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A NOTE ON THE PROTECTION OF OPTICAL INSTRUMENTS IN TROPICAL CLIMATES

by

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INTRODUCTION

It is widely acknowledged that there is no known manufacturing process which will give complete protection to optical equipment against deterioration in tropical climates (OECD, 1963). Such a protective system, or tropicalization, would have to afford protection from the corrosion of metal parts; the propagation and growth of fungi and moulds; the ingress of mites and other arthropods; and the condensation of water on lenses and prisms.

Recent practical experience has produced no new evidence of any manufacturer who makes optical instruments tropicalized to such exacting standards; and there are few who produce equipment which can be said to give complete protection against even one of these. Accordingly, the user of optical equipment in tropical countries must institute protective systems of his own if equipment is to be maintained in serviceable condition; in the adverse conditions of monsoon areas of Asia improperly maintained equipment may deteriorate to such an extent as to be unserviceable in a matter of months or even weeks (Turner et al, 1946). This note aims at evaluating some of the commonly used protective systems and suggests two adaptations of established methods with special application in large-scale malaria eradication programmes.

TRADITIONAL PROTECTIVE METHODS

The WHO Manual for the Processing and Examination of Bloodslides in Malaria Eradication Programmes (WHO, 1961) gives details of commonly used methods of microscope protection in tropical countries: silica gel, other hygroscopic compounds, and heat cupboards.

Hygroscopic compounds such as silica gel and calcium chloride are widely used as drying agents in the optical instrument and pharmaceutical industries for the protection of goods in transit and storage as quite small amounts of these substances will, when packed under factory conditions, that is, the instruments together with a proper quantity of drying agent sealed off from ambient humidity by some waterproof material (plastic-film, impregnated paper etc.). As soon as this moisture-barrier is damaged, e.g. by customs inspection, the effect becomes time-limited, but otherwise it affords protection for protracted periods of time. The extension of the use of silica gel, or other drying agents, into a practical protection technique for day-to-day use under tropical conditions presents a more complex problem since the amount of silica gel required to protect a single instrument in constant use, is much larger and must be subjected to frequent regeneration by heating. Practical experience in East Pakistan bears out the recommendations of the WHO manual (WHO, 1961) that 100 g (4 oz) per instrument of silica gel regenerated weekly is the minimum amount if a high level of moisture absorption is to be ensured. This necessarily limits the use of hygroscopic agents to quite small-scale applications and entails constant close supervision to ensure its efficacy.

Desiccators activated by drying agents such as silica gel, calcium chloride or sulfuric acid, have limited application and are usually only sufficient in size to accommodate one instrument or the lenses from several instruments.

Heat cabinets offer a more practical system for quite large numbers of instruments. To be reasonably airtight and so fully effective they should be made to cabinet-making standards, but this entails high initial cost. A further consideration is the amount of wall space required to accommodate the cabinets in a secure but readily accessible place. However, this method is certainly the most widely used throughout the tropics and is employed in educational, governmental and private institutions throughout the world. It is, probably, the most satisfactory method when the number of instruments to be protected is small - less than 20 - and cost is not an overriding consideration. But it must be borne in mind that at least one manufacturer warns that temperatures for a protracted period of time in excess of 40°C may cause damage to the lens mountings where Canada balsam is employed, and it is for that reason generally necessary to make arrangements so that no optical parts come so close to the heating source that local overheating occurs.

ADAPTION OF THE HEAT CABINET AND DESICCATOR METHODS

Heat Cabinets

For large scale applications in such as zone evaluation laboratories of malaria eradication programmes heat cabinets are expensive and space consuming and the skilled artisans required to make them are rarely found in remote areas. A practical solution to this problem is to simplify the heat cabinet into a metal hood which can be placed over the microscope in its normal position on the laboratory bench. The heat required for the hood can be supplied directly from the microscope illuminator lamp, or more economically due to the high cost of illuminator bulbs, from an ordinary 10 or 15 watt bulb built into the metal hood. No additional electric source is required as the normal A.C. socket provided for the microscope illuminator may be used. The hood can be readily fabricated at a nominal cost (in East Pakistan complete with electrical fittings = Rps 8.00 or US$ 1.60) by any village tinsmith from old kerosene cans. The size of the hood is dictated by the dimensions of the microscopes to be protected; a detailed drawing of a hood designed specifically for the East Pakistan malaria eradication programme is appended at the end of this note - Fig. 1. In the interests of security a simple locking device may be incorporated in the design of the hood and mated with a corresponding device on the laboratory bench.

