WORLD HEALTH ORGANIZATION
Regional Office
for the Eastern Mediterranean

SEMINAR ON SMALLPOX ERADICATION
Dacca, 29 October - 5 November 1969

EM/SEM.SE/6
ENGLISH ONLY

SMALLPOX IN THE WORLD

by

Dr D. A. Henderson

SMALLPOX IN THE WORLD

D. A. Henderson[1]

Although now confined to less than 20 endemic countries in Africa, Asia and South America, smallpox continues to represent by far the most universal and serious threat of any infectious disease to countries throughout the world. Once introduced, smallpox can be transmitted reasonably readily in any country, irrespective of season or the degree of development of the health services. Algeria is quite as much at risk as Iran or Iceland. Case fatality ratios among those infected with variola major are normally 30 to 40%, however satisfactory the health care. There is no specific treatment available.

Our only weapon for attack and virtually our only defence against smallpox is vaccination. Vaccination against smallpox is practiced today in every country throughout the world. As with no other disease certificates of vaccination are universally required for international travel. Of all the immunizing agents available today, far more smallpox vaccinations are performed annually than the total for all other immunizations combined.

In dealing with smallpox, the principal emphasis of all non-endemic countries until 1967 was based on a defensive posture - of keeping smallpox out of one's own country and, if introduced, of containing it quickly. The key principles were vaccination of one's own population, quarantine and surveillance. The simple axiom, "the best defense is a good offense", was largely ignored.

In 1966, an intensified global programme of smallpox eradication was proposed and unanimously adopted by the World Health Assembly. Supported by a modest budget from the Organization and pledges of additional support from a number of countries, particularly the Soviet Union and the United States of America, the programme was initiated in January 1967. It is now in its third year. At the opening of this Seminar it is particularly appropriate that we consider the present status of the programme throughout the world for it is a unique venture in preventive medicine in which now virtually all countries are actively participating.

During 1967, the first year of the eradication programme, reported cases of smallpox actually increased from 89 000 to over 129 000 (fig. 1). This principally was the result of more complete reporting from several of the major endemic

---

[1]Chief, Smallpox Eradication Unit, World Health Organization, Geneva.

countries. However, in 1968, the incidence decreased by 40% and, in 1969, a further decline of about 40% has been observed to date. These decreases have occurred despite steadily more complete recording of cases in most countries. Based on present trends, it is likely that only three countries, Brazil, Indonesia and the Democratic Republic of the Congo, will record rates of 5.0 cases per 100 000 or greater during 1969. Notably, these three countries are numbered among those with the most active eradication programmes today. The decreasing incidence of smallpox is also reflected in the number of countries which have been afflicted with the disease. At the beginning of the programme 43 countries recorded cases; last year, the number fell to 37; this year, only 30 countries have experienced smallpox.

Programmes are now in operation in all but two of the endemic countries - South Africa and Ethiopia. Not surprisingly, however, progress has been greater in some areas than in others.

South America (fig. 4)

In the Americas in 1969, cases have been recorded only in Brazil, with the exception of a single imported case in Uruguay. The eradication programme has been intensified in Brazil during the past year. The number vaccinated in the systematic vaccination campaign is now between 1.5 and 2 million persons per month and over 35 million have been vaccinated since the programme began. This is in addition to approximately 10 million persons being vaccinated annually in routine and maintenance programmes. The assessment programme has been particularly well organized. Assessment teams regularly check a sample of 5 to 10% of the population in all areas vaccinated. Coverage has usually exceeded 90% in all age groups and take rates have consistently been higher than 95% in primary vaccinees.

Smallpox incidence began declining approximately a year ago but in June of this year, recorded cases increased sharply and the incidence has since continued to rise. To date, over 4 500 cases have been recorded and the final total for the year may well be the highest ever recorded in Brazil. The paradox of a rise in incidence at the same time a successful programme is in progress is explained in this case by a marked improvement in surveillance. Physicians for surveillance were trained early this year and commenced active operations just before mid-year. One such person is now assigned to full-time surveillance duties in every major state. The surveillance officers endeavour to develop and expand the network of reporting services and they investigate and control all reported outbreaks of smallpox. The impact of these investigations in increasing notifications is illustrated by the experience in one

state in which it has been found that there for every case reported, 40 additional cases are discovered during field investigations. In Brazil, the routine reporting system for smallpox is certainly less efficient than in most countries although it must be borne in mind that the disease, variola minor, is less severe and most persons are not so severely incapacitated as with variola major.

