A Note on the Protection of Optical Instruments in Tropical Climates

by D. PAYNE, *WHO Technical Officer, Malaria Eradication Training Centre, Lahore, West Pakistan*

It is widely acknowledged that there is no known manufacturing process which will give complete protection to optical equipment against deterioration in tropical climates.[a] 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.[b] In this note some of the commonly used protective systems are evaluated, and two adaptations of established methods with special application in large-scale malaria eradication programmes are suggested.

Traditional protective methods

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 are effective 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 a long 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 very great and must be subjected to frequent regeneration by heating. Practical experience in East Pakistan suggests that 100 g 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 thus fully effective they should be made to cabinet-maker's standards, but this entails a 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 when cost is not an overriding consideration. But it must be borne in mind that at least one manufacturer warns that prolonged temperatures of over 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.

Adaptation of the heat cabinet and desiccator methods

Heat cabinets. For large-scale applications, such as in zone evaluation laboratories of malaria eradication programmes, heat cabinets are expensive and space-consuming and the skilled artisans required to make them are rarely to be found in remote areas. A practical solution to this problem is to simplify the heat cabinet into a metal hood which

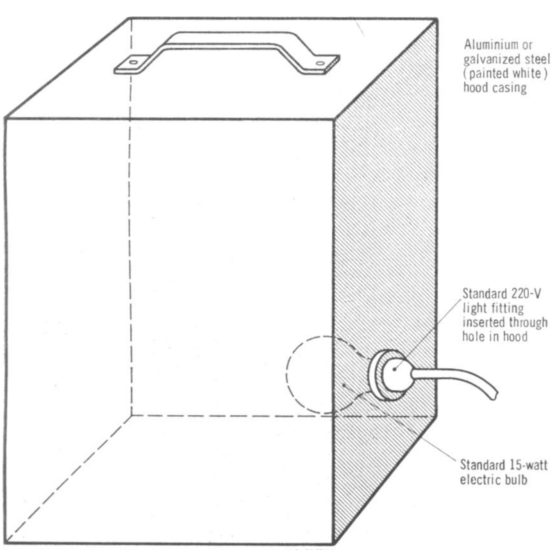
[a] Organization for Economic Co-operation and Development (1963) *Biological deterioration of optical materials*, Paris.

[b] Turner, J. S., McLennan, E. I., Rogers, J. S. & Matthael, E. (1946) *Nature (Lond.)*, **158**, 469.

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, owing to the high cost of illuminator bulbs, from an ordinary 10-watt or 15-watt bulb built into the metal hood. No additional electric source is required as the normal AC socket provided for the microscope illuminator may be used. The hood can be readily fabricated at a nominal cost (about Rps 8.00, or US$ 1.60 in East Pakistan complete with electrical fittings) 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 given in 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., to lower 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 are inhibited; obviously the qualification concerning the effect of high temperature on Canada balsam lens mountings also applies here. Practical experience has shown

FIG. 1. MICROSCOPE HEAT COVER



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 the 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%. Generalizing broadly, 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 lens mounts 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—such use itself being a protective measure. However, it does not meet the needs of larger establishments 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 are 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, allowing 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[c] has shown experimentally that the principal lens-affecting fungi—*Aspergillus* and *Penicillium*—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 at the Malaria Eradication Training Centre, East Pakistan, and Fig. 3 records the temperature and relative humidity in this dehumidified storeroom as compared with that of an adjacent control area over a year (1964-65).

[c] Hawker, L. E. (1950) *Physiology of fungi*, London.