The principle of the heat hood is the same as that of the heat cabinet, i.e. of lowering the relative humidity by raising the temperature with an internal heat source (usually an electric light bulb). By maintaining this elevated temperature, and largely preventing air entry, condensation is prevented and thus corrosion and fungus propagation inhibited; obviously the qualification concerning the effect of elevated temperature on Canada balsam lens mountings also applies here. Practical experiment has shown that if the heat cover is used when the ambient temperature is 32°C and the relative humidity 98%, then the temperature inside the hood will rise by 10°C and bring the relative humidity down to a reasonably safe level of 67%: approximately the same increase in temperature occurs when the ambient temperature is 32°C and the relative humidity is 77% and this brings the relative humidity down to a very safe 60%. To broadly generalise it may be expected that the heat hood with a 15 watt bulb will, at normal temperatures, cause a rise of about 10°C over the ambient temperature, and the effect on the relative humidity will be to reduce it by 15-30%: the greatest reduction occurring at the higher end of the relative humidity range. Accordingly, although the heat hood cannot be recommended for instruments with Canada balsam mounted lenses when the ambient temperature is consistently considerably higher than 30°C, it may be said to give fairly reliable results when high ambient temperatures are not a contra-indication, and to be particularly useful in laboratories when instruments are constantly in use - itself a protective measure. However, it does not meet the needs of larger establishments such as Training Centres, Regional and Provincial Headquarters where there are large complements of optical instruments in storage or in use for only part of the time. It is precisely these instruments in storage which are most susceptible to deterioration, and in the greatest need of protection.

Desiccators

The principle employed in the standard glass, plastic or metal desiccator is different from that of the heat cabinet in that the drying of the air is brought about by the physical or chemical removal of the water from the air by drying agents; there is no rise in temperature. In this way condensation is prevented and thus corrosion and propagation of fungus inhibited.

A recent development of this principle is a refrigerated coil which is used to cool the air drawn over it by a fan. On cooling, the air gives up its moisture and this is collected in a container for disposal. With a machine designed for this purpose (called a dehumidifier) an entire room can be used as a dry storage room, enabling several hundred instruments to be stored in a relatively small space under closely controlled conditions of relative humidity. Unfortunately, despite the considerable research which has been done on the problems of tropicalization of optical instruments, not much is known about the temperature/relative humidity range at which damage to optical lenses occurs. However, Hawker (1950) has shown experimentally that the principal lens-affecting fungi - Aspergillus and Pencillium - have optimum propagation and growth in the temperature range 18°C-35°C and relative humidity 81%+. On the basis of these criteria a desiccation system using the dehumidifier becomes feasible providing that the volume of the dehumidified room is equal to, or less than, the rating of the machine as given by the manufacturer; the windows and any ventilation openings are sealed, and any doors fitted with draught excluders. The interior of the room is fitted with open racks or shelves of wire mesh to keep equipment off the floor and away from the walls so that efficient circulation of the air is ensured. Under these conditions the dehumidifier should maintain the relative humidity of the room at a mean of 50% throughout the year; it will at times be much below this figure but should not exceed it. Fig. 2 shows the layout of the dehumidified storeroom located at the METC East Pakistan, and Fig. 3 records the temperature and relative humidity in this dehumidified storeroom as compared with that of an adjacent control area throughout the year 1964/65.

From these results it will be seen that the conditions in the dehumidified storeroom never went beyond the criteria established by Hawker: the mean temperature was 32.9°C and the relative humidity 46.5%. Careful observation of the instruments under protection showed no evidence of fungus propagation or growth, whilst instruments not protected all became affected by fungus and condensation within three months of exposure. A further practical test was undertaken to support these observations. Four Petri dishes were prepared containing sterile fungus culture media - two with Waksman's and two with P.D.A. media. All four dishes were inoculated with five fungus colonies which had been permitted to grow at random on exposed culture plates. The inoculated plates were covered, but not sealed, and one of each media was placed in the dehumidified storeroom and the same in the adjacent control area. After 48 hours the inhibiting effect of the dehumidified environment was markedly evident even under these ideal growth conditions.