Although the incidence of reported smallpox in Brazil is now reaching alarming proportions, it is anticipated that the surveillance operations will actually result in Brazil becoming smallpox-free as much as one to two years sooner than if surveillance were ignored until the systematic vaccination programme was completed.

Africa, West and Central (fig. 5)

By far the most dramatic progress to date has been in western and central Africa. Programmes in 20 countries embracing a population of 120 million persons were begun in January 1967, with bilateral assistance from the United States of America and additional help from the World Health Organization. It is pertinent to note that health services in this area are less well-developed than in virtually any other endemic area; problems of transport, communication and logistics are formidable. In contrast to countries such as Pakistan or India, for example, there was, before this programme commenced, limited immunity even in most adult populations. Despite these problems, 100 million vaccinations have been administered in a period of less than 3 years. Surveillance activities have been intensively conducted since October last year. Smallpox incidence has declined precipitously. In fact, no cases have been detected anywhere in this vast area since 12 September. Intensive efforts to detect cases continue, however, and will continue but we feel reasonably confident that this area will be smallpox-free by the end of this year. This is all the more remarkable when it is realized that five of the 10 countries which recorded the highest rates of smallpox in the world during 1968 were located in western and central Africa.

Africa, East and South (fig. 6)

During 1969, recorded cases of smallpox in eastern and southern Africa have declined more than 50% from the number reported in 1968. Smallpox incidence is presently at a record low level. No cases have been reported to date in Swaziland or Zambia and only four countries, the Democratic Republic of the Congo, Ethiopia, South Africa and Sudan, have reported more than 100 cases this year.

In the Democratic Republic of the Congo, 1078 cases were recorded through August

compared with 2 597 cases during this period last year. In this country of 17 million persons, vaccination activities have been sharply increased during the past two years and, to date, almost 8 million persons have been vaccinated.

	No. of vaccinations		
	Eradication programme	Other health services	Total
1967	302 000		302 000
1968	2 275 000	574 000	2 849 000
1969 (8 months only)	2 147 000	2 477 000	4 624 000

Since the beginning of 1969, special efforts have been made to improve the completeness of routine case notification and plans are being developed to undertake intensified investigation and containment activities early next year. A successful programme in the Congo is particularly important as this country occupies a strategic position in Africa, having common borders with nine other countries.

Of greatest concern in Africa and perhaps of greatest concern to the global programme as a whole is the smallpox situation in Ethiopia and Sudan. These countries have together recorded a total of 294 cases. It is known, however, that smallpox in Ethiopia is considerably under-reported and based on experiences in other parts of the world, it is reasonable to assume that the number of cases reported can safely be multiplied 20 to 50 times. No formal programme of control or eradication has been planned. In neighbouring Sudan outbreaks occurred for the second year in succession at the time of a large seasonal migration of agricultural workers into east central Sudan from the southern part of the country and from Ethiopia. One hundred and twenty six cases occurred in 34 towns and 4 provinces. An eradication programme, however, has begun and appears to be gaining momentum.

Asia (fig. 7)

Smallpox incidence in Asia declined by 40% in 1968 and appears to be declining at a comparable rate in 1969. However, from one country to the next, progress in the smallpox programmes differs widely as do the trends in incidence and factors influencing these trends.

The most active programme in Asia is in Indonesia. The programme commenced in July 1968 and has progressively been extended throughout the country. Paradoxically, in 1969, the reported incidence of smallpox is little different from that in 1968.

As in Brazil, however, reporting has been greatly intensified and containment teams, constituted in January of this year, have steadily broadened their extent of activity. East Java and Bali with a population of 30 million are now smallpox-free. Central Java, with a similar sized population, has only a few remaining foci. An intensive campaign is in progress in West Java and, with a bit of luck and a great deal of hard work, could become smallpox-free in the next 3 to 6 months. Programmes are in progress in Sumatra and Sulawesi which represent the remaining foci of the disease.

Increased notifications were received during 1968 from both Afghanistan and Nepal, again as a result of more complete reporting, in the context of eradication programmes. In both countries, however, the incidence is once again declining.

A marked decline in smallpox occurred this year in East Pakistan which, in 1968, recorded its highest incidence in a decade. However, the fall in incidence must be attributed principally to expected cyclical variations in the disease incidence. West Pakistan, however, is one of the few reporting areas which has recorded a significant increase in smallpox in 1969. The number of cases this year is almost double the number recorded last year. As Dr Shafa will describe in greater detail, an eradication programme has begun but surveillance activities have not yet been organized.

