"It is apparent to anyone who has followed the discoveries of recent years that tropical medicine, more than any other branch of medicine, is dependent on several of the collateral sciences. Our basis therefore has to be a broad one, and in drawing up the constitution of the Society, this point has been kept steadily in view."

(Sir Patrick Manson, Inaugural Address, 1907)

"Pathological enquiry has grown immensely, but the time has come when a number of practical questions... should receive more attention from our soldiers of research."

(Sir Ronald Ross, Presidential Address, 1909)

Medicine, both preventive and curative, is more complex and changing more rapidly in tropical than temperate countries—its practice, particularly in the preventive and social contexts, requires a much deeper and wider understanding of the environment, of the social and cultural structure, and of the often rapid changes in them, than in higher latitudes. I am well aware that friends and colleagues stoutly defend “tropical medicine” as a discipline under threat of extinction, and I think their fears may be justified if tropical medicine becomes increasingly inward looking; but not if, echoing Manson’s inaugural address, it is prepared to make itself the focus of the many scientific and social disciplines which impinge on health and wellbeing in the tropics.

My first point therefore is that the Society should not confine itself to the exchange of ideas, experience and knowledge within its fellowship, but should much more actively foster such exchanges with other disciplines and thus strengthen its ability both to advance scientifically and to influence economic, social and development policies in favour of health in developing countries and those who aid them. In a recent lecture (Mehler, 1975) the Director General of WHO spoke of the need to demystify medical technology: our profession has long tended to guard its knowledge and skills carefully and to impart them as little as possible to others—including our patients. I doubt whether this makes sense now in industrialized countries, and am quite sure that, in the context of developing countries, we must share our knowledge and ideas as widely as possible if we are to bring benefit to the multitudes of medically deprived.

I intend, during my presidency, to hold a series of one day meetings to explore a widening role for the Society, and here will review a few of the fields to be covered.

The new WHO Tropical Diseases Research Programme is focussed on the development of better vaccines and drugs for the control and treatment of six diseases: malaria, schistosomiasis, filariasis, trypanosomiasis, leprosy and leishmaniasis. Its basis (WHO, 1973) is that the “recent enormous extension of knowledge in the biomedical sciences” has “as yet hardly begun to be applied to the problems of tropical diseases, where methods of control and treatment have scarcely changed in the past thirty years. It has been estimated that the world’s total annual research budget for all tropical infectious diseases is about U.S. $30 million per annum; one country alone spends nine times this amount on cancer research. Research on tropical diseases has not yet got off the ground”.

Many among you may feel (with Ross, in the quotation above) that this last sentence overstates the case and that more effective application of the great volume of research already accomplished could result in considerable progress.

There is little doubt—given time, sufficient resources and the harnessing of modern molecular biology, biochemistry and immunology into well balanced laboratory teams—that the desirable new drugs and vaccines can be discovered, and that these efforts must be most warmly welcomed. However, they will have little or no effect on the morbidity and mortality of the great majority of people in developing countries unless the laboratory effort is balanced by even greater efforts to ensure that they (and previous discoveries) can be effectively used. The very successful control of yaws with penicillin is perhaps the only example of wonder drug control of a major tropical disease—but it succeeded because the disease was confined to man, the parasite survived poorly in the environment, it failed (surprisingly) to develop penicillin resistance, and the drug was available and cheap enough because of its wide use (and profitability) for other purposes in industrialized countries. Few (if any) of these major parasitic diseases will be controlled solely by a wonder drug or vaccine—only the optimal integrated use of a variety of (and perhaps all available) control measures is likely to prevail. The planning of such measures and their evaluation will depend critically on strongly developed epidemiological and operational research, which includes the often neglected human behavioural factors in transmission and control, well ahead of possible introduction of new remedies. There will also have to be more research, and particularly more experiment and evaluation, into the development of effective health services if new remedies are to be effective. Too often health services are viewed structurally from the top rather than built up on a problem-solving basis from the bottom. There is too much reiterative discussion and too little long term experimentation with effective evaluation.

The Programme is to be conducted by task forces and networks. “Task forces are groups of scientists of the highest international standing which aim to develop more effective remedies. For this, they will first define
the remedies that are needed and then plan all phases of
the research... the actual carrying out of the research
will be in the hands of a network of collaborating
laboratories. In Africa, the foundation of the network is
the existing research institutes and university departments,
and the centre planned for Ndola will form an important
component... much of the scientific work will be carried
out in Africa and so most of the network laboratories
will be there, but laboratories in other continents will
also be essential to develop task force plans and will be
included in the network.”

The Programme recognizes that “as the work of the
task forces progresses so increasing attention will have
to be given to the large scale manufacture of the drugs,
vaccines and the other remedies that are discovered”.
Potential manufacturers and user governments of new
drugs and vaccines will have to be convinced not only
of their efficacy but also that they can be effectively
incorporated into overall health plans and budgets and
that their advantages justify either the diversion of
already inadequate or shrinking health resources, or, if
necessary, the provision of additional resources, perhaps
withdrawn from health-related activities such as educa-
tion, housing and agriculture. The evidence must con-
vince not only economists and administrators, but also
politicians.

