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WORLDWIDE SMALLPOX ERADICATION
LAST KNOWN FOCI AND GLOBAL CERTIFICATION [a]

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In accordance with the recommendations made by the Consultation on Worldwide Certification of Smallpox Eradication in October 1977, activities for global certification of smallpox eradication have been intensified since November 1977. During the last 13 months, 22 countries have been visited by members of the Global Commission either to certify the eradication status or to appraise the smallpox situation (Table 1). In addition, ten countries have been visited by WHO epidemiologists. Two meetings have been held - first, a Coordination Meeting in Nairobi in April 1978 and second, an Informal Consultation on monkeypox/whitepox problems in November 1978.

Whilst detailed reports on these activities will be submitted to the Global Commission, in this note background information on the following topics are provided which may facilitate the Commission members' considerations on smallpox eradication.

1. Last known smallpox foci
2. Certification of Smallpox Eradication status
3. Variola virus stocks in laboratories
4. Animal reservoirs of variola virus
5. Monkeypox and whitepox viruses
6. Mutation of poxviruses to variola virus
7. Special studies
8. Immunization against smallpox
9. Conclusion

[a] This paper refers to the situation as of 15 November 1978. During the last half of November an International Commission assessment was scheduled for Sudan.

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1. Last Known Smallpox Foci

Among milestones in the progress of the smallpox eradication programme have been the recording of the last cases in South America in 1970, in Indonesia, west and central Africa in 1971, in southern Africa in 1973 and in the Asian subcontinent in 1975.

During the last three years, the endemic foci were circumscribed in the Horn of Africa and the last known smallpox case was detected in Merka town, southern Somalia in October 1977.(1) The case, a 23 year old male, had an onset of rash on 26 October and is considered to represent the end of naturally occurring smallpox transmission in the Horn of Africa and, thus, in the world.

In August and September 1978, two smallpox cases occurred in Birmingham, U.K. The first patient, a medical photographer, a 40 year old woman, developed a rash on 13 August and subsequently infected her 71 year old mother who developed a rash on 8 September while under close surveillance at home. Although 300 contacts were under surveillance, no other secondary cases were detected. The source is considered to be variola virus stocks in a laboratory situated in the hospital where the first patient worked. There was no suspect smallpox case in the hospital prior to her illness and she had no contact with any travellers from previously endemic areas. The exact route of infection is now under investigation by an enquiry committee in the U.K.

Thus, the Birmingham episode is considered to have an artificial source of origin and it remains that the world has now enjoyed one year of freedom from endemic smallpox.

2. Certification of Smallpox Eradication Status

Claims of the current absence of smallpox reports throughout the world may raise suspicions as to whether or not smallpox is hidden in areas such as densely populated slum areas, remote tropical rain forests and isolated deserts. During the smallpox eradication campaign, the sensitivity of smallpox surveillance has been increased considerably. In all previously endemic countries, national eradication programmes developed search operations for hidden foci even in the most remote areas. When smallpox incidence in these countries became very low, case detection rates in most instances reached 95% and when the countries declared their last known case, it was believed that all areas had been searched with 100% detection rates. However, there were a few exceptions. In Indonesia a large outbreak was detected eight months after the date of the last declared smallpox case and in Botswana after six months had passed without a reported case. Hence it was decided by the WHO Expert Committee for Smallpox Eradication in 1972 that smallpox eradication can be declared only if active surveillance for at least two years after the last known case fails to discover any smallpox.

The major surveillance measures undertaken during this two year surveillance period in each of the countries concerned can be summarized as follows.

First, the programme organization is maintained after the declaration of the last known case. The strategy is shifted from containment of smallpox outbreaks to searching for hidden foci. The search teams visit all houses, schools and health stations in the entire country. Secondly, specimens are collected from smallpox suspects and chickenpox patients with severe rash or those without vaccination scars, and these are tested by WHO Collaborating Centres. Thirdly, surveys are conducted and efforts made to search for pockmarked persons and ascertain the year of infection. This method is useful in areas where variola major strains or intermediate strains were once prevalent, since 60 - 80% of the patients retain distinct facial scarring caused by smallpox. Fourthly, an independent assessment is conducted to find out whether houses have been visited by teams, whether they know about the smallpox reward and whether they know where to report if a smallpox suspect is found.