In India, an increased emphasis has been placed on vaccination of those never previously vaccinated, particularly pre-school children; the use of liquid vaccine has been totally abolished; vaccine storage has been improved; and the bifurcated needle is being substituted for the rotary lancet in the vaccination programme. Although reporting is still very incomplete and surveillance activities are still very limited, there appears to be a continuing decline in incidence from 1968 and 1967.

Significant Factors in the Progress of the Programme to Date

Overall, the progress to date in the global eradication effort has been most gratifying. Significant to this progress is, of course, the whole-hearted support for the programme by the governments of most endemic countries and many non-endemic countries, particularly the Soviet Union and the USA, and the dedicated work of those engaged in the eradication effort. Two factors, however, have greatly facilitated their efforts: first, the now almost universal use of freeze-dried vaccine which meets WHO standards of potency and stability and the use of newly developed vaccination techniques which assure a high proportion of takes, and; second, the recognition that the surveillance component of the programme is at least equally as important as mass vaccination. I should like to comment briefly on both of these points.

When the programme began, it was recognized that use of fully potent and stable freeze-dried vaccine throughout all endemic countries was an absolute necessity if the programme were to succeed at all. The potency of liquid vaccine cannot be assured for more than a day or two after removal from the freezer - even in temperate climates with adequate refrigeration and well-developed health services, we know that much of the liquid vaccine is impotent by the time it reaches the recipient. Freeze-drying of the vaccine is not, however, the final answer - it must be potent. Tests of freeze-dried vaccine conducted in 1967 by a WHO Reference Centre, revealed that probably not more than 10 to 20% of the vaccine in use in the endemic countries met requisite standards. In one area, immediately after 100 000 persons had been vaccinated to "control" an outbreak, assessment revealed a take rate in primary vaccinees of less than 1%.

To assist in improving this appalling situation, WHO established two reference centres for smallpox vaccine and offered to test vaccine lots free of charge: this year nearly 250 lots were tested compared to 43 in 1966. WHO consultants visited 24 production laboratories, many on several occasions, and equipment, special reagents and testing materials were provided to over 30 laboratories. At this time, I am pleased to report that, except in Brazil and Pakistan, essentially all vaccine in use in the endemic countries is freeze-dried vaccine which meets WHO standards of potency, stability and purity.

In respect to vaccination technique, the jet injectors were first introduced in 1967 and the bifurcated needles in 1968. Take rates with both techniques are usually found to be higher by 10 to 20% than by older scarification methods. Recent studies in India also reveal much higher take rates with the bifurcated needle than with the rotary lancet. Both the jet injector and the bifurcated needle conserve vaccine by a factor of 2 to 3 fold. These devices are now in wide use throughout the world. Originally, the jet injector was favoured for collecting point programmes because of its greater speed. The speed of operation compensated for the intrinsic vexing problems of maintenance and repair of this instrument. However, the supposedly slow multiple puncture technique has been found, in practice, to be anything but. In Uganda, Burundi and Tanzania vaccinators routinely average 500 vaccinations each per day. During one large scale operation in Rwanda during which 130 000 persons were vaccinated in 20 days, the vaccinators averaged slightly over 1 200 vaccinations each per day. We have increasingly come to the conclusion that the bifurcated needle is the instrument of choice and there are now few endemic countries in which it is not widely used.

The second important factor which has so greatly accelerated the eradication effort

is the comprehension of the importance of the surveillance component of the programme. The objective of the surveillance component of the programme quite simply is to investigate every case of smallpox, to trace its source and to take containment action.

Prior to the intensified eradication programme, most experts regarded a smallpox eradication programme very simply as a vaccination programme. If one vaccinated 80% of the population and cases continued to occur, then one should increase one's target to vaccinate 100% of the population - and so it was stated by a WHO Expert Committee only 5 years ago. This strategy bore a striking resemblance to the strategy of malaria eradication - first, spray all the people with vaccine and then look about and see if there are any cases. If there are, spray again. This is a rather crude way of expressing the concept and it is not meant in a derogatory vein with reference to malaria. However, epidemiologically, microbiologically, ecologically and in every other way, smallpox and malaria could hardly be more different. The strategy for one should and must be different from the other.