It is fervently to be hoped that adequate funds will be
forthcoming, not only for the development of new
remedies, but also for the equally important counterpart
research that I have outlined. The Society, the schools
and all individuals concerned with tropical medicine
should do everything they can to ensure its support, to
participate in it and to guide it into the most fruitful and
relevant paths. Very much larger amounts of money will
be needed to finance the manufacture, testing, trials, and
eventually the application of these new remedies—it is
less clear where these funds are to be obtained. Health
administrations in developing countries are hard pressed
for money, and may not give top priority to the six
diseases when faced with galloping population growth,
associated with malnutrition, gastroenteritis and respira-
tory diseases which, as the main killers of childhood,
inhibit progress with population control. It can only be
hoped that family planning services, made possible by
the large injections of money from the richer countries
are going to be essential; but these will be ineffective in
the longer term unless the costs become integrated over a
relatively short period into the budgets of the developing
countries.

My second main point to the Society is, therefore, that
it should take a much more active role in influencing
policies so that the best use is made of existing and new
knowledge (and remedies) in the control of morbidity
and mortality in developing countries.

**Population**

Galloping population growth, with its still increasing
concomitants of under-nutrition, malnutrition and the
diseases of overcrowding in poor socio-economic condi-
tions, aggravated by migration from rural areas to the
cancerously growing cities, is the predominant single
present and future factor in morbidity, mortality and
human misery in most tropical developing countries:
medicine very largely ignores it, paying lip service to
family planning but concentrating the vast majority of
health resources on individual medical care for the better
off and more culturally or socially accessible segments
of the community.

The problems of teeming population in India, Bangla-
desh and parts of Indonesia are perhaps best known.
Africa seems a vast continent in relation to its total
population, but much of it is inhospitable either because
of soil and climate or because of diseases such as trypano-
somiasis or onchocerciasis. But Africa now accommodates
about 10% of the world population and the present
400 million is expected to double before the end of the
century (BOUVIER, 1975). Its overall death and birth
rates are the highest in the world (20 per 1,000 and
46 per 1,000 respectively) and its Growth Rate (2-6% p.a.)
is exceeded only in Latin America (2-7%). In many
tropical countries a high birth rate, a slowly falling death
rate (especially infant mortality) and a predominantly
young population mean that population increase is more
likely to accelerate than decelerate. Moreover, the
expectation of life at birth is increasing: in Africa, south
of the Sahara, it is expected to increase by five years in
every decade (BOURgeois-PICHAT, 1963).

In many African countries and in all of their rural
populations, measures to reduce population growth are
not an accepted objective either at government or at
individual level. A long term future is a meaningless
concept to most of the people of tropical countries:
children provide not only status, but the only practicable
insurance for old age, should it be reached. Only seven
of 53 African countries have population control policies
(BOUVIER, 1975): Botswana, Egypt, Ghana, Kenya,
Mauritius, Morocco and Tunisia. Ghana (birth rate 48.6,
death rate 21.8) has a far-sighted programme combining
family planning with better educational and employment
opportunities for women. Tunisia has made polygamy
illegal, raised the legal age of marriage, limited child
allowances to four children, legalized abortion up to
12 weeks gestation and legislated for equal rights for
women. On the other hand, Nigeria, with the largest
population in Africa and a growth rate of 2.7% p.a.,
seems to confine itself to an official view that family
planning should be encouraged. Francophone territories
have been traditionally opposed to population limitation:
above the highest birth rate in the world (52.2 per 1,000),
Niger has no organized family planning services. Malawi
views rapid population growth as desirable and goes so
far as to prohibit advice and publicity in family planning.
It can only be hoped that African populations and their
governments will reach a fuller understanding of the
size and consequences of their future population prob-
lems, that more active and effective measures will be
accepted and implemented before long, and that the
predictions may turn out to be exaggerated.

Excessive population growth inhibits development and
the improvement of living conditions, without which
many of the health problems are insoluble. In particular,
the gastrointestinal and respiratory infections, responsible
for a high proportion of morbidity and mortality among
children, are unlikely to be brought under satisfactory
control without the improvements in nutrition, housing
and hygiene which can only be attained with substantially
improved standards of life for very large numbers of
people.