The extent of such activities is exemplified by the massive house to house searches undertaken in India and Bangladesh. On combining the data for the two countries it is found that an average 98.2% of the 726 811 existing towns and villages were visited in each of the searches during the two years after the respective last smallpox cases. During these periods three such searches were conducted in India and eight in Bangladesh (Table 2). No cases were found in any of these searches. Specimens are being collected in all previously endemic countries and neighbouring countries. A total of 7 744 specimens have been collected from 41 countries in 1977 and 1978 (Table 3). All have been negative for variola virus since October 1977 when the last endemic case occurred in Somalia. Pockmark surveys were carried out in 28 countries of west, central and southern Africa from 1975 to 1978. Of the total estimated population of 211 713 000, 9 059 119 were seen (Table 4). No pockmarked person was found among children born after the year of the last known case in each country. In Ethiopia and Somalia, where the last endemic foci were detected during 1976 and 1977, the latest assessment results illustrate the intensity of the search for hidden foci; over 75% of the inhabitants met search workers who enquired about smallpox rumours, over 75% knew about the cash reward which was offered to them if they found a smallpox case, and over 70% knew where to report such a case.

Lastly, the adequacy of these activities is verified during visits by an international group of experts - known as an International Commission for the Certification of Smallpox Eradication, and convened by WHO. During the eradication campaign, 77 countries have been identified as either endemic for smallpox (35 countries) or exposed to the risk that an imported case of smallpox might establish endemicity. Of these, 47 countries conducted intensive surveillance for at least two years after the last known case and their eradication status was certified by International Commissions (Figure 1). Currently, the 30 countries remaining are continuing their preparation for certification.

In March 1978, WHO formed the Global Commission for the Certification of Smallpox Eradication. This Commission will evaluate the smallpox eradication status worldwide and is expected to report on its activities by the end of 1979.

3. Variola Virus Stocks in Laboratories

As the confirmation of nil incidence of smallpox in the world increases, the potential danger of live variola virus in the laboratories becomes more important. Available data indicate that laboratory associated smallpox infections occurred in Liverpool in 1946, in London in 1973, in San Antonio in 1976 (chimpanzee infection, not human infection) and recently in 1978 in Birmingham. In 1975, WHO initiated a worldwide survey to prepare an international register of laboratories retaining variola virus stocks. In the process, of 181 countries and territories contacted, 180 reported on their status. References from 1950 to 1978 were reviewed by WHO to find any laboratories which had conducted research with variola virus and to enquire whether any virus stocks still remained. Over 600 laboratories were individually contacted either through national health authorities (Canada, India, Japan, U.K. and the USA) or by WHO. In India, national and WHO teams visited laboratories. In total, worldwide, seventy-six laboratories were registered as retaining variola virus. Of these, 64 have already destroyed or transferred the virus to WHO Collaborating Centres. At present, there are 12 laboratories registered: five WHO Collaborating laboratories (one each in the USA, USSR, U.K., the Netherlands and Japan) and seven other laboratories (two in the USA, two in the Federal Republic of Germany, one in South Africa and more than one in China). In August 1977, safety measures for laboratories retaining variola virus were formulated by WHO and recommended to all the laboratories concerned.

There are three major points regarding the current situation. First, efforts are being made to reduce the number to three WHO Collaborating laboratories by the end of 1979. All other laboratories are recommended to destroy or transfer the virus. Secondly, the question has arisen as to whether total destruction of all variola virus stocks is desirable, since retention of the virus leaves a chance for re-introduction of smallpox infection in unexpected circumstances, including possible biological warfare or use in terrorist activities. In my view, total destruction is not desirable since it is prudent to maintain research capabilities in case they are needed in the future. It may be necessary to

confirm the nature of unknown pox viruses if such viruses are detected. Perhaps, in collaboration with national security authorities, the Collaborating Centres with reference strains must be placed under strict international supervision. Thirdly, there is concern as to whether the WHO survey, although intensive and meticulous, succeeded in locating all the laboratories retaining variola virus. In this respect, as a precautionary measure, an announcement is to be published in relevant scientific journals to request further searches for variola virus ampoules which may have been inadvertently overlooked.

4. Animal Reservoir of Variola Virus

There is no evidence of an animal reservoir of variola virus.(2) In earlier literature (1767 to 1949) there were seven references indicating smallpox-like disease in non-human primates. Except for one in Indonesia, which occurred in the Jakarta Zoo in 1949, there was no valid evidence that smallpox occurred in non-human populations. From 1966 to 1970, a study was made to isolate viruses from 7 497 specimens collected from African mammals in West Africa.(3) (Of these, 104 were non-human primates and 5 517 were rodents). Although the virus isolation method (inoculation of the brain of suckling mice) was not particularly sensitive for pox viruses, among 83 virus isolates obtained a single pox virus isolate termed "gerbilpox" was identified which was distinguishable from variola virus. From 1970 to 1975, 3 554 sera were collected mainly from non-human primates and rodents (1 024 from tropical Asia and 2 930 from the sub-Sahara region of Africa),but no evidence of poxvirus infection was found in these sera.(4)

More important are the epidemiological findings. Notably, in the Philippines and Central America, where it has been eradicated for several decades, smallpox has never returned spontaneously, although in these areas non-human primates are plentiful. In addition, during the last ten years of the smallpox eradication campaign comprehensive epidemiological investigations were conducted on more than 100 000 outbreaks in South America, Africa and tropical Asia. None of the sources of infection could be traced back to an animal origin.