I need not recount to you the numerous failures of eradication programmes which were based on the strategy of "spray the population with vaccine and sit back to see what happens". However, I should like to note a couple of examples in which special surveillance units were constituted and in which this phase of the programme operation received equal emphasis with mass vaccination. Guinea and Sierra Leone recorded in 1967 by far the highest rates of smallpox of any countries in the world. Eradication programmes began in January 1968. The last cases of smallpox were detected in May, almost 6 months ago and less than one and a half years after the programmes started. At that time, the systematic vaccination programmes had reached less than 70% of the population - large areas had not even been vaccinated. Another illustration - in East Java, with a population of some 25 million persons, only two imported outbreaks of smallpox have been detected this year; in West Java, with a similar-sized population, over 7 000 cases have occurred during the same period. Assessment surveys interestingly show very similar levels of immunity in East Java and West Java; the difference - surveillance units have been immediately investigating all outbreaks in East Java for over a year. In West Java, little was done until the past few months.

The moral, quite simply, whether for endemic or non-endemic countries, is that surveillance and immediate containment of smallpox outbreaks is the key to maintaining or achieving a smallpox-free status. This task is considerably simplified if one has a highly immune population and so the need for continuing vaccination programmes. Vaccination alone is not likely, however, to result in a smallpox-free status.

I think there is no question of the fact that if we can further extend the use of potent, freeze-dried vaccine and multiple-puncture vaccination with the bifurcated needles and can instill everywhere the concept that every case of suspected smallpox must be investigated as an emergency measure and containment measures taken, smallpox, within a period of a few years, could become as extinct as the dinosaur or the dodo bird and smallpox-free countries could cease to worry about infested neighbours and divert their scarce resources to better purpose.