FIG. 2. DEHUMIFIED STOREROOM AT MALARIA ERADICATION TRAINING CENTRE, EAST PAKISTAN

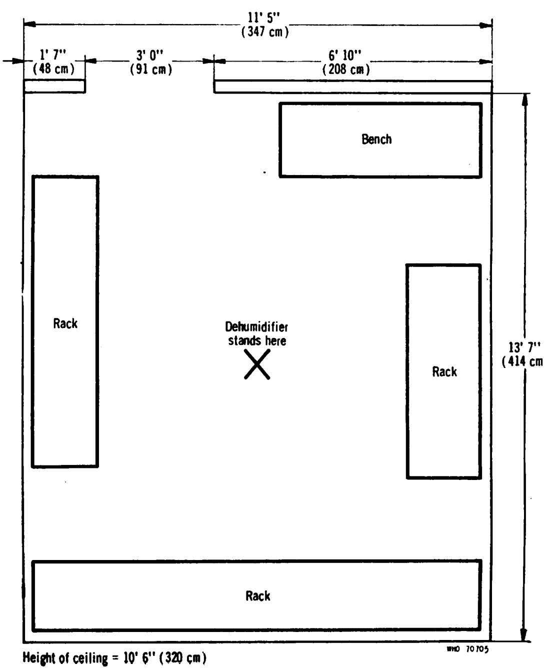
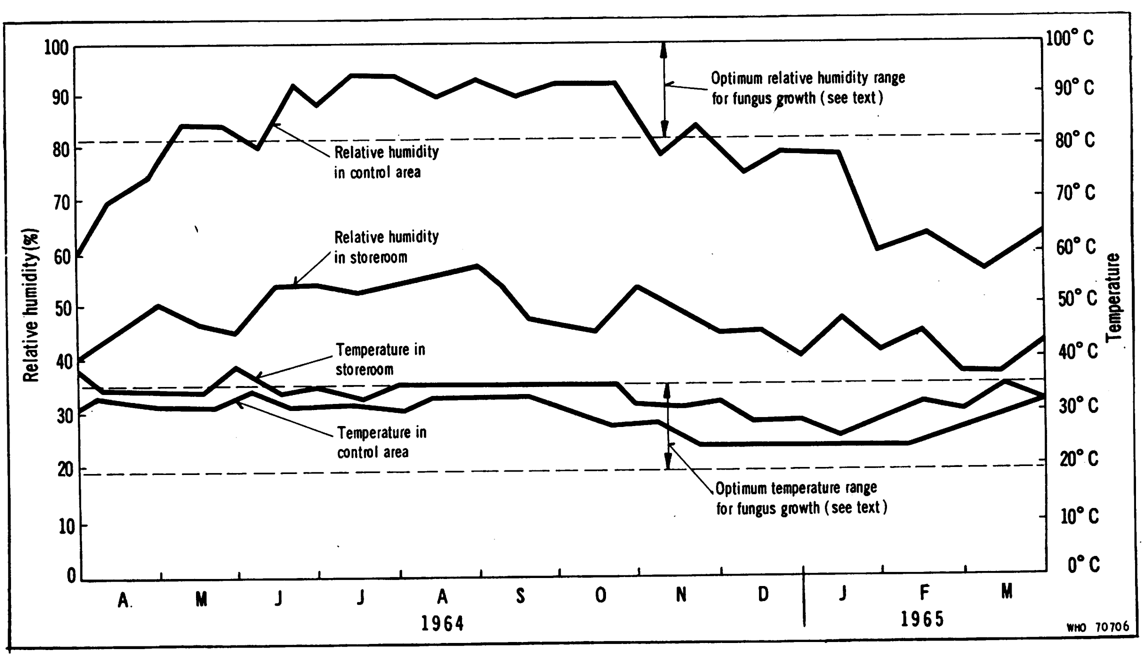


FIG. 3

RELATIVE HUMIDITY AND TEMPERATURE IN A DEHUMIFIED STOREROOM AND AN ADJACENT UNPROTECTED ROOM



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, while instruments not protected all became affected by fungus and condensation within 3 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 PDA medium. All 4 dishes were inoculated with 5 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 medium 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 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. Apart from mites, which are a frequent source of infestation, air-borne fungus 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.

Transliteration from Cyrillic characters

The " International System for the Transliteration of Cyrillic Characters ", set out in Recommendation ISO/R9-1954 (E) of the International Organization for Standardization, is normally used in the *Bulletin of the World Health Organization* for personal names, titles of publications, etc. However, papers accepted for publication may contain names transliterated differently, and if the original Cyrillic spelling is not recognizable inconsistencies may occur.

For convenience the transliteration from Russian according to ISO/R9 is given below:

Translittération des Caractères cyrilliques

Le « Système international pour la translittération des caractères cyrilliques » présenté dans la Recommandation ISO/R9-1954 (F) de l'Organisation internationale de Normalisation est généralement utilisé dans le *Bulletin de l'Organisation mondiale de la Santé* pour les noms de personnes, les titres de publications, etc. Cependant des articles acceptés pour publication peuvent contenir des noms translittérés différemment et si l'orthographe cyrillique originale n'est pas reconnaissable un manque d'uniformité peut s'ensuivre.

A toutes fins utiles, la translittération du russe selon la recommandation ISO/R9 est indiquée ci-après:

Cyrillic character Caractère cyrillique	Transliteration from Russian Translittération du russe	Examples and remarks Exemples et observations
А, а	a	Адрес = Adres
Б, б	b	Баба = Baba
В, в	v	Вы = Vy
Г, г	g	Глава = Glava Голова = Golova
Д, д	d	Да = Da
Е, е (ё)[1]	e (ë)	Ещё = Eščë
Ж, ж	ž	Журнал = Žurnal
З, з	z	Звезда = Zvezda
И, и	i	Или = Ili
Й, й	j	-ый, -ий, -ой = -yj, -ij, -oj
К, к	k	Как = Kak
Л, л	l	Любить = Ljubit'
М, м	m	Муж = Muž
Н, н	n	Нижний = Nižnij
О, о	o	Общество = Obščestvo
П, п	p	Первый = Pervyj
Р, р	r	Рыба = Ryba
С, с	s	Сестра = Sestra
Т, т	t	Товарищ = Tovarišč

Cyrillic character Caractère cyrillique	Transliteration from Russian Translittération du russe	Examples and remarks Exemples et observations
У, у	u	Утро = Utro
Ф, ф	f	Физика = Fizika
Х, х	h	Химический = Himičeskij
Ц, ц	c	Центральный = Central'nyj
Ч, ч	č	Часы = Časy
Ш, ш	š	Школа = Škola
Щ, щ	šč	Щека = Ščeka
(medial, médial) Ъ, ъ (final)	″or″ ″ou″ (Not transliterated. Non translittéré.)	In modern Russian, where ′ sometimes replaces medial ъ, transliteration is still ″. En russe moderne, où le ′ remplace quelquefois le ъ médial, la translittération reste ″.
Ы, ы	y	Был = Byl
Ь, ь	′or′ ′ou′	Маленький = Malen'kij
Э, э	ė	Это = Ėto
Ю, ю	ju	Южный = Južnyj
Я, я	ja	Яйцо = Jajco

[1] Cyrillic ё to be transliterated by ë only when the diacritical appears in the original. Le ё cyrillique ne doit être translittéré par ë que lorsque la diacritique apparaît dans l'original.