The Wellcome Museum of Medical Science, 1914-1964 : an account of its development, content and techniques / compiled and illustrated by members of the staff.

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THE WELLCOME MUSEUM OF MEDICAL SCIENCE

1914-1964

Edwin Clarke

21 November

1969

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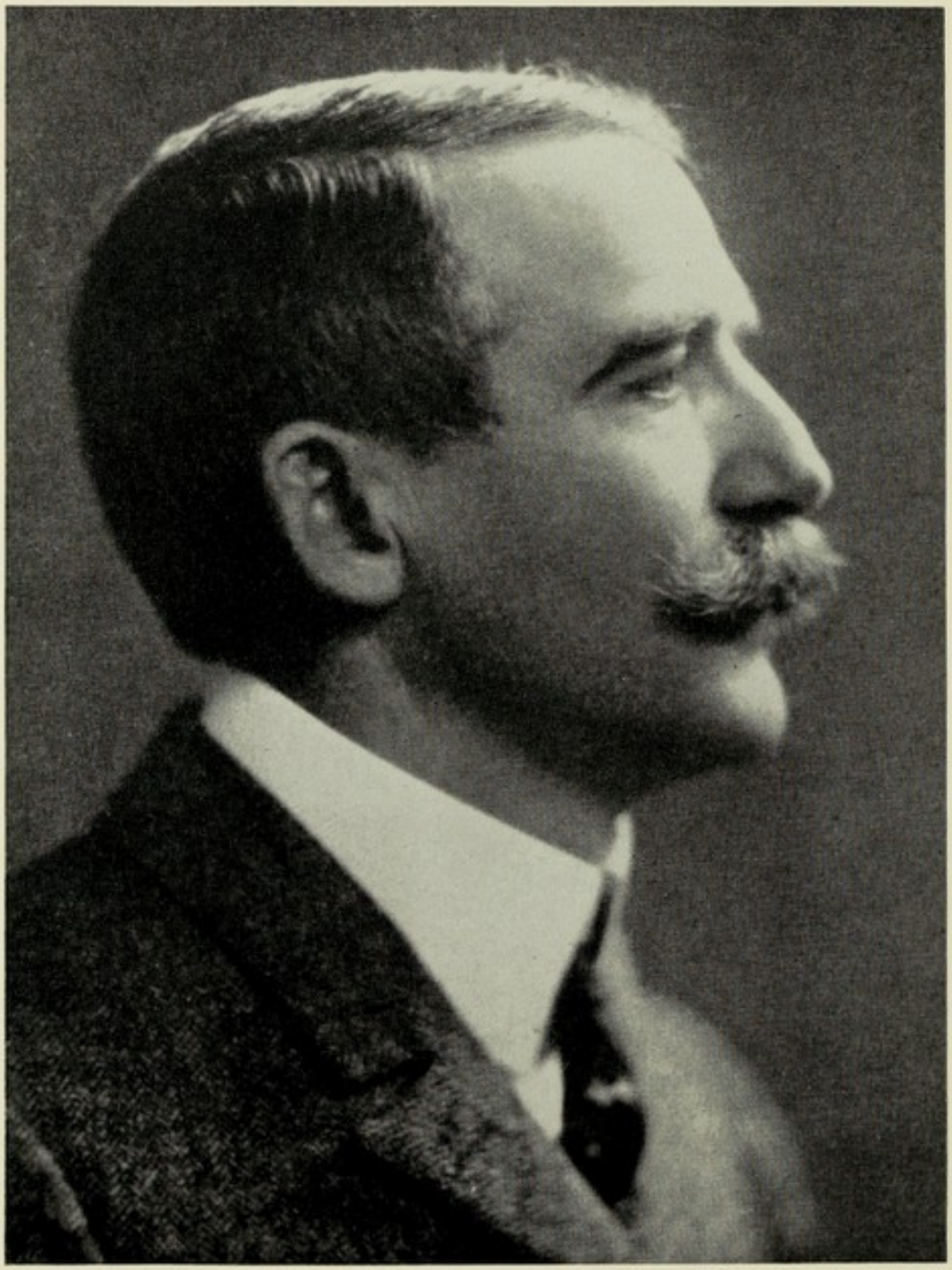

Sir Henry Wellcome at about the time he founded the Wellcome Museum of Medical Science

THE WELLCOME MUSEUM OF MEDICAL SCIENCE

1914-1964

An Account of its Development, Content and Techniques

Compiled and illustrated by
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1964

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PREFACE

This is not the first book on the Museum of Medical Science to be published by the Wellcome Foundation Ltd. But, issued as it is on the occasion of the Museum's Fiftieth Anniversary, this volume does more than describe its present content and activities; it includes an account of its development in the hands of successive Directors whose different ideals and skills have contributed to its present form.

Sir Henry Wellcome, as an industrialist with a background in pharmacy, brought many original ideas into operation in his Company. One of these was his insistence that commerce and production should go hand in hand with research, both fundamental and applied. He was also a keen archaeologist and private collector, and this pursuit took him upon excursions into the tropics. It is hardly surprising that a museum of tropical medicine was created, initially as a by-product of the early researches carried out in his laboratories both at home and overseas. Once it had been established, he was stimulated to expand it by the rapid growth of tropical medicine in the early years of this century and by his close personal acquaintance with great pioneers in that field.

Since Sir Henry Wellcome's death in 1936, The Wellcome Foundation Ltd. (Burroughs Wellcome & Co.) has continued to maintain, and where possible improve upon, the standard of teaching presented in the Museum, and also to encourage the publication of original work by its staff.

The Museum is now used by doctors, nurses, biologists and other workers concerned with almost every branch of medical science, from all over the world. The annual attendances have for several years numbered over ten thousand. The teaching methods and the choice of display are determined by the Director of the Museum, and the attitude adopted towards tropical medicine in regard to the exhibits is impartial and independent of any direct interest of the Company. In continuing to foster Sir Henry's ambition to guide and influence the practice of such an important aspect of medicine through a high standard of visual teaching, The Wellcome Foundation Ltd. is proud to support an activity which is of acknowledged importance to both academic learning and the welfare of tropical peoples.

MICHAEL W. PERRIN
Chairman
Wellcome Foundation Limited

Chapter 1

DEVELOPMENT

HISTORY

Throughout much of his life Sir Henry Wellcome took a keen interest in the social welfare and culture of tropical people, particularly in Africa. He was a personal friend of Stanley, the explorer, and in 1901 he travelled extensively in the Sudan, being one of the first civilians to visit that country after Kitchener's expedition. He noted the backwardness of communities in terms of sanitation and medical facilities, and the opportunities this gave for public service. In 1902 he established Research Laboratories under the direction of Sir Andrew Balfour in the newly-constructed Gordon Memorial College in Khartoum (Fig. 1). By 1912 this enterprise was fully developed with a staff of eleven medical scientists, and the whole undertaking was given to the Sudanese Government. This benefaction included a museum (Fig. 2) which Balfour had built up from material collected as a by-product of his team's manifold investigations.

In the following year Balfour returned to London to direct the Wellcome Bureau of Scientific Research which Sir Henry founded in June 1913 in temporary quarters at 54a Wigmore Street, London. On the basis of his Sudanese experience, Balfour (Fig. 3) proposed the establishment of a graphic Museum of Tropical Medicine and Hygiene. This suggestion was approved, and for the purposes of finance and administration the museum became part of the Bureau. Balfour had previously undertaken medical exhibitions at Dresden and Ghent, graphic displays which were directly in line with the traditions of the great medical teacher Sir Johnathan Hutchinson. These exhibits had dealt with selected tropical diseases, and after they were brought back to London, they formed a nucleus with which the Wellcome Museum of Tropical Medicine and Hygiene was set up in 1914 at 10 Henrietta Street (now Henrietta Place), to which address the Bureau had been moved (Fig. 4).

Within a few months the First World War broke out, yet notwithstanding the preoccupation of the staff of the Bureau with problems of military hygiene, a variety of material relating to tropical medicine was collected by Balfour and his staff during their travels overseas. The subject lent itself particularly to museum methods of demonstration, and the early collections

Fig. 1 The Gordon Memorial College, Khartoum in which Sir Henry established a research centre and museum

Fig. 2 Interior of museum in Gordon Memorial College

consisted largely of zoological material ranging from large mammals to insects of importance as reservoirs or vectors of communicable disease, Fig. 5. At the end of the War, in January 1919, the Museum was established in shop premises at 8 Vere Street, opposite the building which housed the Bureau, and Dr G. Buchanan, who had served in the laboratories at Khartoum, was appointed the first full-time Curator. The Museum became chiefly concerned

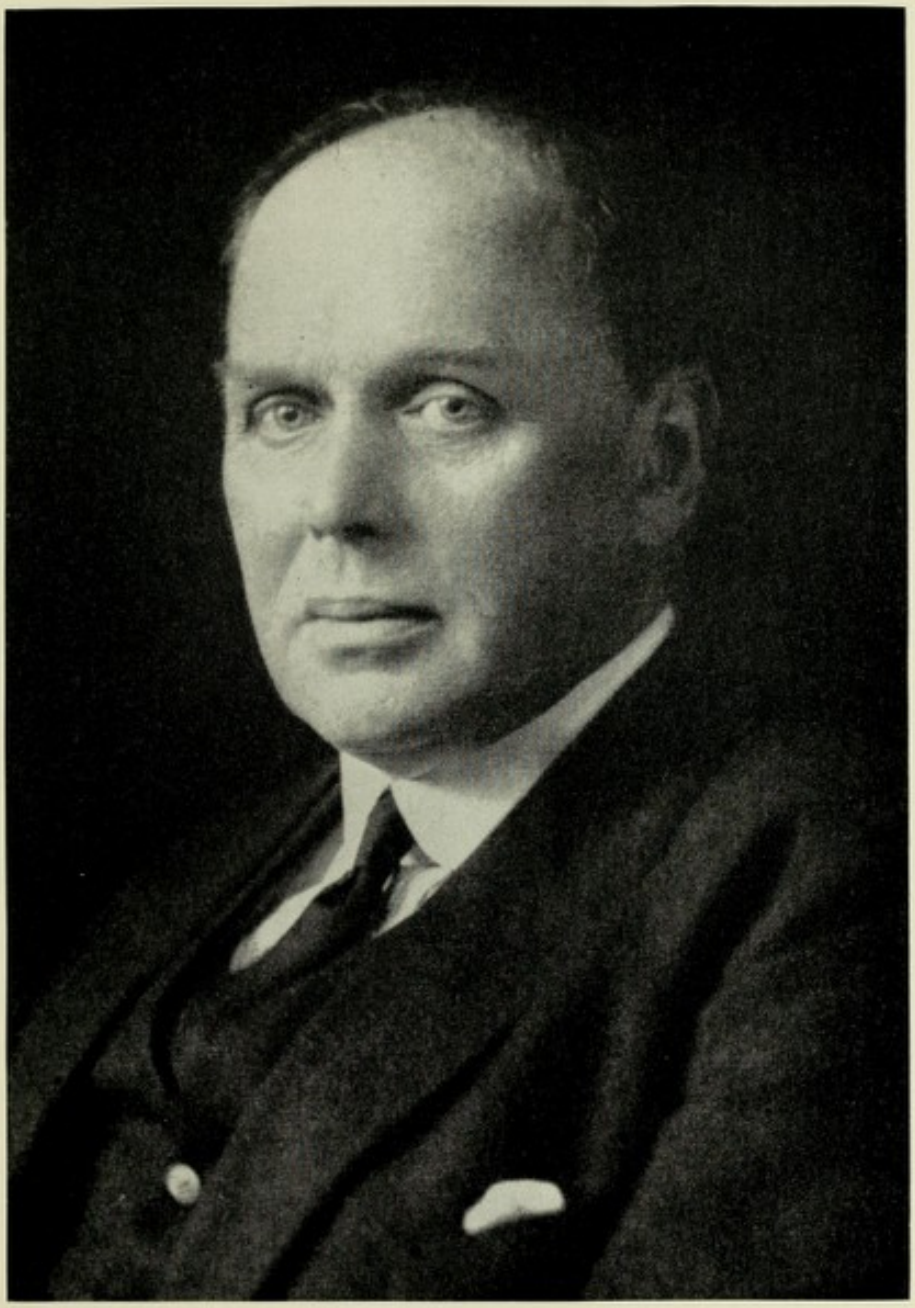

Fig. 3 Sir Andrew Balfour, at whose suggestion Sir Henry established the Museum in the Bureau of Scientific Research

with the prophylaxis of tropical diseases, with special reference to their cause, transmission and methods of prevention. The pictorial methods advocated by Balfour quickly proved their value in demonstrating the international importance of the subject.

In June 1919 Dr Buchanan was succeeded by Dr. S. H. Daukes (Fig. 11), whose organization of visual teaching at the Leeds School of Army Hygiene had much impressed Balfour when he had visited it on the advice of the War Office in the previous year. This school was for the training of British and American officers who were proceeding to tropical countries, and had

Fig. 4 10 Henrietta Street (now Henrietta Place), London, W.1

proved very successful. Daukes' outstanding talent for visual teaching was applied to great effect in the Museum for the next 27 years.

In 1920 the Museum moved, with the Bureau, to premises on the corner of Euston Road and Gordon Street, and an active period of expansion, rearrangement and labelling took place. In 1922 classes of students, consisting chiefly of missionaries and educationalists, were given formal demonstrations on tropical medicine and hygiene. The Museum grew rapidly, and sections were gradually added, such as those on blood and skin diseases, which were extensions of those dealing with tropical medicine in the strict sense (Fig. 6).

At this time the London School of Hygiene and Tropical Medicine was established nearby, with a museum of its own, and it became evident that the Wellcome Museum would have to develop on broader lines, embracing general medicine. Therefore an elaborate scheme was drawn up and submitted by Daukes to Sir Henry Wellcome in 1924. The plan was adopted and the Museum was renamed the Wellcome Museum of Medical Science.

Fig. 5 Interior of the Museum in Henrietta Street

In that year Sir Henry enlarged his premises in the Euston Road to include 28 Endsleigh Gardens, and in 1926 the Museum was transferred to that address, which later became Endsleigh Court, 33 Gordon Street (Fig. 7).

The Bureau and the Museum of Medical Science were formally reopened on December 8th 1926 when Sir Neville Chamberlain, then Minister of Health, presided over a large gathering of distinguished medical scientists. In his speech on that occasion Sir Walter Morley Fletcher said that 'the Museum, apart from its obvious functions and merits, is making a pioneer experiment that may point a way to wide developments in both teaching and medical education'.

They were spacious days in comparison with the dimensional limitations which changing circumstances have since imposed. Even then, Daukes later lamented that, 'only 20 small halls were available' for his displays (Fig. 8).

However, another change lay ahead. In 1932 the present building at 183 Euston Road (Fig. 9) was completed and Daukes was enabled to expand his museum throughout the ground floor in the way in which he had always wished (Fig. 10). His ambition was realized in 1938 with the completion of the last section, dealing with clinical biochemistry. Thus during the 1930's the Wellcome Museum of Medical Science became a centre not only for the postgraduate study of tropical diseases but for the undergraduate teaching

Fig. 6 Interior of the first Museum in the Euston Road, 1922

of medicine in general. It was visited by hundreds of students from the great London medical schools, and their teachers held demonstrations and tutorial classes in the Museum.

The Second World War forced the Museum to close in September 1939, and it was dismantled during the bombing of London in May 1941. It was not reopened until the 1st of January 1946 when Dr C. J. Hackett, who joined the staff under Daukes in 1945, became Director upon the latter's retirement. At this time, severe restrictions of space were imposed upon academic enterprises in the overcrowded war-damaged capital. Moreover, the museum at the London School of Tropical Medicine had been destroyed. Thus, once again, the Museum became reduced in size, and specialized in the teaching of tropical medicine. Although this step was therefore dictated by circumstance, it was in the Wellcome tradition and dovetailed with the development of the Wellcome Laboratories of Tropical Medicine, which were established at this time as the successors to the former Bureau of Scientific Research. Fortunately, too, Hackett (Fig. 12) was a recognized specialist in tropical medicine and his skill, not only in the arts of visual education, but also as a lecturer, soon attracted advanced students from the London School of Tropical Medicine and the Tropical Diseases Hospital. The eight years of his directorship saw many improvements in display techniques which blended with, and enhanced, the basic principles of museum teaching that his predecessor had laid down.

Fig. 7 Endsleigh Court

Dr Hackett was succeeded by Dr R. Y. Dunlop (Fig. 13), who redesigned the present South Gallery in 1955, and from 1956 to 1964 the Museum was directed by Colonel C. A. Bozman. The concept of tropical diseases was changing and being enriched by discoveries in genetics, bacteriology, endocrine diseases and cancer, which underlined Daukes' foresight in introducing general medical subjects into the Museum. Notwithstanding the limited size of the Museum in the late 1950's, much was done to meet the changing emphasis on these subjects and to teach, not tropical medicine, but the practice of medicine in the tropics. Within a few years of Bozman's directorship the attendances had risen to the unprecedented level of over 10,000 a year.

Every curator finds for himself an aspect of museum discipline to which his talents are specially attuned. Daukes made a major breakthrough in display techniques and Hackett in the application of conservation methods. In 1956 special emphasis was placed by Bozman (Fig. 14) upon the need to catalogue and adequately document the Museum collections which were the heritage of nearly 45 years' curatorship, and much of which had lain untouched since the Museum was dismantled in 1941. Into this system were integrated new acquisitions and illustrative material acquired through the

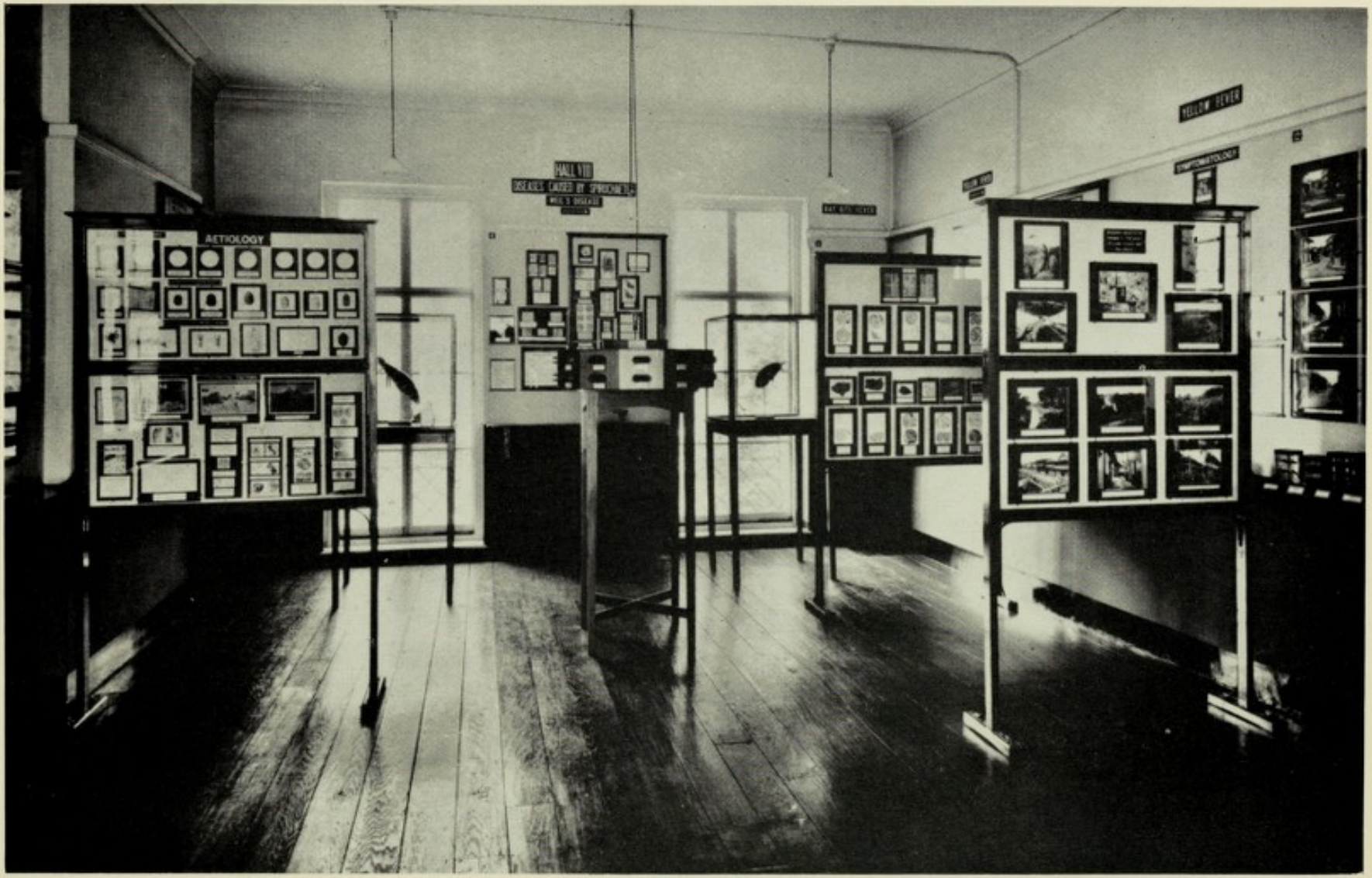

Fig. 8 Interior of the Museum after expansion in Endsleigh Court

Fig. 9 The Wellcome Building, Euston Road, the present situation of the Museum

development of colour photography and photomicrography. At the same time, the workshops were modernized and the photographic unit was equipped with the latest instruments, enabling important new techniques including colour photography and macrophotography, to be pursued.

EVOLUTION OF TEACHING METHODS

During the nineteenth century John Hunter's original conception of a medical museum as an instrument of research and a platform for personal teaching became seriously obscured. The collections of his later disciples reflected in a medical way the indiscriminate kleptomania so characteristic of nineteenth century curatorial practice, and unmerited emphasis was placed upon bizarre and rare specimens. Furthermore, natural history in its broad sense became separated from the study of man in health and disease. The anthropocentric nature of medical science generally prevailed. In the teaching hospitals the collections were displayed on an anatomical basis thus partitioning the total effects of a single disease and confronting students with monotonous vistas of post-mortem material. In the Wellcome Museum of Medical Science Daukes invoked wider principles than those which depended

Fig. 10 Interior of the Museum, in 1935

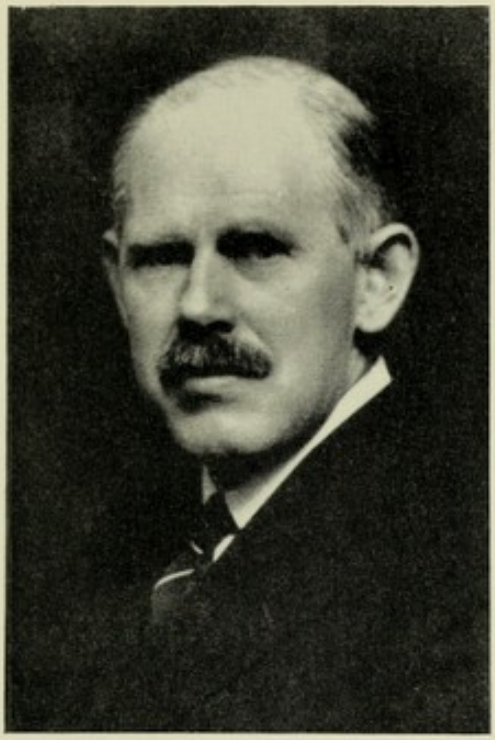

Fig. 11 *Dr S. H. Daukes*, O.B.E., *Director, 1919–1945*

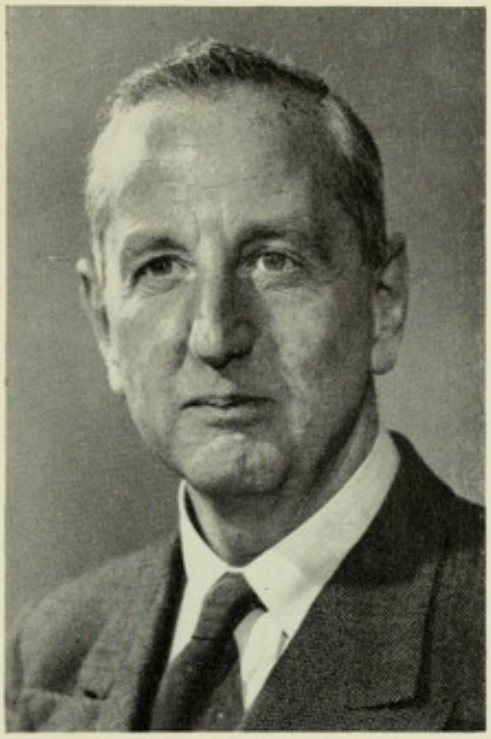

Fig. 12 *Dr C. J. Hackett*, *Director, 1946–1954*

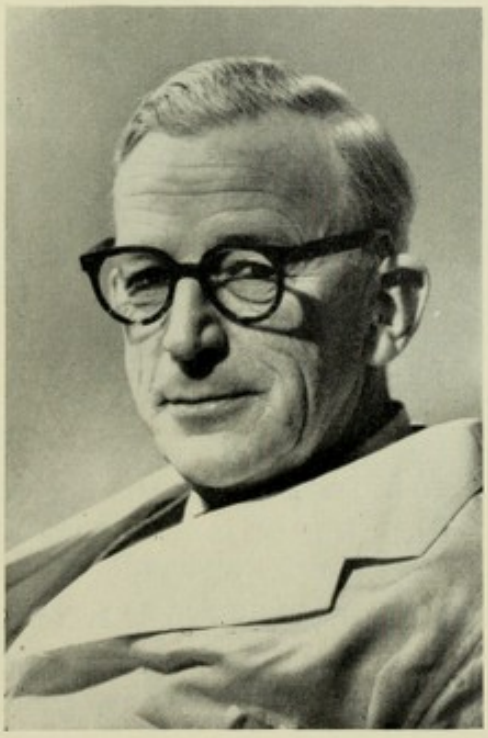

Fig. 13 *Dr R. Y. Dunlop*, *Director, 1955*

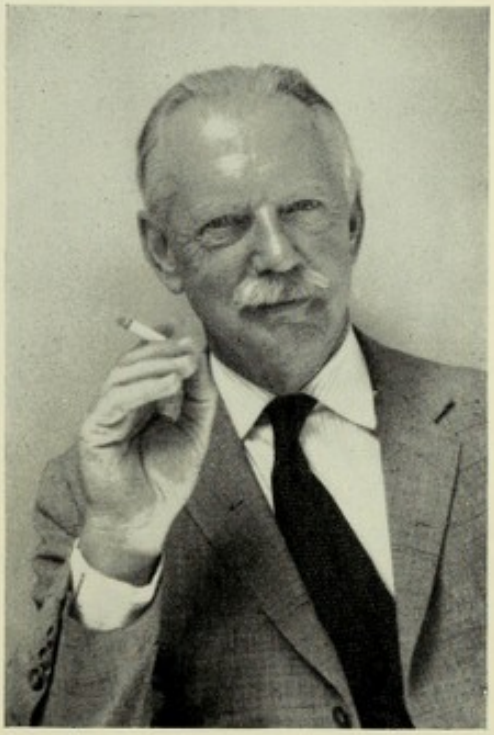

Fig. 14 *Col. C. A. Bozman*, O.B.E., *Director, 1956–1964*

Fig. 15 Distribution of material on screens before eye-level displays were introduced

only upon morbid anatomy. He had no shortage of exhibits with which to illustrate the causation, transmission and prevention of disease as well as its underlying pathological processes.