FIG. 1

WORLDWIDE SMALLPOX INCIDENCE, 1967–1969

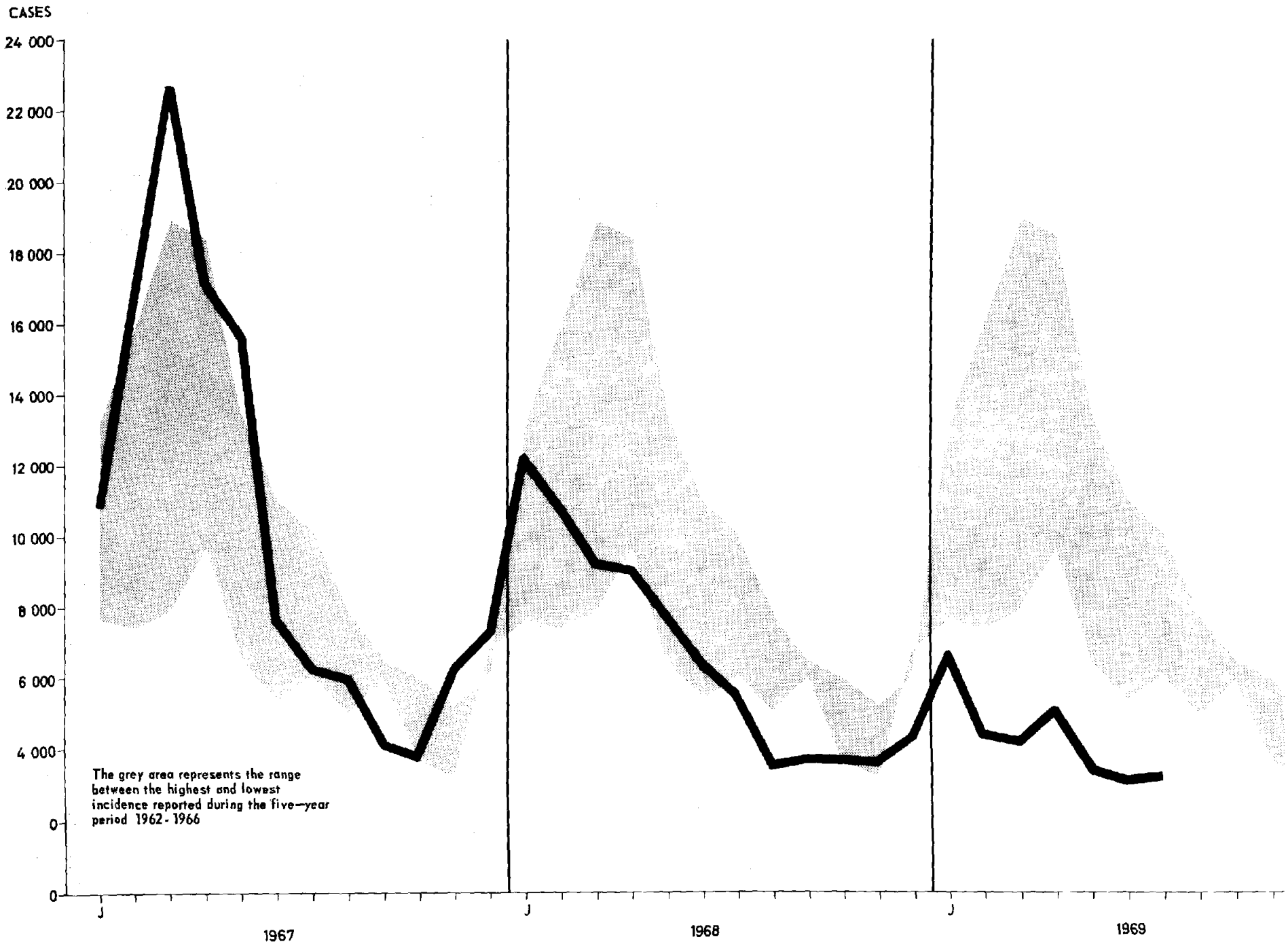

FIG. 2

SMALLPOX CASES PER 100 000 POPULATION - 1968