However, the problems are not only those of overall
population increase but also of the squalid overgrowth
of tropical cities due to migration from rural areas.
In most African countries, urban populations are growing
at least twice as fast as the total population, and cities
are growing faster than towns (ECONOMIC COMMISSION
FOR AFRICA, 1968). More than one fifth of the rural
populations of three major Latin American countries
migrated to their cities between 1950 and 1960; Mexico
City more than doubled between 1950 and 1968 (JACOBY, 1970). In India the urban population doubled between 1941 and 1961 and is expected to have doubled again by 1981; migrants make up two-thirds of the populations of Bombay and Delhi (CHANDRA SEKHAR, 1971). The virtually impossible health problems of these too rapidly growing cities, with their vast squatter or shanty town populations, include not only undernutrition and enteric diseases but also huge populations of urbanized mosquitoes such as *Culex fatigans* and *Aedes aegypti*, and their associated diseases such as filariasis and dengue (SMITH, 1972, 1975). And the loss of social structure in these communities leads to increased rates of crime, veneral disease, drug abuse, alcoholism, psychosomatic and psychoneurotic diseases (LAMBO, 1965).

Perhaps the only hope of at least stemming the torrent of migration to the cities is to improve conditions in the rural areas. Satisfactory health services are vital to the success of resettlements and agricultural development if they are to reduce migration. There is an urgent need for the development and evaluation of experimental schemes for surveillance and health services appropriate to such schemes, such as those proposed, with MRC/ODM support, for the new large Bura irrigation scheme planned in the Tana River basin in Kenya.

We simply cannot afford to regard population control as too difficult. We cannot leave it to the family planners, nor can we wait for the millennium of high living standards in which birth rates automatically fall. It is unlikely to be solved by technological advances and must largely be tackled by education and the changing of attitudes. The linking of family planning to maternal and child welfare is a step in the right direction, but does not go far enough. The Society must regard population control as central to the improvement of health in most developing countries, and, by debate and publications, must exert its influence more effectively to persuade their governments to devote more resources to it. Illiteracy is rife in the target populations (and even increasing in some), but, with a fuller understanding of local customs and beliefs, and a full use of local traditions and attitudes, modern advertising skills of pictorial communication could surely do much to demonstrate the relationships between population, health and prosperity.

### Undernutrition

Medical science has tended to concentrate on the diseases of malnutrition, on the characterization of specific deficiency diseases, their pathogenesis and treatment. Work in this field supported by our Medical Research Council in Uganda and Jamaica has been particularly distinguished (WHITEHEAD and ALLEYNE, 1972). But by far the major world problem is undernutrition and there is increasing evidence that much of this could be remedied by eating increased amounts of the foods already being eaten. To participate effectively in solving this problem, as surely we must, equal attention must be paid to elucidating the behavioural, socio-economic and ecological causes of undernutrition and to understanding the problems of food production, supply and distribution so as effectively to influence agricultural and nutritional policies.

FAO's 1974 review (FAO, 1975) gives little hope that nutrition will improve for the majority of undernourished people within the foreseeable future. Between 1962 and 1972 the population increased by 2.8% per annum and the food supply by 2.7% per annum in the rich countries, while the annual increases were 2.4% and 2.7% respectively in the poor countries. In the latter, therefore, increases in food production barely kept pace with need. Probably as many as 460 million people are now getting insufficient food for satisfactory health.

There is thus no doubt about the need for increased world food production and that it will have to depend mainly on increasing yields of existing crops on existing agricultural land—new sources (e.g. microbial protein) are unlikely to have a significant effect within the foreseeable future. The bringing of additional land into cultivation is unlikely to outstrip the needs of population increase. The development of high yielding strains of cereals has been highly successful in some areas but their effective exploitation demands more farming skill than traditional strains and depends on the adequacy of irrigation, fertilizers, pest control, and credit for the farmers. Fertilizers and pesticides are increasing in cost. Fuel for farm machinery is already so costly as to threaten agriculture in rich countries and will even more hinder increased production in poor ones. The availability of farm credit in poor countries, particularly to small farmers, severely limits productivity—the average small farmer in southern Asia spends only about £3 per hectare per annum on farm inputs while he ought to spend £10 to £40, depending on the crop, to achieve maximum production (FAO, 1975). The farmer's own work potential, furthermore, is often impaired, perhaps to the extent that he is unable even to feed himself and his family, and particularly in irrigated areas, by a variety of diseases: e.g. epidemic malaria which often coincides with the rice harvest, and the more chronic debilitating effects of schistosomiasis, guinea worm and ancylostomiasis. The relationships between disease and productivity are still very poorly recognized by agriculturists and economists—and even when recognized seldom lead to effective measures to combat them.

However, the much publicized view that undernutrition results from falling behind in the race between population growth and food supply—and that this is mainly attributable to a failure of the poorer countries to exploit new techniques of food production fast enough—is not wholly tenable. It is more likely that production is limited by ability to purchase food and that it will be enhanced only when there is increased ability to buy, or to pay for increased production, among countries and populations who are short of food. Unfortunately, improved, and particularly mechanized, agricultural methods (and even perhaps increased productivity due to better health) tend to aggravate the problem in the rural populations of developing countries, because they increase unemployment and the numbers who cannot afford enough food for health. The malnourished are increasing with population growth primarily because the increase is in those who cannot afford to live. Increased prosperity in a poor country (e.g. increased per capita income) does not necessarily reduce or even slow the increase in the malnourished. The age-old problems of achieving equitable distribution of food are far more difficult, and far less likely to be solved, than those of increased production.