At the same time new visual teaching methods were attempted. The lack of any display tradition in medical museums from which to advance was well illustrated by some of the early mistakes made during this time. Small typewritten labels and legends were mounted so high that they could be read only by standing on ladders provided for the purpose (Fig. 15) while

Fig. 16 Pathological specimens ranged on the Museum floor, about 1936

below, students groped in semi-darkness with a specially designed torch to enable them to find and examine pathological specimens stacked on the floor (Fig. 16).

As time went on, these shortcomings were made good. The Museum gallery was broken up by screens into bays, in which the teaching material was limited to a single subject or group of subjects. The bays were furnished to provide a series of study units in each of which one or two students could work.

Finally, a synoptic method of display was evolved in which each disease was approached by logical steps, beginning with a general introduction and a consideration of its cause, and concluding with a presentation of methods of prevention and control. The introduction of a colour scheme whereby each division of the synopsis carried its own special colour was an important advance, making for easier reference and giving the whole Museum an atmosphere of interest and alertness. The subject matter was classified in the Museum, not upon a basis of clinical syndromes or organs, but upon aetiology, thus avoiding the separation of different material from the same patient, and permitting each case to be presented in its entirety. Clinical photographs were introduced into the displays, and clinical teaching became so well

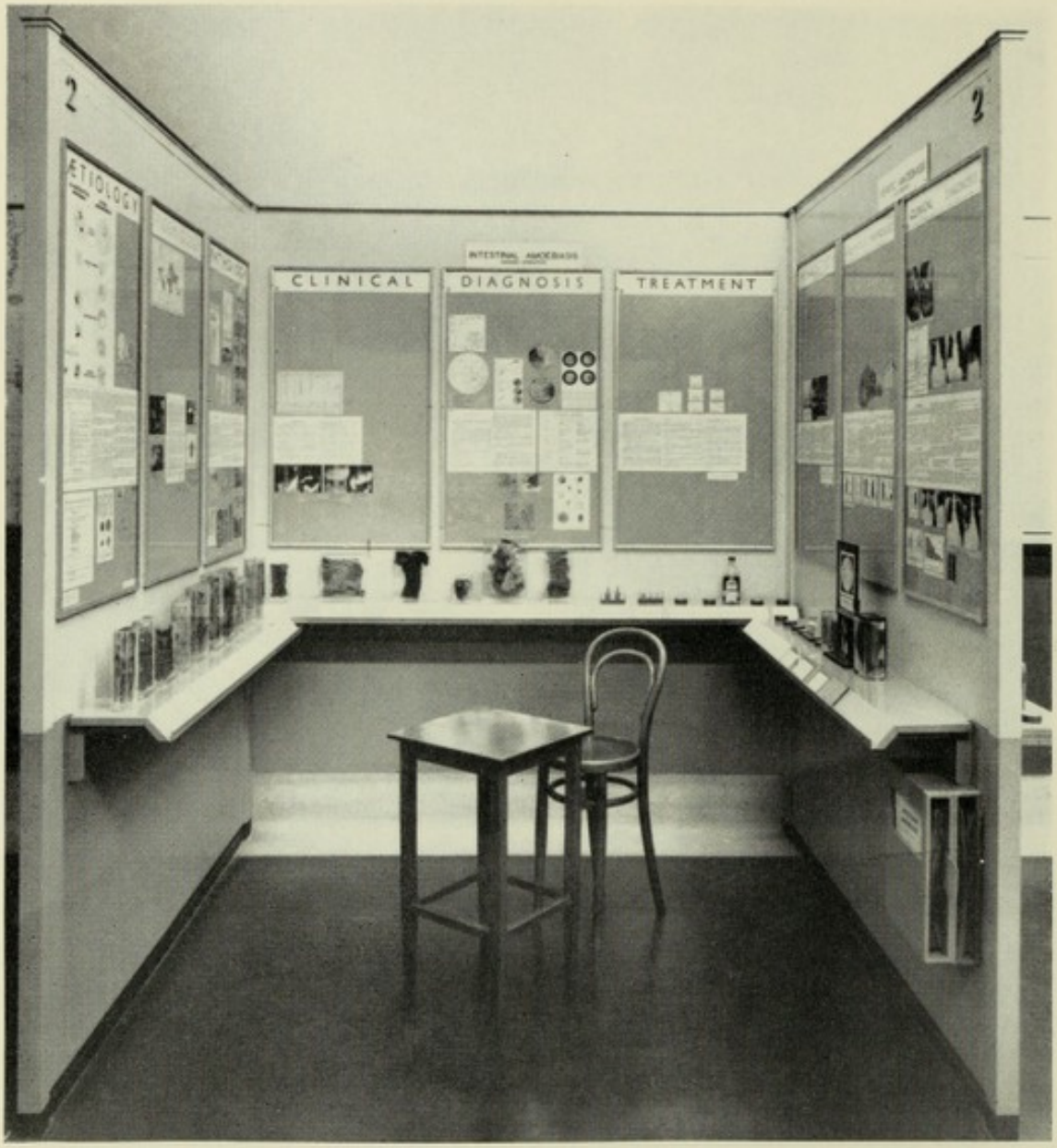

Fig. 17 A Museum bay in 1947, showing the beginnings of the modern arrangement

developed that at one time patients were demonstrated to students in the Museum (Fig. 17).

Further attention was given to the application of display techniques, especially with regard to adjusting visual levels; for many years no material has been displayed in the Museum at a height of less than 36 inches. The flexibility of Daukes' synoptic approach soon became apparent and different medical subjects could be allotted space ranging from one panel to several bays, according to their topical importance. The Museum reflects the modern application of John Hunter's principle that a medical museum should contain not only dead human material but should concern itself with man's relationship to other forms of life within a single biological environment (Fig. 18).

Fig. 18 A modern study unit, 1964

EXTERNAL ACTIVITIES

It has become traditional for the Museum to assist with medical exhibitions and teaching demonstrations in different parts of the world, modifying its display techniques to suit various types of audience. The first important contribution along these lines was Daukes' participation in the Wembley Exhibition of 1924, where he installed a section on tropical diseases in the Government Pavilion. The Museum contributed many of the exhibits, and in the following year Daukes, who was Organizing Secretary, supervised the hygiene demonstration in the Government Pavilion, in which all departments of the Ministry of Health participated. A large part of this exhibit was subsequently displayed at the Dunedin Exhibition and further assistance was given to the New Zealand Government. These exhibitions greatly enhanced the reputation of the Museum as a leading visual education centre and merited the award of the O.B.E. to its Director.

In 1930, at the request of the Board of Trade, Daukes organized the tropical health exhibit in the British Pavilion at the Maritime and Colonial Exhibition in Antwerp. The material and specimens were supplied mainly by The Wellcome Museum of Medical Science and the Liverpool School

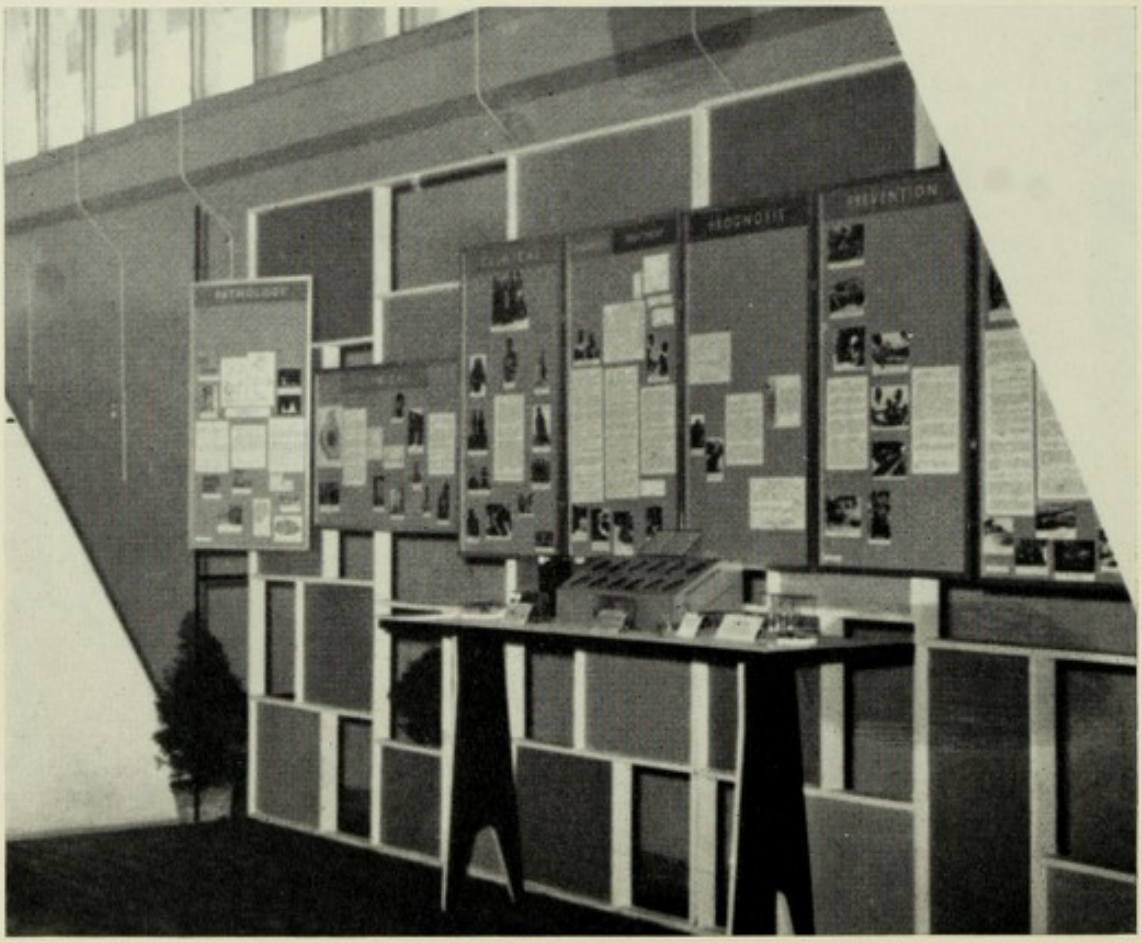

Fig. 19 Exhibition on Chagas' disease shown at Lisbon, 1958

Fig. 20 A panel of a display on public health shown in Birmingham University, 1961

of Tropical Medicine. So successful was this exhibit that it was subsequently transferred to Buenos Aires and then to the Dresden Exhibition.

The British Health Section of the Paris Colonial Exhibition in 1931 was organized by Daukes at Government request. For this section, which included most of the important diseases which afflict Commonwealth peoples, the exhibits were provided entirely from the resources of the Museum.

In 1934 six notable exhibits on different tropical diseases were prepared and shown at the Chicago Exposition. These included elaborate statistical devices and specially constructed models of insect vectors relating to malaria, sleeping sickness and plague. One more exhibition was planned before the Second World War, and was erected in Paris in 1937.

A large display on Chagas' disease was exhibited at the Sixth International Congresses of Tropical Medicine and Malaria at Lisbon in 1958 (Fig. 19)

and the panels were subsequently presented to the University of São Paulo, Brazil. Exhibitions on bilharziasis and amoebiasis were demonstrated at Johannesburg during medical conventions in 1959 and 1963 respectively. Epidemiological exhibits were shown under the title of Man and his Environment in Baghdad and Birmingham in 1960 (Fig. 20).

Material has been provided for numerous provincial health exhibitions in Great Britain, ranging from smallpox to diabetes, and assistance has been given in setting up medical museums in several British universities since the end of the Second World War.

Because of its synoptic presentation of medical subjects, the Museum has become known as a useful instrument for the teaching of applied biology, and is used by a variety of educationalists whose interests lie outside clinical medicine and human pathology. Among them are teachers of science at University Entrance level, many of whom bring students for tutorial sessions. At the request of the British Association for the Advancement of Science, travelling exhibitions for schools, on malaria (Fig. 21) and the helminthiases, have been compiled and circulated. Biological illustrations have also been supplied for the textbooks of the Nuffield Science Teaching Project.

In 1963 the Conference of Directors of Tropical Medicine Institutions in Europe decided to set up an international agency to facilitate the exchange

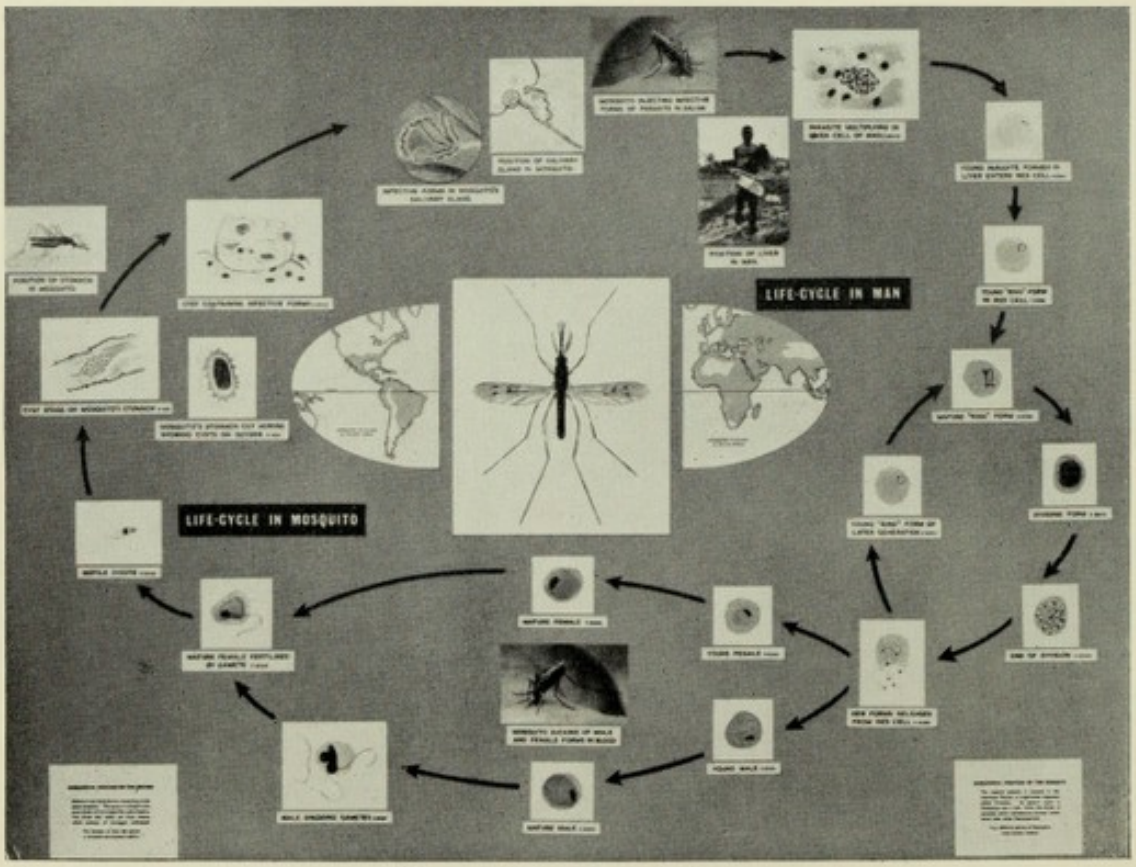

Fig. 21 A panel from a travelling exhibition on malaria prepared for the senior classes of secondary schools in England, 1961

of material between their teaching centres. In the following year this agency was established in the Museum, to provide an information and distribution service for the chief European schools of tropical medicine.

RESEARCH AND PUBLICATIONS

The flexibility of a museum as an instrument of research, both for minute enquiry and for large-scale review, is often overlooked, yet some leading curators believe that research, and not display, should be the primary function of a museum.

The staff of the Wellcome Museum of Medical Science has always been fortunate in having natural ties with research workers in the Wellcome Bureau and, later, in the Wellcome Laboratories of Tropical Medicine. There has thus been no lack of example and stimulation in the field of original enquiry.

In the sphere of curatorship, the evolution of Daukes' display methods was a notable advance based on careful observation and numerous experiments in visual teaching. Hackett and Norman were among the first to exploit the many uses of Perspex in museums, and other papers have been published by the staff, from time to time, pertaining to basic museum disciplines. In one of these, Hackett undertook a comprehensive survey of medical museums in Britain, not only furnishing an important collection of data, but promoting the revival of museum teaching in medical education after the Second World War.

The staff has also published work of a purely medical character relating to public health and tropical medicine, particularly with reference to yaws and trypanosomiasis. During the visits to tropical countries which such investigations entailed, and these have included India, Indonesia, Malaya, Brazil, and most of central Africa in recent times, much valuable teaching material has been collected.

The *Journal of Tropical Medicine and Hygiene* has been edited by a member of the staff since 1958. This activity ensures the constant appraisal of modern trends in subjects with which the Museum itself is vitally concerned.

Fig. 22 Entrance to the Wellcome Museum of Medical Science, 1964

Chapter 2

THE MUSEUM

Although the Museum is chiefly concerned with the teaching of tropical medicine, it is now accepted that the subject must widen in scope until it incorporates knowledge which is both fundamental and cosmopolitan. Many diseases that are displayed are, strictly speaking, communicable, but more recent additions include sections on nutrition, cancer, hereditary abnormalities and endocrine disorders, which indicate the expanding conception of medical practice in hot countries.

The two galleries which contain the exhibits are intersected by screens which not only considerably increase the available display surface, but form bays arranged as complete units in which students may work in surroundings conducive to study and reasonably free from distraction (Fig. 23). Most information is presented in concisely written summaries placed on vertical panels which are attached to the screens and walls. These summaries are, in most cases, prepared in consultation with specialists and are illustrated by photographs, charts, maps and diagrams, so that each panel resembles the page of a lavishly illustrated textbook. This information is kept up to date, between revisions, by extracts from medical publications, placed in a folder. Each unit therefore contains a clear and balanced account of modern knowledge relating to one specific condition or a single group of closely related subjects (Fig. 24).

Each subject is considered under nine main headings in logical sequence, ranging from a general introduction through aetiology, epidemiology, pathology, clinical aspects, diagnosis, treatment, and prognosis, concluding with an account of prevention and control. The main sections of the Museum comprise protozoal diseases, bacterial infections, helminthological disorders, diseases due to viruses, rickettsiae, fungi and spirochaetes and sections on nutrition and cancer. Limitations of space are such that the displays on heart disease, endocrine disorders and genetic abnormalities are at present very restricted and simply indicate the importance of these subjects to students of tropical medicine. Although the panels contain more than 5,000 illustrations of different kinds, these represent less than one-third of those kept in the Museum collections.

PROTOZOAL DISEASES

Diseases due to protozoa include malaria, amoebiasis, leishmaniasis and trypanosomiasis and are thus of particular importance to workers in the tropics and sub-tropics. African trypanosomiasis, or sleeping sickness, is the only major human disease entirely confined to the tropics because its vector, *Glossina*, is restricted to tropical Africa. Recently South American trypanosomiasis, known as Chagas' disease, has attracted considerable notice, as it is believed to affect the health and economic welfare of several millions in South and Central America.

The protozoology section consists of 72 panels and 38 swinging screens. It begins with an account of pathogenic and non-pathogenic protozoa inhabiting the intestinal tract, and is followed by descriptions of protozoal parasites of other organs and finally, of the haemoflagellates and *Plasmodia*.

Two panels are devoted to an introduction to protozoa, in which the structure and ecology of these unicellular organisms are described, followed by short accounts of the amoebae, flagellates, coccidia and ciliates that are found in the intestine. The most important intestinal protozoon of man, *Entamoeba histolytica*, is then considered. The illustrations include copies

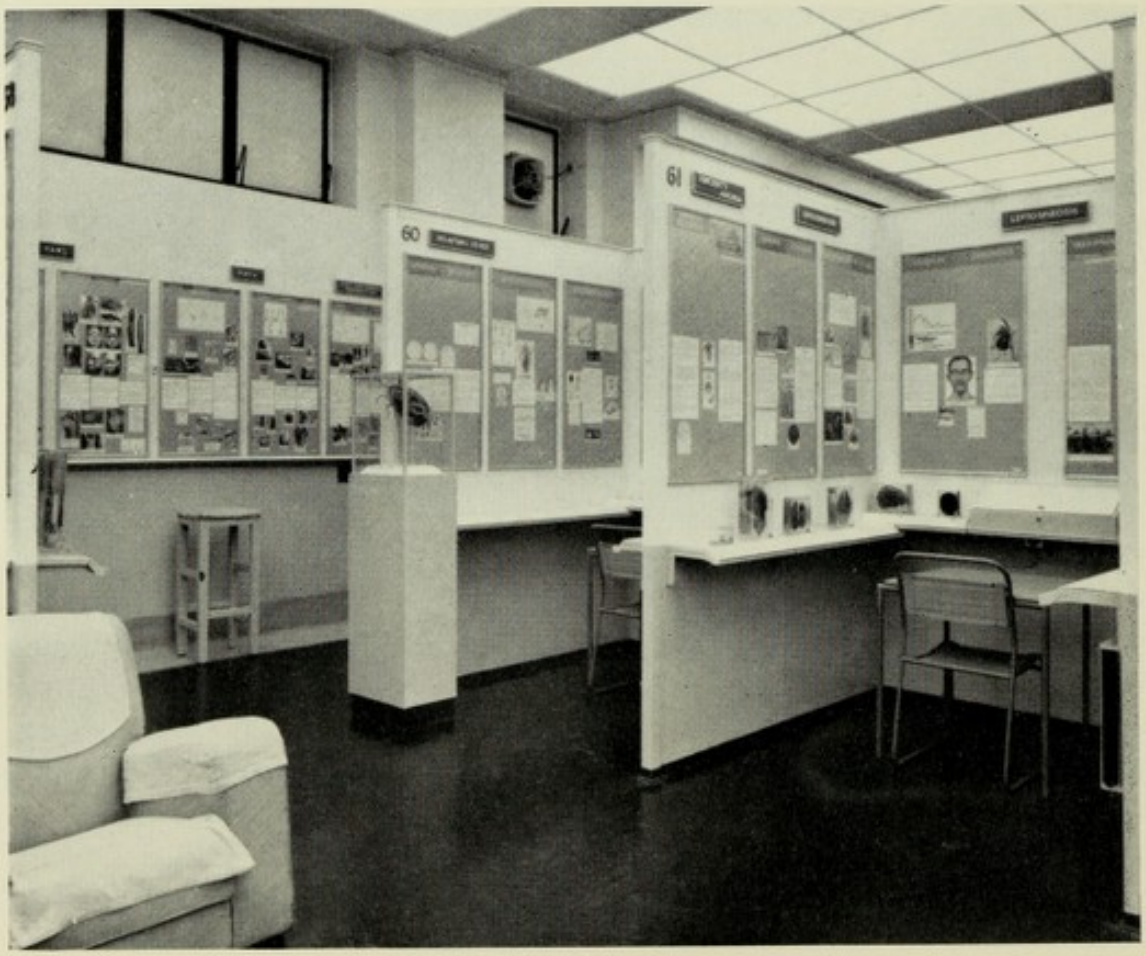

Fig. 23 The bays which comprise the spirochaetal section of the Museum

Fig. 24 Part of a modern bay showing panels, viewing box and pathological specimens

of classical taxonomic figures drawn by Dobell, the originals of which are held in the Museum collection. Diagrams and charts are taken from recent publications of Hoare who collaborated and advised on the aetiological aspects of the display. Other illustrations in the collection include a classic sequence of the life history of *E. histolytica* in the bowel, and many original illustrations of Jobling and Schwarz-Lenoir. Of particular interest is a drawing by Manson-Bahr showing the early histology of amoebic liver abscess from one of the specimens on display, and fully described in an early, classic publication. The photomicrographs include preparations stained by Kohn with chlorazole technique revealing particularly vivid contrasts between the cell structure of *E. histolytica* and ingested red blood cells. Pathological specimens provide a complete range from early to late intestinal lesions and depict all the classical pathological features of amoebic dysentery, ranging from collar-stud abscesses to Dyak-hair sloughs. A block dissection of liver and lung shows the anatomical configuration of ruptured liver abscess and is explained by an annotated diagram (Fig. 25).