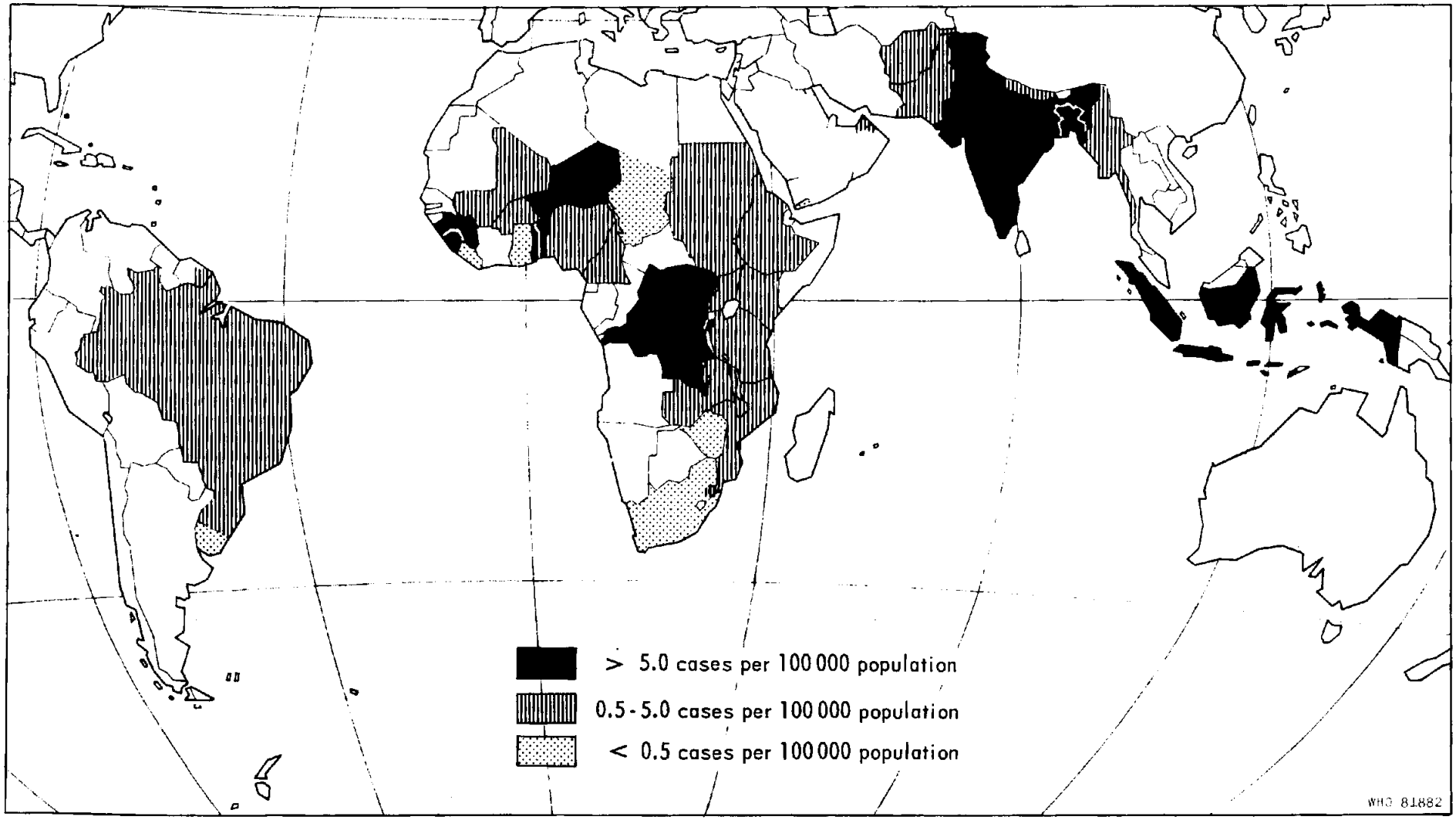

FIG. 3

SMALLPOX CASES PER 100 000 POPULATION - 1969

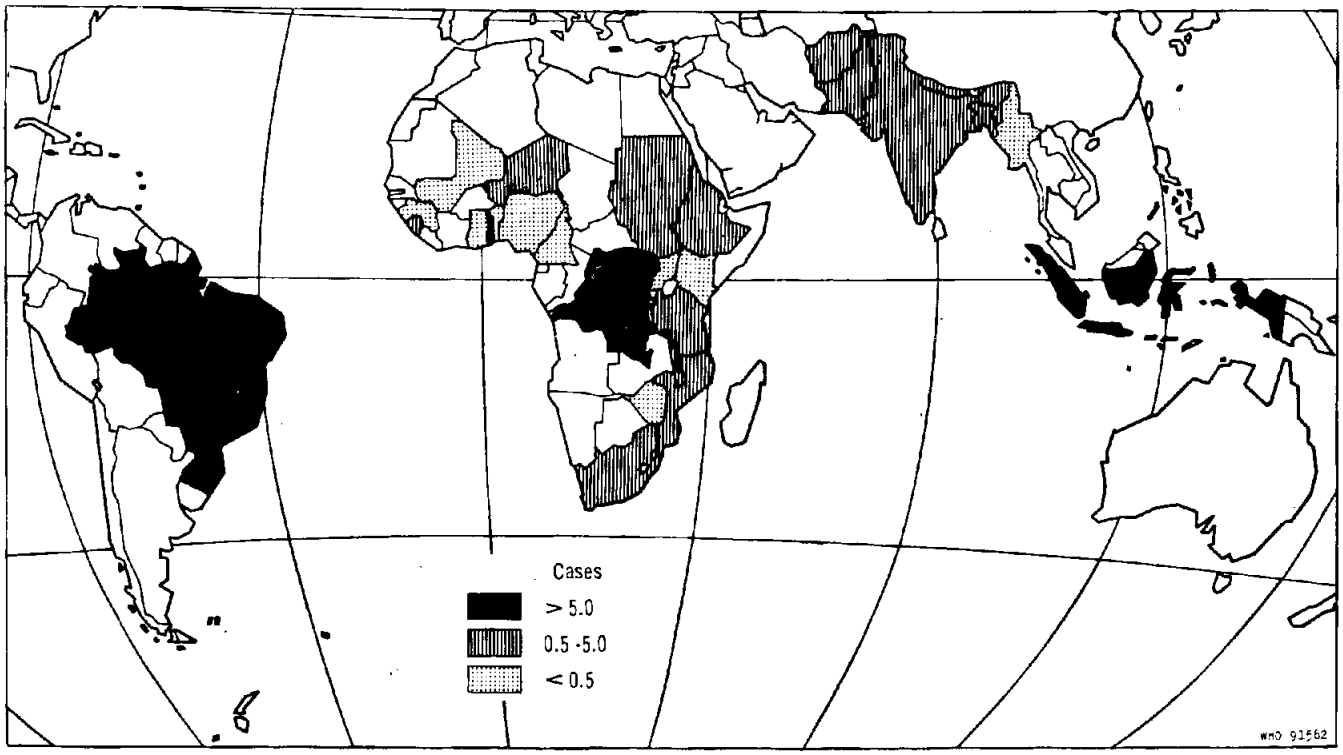

FIG. 4

SMALLPOX INCIDENCE : SOUTH AMERICA, 1967 - 1969