CAUSES OTHER THAN HIGH HUMIDITY CONTRIBUTING TO THE FOULING OF MICROSCOPE LENSES

There is little doubt that the growth of fungi on microscope lenses is aided by organic debris settling on the lens and providing a focus from which the fungi can radiate (cf. photomicrograph Fig. 4). Apart from mites, which are a frequent source of infestation, air-borne fungi spores and organic particles may be introduced into the lens system when lens combinations are being changed or cleaned.

Facility of entry is further aided when the ports of the revolving nosepiece are not either carrying the lenses or capped. Under no circumstances should microscopes be stored without adequate cleaning of all the exposed surfaces to remove the grosser particles of organic debris and any perspiration and oily deposits from the skin as these form ideal foci for the propagation and growth of fungi. The eyepiece is particularly affected by oily deposits from the eyelashes. Cleaning of the exposed optical parts is best done with a tissue dampened with Xylol, immediately followed by wiping with a clean, dry lens tissue paper or linen cloth. Mineral oil should be wiped over all metallic and painted parts. The cleaning of internal lenses and prisms is best left to a skilled optical mechanic but much of the dust which collects on the prism of binocular and monocular microscopes and the back lens of objectives can be removed using a photographer's lens brush of the type which incorporates a bulb to blow off the dust removed by light brushing.

SUMMARY

The problem of the protection of optical instruments in areas of adverse climatic conditions persists in view of the technical complications and production costs involved in introducing an inherent protective process. Optical instruments can be kept in serviceable condition for long periods even under the most adverse of climatic conditions, but adequate precautions must be taken to protect them from prolonged exposure to humidity. This is of particular importance with regard to instruments under prolonged storage. Two adaptations of established protection methods, heat cabinets and dehumidifiers, have proven their worth in large scale evaluation work in the East Pakistan Malaria Eradication Programmes. The former, however, may be limited in applications where Canada balsam mounted lenses are in use.

REFERENCES

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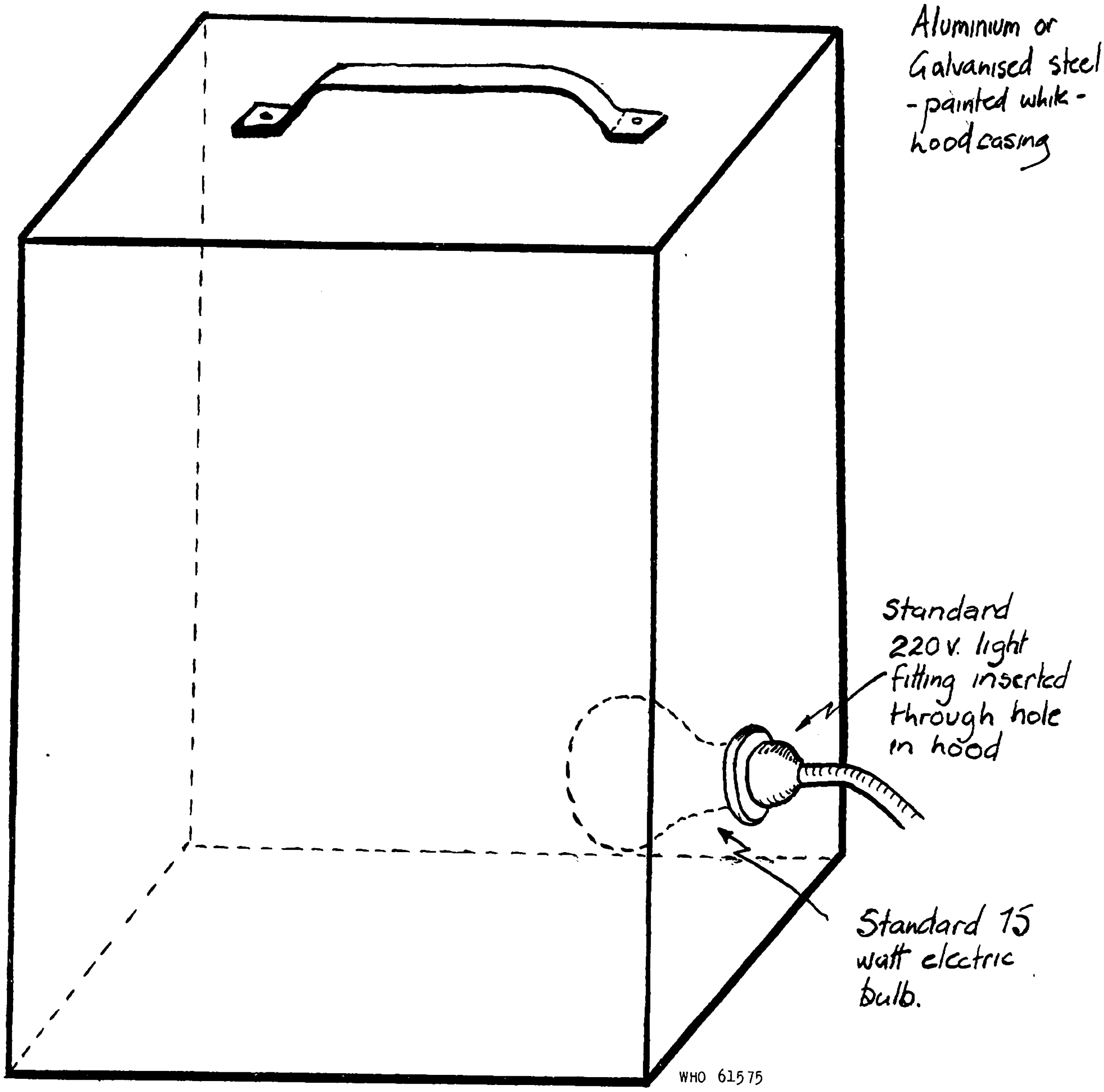
RESUME