Photomicrographs in this section show different stages of *E. histolytica* as

seen in stained and unstained specimens from patients and laboratory animals. There is a display of drugs in common use for the treatment of amoebiasis and the roles of man and house flies in the dissemination of this condition are emphasized in coloured original drawings.

Descriptions of balantidiasis, giardiasis, coccidiosis and trichomoniasis

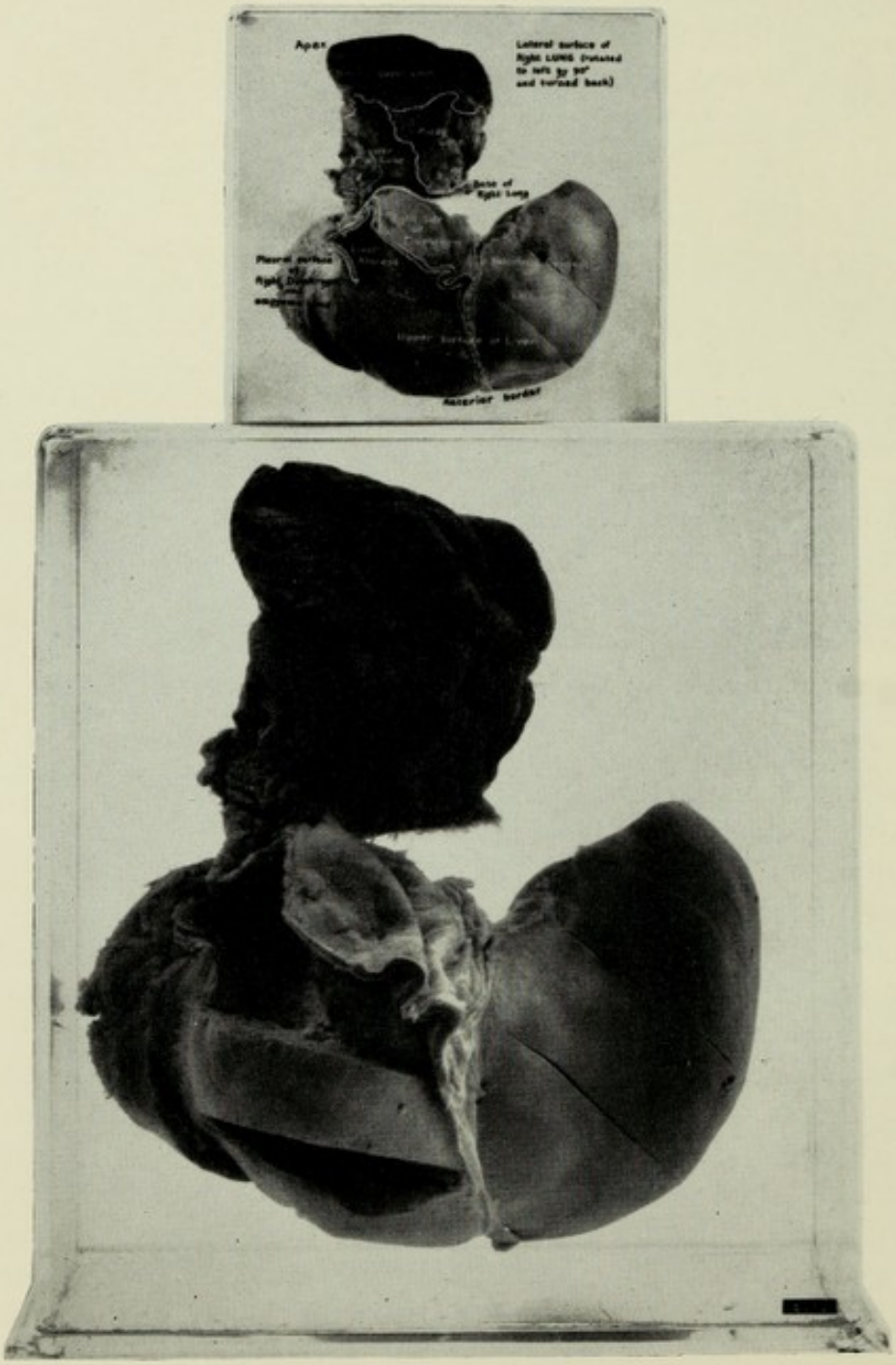

Fig. 25 An amoebic liver abscess, with rupture into the lung, mounted below explanatory diagram

follow, and the causal protozoa are illustrated by original drawings. At this point an aid to diagnosis is introduced by a panel devoted to various non-pathogenic protozoa such as *Entamoeba coli*, *Iodamoeba butschlii* and others, including flagellate organisms. A diagrammatic key indicates their main characteristics and each is illustrated by original drawings. Examples of these non-pathogens are shown in photomicrographs.

This part of the section is completed by displays on conditions produced by three organisms which are classified with the protozoa, though a final decision on their taxonomic position has yet to be reached; these are *Pneumocystis carinii*, *Sarcocystis lindemanni* and *Toxoplasma gondii*. A viewing box shows a transilluminated section of lung from a case of *Pneumocystis* infection and photomicrographs of these parasites can also be seen.

The subject of leishmaniasis is introduced by panels which describe the developmental stages of *Leishmania* and the species of *Phlebotomus* concerned in their transmission. The vectors are dealt with in further detail on swinging screens, the description being supported by Whittingham's paintings of the developmental stages of the sandfly. At the entrance to the bay stands a scale model of *Phlebotomus* magnified 40 times.

The visceral type of leishmaniasis, kala-azar, is displayed on four panels; a plaster model of an Indian suffering from kala-azar emphasizes the appearance of those who suffer from this chronic wasting disease. The cutaneous variety, oriental sore, and the types of South American leishmaniasis are then discussed. The pathological specimens show the morbid visceral changes and the effects produced in experimental mice by inoculation of the organisms. Photomicrographs demonstrate *Leishmania* at different stages of their development, and Leishman-Donovan bodies in spleen and liver smears from cases of kala-azar, and in skin sections from Oriental Sores. The various preparations of antimony used to combat this infection are shown.

At the entrance to the display on trypanosomiasis there is a model of the tsetse fly, *Glossina palpalis*, magnified 28 times.

The display is introduced by panels which describe the morphology and the group characteristics of the mammalian trypanosomes. A short table compares the sites of development in *Glossina* of different species of trypanosomes, and a large panel shows in detail the host-parasite relationships and the distribution of the important mammalian trypanosomes. A battery of swinging screens in the bay contains accounts of the complicated problems of the chemotherapy of trypanosomiasis and the ecology of *Glossina*, completed by two fine Terzi originals.

The description of African sleeping sickness is supported by pathological specimens and photomicrographs showing species of trypanosomes and the characteristic lesions in the brain. Boxes containing specimens of different species of *Glossina* are placed so that the flies can be viewed under a magnifying glass (Fig. 26).

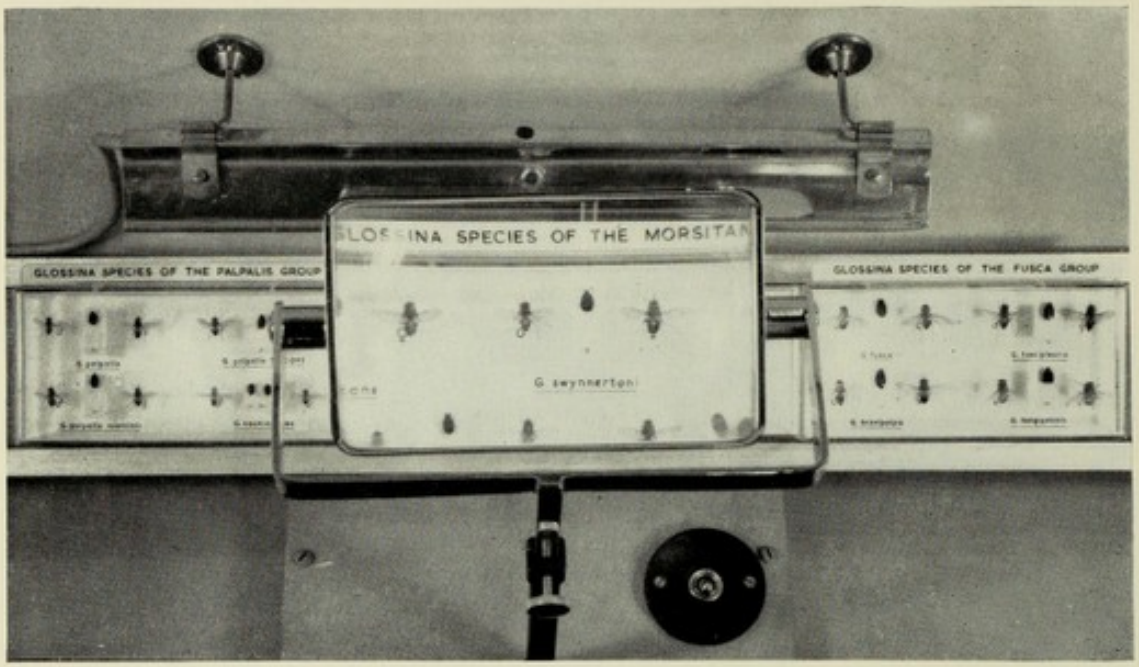

Fig. 26 Display of tsetse flies

The account of South American trypanosomiasis, includes Chagas' disease and infection by *Trypanosoma rangeli*. Specimens of Triatominae are on view and so is an armadillo (*Dasypus* sp.), one of the principal animal reservoirs of Chagas' disease. A Perspex outline map of South America demonstrates the area in which the disease occurs and the animal reservoirs that are involved in its epidemiology.

Malaria is caused by blood parasites of the genus *Plasmodia*, and the complicated problems which make it still one of the most important tropical diseases call for detailed treatment. The account begins with the major historical landmarks in the investigation of malaria, followed by descriptions of its aetiology, epidemiology and pathology. The clinical aspects are dealt with, including problems of diagnosis and treatment. The prevention and control of malaria is given much prominence, with a wealth of original drawings, diagrams and pictures. Photomicrographs of the four malaria parasites of man are displayed, including a series depicting the life-cycle of *Plasmodium vivax* in the invertebrate host. Specimens include the 'ague-cake' spleen of chronic malaria, and organs from a fatal *P. falciparum* infection contracted during a short visit to West Africa. The anopheline vectors of malaria are shown by specimens and a wax model of *Anopheles gambiae*, and are further described on swinging panels. Work on avian and monkey malaria is also mentioned. Modern methods of malaria control are extensively depicted, and the display includes living specimens of the larvivorous, surface-feeding minnow *Gambusia affinis* that is used to control mosquito breeding (Fig. 27).

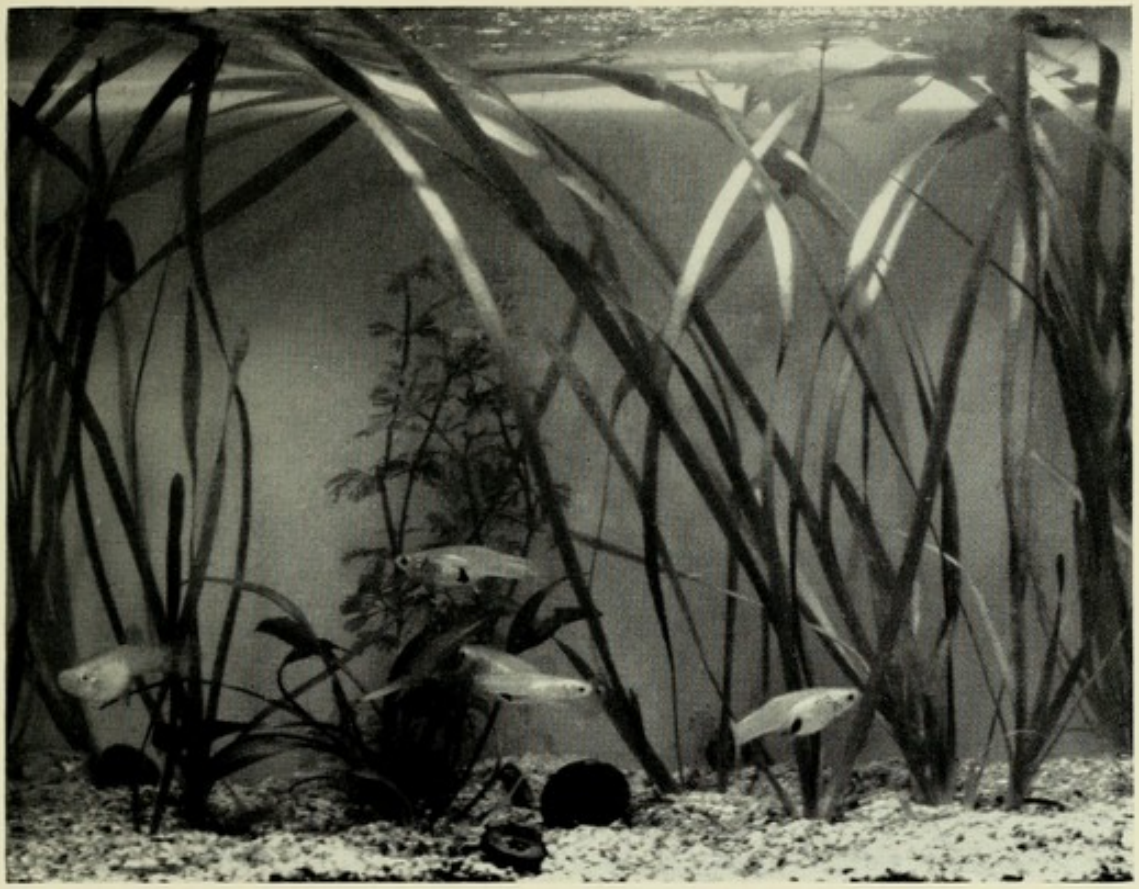

Fig. 27 Display of larvivorous fish

BACTERIAL DISEASES

Limitations of Museum space have made it necessary to select those infections which are of major importance in the tropics. Among them are two groups of special interest. One group commonly accompanies low standards of personal and community hygiene and includes cholera, the enteric fevers, bacillary dysentery and bacterial food poisoning. The other comprises mycobacterial infections, of which tuberculosis and leprosy are the most important.

Several panels are devoted to cholera. The causal vibrio is illustrated in original drawings and by electron photomicrographs at a magnification of 35,000. The part played in the dissemination of this disease by large congregations of people is emphasized by suitable photographs, and the natural history of the housefly is fully described on swinging panels. The clinical aspects of cholera and their treatment are described. The measures taken to prevent this disease, including vaccination, the protection of food and the chlorination of water are illustrated, and the specimens include part of the small bowel from a fatal case.

Salmonella food poisoning and the enteric fevers are introduced by a panel

showing the classification of the Enterobacteriaceae according to their biochemical reactions. Their clinical effects are fully described; a coloured chart illustrates the clinical pattern of typical typhoid fever, and a coloured original shows the rose spots which may appear on the abdomen in the second week of the illness. Pathological specimens include the liver, spleen and small intestine from fatal cases, and a gall bladder recalling the importance of this organ in typhoid carriers.

The causal organisms of bacillary dysentery, species of *Shigella*, are classified according to their biochemical reactions. An electron photomicrograph of *Sh. flexneri* shows fimbriae, which do not, however, confer motility upon the organism. The microscopic appearance of a faecal smear in acute bacillary dysentery is illustrated in a coloured original drawing. The specimens include pieces of large intestine with characteristic ulceration in acute and chronic stages.

Ten panels are allocated to tuberculosis which is of great importance throughout the tropics. Emphasis is laid on the environmental factors underlying its transmission. The casual organisms, *Myco. tuberculosis* and *Myco. bovis*, are shown in coloured illustrations, and a coloured chart describes the natural history of a primary infection. The importance of non-respiratory tuberculosis is illustrated by pictures of tuberculous adenitis, erythema nodosum, and tuberculous meningitis. The execution of a BCG vaccination campaign is described in detail. The photomicrographs show a typical specimen of sputum and the morbid histology of respiratory tuberculosis. Specimens illustrate tuberculous infection of the lung, pleura, lymph glands, bone and other internal organs. X-rays and resected lung specimens with clinical details are matched to show the radiological appearances of certain types of lesion. Whole lung sections demonstrate different types of industrial silicosis in underground mine workers in the tropics (Fig. 28).

The classifications of clinical leprosy are shown in a chart on the first panel. The current classification divides the disease into lepromatous, tuberculoid, indeterminate and dimorphous varieties, and their clinical appearances are illustrated on separate panels. Photomicrographs showing the histology of this condition include a fine example of Lucio's phenomenon. A cast of the face in lepromatous leprosy and a specimen showing complete resorption of the phalanges in advanced tuberculoid leprosy serve to impress the importance of early diagnosis and treatment in this mutilating disease.

Several panels describe mycobacterial skin conditions which include Buruli Ulcer. These infections have aroused considerable interest and stimulated enquiry into the classification of the atypical mycobacteria.

Three venereal diseases of bacterial origin are described in this section. Granuloma venereum has a world-wide distribution although it occurs mainly in the tropics. This disease, associated with poverty and poor personal hygiene, is due to an organism *Donovania granulomatis* or Donovan body. A

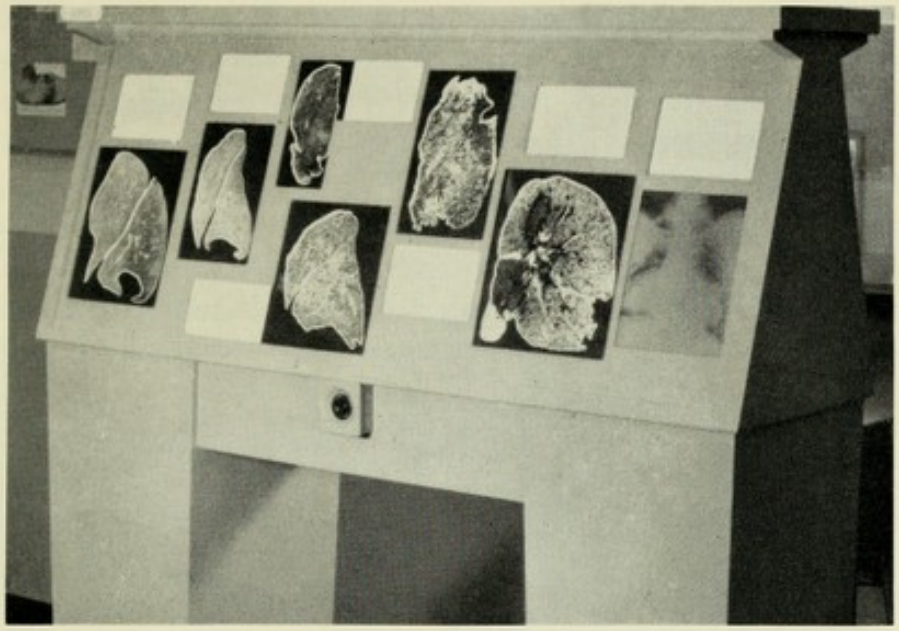

Fig. 28 Display of Gough-Wentworth lung sections

diagram illustrates the possible life cycle of this organism. On a second panel a chart details the important points to be considered in the clinical diagnosis of genital lesions with adenitis. A coloured drawing of *Haemophilus ducreyi* shows the chain formation, the intracellular forms and the 'school of fish' arrangement of the organism of chancroid in a pus smear stained with methylene blue. Gonorrhoea is the most important disease of this group. The Gram-negative gonococcus with its characteristically shaped opposing pairs is shown in a coloured drawing. The sequelae of the condition such as arthritis and ophthalmitis are demonstrated in coloured and black and white photographs. The pathology of the condition is shown in specimens illustrating stricture of the urethra and abscess of the Fallopian tube and ovary.

Cerebro-spinal meningitis is also due to a Gram-negative diplococcus, often arranged in sets of four. Coloured pictures show the petechial rash, head retraction, and other clinical features.

Plague, formerly of great importance, is now a rare disease. Primarily it is an epizootic of small mammals, and some of the more important of these are displayed in the zoology section. Wax models show the life history of *Xenopsylla cheopis*, the rat flea, which is concerned in transmission. On swinging panels the taxonomy and ecology of the flea is dealt with. Specimens show the effects of plague on spleen and liver, a lung from a case of pneumonic plague, and intense haemorrhage produced in the kidney and ureter. The important part played in the control of this condition by insecticides and rat poisons is dealt with.

Like plague, tularaemia is a disease of small mammals, transmitted to man either through handling an infected animal or by the bite of an infected arthropod, particularly the tick *Dermacentor andersoni.*

Brucellosis, otherwise known as undulant, or Malta, fever, is caused by Gram-negative cocco-bacilli of the genus *Brucella*, cases in man being connected with infected goats, pigs, or cows, as is shown in a diagram. One of several photomicrographs shows the appearance of *Brucella abortus* in a smear from a bovine placenta.

Tetanus is an important disease, particularly in tropical areas. The causal bacillus, *Clostridium tetani*, is present in soil, manure, and the excreta of domesticated animals. It is transmitted through contaminated wounds, and is of particular importance among neonates in whom umbilical infection may result in tetanus neonatorum. Illustrations show the attitude of a patient in tetanic spasm, and the characteristic *risus sardonicus*.

Anthrax is chiefly a disease of animals and is world wide in its distribution. It is caused by *Bacillus anthracis* whose characteristic appearance in culture is illustrated. The cutaneous disease in man is associated with contact with animal materials such as wool, hides and horse-hair, and special measures are employed to disinfect these articles.

Diphtheria remains a public health problem in many countries, although the practice of immunization in the western world has almost eliminated it, so that many doctors have no personal experience of it. The display includes photomicrographs of the causal organism, the histological appearance of a diphtheritic membrane and a specimen to show the pharyngeal involvement and cervical glands.

Bartonellosis is restricted to limited areas in the Andes, and is due to a Gram-negative bacterium transmitted to man by species of *Phlebotomus*, and possibly by healthy carriers of the organism, *Bartonella bacilliformis*. The appearance of the bacillus in a culture and in blood is demonstrated. The hot narrow valleys in which it is found, and the haemorrhagic wart-like eruption of the later stages are illustrated.

SPIROCHAETAL DISEASES

This section contains 30 panels, beginning with an introduction in which the three genera, *Borrelia*, *Leptospira*, and *Treponema* are described. Reproductions of electron photomicrographs illustrate the difficulties of differentiating species of these genera on morphological lines. A particularly interesting picture shows, at a magnification of 40,000, a spirochaete undergoing binary fission. Reference is made to the unitarian theory that the treponematoses are due to infection by a single organism, the different clinical conditions being due to environmental modifications.

Yaws is illustrated with pictures showing the clinical appearance of the primary, secondary and tertiary stages. The part played by direct contact under warm humid conditions is well shown by a photograph of African miners working at a depth of 7,000 feet. Lesions on the sole of the foot are

demonstrated in coloured prints. Finally a chart shows the steps to be taken in a control campaign.

Pathological specimens include the femur of an Australian aborigine with its X-ray, demonstrating necrosis of the cortex and the expansion of the shaft of the bone. Two other specimens of bony lesions are believed to be the only wet specimens of tertiary yaws in Europe (Fig. 29). A wax model portrays the appearance of framboesia of the lip.

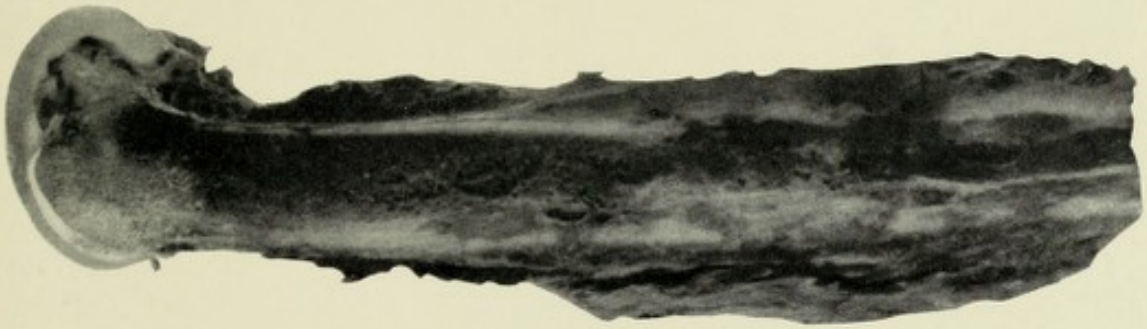

Fig. 29 Wet preparation of tertiary yaws lesion of humerus

A reproduction of an electron photomicrograph of *Treponema carateum*, the causal organism of pinta, reminds the student how similar are the allegedly different species of treponemes. The distribution of the lesions is shown on a chart, with photographs of the depigmentation of early pinta and the leucoderma typical of the late stage. One of the pictures shows that as in yaws, plantar hyperkeratosis occurs in pinta.

One panel describes the various other non-venereal treponematoses. Emphasis is laid on the familial pattern of incidence, and the importance of treating all household contacts of an infected person.