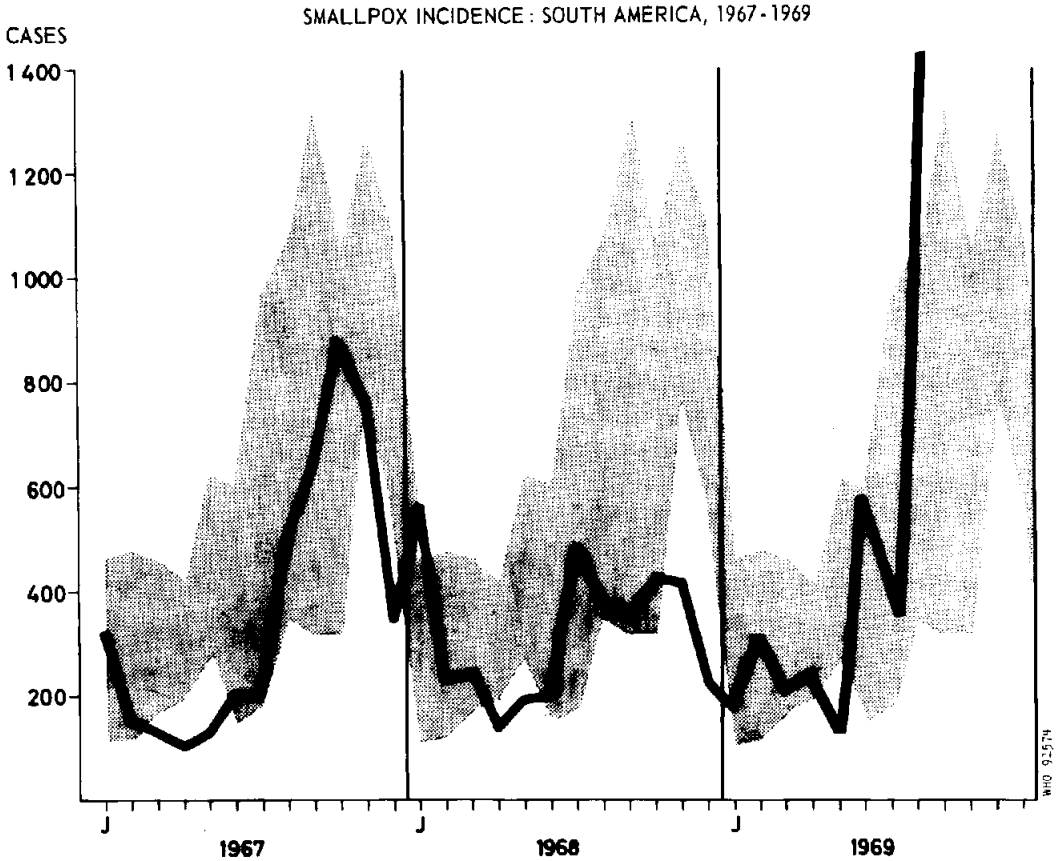

FIG. 5

SMALLPOX INCIDENCE : AFRICA, WEST AND CENTRAL, 1967-1969

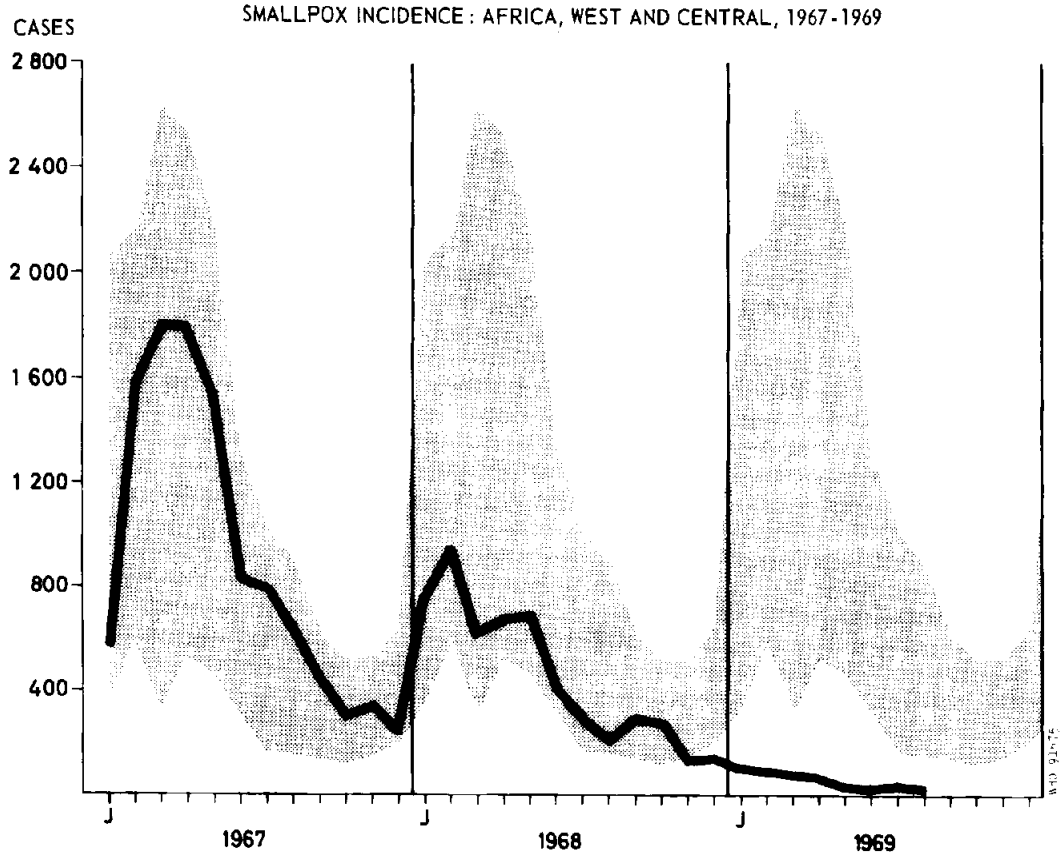