Le problème de la protection des instruments d'optique dans des conditions climatiques défavorables continue à se poser du fait des difficultés techniques et des coûts de production que sous-entend la mise au point d'un procédé qui assurerait la protection voulue. Même dans les conditions climatiques les plus défavorables, des instruments d'optique peuvent être maintenus en bon état pourvu que des précautions adéquates soient prises pour les protéger contre une exposition prolongée à l'humidité, surtout lorsqu'ils restent longtemps entreposés. Deux variantes des méthodes de protection classiques, des armoires chauffantes et des déshydrateurs, ont fait leurs preuves dans les enquêtes d'évaluation à grande échelle effectuées dans le cadre du programme d'éradication du paludisme au Pakistan oriental. Toutefois, les applications de la première méthode peuvent être limitées lorsqu'on utilise des lentilles collées avec du baume de Canada.

FIG. 1 SPECIFICATION FOR MICROSCOPE HEAT COVER



1966.

FIG. 2 DEHUMIDIFIED STOREROOM AT THE MALARIA ERADICATION TRAINING CENTRE EAST PAKISTAN :

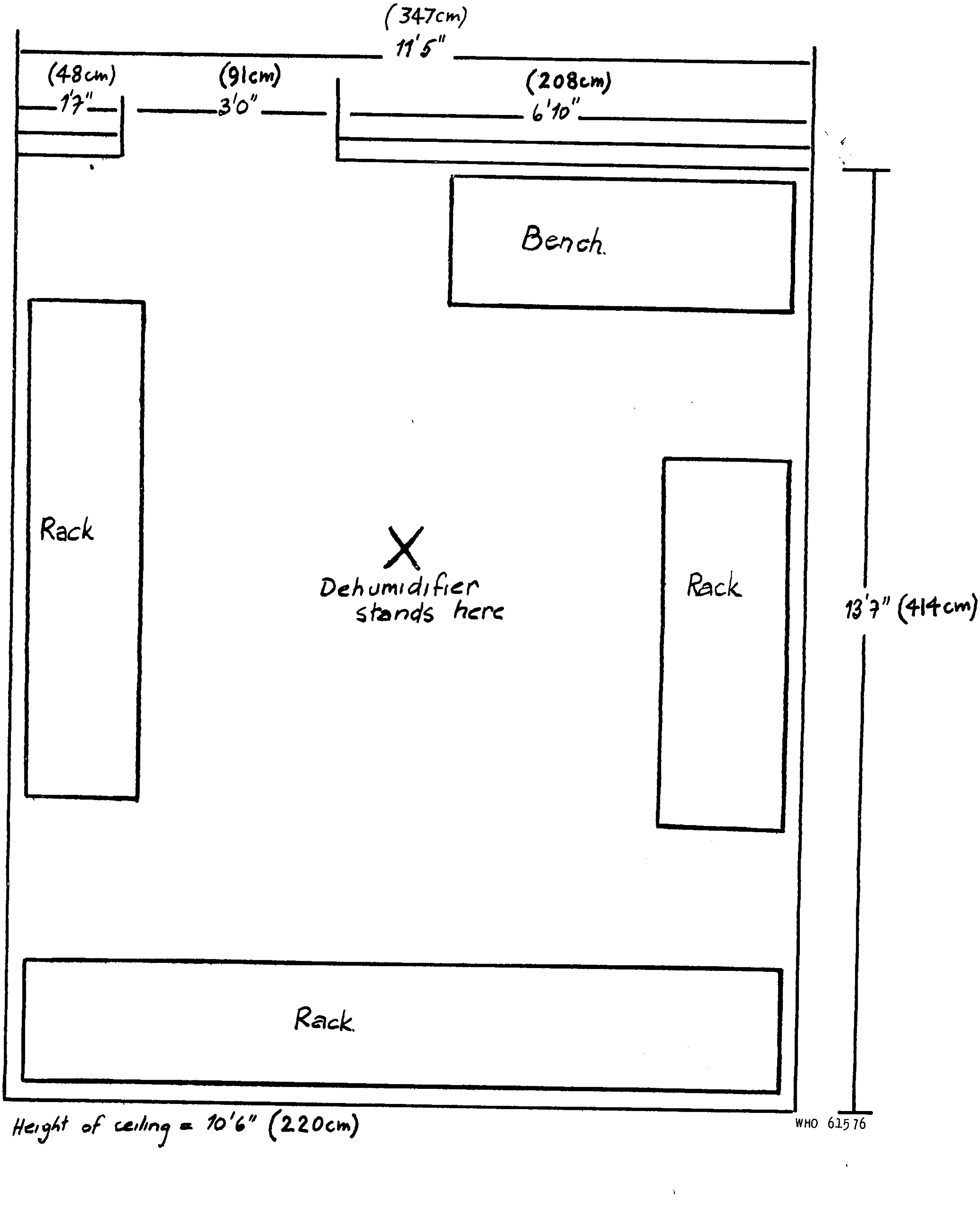
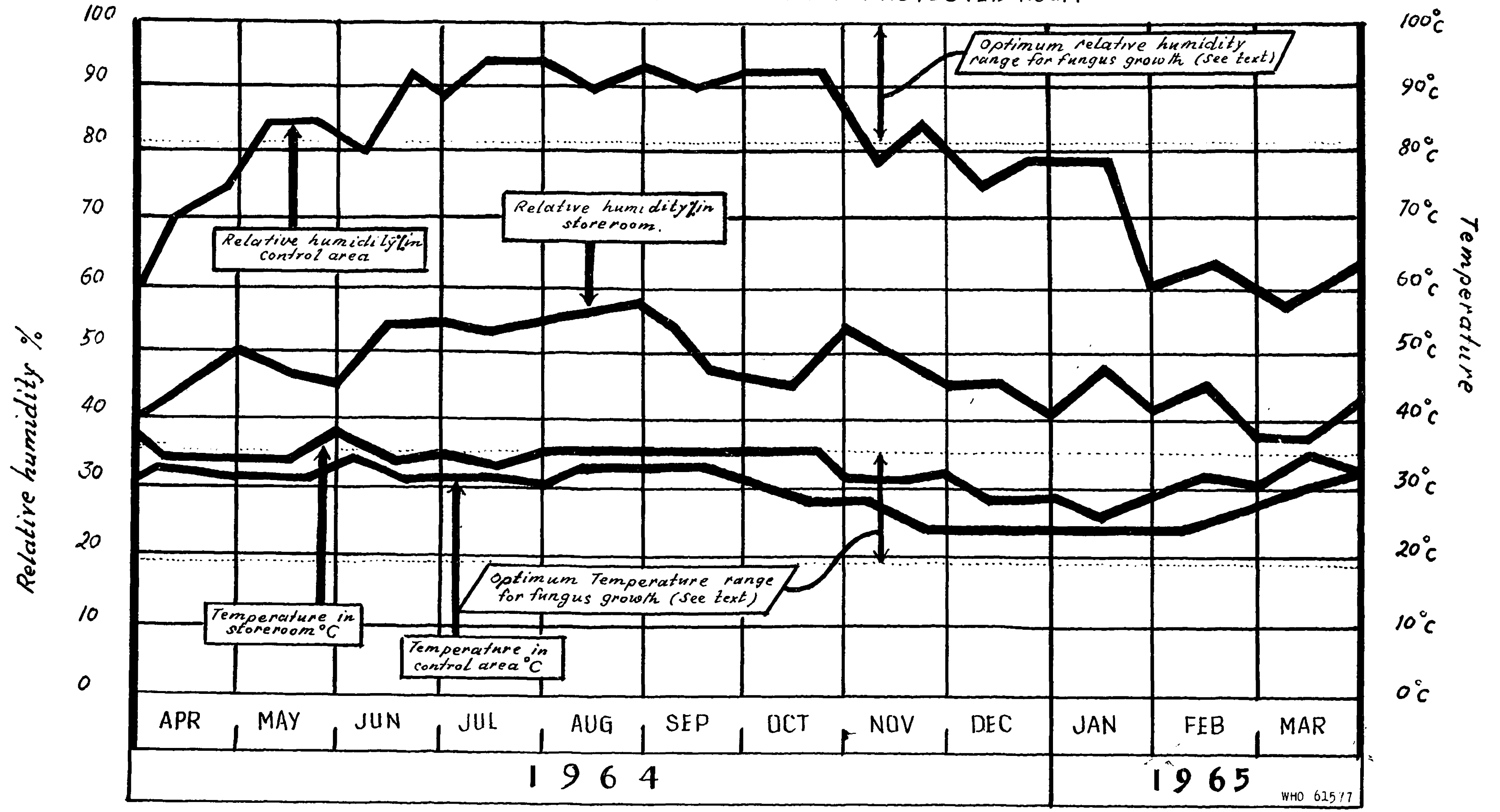