Venereal syphilis occupies four panels, a fifth being devoted to congenital syphilis. Electron photomicrograph reproductions show, at a magnification of 80,000, the appearance of the causal organism *T. pallidum* and its flagella-like structures. Emphasis is laid on the speed with which it invades the body, penetrating the mucous membrane surfaces in a few minutes, and becoming disseminated within a few days. The clinical appearances of primary, secondary, and tertiary syphilis are shown. The characteristic appearance of a child suffering from congenital syphilis and interstitial keratitis, so often seen in this condition, are shown in coloured prints. The pathology is demonstrated by specimens of syphilitic hepatitis, aortitis, and aneurysm. The characteristic morbid histology of treponemal infections is displayed in 12 photomicrographs which include the appearance of *T. pallidum* in a smear from a primary chancre.

A model of *Ornithodorus moubata* faces the account of relapsing fever in Central and Southern Africa, in which areas this tick is an important vector. Many species of spirochaetes are involved in the causation of relapsing fever,

and are detailed on a comprehensive chart which shows their vectors and the localities in which they occur. The display includes specimens of *Pediculus corporis* and several species of tick that can convey infection to man. The anatomy of *Ornithodorus* is illustrated in a series of drawings.

The consistent finding of *Spirochaeta vincenti* in tropical ulcers suggests that it has an aetiological role, and this condition is therefore displayed in the spirochaetal section. Clinical photographs give excellent views of the appearance of the ulcer, and its tendency to progress to malignant change is illustrated by pathological specimens.

One panel describes Vincent's angina which is also closely associated with *Borrelia vincenti*.

Four panels describe leptospiral infections in man, and the material is presented to remind the student that cases of leptospiral infection in human beings are not all due to *Leptospira icterohaemorrhagiae* and that the absence of the classical signs of Weil's disease does not exclude leptospirosis. The principal modes of infection are shown in a chart which illustrates the occupations associated with this disease. The role of the rat is also emphasized. The less severe leptospiral infections contracted by contact with domestic pets are then dealt with. The characteristic postmortem appearance of the stomach, liver, and kidney, can be seen in specimens. The photomicrographs include a copy of a slide from Dr Stimson's case in New Orleans which was misdiagnosed and led Noguchi to believe he had discovered the cause of yellow fever.

One of the causal organisms of rat-bite fever is *Spirillum minus*, illustrated by an original drawing and a coloured print of a stained blood film. The characteristic course of the fever and the dramatic response to penicillin are depicted on a chart. The display concludes the section on spirochaetal diseases.

HELMINTHOLOGY

One of the largest sections of the Museum is devoted to human helminthology. It begins with a short introduction followed by detailed accounts of trematodes, cestodes and nematodes, in that order, which parasitize man either in their adult or larval stages.

The trematodes are introduced by descriptions of *Fasciola hepatica* and *Dicrocoelium dendriticum*. Although man is only rarely a host of the latter, its straightforward morphology makes it a useful example of its class for teaching purposes. The biliary flukes, intestinal flukes, and the lung fluke *Paragonimus westermani*, are then considered and followed by a large display on the human blood flukes, *Schistosoma* species.

Examples of these worms are shown with a comprehensive series of their molluscan and crustacean hosts. A special display, assembled with the advice of Dr Christopher Wright of the British Museum, is found in this section,

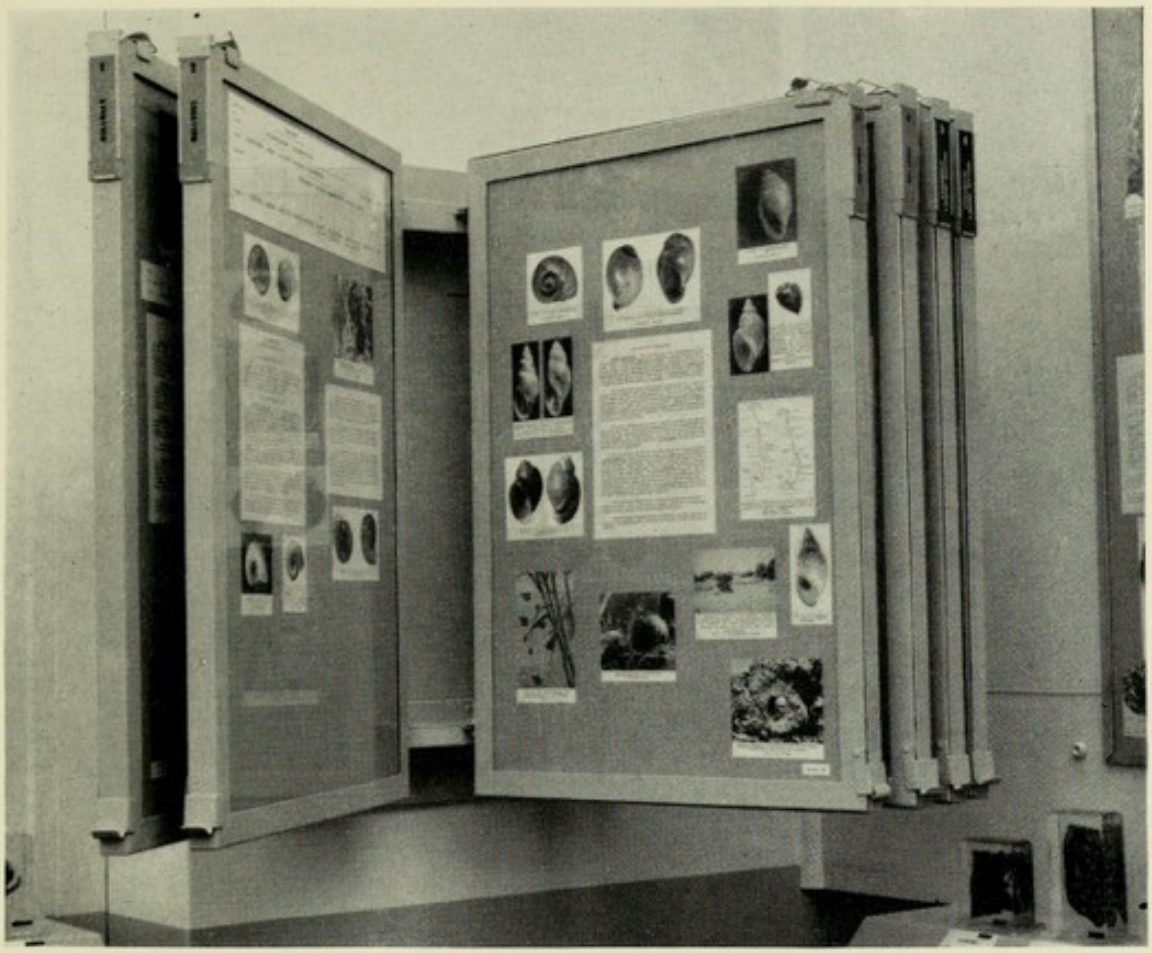

Fig. 30 Part of a display on molluscs, mounted on swinging screens in the helminthiasis section

and deals with molluscs of medical importance, including the numerous intermediate hosts of *Schistosoma* species (Fig. 30). In the section which deals with bilharziasis, numerous pathological specimens relating to all three types of human infection are to be found, ranging from early to advanced pathological changes in the liver and hollow viscera.

The section which deals with cestodes begins with a short introduction and an account of sparganosis and proceeds to describe alimentary infestation with *Diphyllobothrium* and *Taenia* species. Pathological specimens show the adults of these tapeworms as they occur in the gut, and the larval stages in solid viscera from cases of cysticercosis due to *T. solium*. Both types of hydatid disease and coenuriasis serve to illustrate human infestation with larval stages of the tapeworms of domesticated animals, and the section is completed with an account of the less pathogenic parasites *Dipylidium*, *Inermicapsifer*, and *Hymenolepis*.

In its introduction the section on nematodes includes accounts of cutaneous larva migrans and tropical pulmonary eosinophilia. This is followed by displays on *Enterobius*, *Toxocara*, *Ascaris lumbricoides*, and other, less common, but zoologically related nematode parasites. A bay is devoted to intestinal

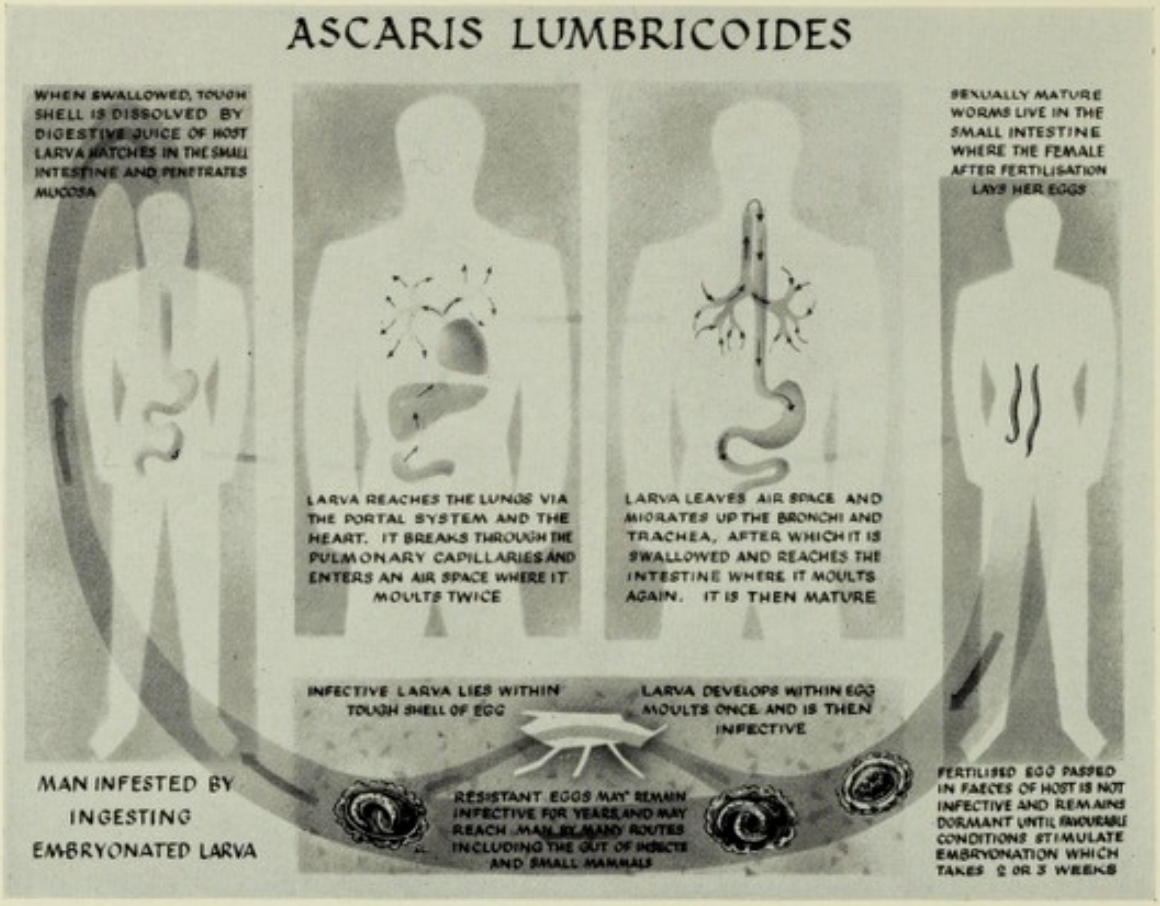

Fig. 31 One of the characteristic life cycle drawings to be found in the helminthiasis section

parasitism by hookworms, *Strongyloides* and *Trichinella*. The helminth section is completed by a detailed account of human filarial infections, particularly emphasizing the importance of *Wuchereria*, *Brugia* and *Onchocerca* infestations.

In the helminth section as a whole there are nearly a thousand illustrations, and these include a collection of life cycle diagrams in colour drawn by Ian T. Morison (Fig. 31). The section also contains several dozen photomicrographs, many pathological specimens, wax models, and examples of drugs and diagnostic reagents used in the practice of human helminthology.

FUNGUS DISEASES

Mycology as a science is older than bacteriology. It began in 1677 when Hooke observed fungi on the leaves of plants, and continued to provoke interest, mainly among botanists, until 1839 when Langenbeck, by discovering the cause of thrush, drew attention to parasitic fungal infections in man. However, the bacteriological discoveries by Pasteur and Koch later in the nineteenth century temporarily eclipsed research on fungi, and it was not until 1910, when Sabouraud's scientific work was published, that interest in mycology was revived. Since that time there have been great advances,

notably in the production of antibiotics, improved diagnostic techniques and epidemiological surveys. It is now known that fungus diseases are not limited to the tropics but are found in many parts of the world, and that in addition to infections which are superficial or localized to particular organs, serious systemic fungal infections occur, particularly in patients whose body defences have been lowered by prolonged treatment with antibiotics, steroids and other chemotherapeutic agents. Forty-six panels are devoted to this subject to familiarize the student with the salient features of the fungus diseases which occur in man. A definitive exposition of a subject as complex and dynamic as mycology has not been attempted, but for further study, an extensive bibliography is provided.

The account begins with two introductory panels dealing with basic mycological terms and definitions. A glossary with line drawings is available in a folder for reference throughout the fungus section. In classifying fungi, the three groups of perfect fungi are mentioned briefly, while the fourth group, the imperfect fungi, are given in more detail. This latter group contains the majority of fungi pathogenic for man and these give rise to predictable reactions in tissues and special organs according to the particular fungus involved. Finally, the nomenclature of fungus diseases and diagnostic methods which include methods of identification, formulae for culture media and determination of skin sensitivity to fungal antigens are presented. Line drawings and photographs, both monochrome and coloured, illustrate the introductory material. In this section, as well as in the remainder of the fungus section, coloured photomicrographs of fungus preparations are available in viewing boxes.

The term mycetoma, strictly speaking, implies a specific lesion of fungal origin. It is customary, however, to include lesions produced by the actinomycetes as well as the fungi since clinically the two types of mycetoma cannot be distinguished. In the three panels on this subject, the term maduromycosis is reserved for mycetomas caused by fungi, actinomycosis and nocardiosis being used for the lesions of non-fungal origin.

The cultural and clinical manifestations of the three types of organisms are illustrated photographically. Of historical interest are photographs of Vandyke Carter's original case of Madura foot and the grains of *M. mycetomi* which he demonstrated in 1859. Surgical specimens of Madura foot showing the extent of involvement are on display. Autopsy specimens of actinomycosis of the lung and liver are also shown. There are X-rays of the skull and extremities showing the invasion of adjacent bone structures which may occur in mycetoma.

Two panels deal with phycomycosis, an infection which may be either systemic and usually fatal, or more benign when it involves cutaneous and subcutaneous tissues. The subcutaneous form is particularly important in the tropics.

In sporotrichosis and chromoblastomycosis the skin is affected, while

rhinosporidiosis affects mucous membranes, chiefly nasal and conjunctival. All three conditions are illustrated with photographs showing the main fungi concerned, both in culture and microscopically. Several clinical photographs show these lesions in their typical sites, along with photographs of less usual manifestations. A surgical specimen of 'mossy foot' demonstrates the difficulty in the differential diagnosis of chromoblastomycosis. Specimens of surgically removed rhinosporidiosis tissue are also on view.

Ten panels deal with fungi which produce visceral lesions or systemic disease in addition to skin manifestations. There are three panels dealing with North and South American blastomycosis, two each for coccidioidomycosis and histoplasmosis, and one panel each for moniliasis, cryptococcosis, and aspergillosis. The mycological diagnosis and histology of these diseases are illustrated in monochrome and coloured photographs. On the clinical side, X-rays, coloured prints and photographs show the characteristic lesions of each fungus concerned. The acknowledgements of the varied sources of this material indicates the world-wide incidence of these fungus infections.

Dermatophytes are the superficial or 'ringworm' fungi. The characteristics of the three genera concerned, *Trichophyton*, *Epidermophyton* and *Microsporum*, are described and their important members defined. These dermatophytes have a world-wide distribution, the extent of their prevalence and incidence being determined by climate and hygiene. The tissue reactions of these organisms and the methods of laboratory diagnosis are shown. Wood's light, an aid in the diagnosis of tinea capitis due to *Microsporum* infection, is available and demonstrates the fluorescence of hair infected by this organism.

The large number of coloured prints and photographs of the common, ubiquitous ringworm infections, 'athlete's foot', tinea capitis, tinea cruris and corporis, stresses the importance and world-wide distribution of these conditions (Fig. 32). Tinea imbricata, with its bizarre, unmistakable skin pattern, however, is restricted to tropical and subtropical regions as demonstrated by a coloured map showing its distribution and by the photographs of patients affected.

Favus, which involves the scalp and has been shown to occur in Eastern Europe and Mediterranean countries, and piedra, the result of infection of the hair shaft, are included among the diseases of *Trichosporon* origin. The scutula, the characteristic cup-shaped lesion of favus, and the typical nodules on hair found in piedra, are shown in coloured prints, drawings and photographs.

No presentation of the superficial fungus diseases would be complete without a description of the extremely common skin disorder, pityriasis versicolor. It can be found anywhere in the world, and may affect as much as 50 per cent of the population in hot, humid areas. The cosmetic changes produced and the distribution of the lesions are shown in coloured and black and white photographs. *Malassezia furfur* is considered to be the cause of pityriasis versicolor but has so far eluded cultivation.

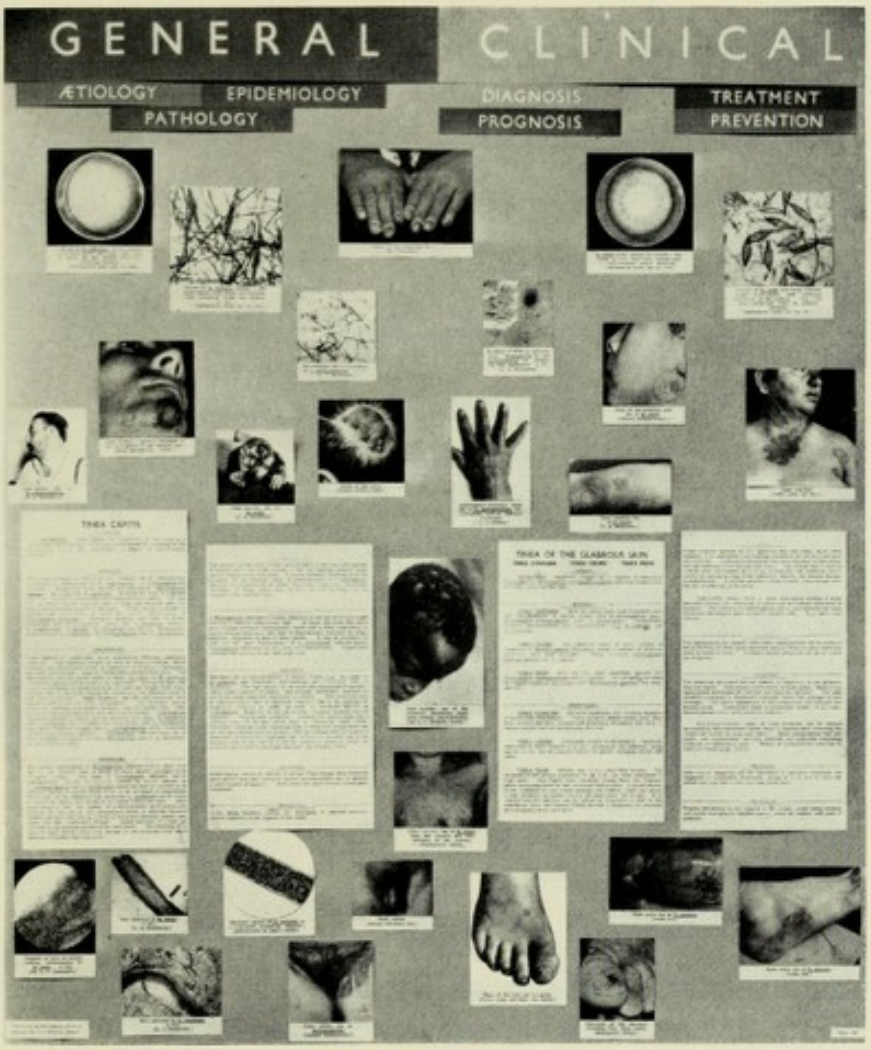

Fig. 32 A panel displaying superficial fungus infections

NUTRITION

It has long been known that a deficiency of one or other of the vitamins can produce specific illness, and it is accepted that prolonged consumption of an inadequate or ill-balanced diet is an important factor in the aetiology of many diseases. The account of the medical aspects of nutrition and the diseases due to malnutrition occupies a total of 38 panels.

In the first two bays the problems of work in nutrition are briefly reviewed. After a reference to the principal historical landmarks in the long story of enquiry into this subject there is an account of the general and the particular objectives of nutrition work. This is followed by discussions on the feeding of the important vulnerable groups in any community, *i.e.* the expectant and nursing mother, the baby, children and young adults. The importance of education in all matters pertaining to the nutrition of the individual and the community is then stressed. In these bays there are two contrasting

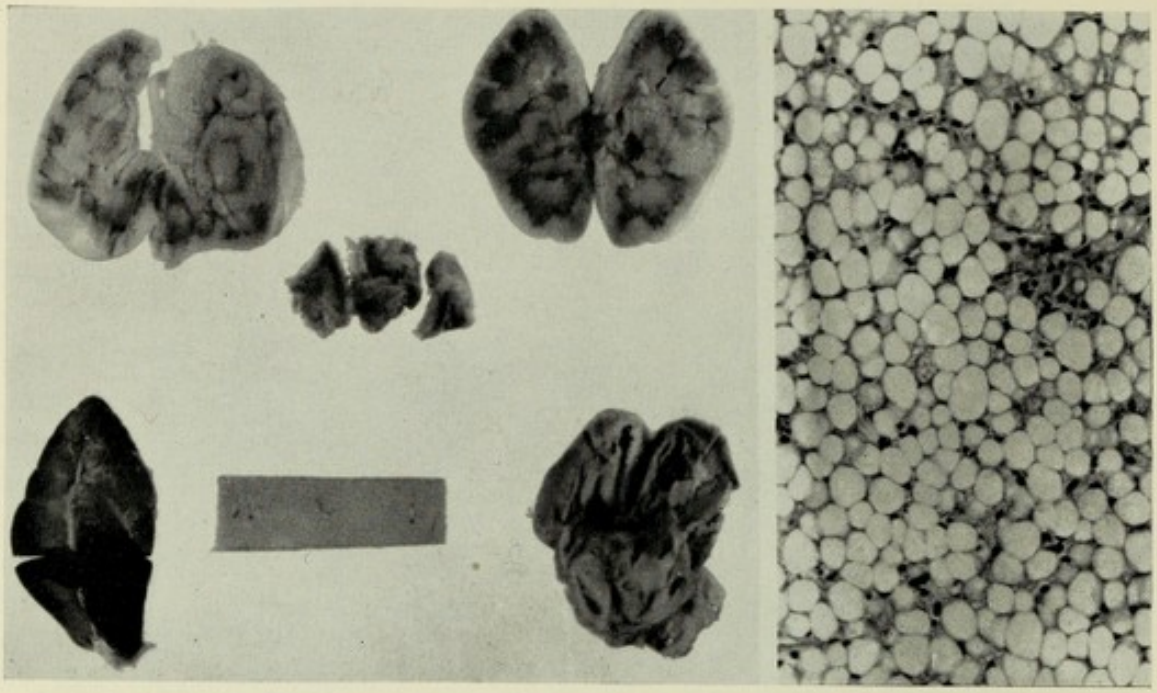

Fig. 33 Specimens and photomicrograph of the liver from a case of kwashiorkor

specimens. The first is a 'lake-fly cake' which is composed of a crushed mass of midges and demonstrates how the African of the Rift Valley supplements his protein intake. The other is a sample of edible protein made from green leaves by a modern process at Rothamsted Experimental Research Station. The displays then describe the results of failure to achieve the objectives of nutrition, and after a brief account of the most dramatic result, namely starvation, goes on to deal with the various syndromes that arise from malnutrition.

Four panels are used to describe rickets and osteomalacia, illustrated with clinical pictures and X-ray photographs to show their effects on children and adults. The pelvic distortions that occur in women suffering from osteomalacia are particularly striking. The structure of vitamin D is shown diagrammatically.

One large panel is used to describe the skin and eye conditions that arise from vitamin A deficiency and these are illustrated by coloured and monochrome prints. Vitamin A therapy is discussed separately.

Three panels are devoted to accounts of beriberi, the anaemias associated with folic acid deficiency, and ariboflavinosis. Both clinical varieties of beriberi are illustrated, and specimens show the pathological appearance of the heart in this disease.