FIG. 6

SMALLPOX INCIDENCE : AFRICA, EAST AND SOUTH, 1967-1969

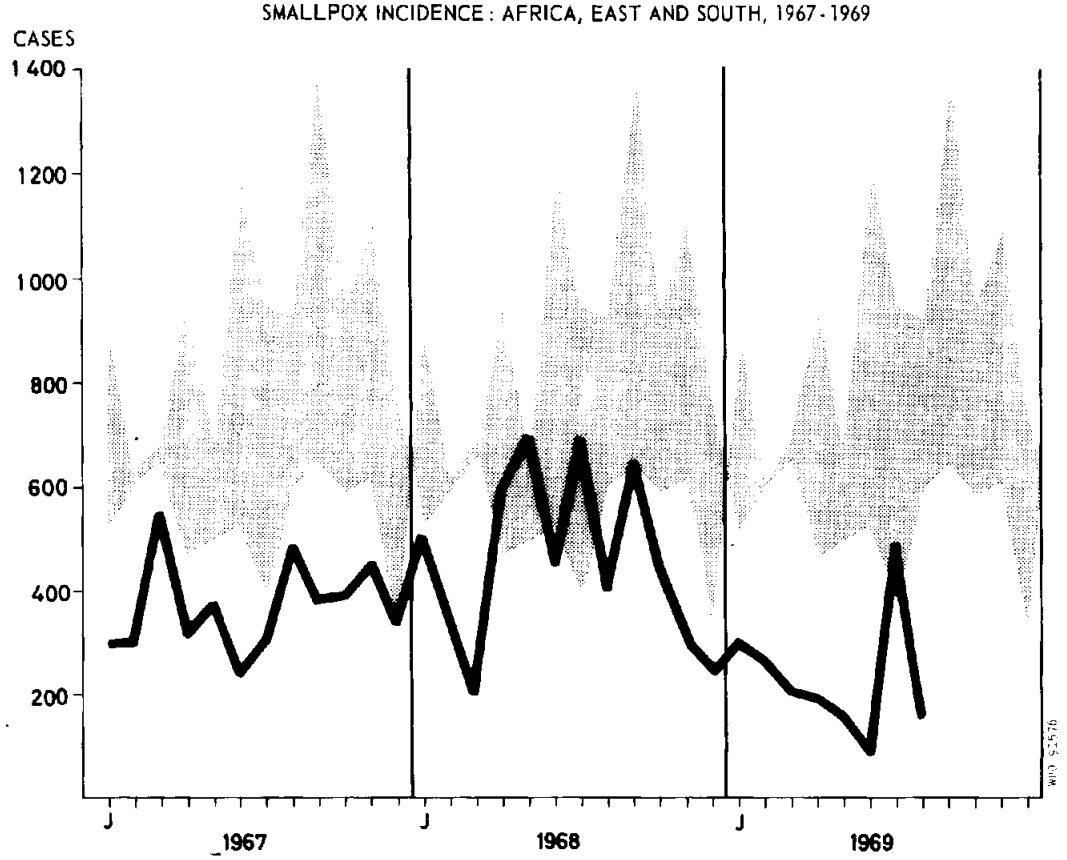

FIG. 7
SMALLPOX INCIDENCE: ASIA, 1967–1969