But the increasing multitude of the undernourished is not and cannot be acceptable. Like population, undernutrition is not directly a medical problem, but it is so central to the improvement of health in developing countries that the Society should encourage the elucidation of its causes, including the agricultural and economic factors in food supply and distribution. It should
engender debate between its fellows and experts in agriculture, economics, demography, etc., so as to increase its ability effectively to influence food and agricultural policies in developing countries, in international organizations and in the aid-giving countries. If the kinds and numbers of people affected, the trends in these numbers, the reasons, and the costs of remedying them were clearly identified, priorities could be established between different sectors of a population and the probable beneficial or adverse effects of possible alternative measures could be assessed.

Development programmes

All developments impose ecological changes, especially on the distribution, population density and behaviour of its inhabitants, both human and other animals. These changes have notable effects on zoonoses (including arthropod-borne diseases) and on their risk to man— which may be enhanced or diminished (Smith, 1964). They also affect the transmission rates of other communicable diseases, the diet, and the social and economic structure, with wide-ranging consequences. In recent years it has fortunately become accepted, among the major funding agencies of larger scale developments in poorer countries, that health measures are an essential component of both their planning and implementation. Thus larger schemes are now tending to receive the attention to health which they deserve and some fairly notable successes can be recorded in terms of the “acute” (construction) and “early convalescent” (settlement) stages. It is less clear that provision is being made for the “diagnosis” and “treatment” of the more “chronic” (long term) problems or for “relapses”—which may be incurable by the time they are recognized. Moreover, adequate health provisions are seldom made in smaller schemes, and little or none in the many large areas where landless people are moving into new territories or onto large scale farms and estates to undertake squatter agriculture.

Large scale developments involve such important changes as the creation of new communications (e.g. the Trans-Amazon Highway) which lead to increased population movement, the importation and exportation of infections and their vectors (e.g. triatominine bugs and Ae. aegypti), settlements in virgin territory, and loss of the fauna and flora can enhance the risk of zoonoses. Population growth followed by deforestation and erosion of the social, cultural and administrative structure (Smith, 1975). Deforestation for agriculture may lead to erosion and by “simplification” (Acrey and Harrison, 1951) of the fauna and flora can enhance the risk of zoonoses. Population growth followed by deforestation and erosion led to the hyperendemic onchocerciasis of the valleys of the Volta basin (Waddy, 1969). However, water developments often create the greatest disease problems because of the mosquito, snail and other aquatic hosts of infections which they may increase, especially man-made lakes and irrigation projects.

The Kariba Dam construction employed about 13,000 men over six years but the sick parade never exceeded 2% of the force, the vast majority of it minor ailments. Despite prior risks of both malaria and trypanosomiasis, health was maintained at only 0·3% of the cost of the scheme (Wernke, 1960, 1975). In general, labour forces on recent major dam schemes in the tropics seem to have been maintained in good health—in most cases because of a clear appreciation of short term risks, the availability of advice and money to cope with them and a fairly clear monetary penalty for the contractors if they were ignored.

Longer term problems are however less under control, mainly because the settled populations are less manageable and most of all because the necessary resources tend to dry up when the construction work is complete. For instance, schistosomiasis is increasing around the Kariba Dam (Hira, 1969), the Volta Dam (Jordan, 1975) and the Kainji Dam (Imvbore, 1975). But it is as yet too early to assess fully the long term health effects of many of the larger man-made lakes; nor are these problems confined to Africa. The Ubduratana Dam complex in Thailand has a population with high prevalences of helminth and protozoal infections. Infections with the liver fluke, Opisthorchis, are common, and 6-7% of fish in the lake are infected; the custom of eating raw or semi-cooked snails and fish presents a particular health education challenge in this area. Leptospirosis, scrub typhus and Anisoxystomus are prevalent in rodents in the area and seem likely future problems (Haranasuta, 1975). Similar problems can be expected in projected even larger developments on the Mekong River.

A dam in an arid, sparsely populated area is likely to show the full scope of its health hazards rather more slowly than in a wet tropical environment. Lake Nasser (Farid, 1975), because of its huge scale, epitomizes the very wide reaching consequences of such a development. The construction cost was about U.S. $625 million for an ultimate estimated economic gain of U.S. $470 million per annum. Set against that, however, is the loss of silt as a fertilizer in lower Egypt, erosion of the delta, accumulating salinity in the irrigated areas with adverse effects on agriculture, and the migration of sardines from Egyptian shores (estimated $7 million per annum and affecting the livelihood of 150,000 people). To these costs must be added those of the effects on productivity of aggravated health problems and preventing or rectifying them in order to realize the full potential of the scheme. Perhaps the major health hazard is malaria if Anopheles gambiense or An. pharoensis become established in the lake, which has a seasonal fall of 5-7 m exposing an estimated margin of 892 km² with residual pools, and especially when the proposed population of 200,000 people with associated cattle and other domestic animals are established around the lake and provide blood meals. An. gambiense is present only 150 km upstream and when introduced to the area in 1941-42 it caused an estimated 130,000 deaths from malaria. Other health risks include schistosomiasis (prevalence of Schistosoma haematobium is 63 % among fishermen), anciylostomiasis, Bancroftian filariasis (C. fatigans is already breeding extensively) and a substantial number of arbovirus infections (yellow fever, dengue, o'nyong nyong, chikungunya).