A large and conspicuous panel is devoted to kwashiorkor. The clinical appearances of children with early, mild and severe grades of this disease are

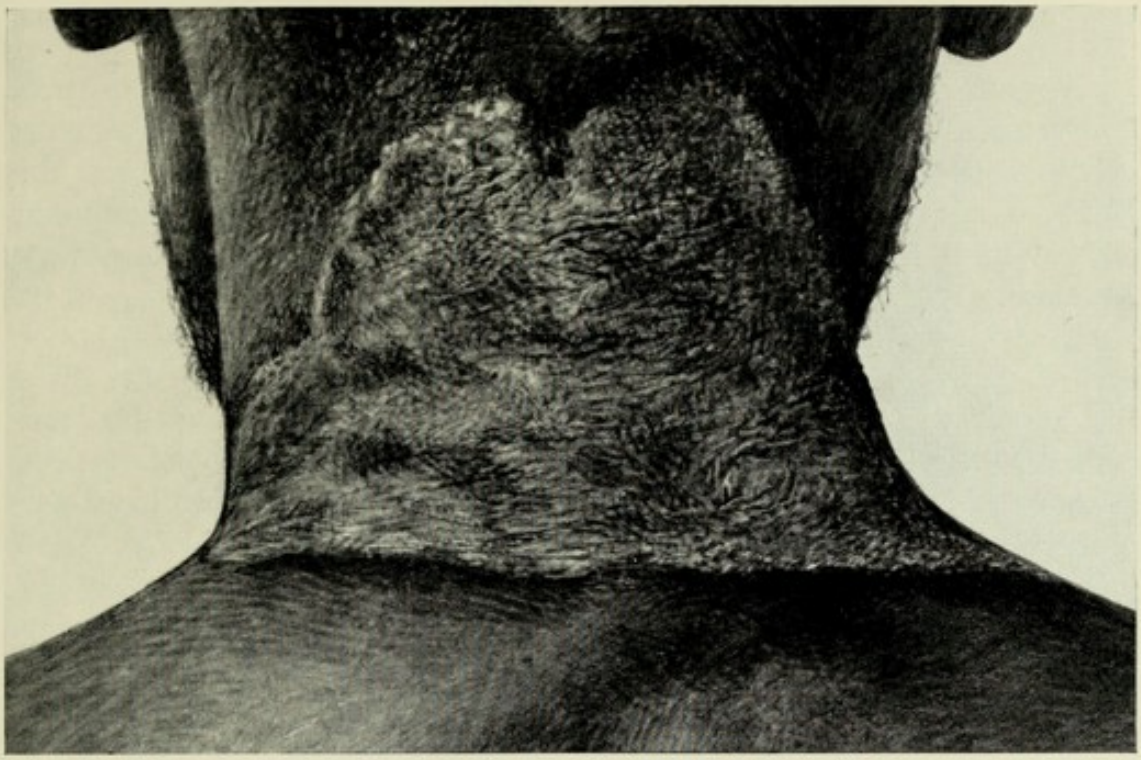

Fig. 34 A painting by A. J. Terzi showing Casal's collar in pellagra

demonstrated in a series of prints. The gross pathology of the liver in these cases is shown by specimens, and in a viewing box the characteristic morbid histology of the liver and pancreas is shown in photomicrographs (Fig. 33).

Two panels are given to scurvy which was one of the earliest diseases to be recognized as curable by dietetics, and still occurs from time to time, even in Europe and North America. Illustrations show the typical attitude adopted by a child afflicted with this painful disease; the skin haemorrhages characteristic of scurvy; and the lesions of gums and teeth which are early signs of the onset of an attack. There are also X-rays to show how lack of vitamin C impairs the growth of bones, notably those of the wrist. A panel is allotted to vitamin C therapy and its importance in the treatment of burns and as an aid to healing in patients undergoing surgical operation.

Pellagra is described in two panels. It is now of decreasing importance as the standard of living in maize-eating countries rises. The appearance and distribution of the skin lesions in pellagra are highly characteristic and these are shown in pictures of Casal's necklace, one of which is an original coloured painting, and of the glove-like rash that is seen on the back of the hands (Fig. 34).

Diseases associated with vegetable poisoning include veno-occlusive disease of the liver, the vomiting sickness of Jamaica, lathyrism and epidemic dropsy. The histology of veno-occlusive disease is shown in photomicrographs, in contrast with the effects of kwashiorkor.

NEOPLASMS

Limitations of museum space permit the display of only three neoplasms. The subjects have been selected because they have a high endemicity among certain tropical peoples; they are Burkitt's tumour, primary liver cancer and Kaposi's sarcoma. Malignancies which occur as complications of conditions such as tropical ulcer or bilharziasis are mentioned in other sections of the Museum.

Burkitt described his tumour in 1958, and this highly malignant neoplasm occurs in areas of similar altitude and rainfall, extending across West, Central and East Africa, which are shown in maps. Charts show the age incidence and the anatomical distribution of these neoplasms. Clinical photographs show the early and advanced stages, and there are several autopsy specimens on display. Photomicrographs show the characteristic monotonous histopathology of the tumour.

The endemicity of primary liver cancer in certain parts of the world and its frequent association with cirrhosis have suggested the existence of related aetiological factors. These are discussed with reference to experimental work using carcinogenic agents, hormones and metabolites. Two photographs show experimental hepatoma induced in rats by a diet containing an azo compound. Photographs, coloured photomicrographs and autopsy specimens demonstrate the two types of primary liver cancer, the hepatoma and the less common cholangioma, and a specimen treated with Prussian blue reveals the absence of free iron in the malignant deposits.

Since the original publication by Kaposi in 1872 of his 'Idiopathic Multiple Pigmented Sarcoma', its histogenesis and histopathological interpretation remain controversial. Within recent years, however, two facts have emerged: its frequent simultaneous occurrence with lymphoma, and its geographical, rather than racial distribution. The pleomorphism of the histology of Kaposi's sarcoma is shown in photographs of the earliest inflammatory lesions to the final, frankly neoplastic changes. Clinical photographs show typical cutaneous lesions with accompanying oedema. The occurrence of this lesion in less common sites such as the conjunctiva, endocardium, and tonsils is also shown. The effects of cautery incision and X-ray therapy are presented. A surgical specimen of an amputation of the lower third of the leg and foot (Fig. 35), and an autopsy specimen of lesions in the small intestine are on display.

VIRUS DISEASES

As a definitive classification of the pathogenic viruses is still awaited, the scheme adopted in the Museum is to portray infections due to arthropod-borne viruses, and group the others in relation to their clinical effects. The section occupies 72 panels in nine bays.

Fig. 35 A specimen showing Kaposi's sarcoma of the lower limb

The section begins with an introduction to viruses which deals with their shape, structure and chemical composition, methods of multiplication, and the formation of elementary and inclusion bodies. This is followed by a general account of virus infections and some of the methods used in virology. Immunity to, and prevention of, virus infections are discussed, and after the introduction a selection of arborvirus infections is then displayed in detail.

At the entrance to the bay dealing with yellow fever is a model of *Aedes aegypti* enlarged 28 times. A detailed account of the genus *Aedes* is shown on swinging panels, and the vectors of jungle yellow fever are shown by coloured prints. Numerous coloured drawings illustrate the epidemiology, pathology and clinical course of the disease. The crabwood tree, associated with the breeding of arboreal yellow fever mosquitoes, is shown in relief. Photomicrographs show liver sections from infected Rhesus monkeys; postmortem material and mosquitoes are also displayed.

Other panels give accounts of arborvirus diseases such as West Nile fever, O'Nyong-nyong fever, Kyasanur Forest disease, sandfly fever, dengue, Rift Valley fever and arthropod-borne encephalitides.

Virus infections of the central nervous system include other encephalitides, lymphocytic choriomeningitis, rabies and poliomyelitis.

The section on rabies is illustrated by prints showing the clinical signs in human beings and dogs. An electron photomicrograph shows Negri bodies in the hippocampus of an infected laboratory animal. Pictures of *Desmodus rufus* remind the student that, in certain areas of the world, vampire bats spread this disease.

On the poliomyelitis panel a series of prints show the changes in the anterior horn cells produced by this infection and a clinical chart depicts the common pattern of the major illness. The medical and surgical measures used in the therapy of paralytic poliomyelitis are also displayed.

A panel on zoster links the viruses with an affinity for the nervous system with those of the pox group, and is followed by accounts of varicella, variola, vaccinia and cow-pox. The typical rash of varicella is shown in a coloured picture and an X-ray shows the possible pulmonary complications in adults.

There are mounted specimens of variola, vaccinia and cow-pox virus colonies on chick chorio-allantoic membrane (Fig. 36). As an aid to the

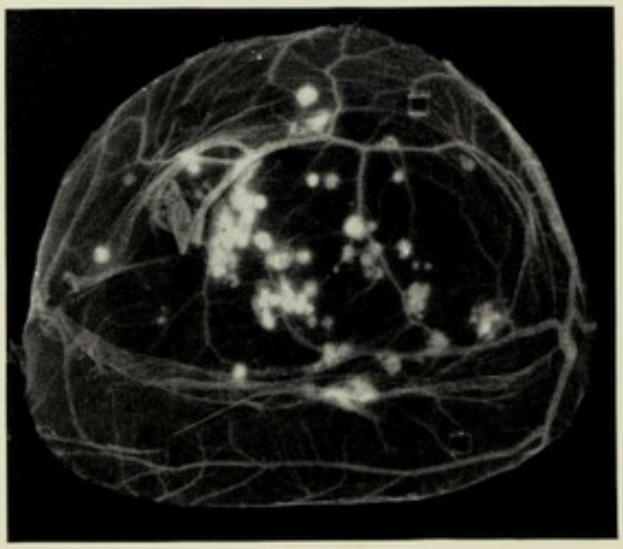

Fig. 36 Specimen showing the growth of virus colonies on the chorio-allantoic membrane of a chick embryo

diagnosis of smallpox in dark-skinned people there are excellent coloured illustrations. In a special folder a series of pictures and reproductions of pages from a parish death register in Manchester (1793) remind the student of the former ravages of smallpox in this country. On the vaccinia panels a coloured chart illustrates the appearances seen after smallpox vaccination.

The account of cutaneous virus infections is completed by a description of molluscum contagiosum, Coxsackie viruses, herpes simplex and verruga. In each case the virus is illustrated, and coloured and black and white prints demonstrate the clinical appearance of the condition. On the Coxsackie virus panel a chart shows the distinguishing features between infections with Group A and Group B viruses.

The pictorial aids in the account of influenza include electron photomicrographs. The histological changes in the nasal epithelium of the infected ferret are shown in a series of prints. The gross pathology and histology of the lung in human cases are depicted by illustrations and a lung from a fatal case of influenzal pneumonia.

The clinical characteristics of mumps are shown in a series of pictures. Epidemic mumps has a considerable nuisance value and occasionally produces important complications such as orchitis and pancreatitis.

Measles and rubella are virus diseases of considerable tropical importance. The clinical appearances are illustrated by coloured and black and white prints.

The two varieties of viral liver disease, infectious hepatitis and homologous serum hepatitis are described. A chart contrasts these two diseases. The appearance of the liver is shown by specimens and illustrations.

Epidemic kerato-conjunctivitis is almost certainly a virus disease. It is seen more frequently in men than women and is world-wide. The characteristic appearance of the infected eye, with oedema, lacrimation and folliculitis, is illustrated by coloured prints.

Glandular fever is included in this section, although its viral aetiology is unconfirmed. Blood changes are illustrated in photomicrographs and coloured prints.

One panel contains a description of the common cold.

Primary atypical pneumonia occurs chiefly in young adults, and may occur in epidemic form. Such outbreaks are probably due to symptomless carriers passing on the infection by droplets. The disease is rarely fatal, but convalescence is often prolonged. The account lays stress on the varied underlying causes and the value of radiology in diagnosis. A series of X-ray prints show the so-called 'ground glass' appearance of the lung fields and the subsequent resolution.

DISEASES DUE TO LARGER VIRUSES

In an introduction it is explained that the final classification of the larger viruses, sometimes called Chlamydozoaceae, has still to be determined. They produce disease not only in man but in domestic animals and stock.

Psittacosis is described in two panels, and coloured illustrations show the various avian species that may carry the disease. A coloured chart shows the developmental stages of the causal organism in mouse spleen, and demon-

strates its appearance at a magnification of 40,000. Psittacosis is the only one of this group of infections that may be fatal to man, although the radiological picture is indistinguishable from that of primary atypical pneumonia. Laboratory workers wear protective clothing, a picture of which is shown.

Lymphogranuloma inguinale is caused by one of the Chlamydozoaceae called *Miyagawanella lymphogranulomatis* after Miyagawa, who described the elementary bodies in 1936. The organism is illustrated in a coloured chart while a series of prints demonstrates the effects of this infection in men and women. Specimens include inguinal lymph nodes from an experimentally infected guinea pig, and the rectum showing fibrosis and stricture in the female. Two coloured prints demonstrate the Frei test which is a valuable diagnostic aid. The importance of early treatment with antibiotics is stressed as this may reduce the risk of long-standing ill health and disability.

Cat-scratch disease is a benign condition which is nearly always due to a scratch, lick, or bite from a domestic cat.

Inclusion conjunctivitis is caused by elementary bodies whose appearance in smears is shown by prints. The characteristic appearance of the affected eye is shown in a coloured picture that shows oedema of the eyelids and the granulations that appear, particularly on lower palpebral conjunctiva.

Three panels are taken to describe trachoma, the most widespread and important of eye infections. The trachoma virus is shown at a magnification of 20,000 and a series of coloured pictures illustrate the stages of infection. The differential diagnosis is dealt with in a chart, and stress is laid on mass campaigns for the cure and prevention of this disease.

RICKETTSIAL DISEASES

The section comprises 26 panels and begins with an introduction. The taxonomic position of the *Rickettsiae* is shown on a chart, and a diagram illustrates the developmental forms of *Rickettsiae* during fission. Coloured illustrations show the organisms as they appear in lung impression smears, and black and white prints show them under electron microscopy at a magnification of 20,000. The risk to laboratory workers handling infected material is stressed and the means of avoiding infection is illustrated. Two coloured prints demonstrate the primary eschar characteristic of some of these infections and the type of rash which may follow.

Rocky Mountain spotted fever is taken as the 'type' of rickettsial infection in North America. It is described in two panels which illustrate the characteristic microscopical appearance of the peripheral blood vessels and rickettsial infection, including a Wolbach node and the typical vascular lesions in the dermis. The eggs, larvae, nymphs and adults of the vector, *Dermacentor andersoni* are displayed. Other specimens include the dock tick *Dermacentor variabilis* and the ticks *Rhipicephalus sanguineus* and *Amblyomma hebraeum*.

Other American spotted fevers so closely resemble Rocky Mountain spotted fever that they are generally regarded as varieties of that disease. The illustrations on the panel show the typical topographical extremes under which these infections may occur, ranging from open plain country to the foothills of the Rocky Mountains. The importance of this group has declined since the introduction of antibiotic therapy, which greatly reduces their mortality.

Fièvre boutonneuse occurs in the Mediterranean Basin and is conveyed to man by the dog tick *Rhipicephalus sanguineus*. The typical eruption is shown in coloured illustrations, black and white prints being used to demonstrate the histology of the skin lesions.

African tick typhus is a group of rickettsial infections found in tropical Africa and South Africa. The infection is transmitted by *R. sanguineus* and by other ticks such as *Amblyomma hebraeum*. The characteristic effects of this infection have been mostly studied by experimental means, as the mortality is very low. The typical rash is illustrated and the terrain associated with the infection is also shown.

Accounts of North Queensland and Asiatic tick typhus complete the description of the tick-borne rickettsial diseases. The limited distribution of these two infections are illustrated, the suspected vector in the case of North Queensland tick typhus being *Ixodes holocyclus* and of the Asiatic variety, *Dermacentor sylvarum*.

Mite typhus, frequently called Japanese River Fever or scrub typhus, was of considerable importance in the Far Eastern theatre during World War II. A large panel is devoted to the epidemiology of this condition (Fig. 37). The chief anatomical features of trombid larvae are shown in a diagram and there are pictures of adult *Trombicula akamushi*. The life cycle of a trombiculid mite is shown from the ovum to imago in a series of seven coloured diagrams. A print shows a typical fringe of forest in Malaya, a habitat favourable to rodents and their trombiculid ectoparasites. A coloured diagram shows the course of a clinical attack; the eschar of scrub typhus and the histology of the lung and trachea are illustrated. The changes in the vascular system resemble those of other rickettsial infections and are demonstrated by prints. *Trombicula akamushi* can be seen on an ear from the field mouse *Microtus montebelli*.

Rickettsial pox, an infection of house mice, is transmitted to man by the bite of a mite. The causal organism is *R. akari* and the mite most concerned is *Allodermanyssus sanguineus*, illustrated at a magnification of 100.

Louse-borne typhus is the classical form of typhus, for many years a world-wide scourge, particularly in times of war, famine or other disasters. The causative organism is *R. prowazeki*, shown in the cytoplasm of cells from the mid-gut of a louse and in the yolk-sac of a chick embryo. The life cycle of the organism is shown diagrammatically. The two species of lice commonly involved, *Pediculus humanus corporis* and *Phthirus pubis* are illustrated and coloured originals show the environments in which lice flourish. The develop-

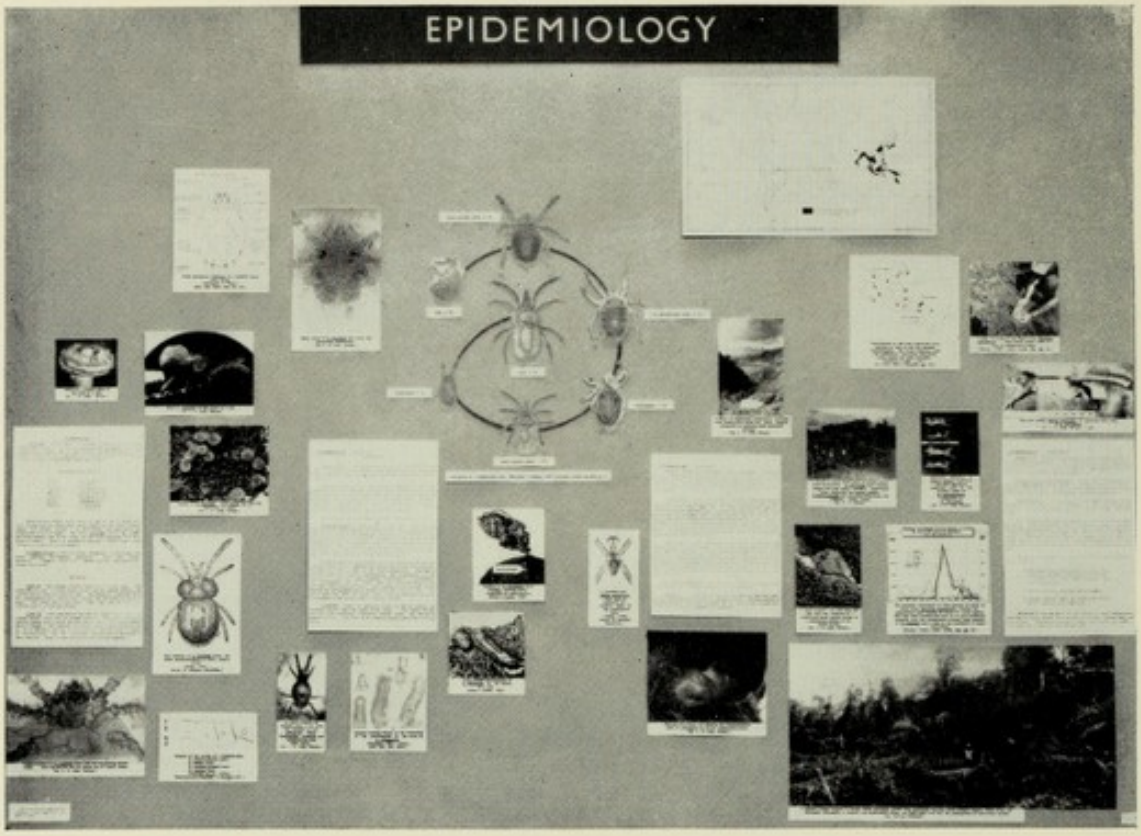

Fig. 37 A panel showing the epidemiology of mite-borne typhus

ment of the louse from egg to adult is shown, and a colour chart indicates the major clinical features. Prints show the changes in the capillaries and small blood vessels, characteristic of a rickettsial infection, which lead to the formation of Wolbach's nodes. Modern methods of prevention are illustrated.

A model of *Pediculus humanus* at a magnification of 135 is displayed with male and female specimens, mounted in Perspex. An unusual display here is a small tube containing 1·12 gm of louse faeces, the amount which will be shed by about 4,400 lice in a day, and sufficient, were they infected, to convey typhus to 10,000 people.

Flea-borne typhus, due to *R. mooseri*, is cosmopolitan, being maintained among rats by blood-sucking fleas such as *Xenopsylla astia* and *X. cheopis*. In lice the species *Polyplax spinulosa* and in mites *Liponyssus bacoti* are also infected in nature. On the panel a drawing of *X. cheopis* is shown at a magnification of 60, with a coloured diagram of the cycle of transmission of *R. mooseri*.

The causal organism of Q fever is *Rickettsia burneti* and its appearance is shown in an electron photomicrograph at a magnification of 50,000. The vectors are various species of tick, 22 in all having been incriminated. The only wild animal found consistently infected is the common bandicoot of South Queensland, *Isoodon torosus*, a picture of which is shown. A series of

radiographs are shown, illustrating the radiological course of the disease from the 5th to 28th day, the picture being indistinguishable from that of atypical pneumonia. On the display shelves are specimens of *Haemaphysalis bispinosa ; Boophilus annulatus microplus* and *Ixodes holocyclus.*

GENETIC ABNORMALITIES

Modern research has brought to light many inherited disorders of great significance to medical scientists, anthropologists and biologists generally. The day is still awaited when sufficient space will be available to devote a section to these fundamentally important conditions. Meanwhile, reference is made simply to a few of them which are of interest to the tropical practitioner.

Within recent years haematological techniques have elucidated the cause of a wide group of congenital haemolytic anaemias due to the inheritance of abnormal types of haemoglobin. Some of these techniques, and methods of demonstrating the sickling phenomenon are described on an introductory panel. A coloured map shows the world distribution of haemoglobin S and a diagram indicates its pattern of inheritance. The display goes on to show the characteristic habitus and facies of patients with homozygous sickle-cell disease, and the changes in the size of the liver and spleen which occur during life are shown in a series of photographs. Radiographs show calcification of the spleen and skeletal changes. Histopathological changes in viscera are also demonstrated.

Since Cooley described thalassaemia in 1925 its racial and geographic incidence has been disclosed by reports, as shown on a distribution map. The various grades of clinical severity are described, with photographs of patients. The appearances of the skull and limb bones are shown radiographically, and photomicrographs demonstrate the abnormal blood picture.

To describe all the known abnormalities of haemoglobin, their genetic combinations and clinical effects is beyond the space available, but the commoner haemoglobinopathies, due to haemoglobins C, D and E are mentioned and illustrated, if only to show the potential range of the subject.

An account of blackwater fever is included here, owing to its possible relationship to glucose-6-phosphate dehydrogenase deficiency. Specimens show the effects of blackwater fever on kidneys, liver and other organs, and samples of urine show the variations in methaemoglobin excretion which may occur during 24 hours.

Kuru, the 'trembling sickness', is the name applied by natives of the Fore tribe in New Guinea to a degenerative disease of the central nervous system which is fatal, usually within a year of its onset. First reported in 1957 by Zigas and Gajdusek, kuru continues to be investigated and evidence suggests that it is genetically determined.

The unique geographical isolation of kuru is indicated on a small-scale map of Australian New Guinea. A large-scale map shows the cultural and

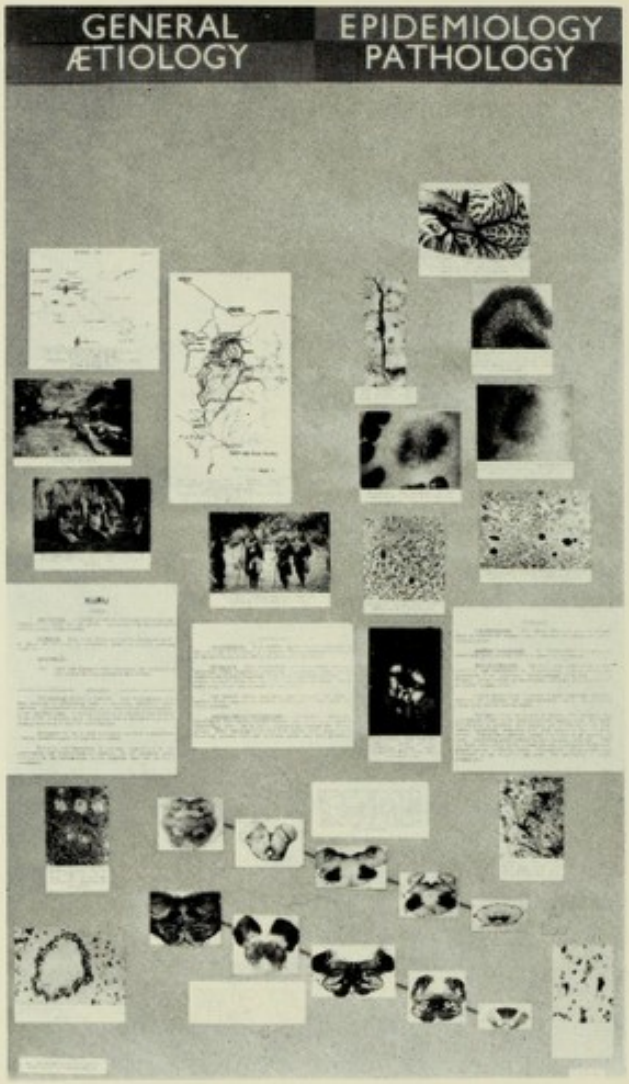

Fig. 38 The first panel of the display on kuru

linguistic groups in the region where kuru is endemic. Coloured photographs show typical Fore village scenes. Black and white photographs show the characteristic pathological changes in sections of the central nervous system (Fig. 38). Coloured photomicrographs demonstrate these changes when special staining methods are used. Clinical photographs of patients, exclusively women and children, show the manifestations of kuru in all stages.

MEDICAL ZOOLOGY

The exhibition of small mammals is one of the most recent displays in the Museum. Hitherto, stuffed animals have been shown in only one or two small sections but as part of the medical zoology section, actual specimens are a prominent feature. To accommodate this type of material, museum cases of conventional style have been used, fitted with fluorescent lighting.