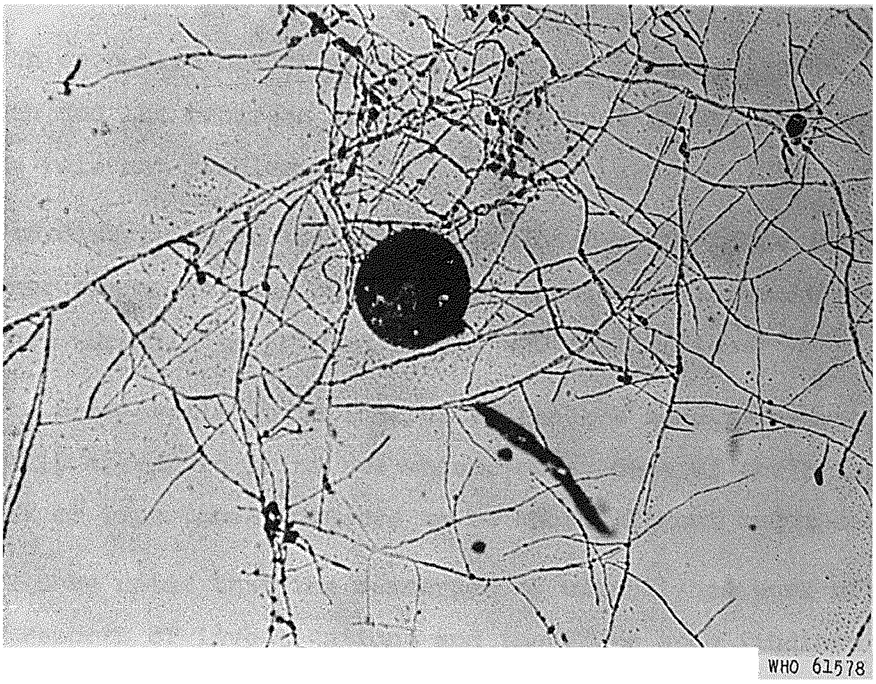
FIG. 3

A GRAPH COMPARING THE RELATIVE HUMIDITY AND TEMPERATURE IN A DEHUMIDIFIED STOREROOM AND AN ADJACENT UNPROTECTED ROOM



Hgnahi.

FIG. 4 PHOTOMICROGRAPH OF FUNGUS COLONIES ON MICROSCOPE LENSES



Fugus colony radiating from a particle of organic debris on the surface of a prism from a binocular head. Each hypha is surrounded by liquid droplets.

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It should be noted that the summaries of unpublished work often represent preliminary reports of investigations and therefore such findings are subject to possible revision at a later date.