With less than 10% of the world’s hydropower yet developed (Stanley and Alpers, 1975), health associated with man-made lakes is clearly of global concern. There is urgent need for the development, trial and evaluation of relevant and economical systems for disease surveillance and health care in such areas if the long term consequences are not going to vitiate or even destroy their human and economic potentials.

Undoubtedly the disease most increased by irrigation in the tropics is schistosomiasis, which is prevalent and increasing amongst most of the tropical populations depending on irrigated agriculture. In lower Egypt alone, the introduction of perennial irrigation increased the prevalence from 5 to 80% within a few years (Dehm, 1972). Now that Lake Nasser is using perennial irrigation possible in upper Egypt, high prevalence can also be expected there. The feasibility of chemical control of snails and hence of transmission within irrigation
schemes has been demonstrated on a large scale in the Gezira (AMIN and FENWICK, 1975) but many schemes are unable to bear the cost of materials and applications, or have failed to appreciate the health need or the potential economic benefit of control. However, control within an irrigation scheme will seldom be effective unless it is extended to all bodies of water used by the people and capable of supporting vector snails (JORDAN, 1975). Other well documented hazards of irrigation are leptospirosis and arthropod-borne infections (malaria and arboviruses). REEVES and HAMMON (1962) found that, in irrigated areas of California, 80% of the breeding places of C. tarsalis (transmitting Western and St. Louis encephalitis viruses) were man-made; throughout its distribution Japanese encephalitis is maintained largely by rice field mosquitoes and, in the Camargue, desalinization of surface waters by irrigation led to a vast increase in C. modestus and to the occurrence of West Nile fever (MOUCHEt et al, 1970).

Special attention needs to be paid to the local development of insecticide policies. Agriculturalists often use massive and repeated applications of complex mixtures of insecticides to combat agricultural pests without the liaison with health authorities which would enable them to assess its impact on arthropods of medical importance, such as malaria vectors. In California, a long term programme of mosquito control, dependent almost entirely on a long series of chemical insecticides, has led to a situation where after spending some $10 million, C. tarsalis has resistance to all licensed insecticides (REVES, 1972).

Irrigated agriculture will have to increase and intensify if world food supplies are to increase. But it will not succeed in realizing its potential either in terms of food or of reducing migration unless sensible health provisions are made. These should be built up on a problem solving basis involving maximum self help based on demystification of relevant health skills.

A further neglected aspect of development programmes is the resettlement of displaced populations in unfamiliar surroundings, often with all the consequences of loss of familiar social and administrative structure. SCUDDER (1975) estimates that the Kariba Dam involved resettling 56,000 people, the Volta Dam more than 70,000, the Kainji Dam 42,000, the Kossou Dam (Ivory Coast) perhaps more than 80,000, the Aswan Dam more than 100,000, and the Ubolratana Dam 30,000. Current plans for irrigated agriculture in the Tana River basin of Kenya indicate settlement of 100,000 (and perhaps eventually 300,000) people in an at present very sparsely populated area, and projected plans on the Mekong River might involve movement of 300,000 people.

Scudder points out that the time, capital, personnel and equipment necessary for the resettlement element in development programmes is nearly always underestimated and that in most of the African schemes the capital cost has exceeded expectation by two to threefold. Stable resettlement needs up to 10 years of careful physical and social nurture. More than nine years after resettlement in the Volta Dam scheme, most of the settlements are only partially taken up because they cannot support their populations even at subsistence level. Food supplies provided to such populations during early development are often unfamiliar and require unfamiliar cooking methods. The Lusito tragedy (GADD et al, 1962), occurring in a population moved to a new area because of the Kariba Dam, illustrates another aspect: 32 people died of acute hepatic poisoning attributed to the eating of some plant, resembling a familiar one, as a "relish". HARINASUTA (1975) found that thiamine deficiency (dry beri-beri, peripheral neuropathy) was common in the Ubolratana population because of a change from growing and eating their own traditionally prepared rice, to growing cash crops and purchasing highly milled rice; 70% of pre-school children were anaemic and 50% had biochemical ariboflavinosis (a sixth of these clinical).