The aims of the mammal exhibit are to present a broad outline of groups

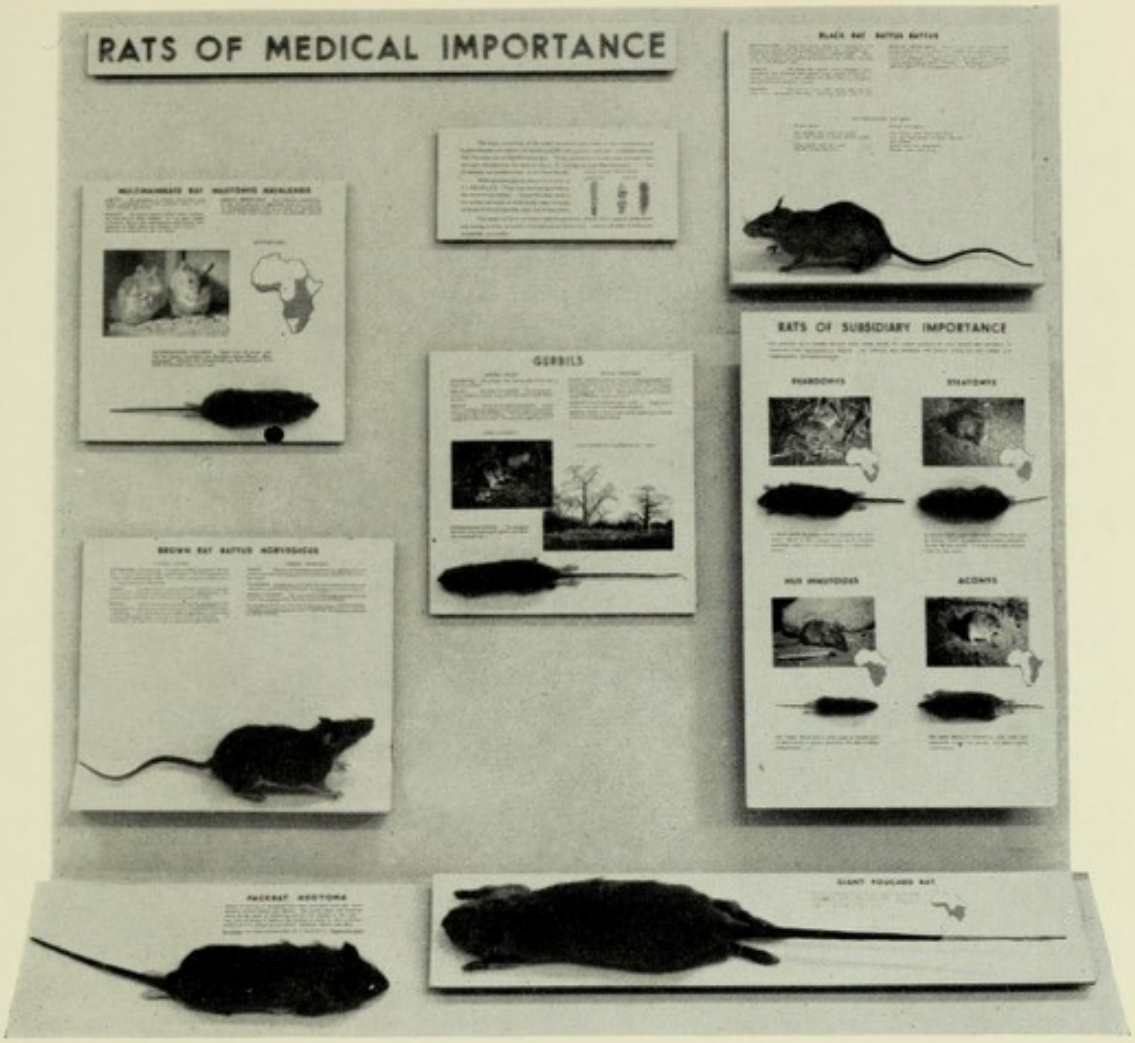

Fig. 39 Part of the display on small mammals of medical importance

concerned with the transmission of human disease and to facilitate the identification of the most important species. The specimens are generally arranged according to the classification of the mammals themselves rather than according to the diseases they carry, although separate panels illustrate reservoir hosts of diseases such as sleeping sickness and yellow fever. Each family or important species is allotted a separate panel containing a representative specimen, distribution map and text. Owing to the present dearth of suitably mounted specimens, a number of study skins have been used as a temporary measure, but where possible these are supported by photographs of living animals.

Following an introductory classification, a large wall case illustrates families of mammals which have been incriminated as vectors or reservoirs of human disease. A separate display of rats has been incorporated owing to their paramount medical importance (Fig. 39).

The mammal exhibit is followed by a short account of venomous marine animals, including the stonefish and sea snakes which are of particular

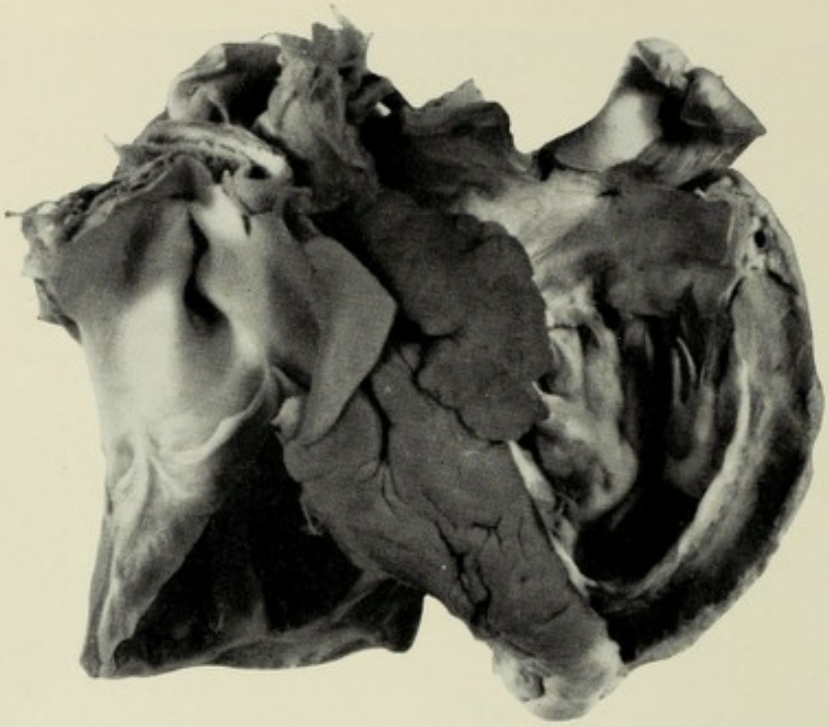

Fig. 40 One of several specimens showing the effects of endomyocardial fibrosis

importance in certain tropical waters. This is followed by an account of poisonous terrestrial snakes with particular emphasis on the identification of the mixed genera, and the treatment of envenomation. The Museum possesses a large collection of these reptiles, but shortage of display space permits only a small section of it to be exhibited.

The medical zoology section ends with an account of arthropods, other than vectors of disease, which inflict damage upon human tissues in various direct ways. The section includes specimens of and accounts of urticating caterpillars, scorpions, spiders and the myiasis-producing Diptera. The section is completed by short accounts of the chigger flea, *Tunga penetrans* and the itch mite of scabies.

OTHER EXHIBITS

An outline of the structure and administration of various international agencies concerned with the welfare of tropical peoples is described on swinging screens. These establishments include the World Health Organization, the Food and Agriculture Organization and the United Nations International Children's Emergency Fund.

A short account is given of endomyocardial fibrosis and this includes specimens of the heart from African patients who have succumbed to this condition, the aetiology of which has yet to be established (Fig. 40).

Fig. 41 General view of the 'Twenty Questions' display

There is a small exhibition on diabetes mellitus, now known to be a disease of cosmopolitan distribution. The displays include photomicrographs showing pancreatic histology and devices used for the guidance of patients who require adjustment to the diabetic life.

Diagnostic exhibits are displayed from time to time, whereby serious students may test their knowledge against a collection of unknown material. These exhibitions are presented under the general title of 'Twenty Questions' and include clinical illustrations, photomicrographs, and pathological specimens (Fig. 41). New acquisitions are usually introduced to students in this way.

Chapter 3

MUSEUM TECHNIQUES

DISPLAY PANELS

The panel on which display material is mounted consists of a six-sheet hard white mounting board. The two main sizes used in the Museum are 42 in. × 20 in. and 42 in. × 26 in. Both sides of the board are painted with a medium grey egg-shell finish oil paint, after the surfaces have been primed with a coating of shellac. The panel can be used repeatedly by repainting each of the surfaces up to three times.

The illustrations consist of photographs, charts, maps, and drawings and most panels also carry typewritten summaries. These materials are usually paper or thin card. The photographs are printed on single- or double-weight paper, and when black and white photographs are used an unglazed glossy paper, giving a semi-matt finish, is desirable. The paper used for summaries is Dover Snow White, double medium paper, opaque offset. Summaries are typed to a six-inch length of line with an IBM electric machine, and the right-hand edge of the script is justified, to make for easy reading. Charts, maps and drawings that happen to be on very thin paper are 'backed' with paper or thin card before mounting on the panel.

Heading labels for each panel consist of white letters on a coloured ground embodying the aetiological colour scheme adopted throughout the Museum. These are silk screen printed and are set on thin card.

Six types of adhesive are used in panel work, and each has its own particular purpose. They are 'Cow' rubber gum, 'Clingfast', 'Scotch brand' double-coated tissue No. 400, Johnson's Mountant paste, dry mounting tissue, and 'Polycel'.

'Cow' and 'Clingfast' are used for labelling charts or diagrams with inserts or overprints. The reason for this choice is the speed with which they can be used, and their lack of interference with the viewing surface. The double-coated tissue No. 400 is our method of choice for the mounting of display material on painted panels. On exhibition the panels are under glass, which overcomes the possible tendency of this adhesive to dry out after a year or two. One advantage of this method is that the mount remains flat on the panel at first intention and with care it can be removed without damage to the illustration. Two widths of this tissue are used, ½ in. and 1 in., the latter being used for large mounts. The method of using this tissue is to press it

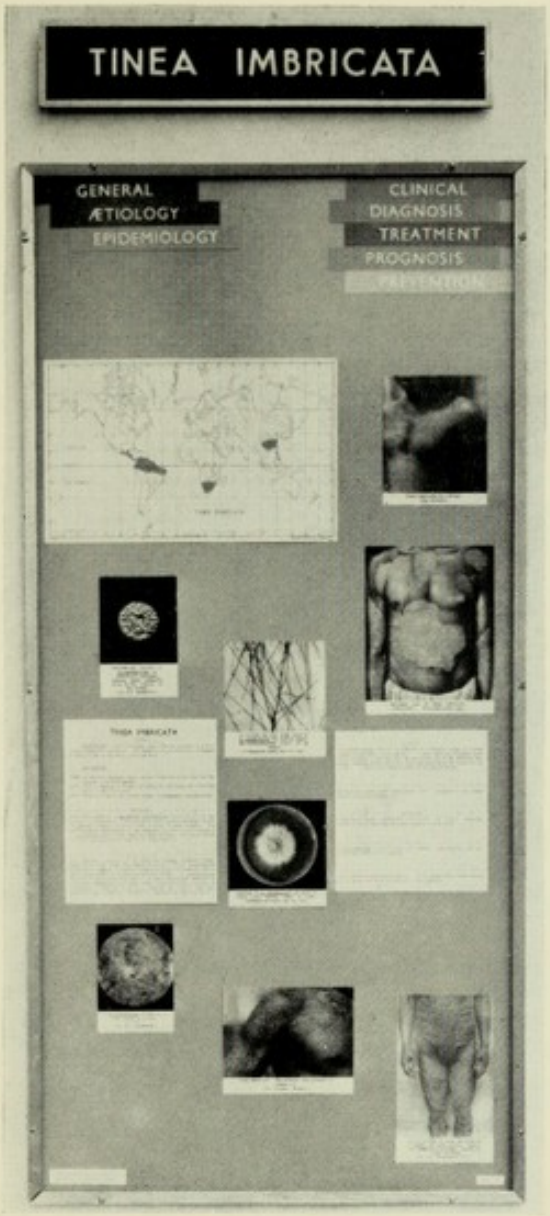

Fig. 42 Distribution of display material on panel

along the edges of the back of the illustration, and, if necessary, across the centre, lift up the protecting plastic film at one corner with a mounted needle or a pointed tool and peel it off. The illustration is then turned over, pressed into position on the panel and the mount is finished.

Dry mounting tissue is useful for permanent mounts and requires heat and pressure for its application. This can be done by hand with an electric iron or by a press made for the purpose. It is most useful for fixing thin illustrations to thin card before panel mounting, or for fixing to the panel direct when permanent unglazed panels are to be exhibited. Johnson's Mountant paste can also be used for this purpose.

'Polycel' is useful for sticking large areas of paper permanently to panels, such as is done to change the colour of all or part of the background. Its

advantage is that any excess of paste which inadvertently finds its way to the viewing surface during application will not be visible if simply left to dry.

The object is for the final panel to have a pleasing overall effect rather than to present a geometrically balanced creation. To achieve this, several considerations must be applied. Overcrowding must be avoided and 'breathing space' provided for each picture. The choice of material to be shown needs considerable thought. Variety of illustration is necessary together with variety of size. Above all, the illustration must make the point indicated by its label (Fig. 42).

The summaries are of main importance and are positioned in the middle of the visual study belt, the centre of which is 60 in. from the floor. The belt extends for 10 in. above and for 20 in. below this level and material that requires detailed examination should be placed within these limits. Theoretically, this visual study belt is in the range of eye movements only, thus reducing fatigue to the viewer. With this in mind, summaries are the first things to be positioned on panels, and following this the illustrations are placed as near to their reference in the text as convenient. Large pictures, charts or maps are then placed above the study belt (Fig. 43). If it is necessary to have a series of pictures that illustrate steps of a technique or a sequence of events and must be grouped together, a thin connecting line or arrow is used from picture to picture, to indicate the direction that the eye should follow. Such a group should be staggered into a flowing order, and not simply placed in a straight line.

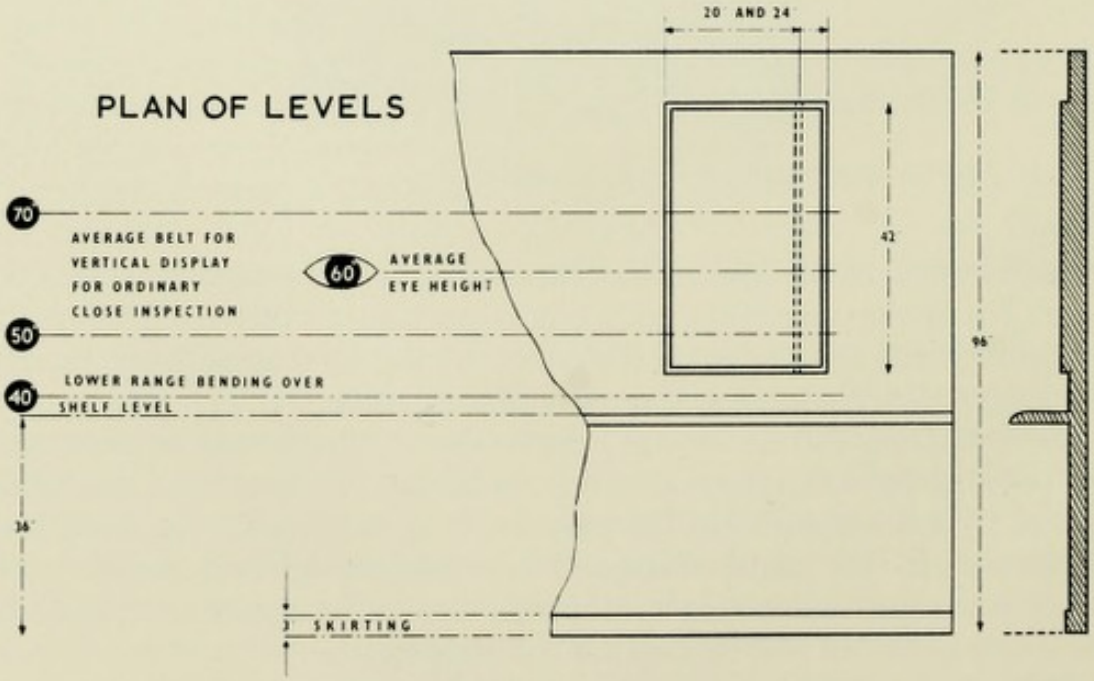

Fig. 43 Diagram showing the method of calculating display levels

Glass is used for protection. Apart from being a barrier against dust and exploring fingers, it also gives a certain degree of protective screening to the coloured photographs from overhead light. Ordinary clear glass gives unsightly reflections, but is largely overcome by using diffuse reflection glass.

The glass is held in place by a frame made from four pieces of wooden beading, which are aluminium-painted and attached to the screen or wall by means of 1 in. No. 6 chrome-plated screws. Ten of these are sufficient to hold the frame in place. The simplicity of this attachment allows the panel to be changed easily when necessary. After loosening only five screws, at the top and one side, both glass and panel can be removed.

Apart from the large label at the top of each panel, every picture carries a legend which is usually attached to the illustration. If one legend belongs to a group of photographs, it is placed in such a position that there can be no doubt as to what it describes. These legends are usually typed, but are sometimes printed on an 'Adana' machine, a fount of Gill Sans being used. The source of every illustration is acknowledged.

Panels for outside exhibition follow the general pattern, with one or two exceptions. They may have to be of different dimensions and usually need to be mobile and therefore it is inadvisable for them to be glazed. Another method of protecting the illustrations is thus called for. Several transparent materials are available for this purpose, but the one commonly used is 'Filmolux'. It is a self-adhesive transparent film which, after removal of the protective coating, is placed directly over the surface of the picture without the use of heat. It is reputed to be water, spirit and oil proof and does not shrink or yellow with age.

As a guide to the contents of the Museum, it is necessary to label subjects within the bays and groups of panels. This is done by pinning white plastic letters on 'Sundeala' board painted grey, edged with a thin aluminium painted stripe to match the beading of the panels below, and cut to a suitable size. The letters are made with 'Ceemar' resin to which a white filler has been added. This is poured into permanent moulds made of 'Verone', a dental impression material, and when the plastic is near gelling-point, very small pins are pushed into it, leaving the points protruding from the back of the letter. This enables it to be fixed easily to the soft 'Sundeala'. The letters can be used repeatedly. Letters of choice are fashioned from Perspex or linoleum to make the original mould.

MUSEUM PHOTOGRAPHY

As in most teaching museums, photography plays an important role in the preparation of display material and in record keeping. The demands of internal and external exhibitions necessitate a full-time photographic unit equipped for all kinds of processes.

The department is called upon to prepare much original material which is often of a specialized nature, such as photomicrographs, macrophotography of living creatures, and illustrations of pathological specimens and clinical subjects. The processing of all monochrome and most of the colour pictures is done by the unit, which has two fully equipped dark rooms.

Although black and white pictures are the main source of illustrative material, whenever possible colour pictures are being introduced. The production of these is now relatively simple, compared to the first experiments with colour in the Museum during the 1920's. Experience has shown that standardization of material is an important asset to efficiency, and, apart from occasional requests for peculiar sizes, two standard types of negative material are used, namely 35 mm. miniature and 5 in. × 4 in. sheet film.

General photography covers many items including studio pictures of all types of subjects; museum apparatus, museum techniques, exhibition stands and historical objects, pictures of new exhibits, revised bays, and occasionally eminent visitors, as well as photography at scientific and medical institutions, such as hospitals, other museums, and zoological gardens.

A permanent bench has been constructed for precision copying from books, photographs, charts, diagrams and manuscripts. The camera is a standard square bellows type using a 5 in. × 4 in. sheet film which has been found preferable to glass plate. Not all such material is of the standard required for exhibition in the Museum, and a considerable amount of retouching, blocking out and general restoration is done. From black and white copy negatives, file prints, enlargements, lantern slides and miniature slides can be made.

Large format colour copies of both the neg-pos and transparency types are also made, great attention being paid to correct exposure and handling of material.

For the copying of 35 mm. colour transparencies a special apparatus has been devised using a 35 mm. single lens reflex camera and electronic flash. The results have proved most satisfactory and a report of this apparatus has been published.

Each newly-acquired specimen is photographed and a half-plate print made for the catalogue. When the present system of recording was evolved there was a backlog of approximately 2,000 specimens to be photographed, and it was found convenient and economical to use 35 mm. film. Occasionally subsequent pictures are taken of parts of the specimen to illustrate particular details.

Photomicrographs are made in the department on a Cooke, Troughton and Simms photomicrographic camera (Fig. 44). This is basically a high quality microscope plus a quarter-plate camera fitted with a shutter. The maximum magnification on the screen is ×2,000, but this can be enlarged during printing. For black and white a medium speed, fine grain panchromatic film such as FP3 is used, and for colour Ektachrome type B. If 35 mm. slides are required it is usual to make a quarter-plate master copy and then

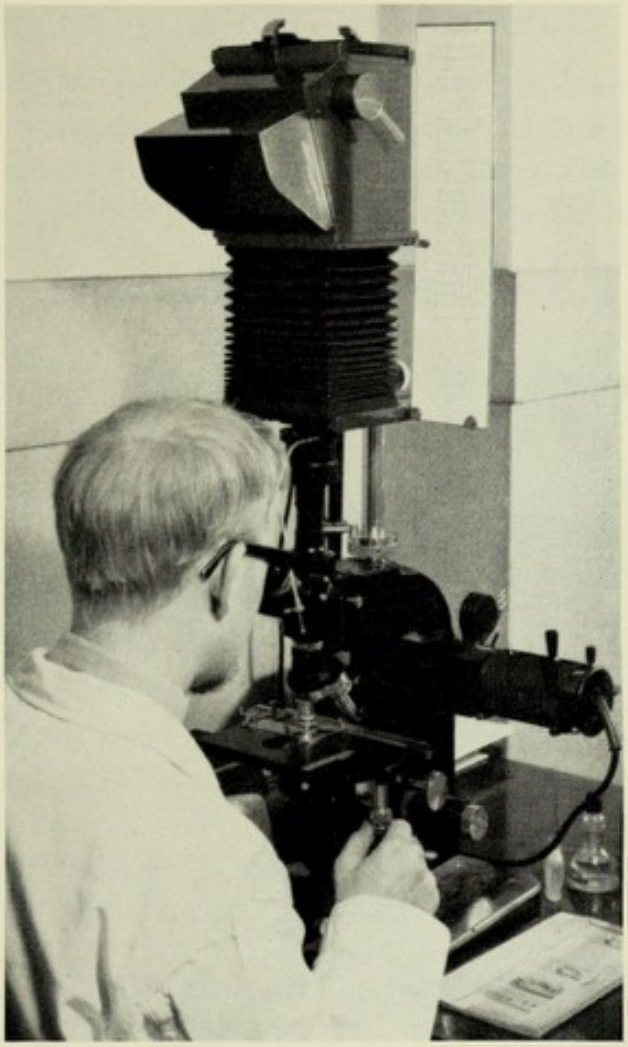

Fig. 44 Photomicrograph apparatus in use

reduce optically on the apparatus previously described. This method seems to give the best resolution and any case may be corrected by the use of colour correction filters.

Macrophotography, the enlarging of small objects by using short focus lenses, is applied to subjects such as insects, snails, and large helminths that are too large for the ordinary microscope. These are usually photographed on a 35 mm. single lens reflex camera with an enlarging bellows unit extended to give approximately three magnifications on the screen. This long bellows extension demands a strong light source, usually provided by an electronic flash close to the subject. This has the advantage of overcoming problems of movement, especially in the case of insects.

Clinical photographs are of great teaching value. Exposures are made by electronic flash, on a 35 mm. single reflex camera. This saves the trouble of taking large lighting equipment into busy wards, and standardizes the exposure.

The techniques for the display of specimens in the Museum fall into three groups, dry, fluid and solid mounting, the latter being at present used only for helminthic and entomological specimens. The ways of preserving pathological material are still, unfortunately, largely empirical; the two methods used are a modification of Kaiserling's method and Wentworth's technique.

The source of our specimens varies considerably, much reaches us from overseas and many specimens are already fixed. Owing to the time that they are in fixing fluids before we receive them, the choice of mounting method is often pre-determined.

The Modified Kaiserling Technique

This has stood the test of time and specimens displayed by this method still resemble the original after many years.

Specimens should be fixed in solution A from 2 to 10 days according to the size and the material. The specimen should be placed in a position approximating the final mount before the fixing solution is added, and ample fluid should be used. Large dense organs such as liver can be injected with the fixing solution to help penetration and speed up the process. The final dissection is then carried out and, after washing in water, the specimen is placed in methylated spirit to restore colour. The spirit should not be less than 85 per cent. The time for this restoration of colour again varies according to the material and size, and can be from an hour to 24 hours to obtain the maximum change. At this stage, the specimen should be closely watched as too long in spirit may reduce the amount of colour restored. The specimen is now placed in solution C until required for mounting and is finally mounted in a fresh quantity of the same solution. The formulae are as follows:

Solution A	Potassium acetate	40 gms.
	Potassium nitrate	20 gms.
	Tap water	1,600 ml.
	Formalin	400 ml.
Solution B	Methylated spirit	
Solution C	Sodium acetate	100 gms.
	Tap water	700 ml.
	Glycerine	300 ml.

Add slowly, while stirring, 2 gms. of camphor dissolved in 5 ml. of spirit. The precipitate will largely redissolve within 48 hours. The solution is then filtered and stored in filled containers.

