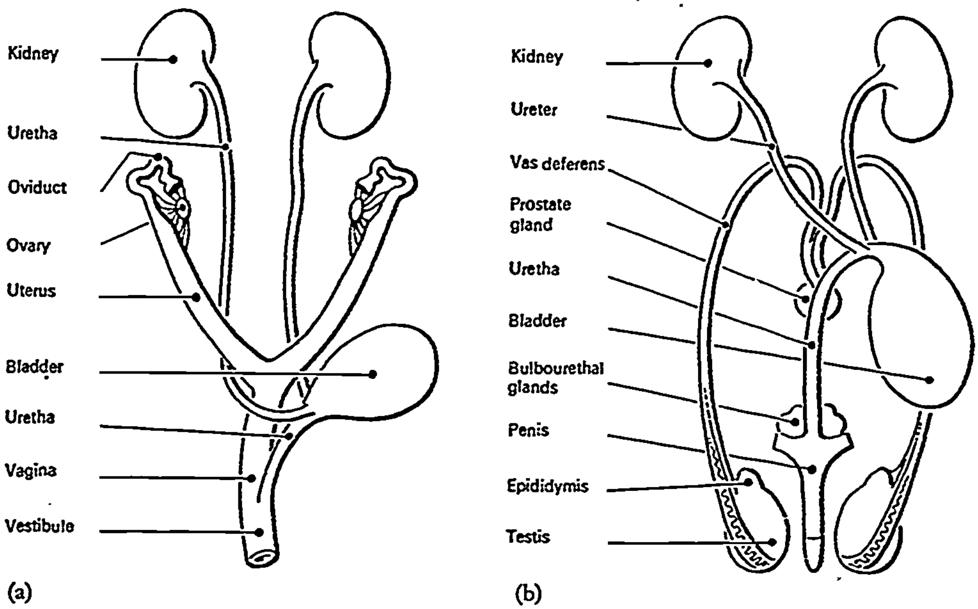


Fig. 43.
Sexual organs of mammal. The cat:
(a) female; (b) male.

formalin or chinosol; *Preservatives for reptiles' skins:* arsenic ($Na_3A_5O_3$) (100 g), water (475 g), washing soap (65 g), kaolin (560 g), spirit of camphor (45 g); tightly sealing metal or plastic vessels. Material that has been preserved in liquid does not necessarily have to be transported in liquid. If necessary, it can also be wrapped in damp cotton wool and placed in tightly-shut vessels or in plastic bags.

D. DOCUMENTING THE COLLECTED MATERIAL

In a museum collection, every animal must have a label indicating exactly where and when it was found and its sex. Depending on the object of the mission or the aim of the research to which the material is to contribute, further data should also be included, such as its fresh weight or special information concerning the circumstances in which it was found. The sex of all large mammals can be determined without difficulty from the external genital organs. Determining the sex of small mammals should also be possible with practice. In all birds, on the other hand, which show no external sexual diamorphism (i.e. no difference in colour, and so on), their sex must be determined by dissecting the internal sexual organs. Some practice is necessary here if the preparator in the field, who is often working in trying conditions, is to make a reliable diagnosis. If he is unsure or if he has not the time or the opportunity to do this, the skinned body should be preserved and provided with the same number as the skin to which it belongs. It will then be possible to determine the sex of the animal afterwards in the museum. A suitable

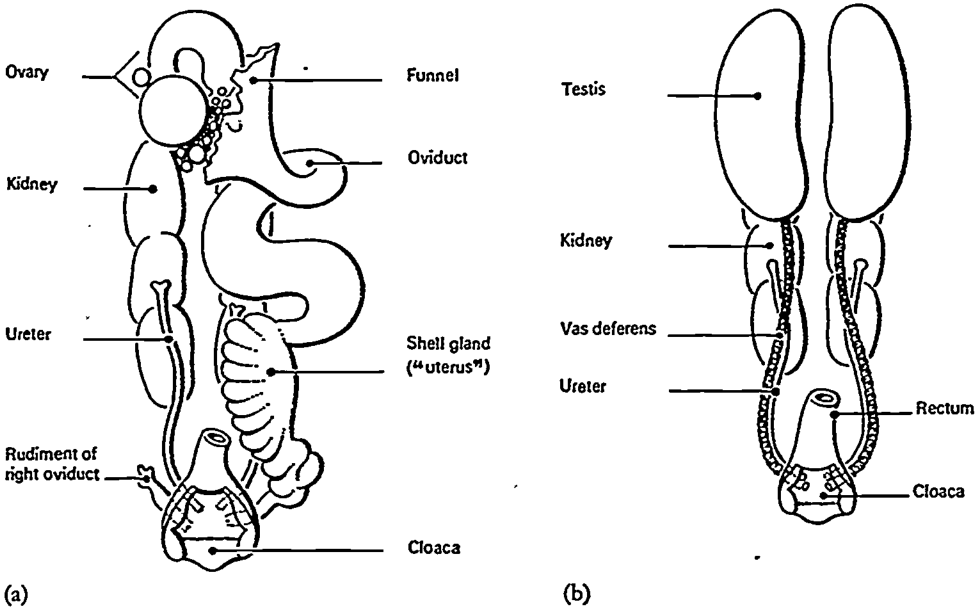


Fig. 44.
Sexual organs of a bird. The domestic fowl: (a) hen; (b) cock.

preservative is a 6 per cent to 10 per cent formalin solution or propyl alcohol 70 per cent. To enable the liquid to penetrate quickly to the internal sexual organs, a short incision should be made to open the abdominal cavity.

Determination of the sex by dissection is recommended in all vertebrates which the preparator does not know or cannot identify, since in such cases he cannot know whether there is an external sexual diamorphism or not.

Figs. 43, 44 should help preparators to learn how to distinguish between the male and female urogenital system of mammals and birds. To get at the system, the abdominal cavity of the dead animal should be opened with a median incision. As the kidneys and nearby ovaries lie on the dorsal side—in birds the testicles too—they can only be seen if the intestine is carefully pushed to one side. It is generally not necessary to remove the intestine from the abdominal cavity. If for some reason, however, it is necessary to take it out, it should only be severed in front at the thorax and carefully eased out of the abdominal cavity without severing the rectum.

In reptiles, things are exactly the same as in birds, with the difference that the females do not have just one ovary and one oviduct, but two. In amphibians, it should be noted that the testicles, too, lie in the region of the kidneys; the seminiferous tubules lead into the front part of the kidneys and the spermatozoa are therefore discharged into the ureter.

[A. 2499] 9.00 (stg.); 28 F