Particularly in relation to the monitoring and control of the long term hazards of development programmes, the Society has an important role in fostering communication and collaboration. It is unlikely that fuller understanding of health problems by engineers and agriculturalists, and of agricultural and engineering problems by medical scientists, would not lead to improved design and management, for instance of irrigated agriculture. It is more likely that modified design of canals could assist in snail control, that carefully designed water management could greatly reduce mosquito breeding without seriously impairing the crop, and that mutually satisfactory programmes of insecticide use and monitoring could be developed. We should debate these matters with our engineering and agricultural counterparts and with the economists and administrators who also have to be informed and convinced. We should encourage long term joint research programmes (such as the MRC Project, KISSING: SIMPSON, 1975) to examine the consequences and possible solutions to longer term problems. Only thus will it be possible to develop integrated methods for disease control and relevant methods for surveillance and health services. With adequate epidemiological, demographic and operational measurements such studies could provide guidance to future developments, and ammunition to modify government policies.

**Major disease control programmes**

WHO has made two major efforts to eradicate diseases. The first, malaria, freed millions from the disease and has great successes in terms of control. However, it can now be seen to have been misconceived in a number of respects and world eradication cannot be expected in the foreseeable future. The second, smallpox, was a more realistic target and seems likely to succeed mainly because the infection is confined to man, and because a highly effective, well tried vaccine was available. Dramatic measures to control diseases are attractive to aid agencies because of their high short term value as public relations exercises and because, usually mistakenly, they are represented as relatively short term financial burdens—the large scale use of measles vaccine in West Africa and parts of Latin America are recent examples, and one still to be thoroughly tried is the current onchocerciasis control programme in West Africa. These programmes are usually based on the belief that a single control measure (a vaccine, an antibiotic, an insecticide) will be effective. Such measures can achieve eradication only when the infection is confined to man and where the infecting organism develops no significant resistance (e.g. smallpox, yaws). Zoonoses seem unlikely to be eradicable. Eradication must be world wide—measures confined to a lesser area must be combined with long term measures to maintain control and/or to guard against re-establishment of the infection. Control (as opposed to eradication, and in most cases more realistic) always implies long term measures and, of course, their cost which is more likely to increase than decrease, not least because of the demo-
In detail, man's behaviour assists these species and how premature cessation of spraying, delays in procurement of resources, as it is conceived and funded on the basis that intensive and makes use of the one resource in which vectors and on the diagnosis and treatment of the disease, exposes him to the enemy, some time honoured custom "almost totally ignoring the behaviour of man". "Yet all too often it is some facet of man's behaviour that interferes. Such "man-assisted" species (also including and C. tarsalis) are among the most dangerous to man.

According to the Lancet (1975), "the main obstacles are not technical; they are administrative and managerial—half-hearted Government support, political unrest, premature cessation of spraying, delays in procurement of supplies, errors of planning, inadequate basic health services, shortage of trained manpower, and limitation and uncertainty of financial resources". But there are also fundamental technical snags: Macdonald (1957) clearly distinguished the stable holoendemic malaria of tropical Africa from the unstable (alternating epidemics and low periods) malaria of India and Sri Lanka; he predicted that the latter but not the former would be controlled by residual insecticide spraying. In India and Sri Lanka the relatively short life span of An. culicifacies and its habit of biting mainly cattle and pigs presents a much easier target for residual insecticides than the longer living, largely anthropophilic An. gambiae of Africa (Waddy, 1975).

There is undoubtedly an overdependence on insecticides and drugs (too expensive for many health budgets) and a serious neglect of "species sanitation" which is labour intensive and makes use of the one resource in which most developing countries abound—abundant under-employed labour. This, if well organized to carry out well defined tasks under adequate supervision and discipline, could make substantial contributions to health, as demonstrated in China. Moreover Gillett (1975) points out that almost all research on arthropod-borne infections is focused on the organisms, their vectors and on the diagnosis and treatment of the disease, "almost totally ignoring the behaviour of man". "Yet all too often it is some facet of man's behaviour that exposes him to the enemy, some time honoured custom or tradition that, so to speak, invites the enemy in or at least smooths the path of entry." There is a direct and causal relation between man's activities and An. gambiae-transmitted malaria; in South East Asia, An. balabacensis, which causes epidemics following "reclamation of forest", is "a harmless forest species until man starts to interfere." Such "man-assisted" species (also including Ae. aegypti, Ae. stegomyia, C. triannulatus, C. fatigans and C. tarsalis) are among the most dangerous to man.

Much more attention should be given to studies of how, in detail, man's behaviour assists these species and how it could be modified to minimize the problem. Obvious examples of simple but effective labour-intensive control measures include elimination of unnecessary puddles and borrow pits (An. gambiae), improved simple methods for sewage disposal (C. fatigans) and the elimination of container breeding sites (Ae. aegypti). We need to educate engineers, administrators and the people themselves in the nature of the risks they create and provide them with simple but effective means of minimizing them. The prevalent scorn among medical and paramedical scientists for behavioural scientists and their work will have to be overcome and fruitful co-operation achieved. The difficulties in modifying behaviour effectively are formidable but we can no longer put our faith entirely in chemicals (pesticidal or therapeutic) if we are to bring malaria and other major tropical diseases to heel.