The Wentworth Technique

Although this method gives pleasing results, even with overfixed specimens, it tends to give false colours in certain cases. Nevertheless it is useful for specimens that have been fixed too long, and for dense material that requires long fixation. It is possible to store specimens for long periods in Solution 1 and yet obtain good results.

Specimens are fixed in Solution 1, which consists of:

Formalin	100 ml.
Sodium acetate	40 gms.
Water	1,000 ml.

When the specimen is fixed and ready to be mounted its pH is tested, and if it is more acid than 6·5, it must be placed in Solution 2, made up as follows:

Formalin	10 ml.
Sodium acetate	40 gms.
Sodium phosphate tribasic	1 gm.
Water	1,000 ml.

This solution has a pH of about 9·5. The specimen should remain in it, the fluid being changed periodically, for 2 to 7 days until a constant pH of at least 8·5 is attained. The specimen is then placed in Solution 3, which is also the mounting solution, made up as follows:

Formalin		10 ml.
Sodium acetate		100 gms.
Sodium phosphate		1 gm.
Glycerine		200 ml.
Water	to	1,000 ml.

Sodium hydrosulphite in a proportion of 3 gms. to every 1,000 gms. weight of the specimen is added to the fluid immediately before the container is sealed.

If, after fixing, the pH of the specimen is 6·5 or more, it may be mounted directly in Solution 3.

Display

When specimens for teaching are to be displayed, certain criteria should be borne in mind. The specimen must be easily seen and recognizable, mounted so as to be handled without risk of damage, and appear as attractive as possible without distracting influences. To these ends, acrylic sheet (Perspex) plays a big part in our display methods owing to the ease with which it can be shaped and jointed. It is used for dry and fluid mounts. Dry mounts vary from making a simple base for a wax model or a stand to hold a viscerotome, to containers to hold specimens of bone or insects mounted on pins. Containers for fluid mounts are made to fit each individual specimen, following

the Duguid and Young technique (Fig. 45). The method makes use of the thermobending property of Perspex and reduces the jointing to three stages. A strip of Perspex which forms the thickness of the container is bent at right angles in two positions after an application of heat at the corners, thus forming three sides of a rectangle. After smoothing the edges, another sheet is adhered to each side by softening with ethylene dichloride, and a container with one open end is made. The specimen is positioned inside and a base is applied in the same way, after which the preserving fluid is run in through a small hole until the container is filled. The hole is plugged and the mounted specimen is ready for exhibiting (Fig. 46).

Jointing is the most intricate part of the procedure. A 5 per cent solution of Perspex dissolved in chloroform provides a substance for jointing Perspex rapidly but has little filling property, and the surfaces to be jointed must be close-fitting. This method is recommended only for small areas with little or no tension on the joint. The joint tends to become less secure with age.

The use of ethylene dichloride, a solvent of Perspex, is a slower method for jointing but has the advantage of being more of a weld and will remain strong for many years. One of the surfaces should be soaked with ethylene dichloride for 10 to 15 minutes. The area then becomes soft and semi-solid and is clamped or weighted in position for several hours, preferably overnight. This method has reasonable filling properties.

Tensol Cement No. 7 (ICI) is a jointing material with excellent filling properties, and requires a catalyst to polymerize the cement. The joint is complete in about four hours. One disadvantage is the appearance of 'bubbles' during polymerization, but it is used for large surface-to-surface jointing (Fig. 48).

Labelling

Various plastics, mostly the polyester types, are used for labelling specimens, making letters for heading labels, and for embedding specimens.

Labels are either typed or printed, cut to size and soaked in a dish of chloroform while the finger is gently wiped over the lettering to dislodge loose particles of ink. Half a minute is usually sufficient. The label is at once dried by blotting. This is most important with typed labels, which should never be left to evaporate as the dye from the letter will permeate and discolour the paper. The label is then placed in a solution of Perspex dissolved in chloroform and allowed to soak for several minutes. It is then quickly placed, face down, on a thin sheet of Perspex, rather larger than the label, and squeezed with the finger or a felt pad to remove minute bubbles between the surfaces. The surplus fluid that is extruded is gathered back over the label and evenly spread so as to retard the drying time. When the label is completely dry, it can be covered with a cellulose paint, to form a smooth back which will remain clean. Finally, the label is trimmed to size (Fig. 47).

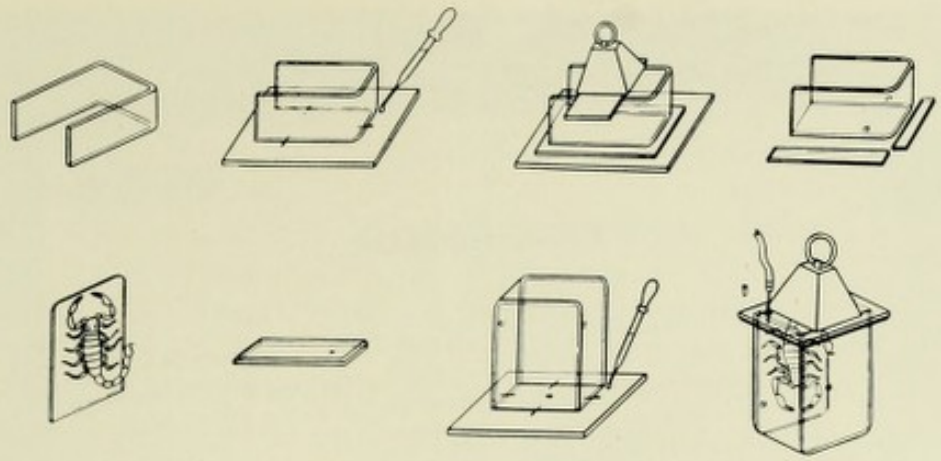

Fig. 45 Diagram showing steps in the preparation of a simple Perspex container for Museum specimens

Fig. 46 A finished container with specimen mounted inside

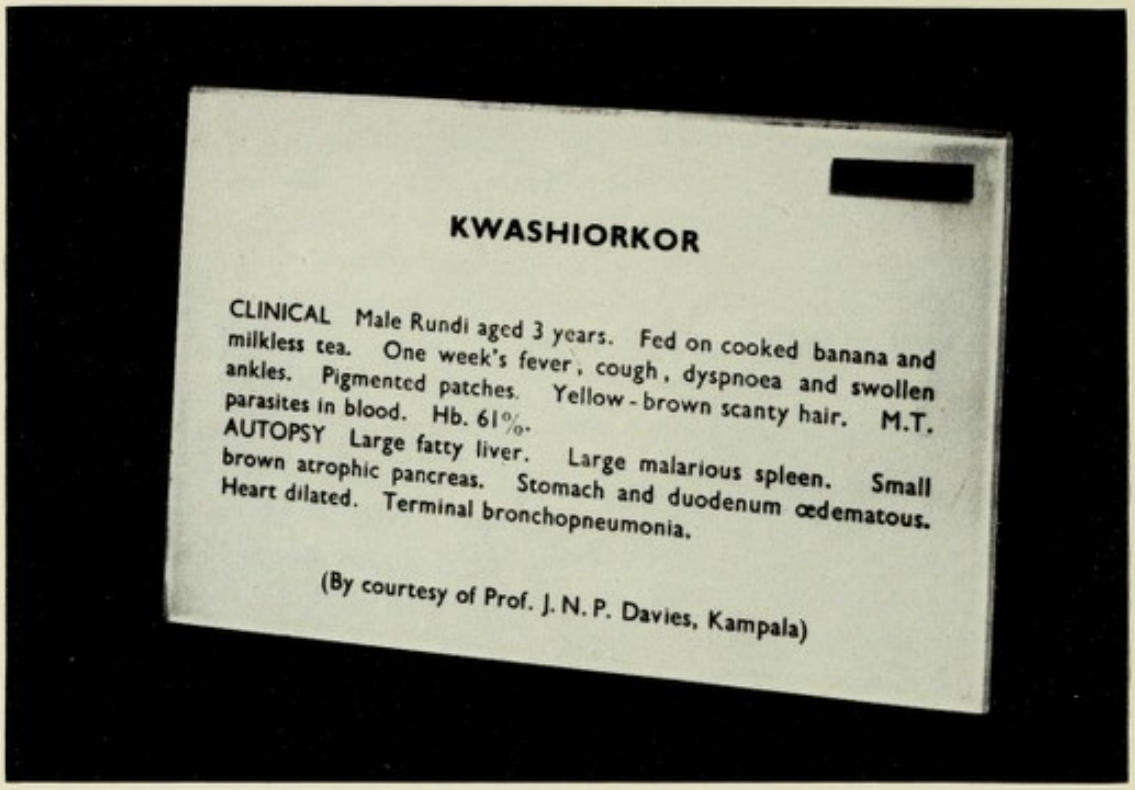

Fig. 47 A characteristic Museum label for a pathological specimen

Solid Mounting

Clear plastics for the embedding of specimens fall into two groups, namely the acrylic resins, which necessitate the complete dehydration of the specimen, and the polyester resins that tolerate small amounts of water without becoming milky, although they require the surface of the specimen to be reasonably dry.

The acrylic resin mostly used is 'Kaladok' (Imperial Chemical Industries), and a description of a possible technique was given by Hackett and Norman (1950).

The polyester resins that may be used are 'Marco Resin 26C', 'Ceemar', 'Turtox', 'Castolite' and Ward's 'Bio-Plastic'. All of them have the property of gelling at room temperature, produce an exothermic reaction and they shrink on setting. Otherwise they vary in colour and viscosity, catalyst, time of polymerization and temperature requirements. Of this group of resins, the last three mentioned vary only slightly in colour and all have their origin in America, while the others are British.

In our hands the best all-round resin is 'Castolite' which is obtained from Stockholm.

The principles of embedding with these resins are similar in each case. The mixture of resin and catalyst and possibly accelerator, as suggested by the manufacturers, is poured into the mould to form the lower portion of the

finished block. This is allowed to gel, usually at room temperature. The prepared specimen is now placed in position and a small quantity of fresh resin mixture is poured over and around it and allowed to gel to anchor the specimen. Finally, a fresh mixture is poured to cover the specimen completely. This completes the block.

The first consideration is the mould, which may be of glass, polythene, or, as used in this Museum, Perspex. With glass, a mould release should be used; this is not necessary with polythene, as the final block, shrinking away slightly from the mould, can easily be removed. A Perspex mould can be quickly made to the required size and shape and allows complete visual inspection during all stages of embedding. It can also be cut with the final block. A coloured Perspex base can give a pleasing effect.

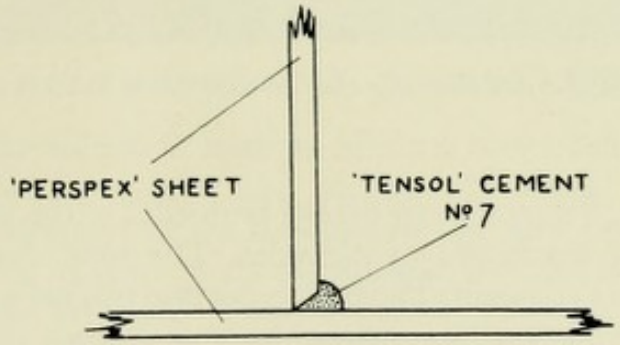

Fig. 48 A method of jointing Perspex sheets, edge to surface, utilising the filling properties of Tensol Cement

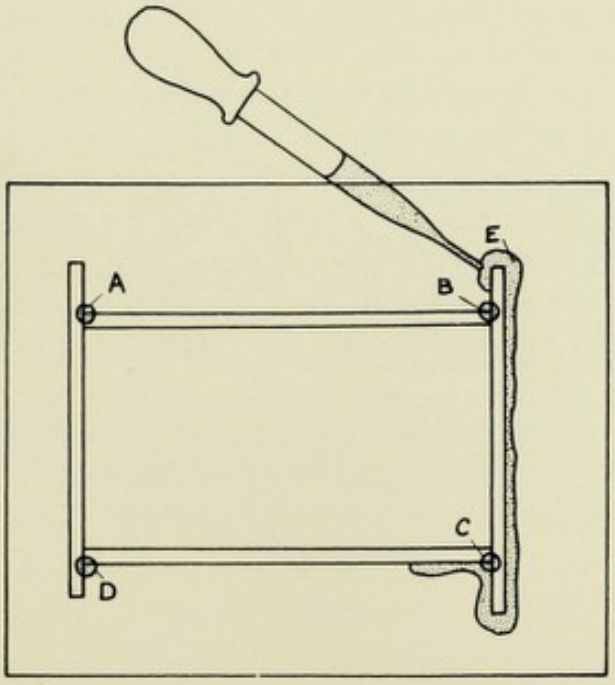

Fig. 49 The first drops of Tensol Cement No. 7 retain the sides of the mould in position at A, B, C and D. At E, Tensol Cement is added for the final sealing

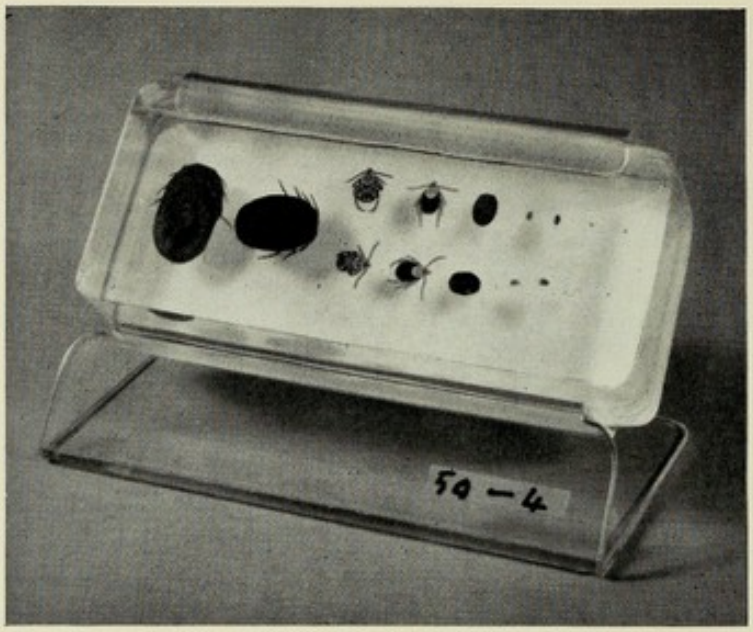

Fig. 50 The life cycle of a tick shown by specimens embedded in acrylic resin

A strip of $\frac{1}{16}$ in. Perspex is cut for the four sides of the mould, the width of the strip being the height of the sides. The base of sheet Perspex is slightly larger than the mould. The strip is cut into two pairs for the sides and placed in position on the base plate. Drops of Tensol cement No. 7 are allowed to run down the outer corners and between the surfaces to be jointed, to keep the sides in position. Finally, the mould is sealed by pipetting the cement along the outside edges of the mould and the base plate (Fig. 49).

This three-layer process is suitable only for small objects, such as entomological specimens, when the final block is a few inches square and no more than an inch deep. For larger and thicker blocks the number of layers has to be increased owing to the exothermic reaction. This reaction takes place when a large volume of the resin/catalyst/accelerator mixture is poured into a thick layer, and may accelerate to a point where the whole block becomes a hot, fractured mass, and the specimen is destroyed.

When a completed and successful block has been made, it is cut to size and shape with a plastic- or metal-cutting saw, sanded and polished to a transparent finish (Fig. 50).

One note of warning should be given. The final solid plastic block is insoluble in all known chemicals, so that if anything goes wrong during the embedding process, the specimen cannot be salvaged unless it is of stone or metal.

Chapter 4

COLLECTIONS

Among its possessions the Museum has a number of unique collections of original material of various kinds, such as paintings, drawings, models and specimens. Very few of these are to be seen on display, yet as a whole they form a considerable heritage of teaching and research value. It is hoped that detailed catalogues of these collections will eventually become available.

PAINTINGS AND SCULPTURE

The Manson-Bahr collection consists of many water colours of sigmoidoscopic appearances in amoebic and bacillary dysentery; paintings of the post-mortem appearances of the intestine in the same diseases; many pen drawings from his original work on filariasis in Fiji, and numerous line drawings of various protozoa.

A. J. E. Terzi was one of the finest entomological artists of his day and was employed at the British Museum (Natural History). The Museum possesses 33 large (24 in. × 12 in.) paintings of ticks and various Diptera, with many smaller paintings and line drawings of various insects (Fig. 51). Dr Daukes probably commissioned him to paint for the Museum about 1920 after seeing his work at the British Museum.

E. Schwarz (later Schwarz-Lenoir) was the first medical artist engaged by the Museum and he worked from 1914 to about 1926. Much of his work portrayed the epidemiological aspects of disease and he tended towards an effective, miniature style. Apart from his pictures which are displayed in the Museum, over thirty others are in existence (Fig. 52). He also painted clinical conditions.

Mr B. Jobling's collection includes his original line drawings for C. M. Wenyon's *Protozoology*, and many entomological studies which have been added to the collections. Mr B. Jobling is a leading entomological artist and has been actively engaged in the Wellcome Laboratories of Tropical Medicine since 1921. A great deal of his work is shown in the Museum.

Miss J. Jackson was medical artist to the Museum from 1934 to 1939. She painted clinical studies of various diseases, her 'models' being patients in hospitals. Twelve of her large paintings are in store and smaller ones are displayed in the Museum. She was commissioned to make dioramas on trypanosomiasis, hookworm disease, yellow fever and leprosy (Fig. 53), which

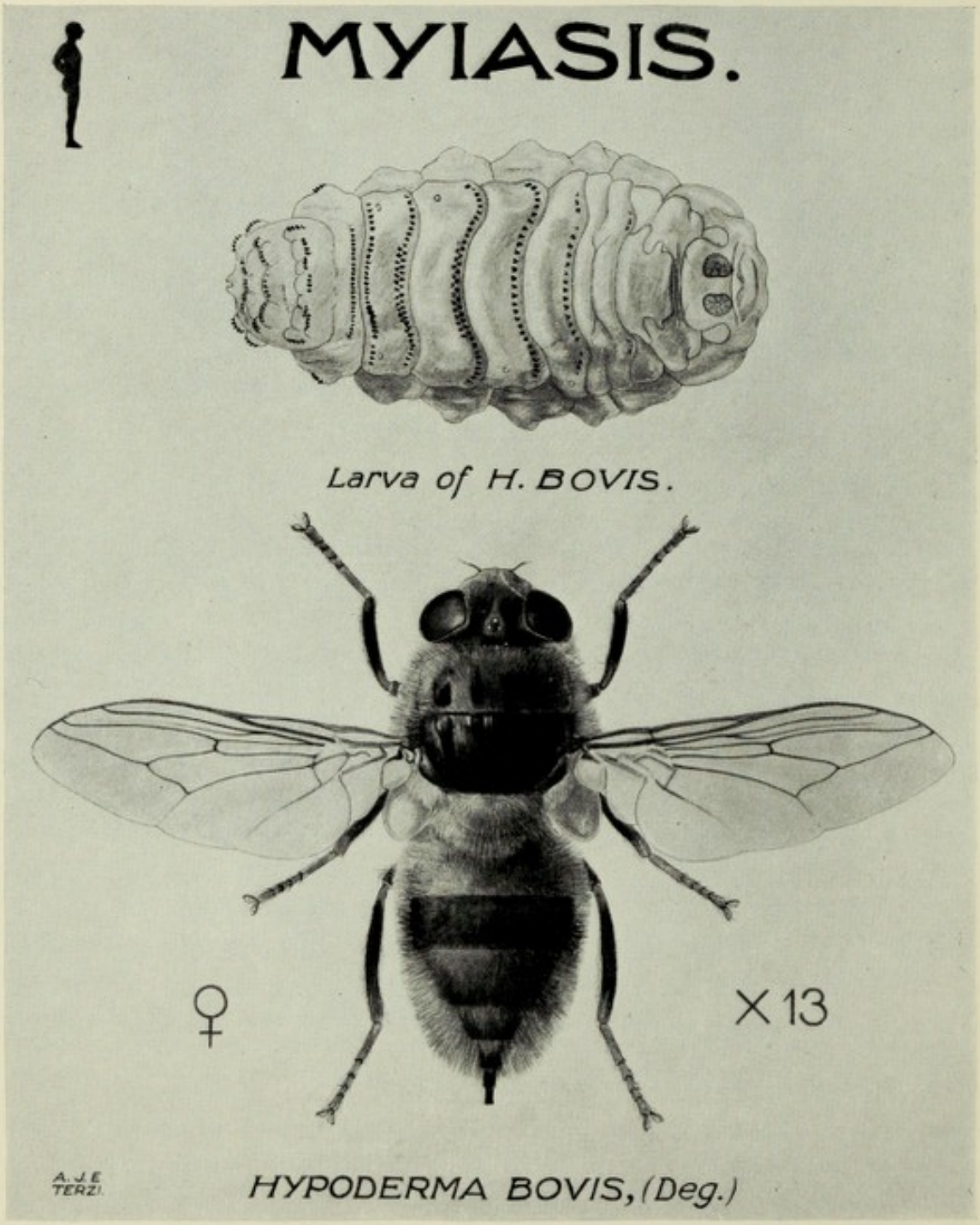

Fig. 51 Painting of Hypoderma bovis *by A. J. Terzi*

Fig. 52 Epidemiological study of hookworm infection by E. Schwarz

Fig. 53 Part of a diorama of a leprosarium by Miss J. Jackson

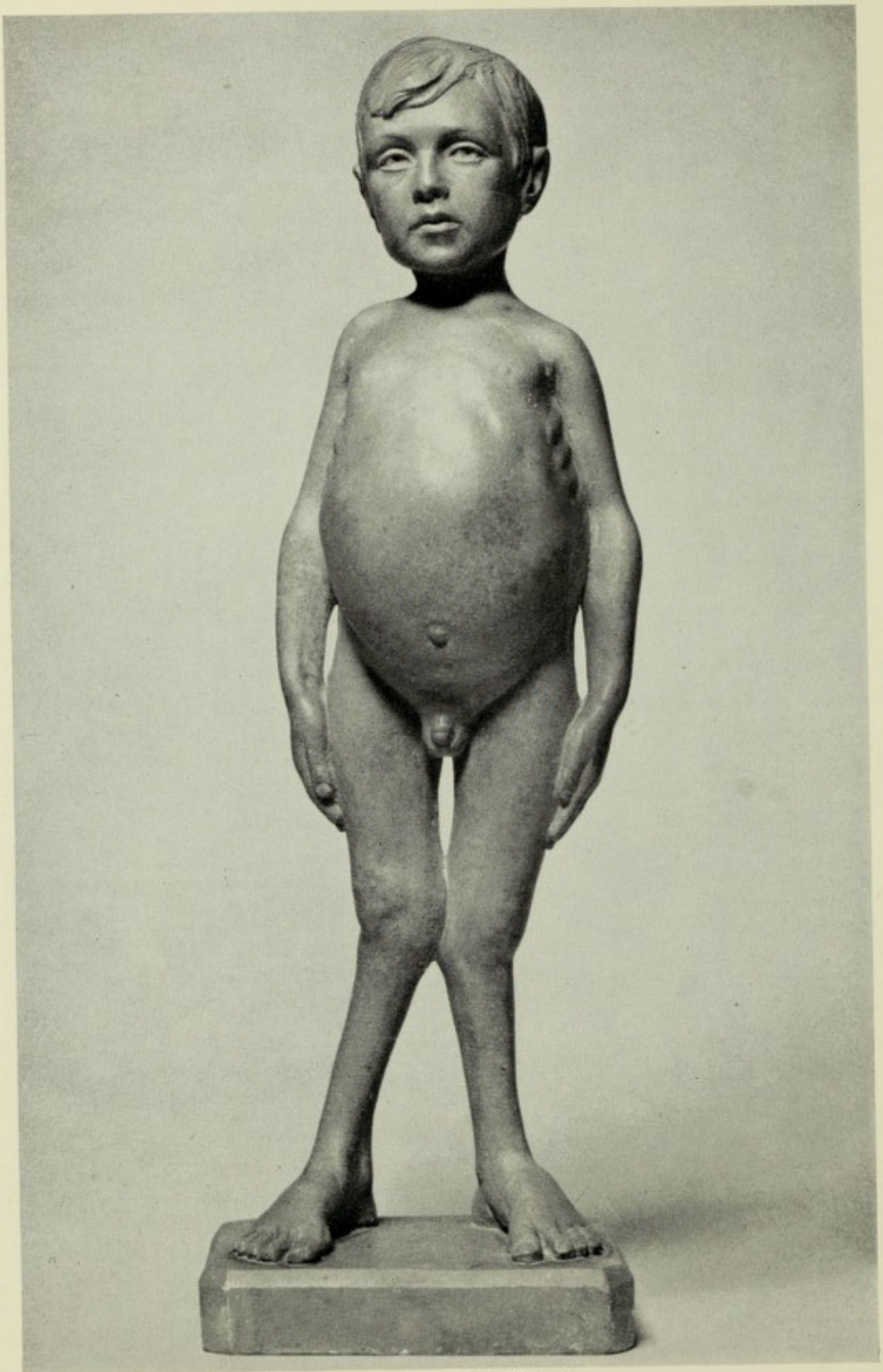

Fig. 54 *Plaster model of a case of rickets by Miss J. Jackson*

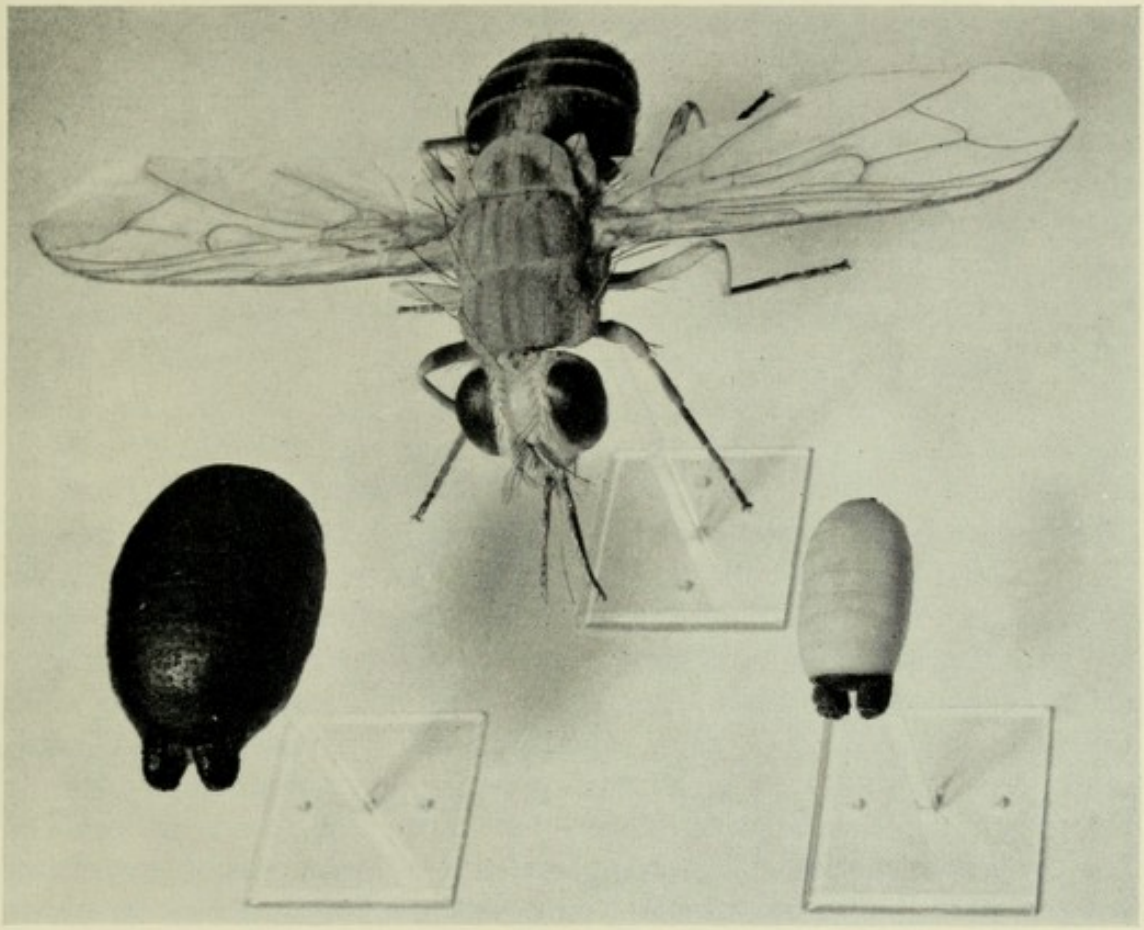

Fig. 55 Life cycle of a tsetse fly, modelled by Miss Grace Edwards

were used as 'arrest exhibits' in the Museum, but unfortunately have since been destroyed. From 1936 to 1938 she made many pen-and-ink drawings of nervous disorders from Sir J. Purves-Stewart's patients. Six of these pictures are still intact. She was also responsible for making plaster models depicting endocrine and skeletal disorders, of which there are 27 busts and 23 statuettes ($\frac{1}{6}$ life-size) (Fig. 54). Also there remains of her work four casts of arthritic hands, two of which are coloured, modelled after Dr W. S. C. Copeman's patients at the Red Cross Clinic, Peto Place.