Geographical medicine

I use this term to describe the great opportunities, at present poorly exploited except in a few fields, for comparative studies of the aetiology, pathogenesis and prevention of cosmopolitan diseases between populations with contrasting ethnic and environmental backgrounds. "Geonetics" (v.i.) and "geographical pathology" are, of course, subdivisions of this.

The principles can be illustrated in heart disease (Miall and Bras, 1972). Heart disorders in industrialized countries are dominated by occlusive coronary artery disease which is still relatively uncommon in many parts of the tropics. Longitudinal comparisons of such populations covering periods of defined change could help to elucidate the aetiology of cardiac disease, not only in the tropics but also in the more industrialized countries. Tropical populations provide particular opportunities for the study of conditions that may be masked by occlusive coronary atheroma in more affluent communities. "In economically advanced societies the risk factors for coronary atheroma and myocardial infarction are so universally distributed that the whole population, to lesser or greater extent, is exposed to them, and suitable control groups cannot be identified for comparison" (Miall and Bras, 1972).

The possible fields of study are however by no means limited to cardiovascular diseases; intriguing questions can be asked about the distribution of such central nervous system diseases as multiple sclerosis and Jacob-Creuzfeld disease, and Burkitt (1973) enumerated conditions common in industrialized countries but relatively uncommon in Asian and African developing countries: appendicitis, diverticulitis, bowel cancer, adenomatous polyps, ulcerative colitis, varicose veins, haemorrhoids, deep vein thrombosis, pulmonary embolism and hiatus hernia. Certain malignant diseases, notably Burkitt's lymphoma and oesophageal cancer, are already the subject of international investigation on a substantial scale.

Another potentially fertile field is that pioneered by Professor D. D. Reid, the comparison of disease prevalence between migrant populations and their national counterparts who stayed at home. Reid (e.g. 1974) has concentrated on respiratory diseases, especially lung cancer and bronchitis, where comparisons of the effects of air pollution, especially cigarette smoking, could be made. But the principle could be extended to any disease in which environment or behaviour plays a strong role—for example, rickets among adult Asian women in Britain. With our substantial immigrant populations from the Caribbean, East Africa and the Indian sub-
continent. Britain offers excellent opportunities for such studies, if comparable populations which have not migrated can be identified, characterized and effectively studied. The absence of adequate demographic and health statistics in most developing countries presents the main difficulty—but two small populations have already been defined in East Africa by the MRC Project, Kisumu, and by the Royal Dutch Institute, Nairobi, and these relatively cheap and simple methods of demography and surveillance could readily be modified and extended to other populations. Factors which select migrants have to be carefully assessed—for example, people with active lung disease are less likely to migrate than those without (REID, 1974).

I am indebted to Dr. J. H. Renwick for the coinage of “Geonetics”, an apparently new word, to denote the geography of genetic differences between persons and populations in terms of congenital diseases and susceptibility to acquired disease. Evidence has been accumulating in recent years of relationships between various genetic markers (e.g. blood groups, tissue antigens) and the occurrence of certain diseases, and that some of these may be expressed as specific deficiencies in the immunological defences against certain infections. Gross immunodeficiency syndromes are rare, but partial immunodeficiencies are probably much commoner and merit serious investigation to explain the gross disparities obvious in many infections, and inexplicable in terms of acquired immunity, between rates of infection and disease. ALLISON (1975) points out that although the overall incidence of leprosy varies greatly between populations, the proportion of lepromatous cases is relatively constant suggesting that there may be a genetically predisposed subpopulation with an immunological defect. Similarly some African children develop severe measles even when infected with vaccine strains of measles virus—a situation perhaps often compounded by the immunodepressive effects of malnutrition. These are worthy subjects for “geonetic” study.

Such conditions as sickle cell disease and glucose-6-phosphate dehydrogenase (G6PD) deficiency, both conditions conferring resistance to Plasmodium falciparum infection, have already been the subject of interesting geographical comparisons. Although even with advanced medical care sickle cell homozygotes seldom survive to childbearing age, the allele has remained common in large areas of Africa and Asia and in parts of Greece, with heterozygote rates of 20% or even 40% in some areas. This cannot be accounted for by mutations and must probably be attributed to the selective advantage of resistance to P. falciparum infections among young heterozygotes. LEHMAN and HUNTSMAN (1974) point out the striking correlation between a high sickling rate and low social status. Populations low on the social scale tend to inbreed and a high frequency of homozygotes for unusual inherited characters. But, probably more important, the higher malaria infection rates in poorer populations enhance selection in favour of sickle cell trait carriers. Malaria also seems to be a possible selective factor for β-thalassaemia, haemoglobin E and G6PD deficiency. Less easy to explain is the considerable resistance shown by American negroes to P. vivax and P. knowlesi infections which is not accounted for by acquired immunity, abnormal haemoglobins or G6PD deficiency (ALLISON, 1975).

In a study of Air Force recruits, a highly significant excess with blood group O and a corresponding deficiency in group A were reported among those clinically affected by infection with a new A2 strain of influenza (McDONALD and ZUCKERMAN, 1962). Moreover, in volunteer infections with influenza virus, a significantly higher proportion of group O persons than group A became infected (TYRRELL et al, 1968). In mice, several examples of single major genetic factors conferring resistance to virus infections have been described; more recently BRADLEY (1974) has demonstrated simple genetic control of susceptibility to Leishmania donovani in mice.

Relationships to ABO group have been demonstrated in certain cancers and in peptic ulceration. Associations of varying degrees and certainty have become apparent between various HL-A tissue antigens and Hodgkin’s disease, ankylosing spondylitis, psoriasis, chronic active hepatitis, adult coeliac disease, myasthenia and multiple sclerosis—usually one antigen haplotype with one disease. HL-A linked specific immune response genes seem likely to be important predisposing genetic factors in a variety of neoplastic, autoimmune and infectious diseases of man (MCDEVITT and BODMER, 1974).

It seems unlikely that the geonetics of disease susceptibility will not provide a rich treasure ground for comparative studies between populations of differing genetic composition and environment. We can couple with this field that of the different responses to drugs between different ethnic or genetic groups, i.e. pharmacogenetics (KALOW, 1962). To take one example, the enzymatic form of hereditary methaemoglobinemia, which is aggravated by nitro- and amino-compounds, is far more frequent among North American Indians and Eskimos than among those of European descent, but has also been reported in Calcutta.

Such studies, whether concerned with comparisons of genetic or environmental factors in pathogenesis, or with migrants who have changed their environments, cannot be entered into lightly. They need a sound demographic basis, clear understanding and agreement in the populations concerned about acceptability of the investigations proposed, a stable duration of several years, and a sound administrative basis both at home and abroad in addition to the necessary scientific resources. Collaboration should be mainly based on supplementary studies in which the various groups can make progress despite lack of it in others. There are countries such as Iran which are anxious to develop collaborative research and with whom comparative medical studies might well be feasible and fruitful. The Society could assist in the development of such investigations by holding discussions to define their planning, structure and prerequisites, and by publishing the conclusions as guidelines for the workers concerned and their governments.

Future prospects

The future strength of tropical medicine depends firstly on its acquiring the focal position in the wider context I have tried to depict; secondly on its demystifying itself to obtain wider and more effective recognition of its value and the importance of application of its advances; and thirdly, but perhaps most critically, on attracting and retaining first class brains in both industrialized and developing countries, on providing them with effective but relevant working conditions and on providing a context for fruitful international and interdisciplinary co-operation.

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saps the enthusiasm of both recruiters and recruits. We are all familiar with the problems of our own students who return to their own countries to find no post or no facilities or no support with which to make use of their expensive overseas training, and therefore to exploit it for the development of their countries. Within the WHO Tropical Diseases Research Programme (and if possible, within the WHO Fellowship Programme as a whole) such trainees should be selected to fill specific research or service posts and their interest and aptitude should first be tested for (say) a year in their own country. Only then should they be given a fellowship and advanced training. When they have completed it and return to their country, and provided they have shown promise, their posts, facilities and support should be provided by the Programme, subject to an agreement from their government or universities to take them over after a specified period of years. Such commitments would (or should) ensure the planned development of research in a developing country based on carefully selected, tested and trained personnel. Developing countries often neglect to balance their provision for scientific personnel with adequate provision for the technological staff so essential to their effective use. In terms of medical research they need to pay more attention to providing technicians with satisfactory careers and training, which must be attractive enough to people with secondary education. Their universities may have to develop Bachelor of Technology sandwich courses in order to achieve this.

So as to provide more careers in the industrialized countries, I have suggested that each should make part of its contribution to the Programme the provision of a number of posts, home based in institutions appropriate to their scientific disciplines, guaranteed up to retirement and seconded long term for work overseas within the Programme. The addition of even 10 such career posts in this country could significantly change attitudes to recruitment—and 10 countries providing 10 posts each could provide precisely the injection of talent which the Programme will need if it is to succeed. In Britain these posts would of course be additional to the I.U.C. Lectureships which have made such a substantial contribution to the work of the schools, but which could have been more effective if their rules had not demanded the payment of salary from non-I.U.C. sources (usually overseas sources) when the incumbents were posted overseas. I hope that before long the agreement can be reached to balance their provision for scientific personnel with adequate provision for the technological staff so essential to their effective use. In terms of medical research they need to pay more attention to providing technicians with satisfactory careers and training, which must be attractive enough to people with secondary education. Their universities may have to develop Bachelor of Technology sandwich courses in order to achieve this.

References