WAX MODELS

Although wax models are somewhat out of fashion as instruments of museum teaching, several notable examples are to be seen in the Museum, including a series of nine life cycles of insects of medical importance, modelled at high magnifications by Miss Grace Edwards. Several of these were specially commissioned for outside exhibitions; the tsetse fly model (Fig. 55), was created specially for the Chicago Exposition. They are all outstanding

examples, not only of artistry but of entomological accuracy, and are to be found associated with the various diseases of which they are vectors.

The Museum possesses over 40 wax models of various clinical conditions although only a few of these, such as the guinea worm blister and a foot showing lymphostatic verrucosis, are at present on display. The majority are of German origin and were probably obtained by Dr Daukes as a result of his visits to museums at Dresden and Hamburg. It is possible that a few of them were modelled by Terzi from specimens at the Royal College of Surgeons Museum.

FORMER RESEARCH MATERIAL

The contact between the Museum and research workers in various parts of the world has led to the collection of important material pertaining to original investigations in both the field and the laboratory. The Museum possesses, for example, the original clinical charts of Sir Neil Hamilton Fairley's malaria experiments at Cairn, Australia; photographs and photomicrographs from Professor W. A. O'Connor concerning his investigations into filariasis in the West Indies; Dr O. D. Standen provided the photomicrographs from his work on the penetration of tissues by the cercaria of *Schistosoma mansoni*. Some collections are of both contemporary and historical interest, such as the series of photographs taken by Dr Cuthbert Christy during his service with the Sleeping Sickness Commission on Buvuma Island and in Leopoldville during the great epidemics in the early part of this century. Dr Anwyl-Davies presented to the Museum its first coloured photographs illustrating the clinical manifestations of syphilis. These comprise six illustrations (10 in. × 8 in.) printed in the old three-colour process.

ARTHROPODS

From time to time the Museum has received collections of arthropods from entomologists in different parts of the world. The genera comprise those which are not only of importance in the dissemination of disease but are also of interest from the systematic point of view.

Collections of ticks have been received from several important sources. The Rocky Mountain Research Laboratories at Hamilton, Montana, gave a collection of *Dermacentor andersoni* Stiles consisting of all stages of its life cycle. The Russian academician, J. Galuzo, of the Zoological Institute at Kazah, USSR, provided a reference collection of ticks from the Soviet Union. These include two species of *Argas*, three of *Ornithodorus*, five of *Ixodes*, five of *Dermacentor* and *Hyalomma*, and four species of *Haemaphysalis* and *Rhipicephalus*. Dr Marshall provided specimens of *Rhipicephalus* and *Dermacentor* from North Siam.

The collection includes several genera of poisonous spiders, among them a few species of *Latrodectus*.

The Diptera chiefly consist of those which are of medical importance as vectors of disease. *Glossina* is fairly well represented by specimens of a dozen species, mainly of the *palpalis* and *morsitans* groups.

Collections of anopheline mosquitoes given either by Mr B. Jobling or Major H. S. Leeson, or inherited from the Wellcome Bureau of Scientific Research, represent about 36 species. There is also a variety of culicines, the majority of which were collected by Dr J. MacGregor in Mauritius, Mr B. Jobling in Great Britain, and Dr C. M. Wenyon in Turkey.

The collection of Tabanidae includes representative species from Britain, various West African examples given by Mr R. Crosskey, and several hundred specimens of about 40 species collected by Dr Balfour in Colombia and Dr Urich in Trinidad between 1914 and 1915.

The families Muscidae and Calliphoridae are fairly well represented.

The entomological collection is in the process of reorganization.

PHOTOMICROGRAPHS

For many years the virtues of photomicrographs as visual aids have been exploited in the Museum, particularly to demonstrate the microscopic appearances of pathogenic organisms and their histopathological effects. Various photographic processes have been employed, from the now obsolete Lumière method (which had the merit of permanency) to the present use of Ektachrome film.

Photomicrographs are mounted between glass plates 3¼ in. square, and are primarily intended for display in viewing boxes (Fig. 56), although they may also be used as lantern slides. Many of them are prepared from gross specimens with which they are shown in the same bay of the Museum, thus providing macroscopical and microscopical aspects of a case for study. Others are taken from stained slides in the Museum's collection, and in some cases offer a comprehensive range of visual data, as in the case of human malaria parasites, made from a large number of preparations stained and presented by P. G. Shute, M.B.E. In other instances, rare slides have been lent to the Museum to enable photomicrographic records to be made for teaching purposes.

The collection of photomicrographs numbers about 1,200, of which one-third are displayed. Their exhibition 'life' is about two years, after which colour alterations render them unsuitable for teaching, and replacement becomes necessary.

Monochrome photomicrographic prints are used for cataloguing in conjunction with the documentation of pathological specimens.

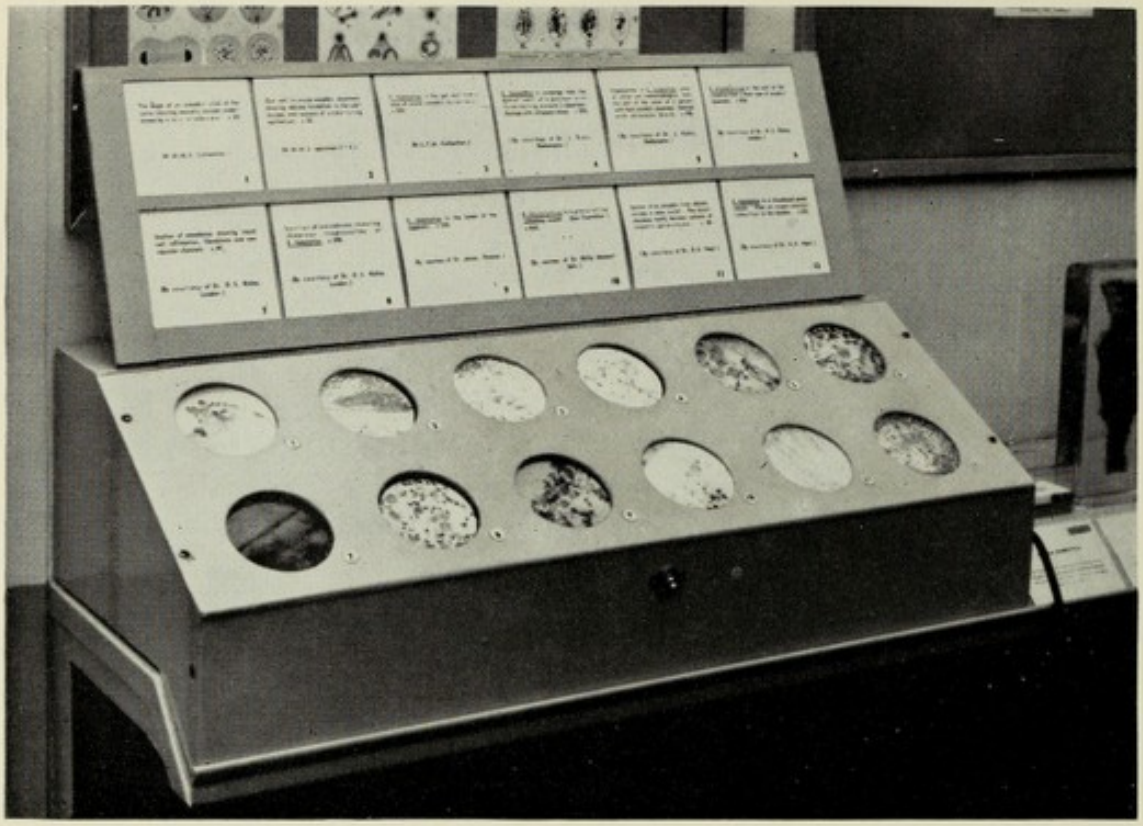

Fig. 56 Photomicrograph box on display

PATHOLOGICAL SPECIMENS

The Museum has no constant single source of supply of pathological specimens, for which it depends on the interest and goodwill of workers in hospitals and organizations in Great Britain and overseas. In the early days when the displays included all branches of medicine, autopsy and surgical material came regularly from the London Hospital through the courtesy of Dr W. W. Woods and from University College Hospital through the kindness of Dr W. G. Barnard. Other gifts were received, from time to time, from several other London hospitals, including the Hospital for Tropical Diseases; the generosity of the Staff of that institution has been the most important source of material since 1946, when the Museum became concerned largely with pathology and medicine in hot countries. Many overseas institutions, particularly in the tropics, have contributed valuable post-mortem material, and other specimens, especially of parasitological interest, were given by the Wellcome Laboratories of Tropical Medicine. From these sources, and many others, about 2,000 specimens have been collected. Although little more than one-third of these are displayed, the whole collection is documented and items can be made available to students by special arrangement.

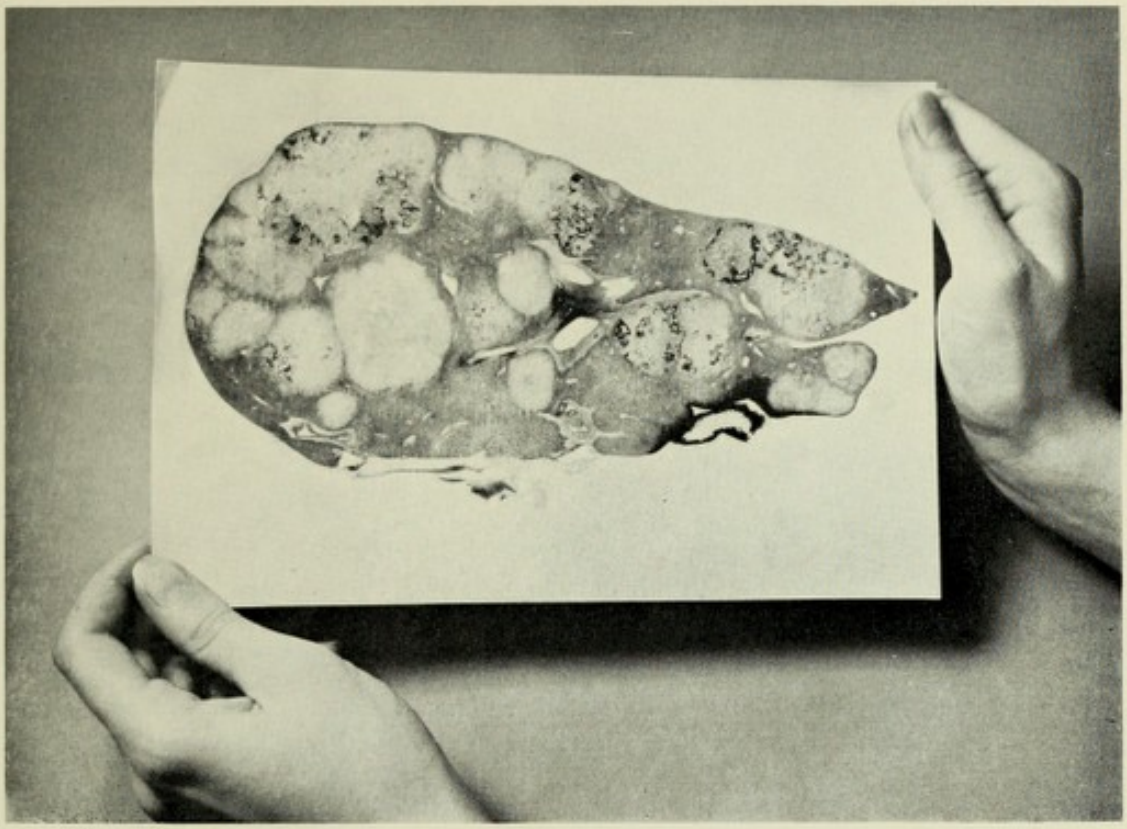

Fig. 57 Gough-Wentworth section

THIN SECTIONS OF WHOLE ORGANS

In 1949 Professor Gough, of the Welsh National School of Medicine, and his associate, Mr J. E. Wentworth, reported their technique for fixing, cutting and mounting thin sections of whole organs. These sections, 400 to 500μ thick, are mounted on translucent paper and are easily filed as permanent records. Used as transparencies, they make admirable display and teaching material, as is shown in the Museum in the tuberculosis section where Gough-Wentworth sections of various types of pneumonokoniosis can be seen (Fig. 57).

The collections contain 80 sections supplied by Professor Gough. These are mainly longitudinal lung sections showing: pneumonokoniosis, the Caplan syndrome associated with collagen disease, tuberculosis, emphysema, infarction, pyogenic abscess, pneumonia, primary and secondary neoplasms, eosinophilic granuloma, and scleroderma. Of special interest is a transverse section of a primary tuberculosis complex showing the bronchial lymph node and pulmonary components.

There are also a few Gough-Wentworth sections of solid organs, such as liver, kidney and heart. Over the years other elegant preparations of a similar

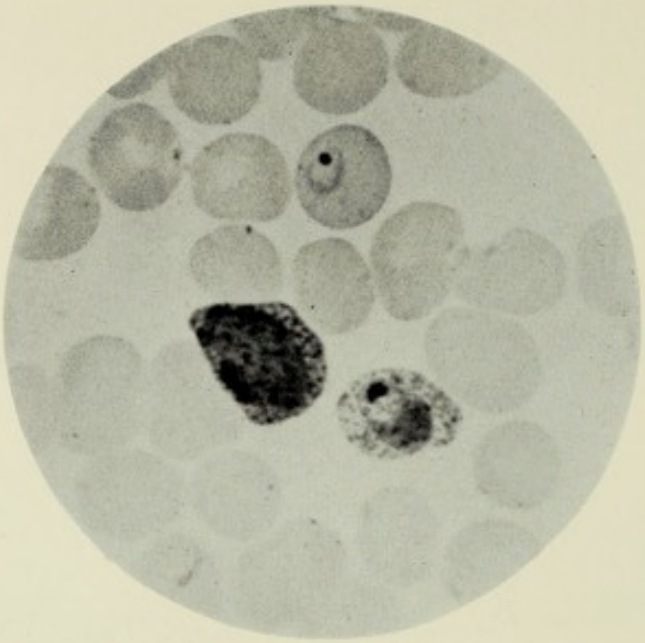

Fig. 58 Malaria parasites shown on a photomicrograph prepared from material given by P. G. Shute

kind, mounted on glass slides, have been acquired. These include a series of 60 preparations of orbital contents in different ophthalmological diseases, 10 sections of whole testis, and several other examples, including a modern preparation of the heart in endomyocardial fibrosis.

MICROSCOPIC PREPARATIONS

The collection of microscopic preparations has been built up from contributions of slides or collections of slides, from the legacies of consultative and experimental work in the Wellcome Laboratories of Tropical Medicine (formerly the Bureau of Scientific Research), and from preparations made in the Museum from gross pathological material.

No formal catalogue of these preparations has been produced, but they include several important collections, such as those on malaria (given by Mr P. G. Shute), and leprosy (given by Dr Cochrane). The Museum has inherited a considerable quantity of microscopic material on protozoology from the work of Dr C. M. Wenyon, and on experimental virology from Dr Findlay.

The majority of the photomicrographs displayed in the Museum are prepared from this material (Fig. 58).

TRANSPARENCIES

Originally this collection consisted of a small number of 35 mm. coloured slides kept as a source of teaching material for display in the Museum. During recent years the advances made in colour photography for clinical purposes

caused a rapid expansion of this collection which now contains over 2,500 items and constitutes the basis of the Museum's loan service.

The collection covers the subjects displayed in the Museum. The material is chiefly clinical, but recently, pathological, epidemiological and statistical illustrations have been introduced, for use in conjunction with formal and informal lectures to various classes of doctors and students. Some series are particularly comprehensive, such as those of kuru and other diseases of New Guinea from Dr D. C. Gajdusek, treponematosis from Dr C. J. Hackett, smallpox from Dr J. R. Lauckner, leprosy from Dr B. D. Molesworth, and Burkitt's tumour from Mr Denis Burkitt. Nutritional syndromes are well represented by donations from Dr Cicely Williams, Professor D. B. Jelliffe, and the Armed Forces Institute of Pathology in Washington.

X-RAY COLLECTION

This, our most recently formed collection, consists of original X-rays, copies on film and photographic prints from published work. The collection attempts to cover tropical diseases in which characteristic radiographic lesions are demonstrable, as well as general medical and surgical subjects.

The collection contains over 1,200 items, including an extensive series of bone lesions in yaws from Dr C. J. Hackett, in leprosy from Dr Souza Campos, and in diabetes from Dr Joan Walker. Other important groups of X-rays show lesions of cysticercosis, tuberculosis and histoplasmosis.

PHOTOGRAPHIC COLLECTION

This collection consists of over 12,000 monochrome prints and 400 coloured prints used primarily for illustrating panels in the Museum. Occasionally these prints are made available for use in other contexts. Some prints are retained for historical or academic interest, but the collection is constantly growing to keep pace with current aspects of tropical medicine. Additions to the collection are made by the staff, by contributors working in various fields, and, when necessary, permission is sought to copy photographs published in medical and scientific journals.

RECORDS OF MATERIAL

Documents and files relating to the various collections are maintained in a record room and classified on an aetiological basis, as used for the Museum displays. Such records pertain not only to the material exhibited, but also to all other specimens and illustrations which are kept in reserve.

Pathological specimens are documented by means of folders which contain all the accession data, clinical and pathological details and photographs of the specimen and photomicrographs of its histology (Fig. 59).

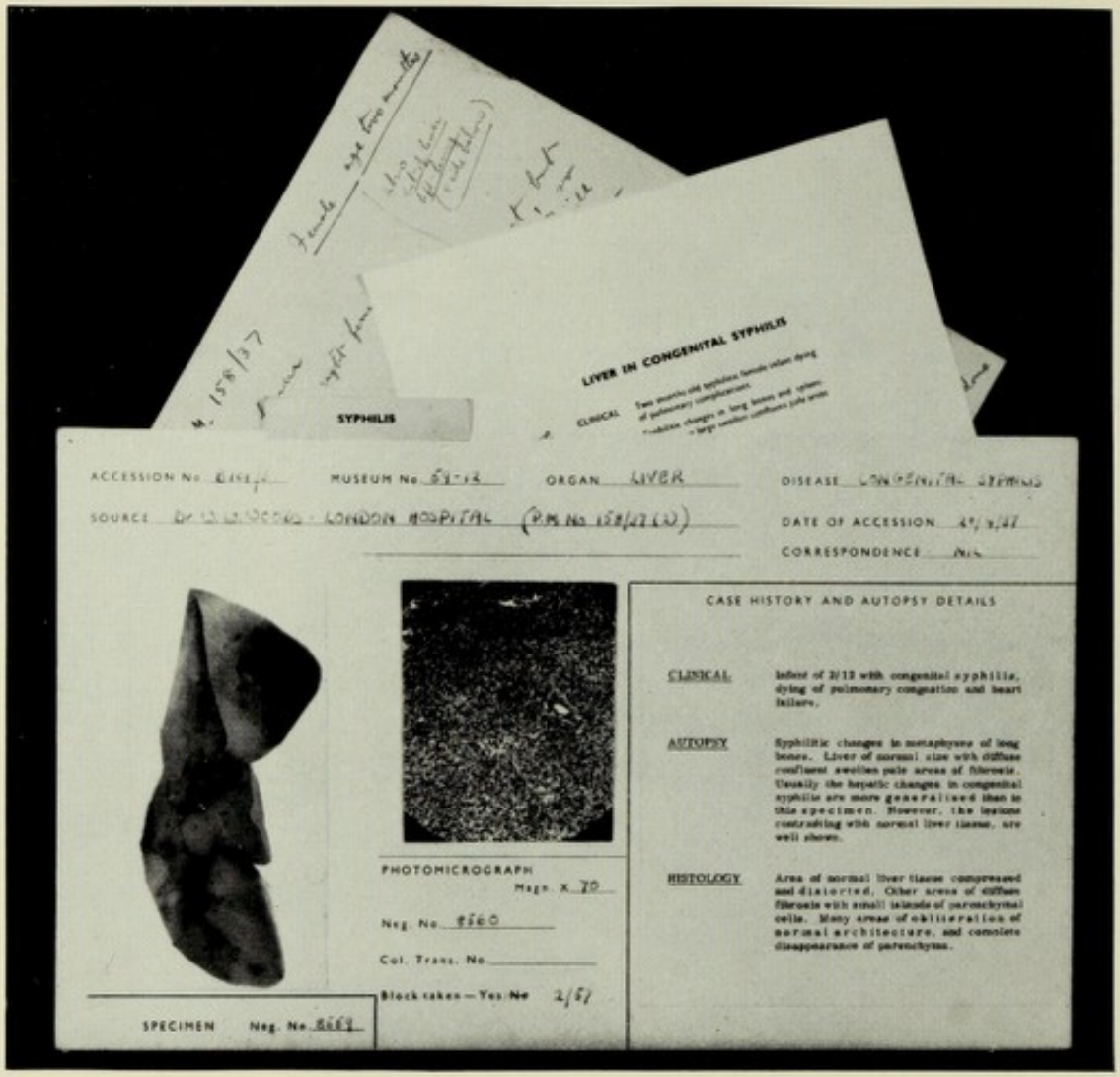

Fig. 59 A folder, as kept in the Museum records, giving full details of a pathological specimen

Transparencies and photomicrographs are catalogued by a system which combines the documentation and information with regard to loans that are made from the collections.

All photographs have classified contact prints, by reference to which the appropriate negatives can be obtained more or less instantly. Detailed catalogues of microscopic material and the arthropod collection are still being compiled.

Fig. 60 A general view of the Wellcome Museum of Medical Science, 1964

Chapter 5

BIBLIOGRAPHY

The successive directors of the Museum and their staffs have included those who followed various lines of work and clinical investigation during their terms of office. Sir Henry Wellcome long appreciated the benefits to be derived from a combination of Museum activity and research, and therefore it has become traditional to permit full-time Museum staff to engage in outside fields of inquiry according to their talents and inclinations. During the last 50 years the publications of these workers have included the following bibliographical items.

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(*Figure numbers are given in bold type*)