5. Monkeypox and Whitepox Viruses

During the eradication campaign, intensive smallpox surveillance revealed 35 cases of human infection by monkeypox virus from 1970 to the present in Liberia, Sierra Leone, Ivory Coast, Nigeria and Zaire. Twenty-eight were children; six died. (This virus was first identified in a monkeypox outbreak in a captive monkey colony in the Staten Serum Institute, Copenhagen, in 1958.(5) The clinical picture of monkeypox in humans resembles that of smallpox, but the virus can be easily distinguished from variola virus by laboratory tests.) On two occasions, in the same families, a second case occurred 9 - 12 days after the first case. This would suggest that person to person infection did occur or that the second case was exposed to the same source of infection from which the first case originated. If the first interpretation is correct, in 56 unvaccinated contacts of these patients, two developed the disease suggesting a transmission rate of 3.5%. This rate is 10 times lower than the 35% transmission rate of smallpox estimated in West Africa.(6) No continuous spread of this virus in human inhabitants was found despite a low vaccination coverage - less than 40% in the immediate area where cases occurred. Non-human primates or rodents are suspected of being the reservoir of monkeypox. Some 20% of sera collected from monkeys in the immediate areas showed poxvirus antibody and among these, three monkey sera showed monkeypox specific antibody.(7)

From 1964 to 1975, six whitepox viruses were isolated. Two from monkey kidney tissue culture in a laboratory in the Netherlands in 1964 (the monkeys had been shipped from Malaysia) and four from animal specimens from Zaire - two from non-human primates and two from rodents (these animals were captured in the Equator Region of Zaire where human monkeypox has occurred). The important characteristic of this virus is that it cannot be distinguished from variola virus by current laboratory tests. However, the last known smallpox case was recorded in 1966 in Malaysia and in 1970 in the Equator Region of Zaire. There has been no evidence of a recurrence of smallpox in these areas since then, despite continuing surveillance especially in Zaire. Presumably, if whitepox virus were identical to variola virus it could have emerged to cause smallpox in inhabitants of these areas. One may conclude that whitepox virus differs from variola virus in some manner which is yet to be determined with continuing research.

6. Mutation of Poxviruses to Variola Virus

Barring the problem of whitepox virus, there is no scientific data to suggest the possible mutation of a poxvirus to variola virus. Genetic studies on variola virus currently being conducted by WHO Collaborating Centres may shed light on this problem. So far, DNA analysis of animal poxviruses does not suggest that there are any parental viruses which may lead to variola virus. Furthermore, epidemiological experience is against this possiblity. There has been no smallpox introduction which has spontaneously occurred in smallpox-free areas. Notably the longest freedom from smallpox was observed in the Americas and Australia prior to its introduction. In these vast areas, smallpox was apparently introduced in the 16th or 18th centuries. Assuming that prior to these centuries species of poxvirus did exist, if mutation were possible it might have occurred. History indicates that it did not occur.

7. Special Studies

Virus excretion from convalescent smallpox patients was studied. The recovery of the virus from patient urine or nasopharynx was possible only up to 25 days after the onset of the rash.(8) The finding is consistent with epidemiological experience that recovered patients are no longer infectious.

The possibility of smallpox scabs remaining in the houses of patients in previously endemic areas has caused concern as it was reported in 1968 that scabs kept at room temperature on a shelf in a laboratory in the Netherlands for over 13 years contained viable virus.(9) More recent experiments measuring virus decay under tropical conditions indicate that virus concentration in scabs may decrease to a non-infective level within three weeks.(10)

During the last decades the practice of variolation still persisted in remote areas of Africa and Asia; in Benin, Ethiopia, Malawi, Togo, Afghanistan, India and Pakistan. The last known use of variolation was in Gondar Region in the Ethiopian highlands in May 1976; 19 cases of smallpox resulted. Samples of variolator's stocks have been collected from Afghanistan, Ethiopia and Pakistan during the last ten years. Of 21 specimens, 17 did not grow variola virus despite the fact that several specimens showed numerous poxvirus particles on electron microscopy. Four specimens, all from Afghanistan were positive for viable virus when tested four to nine months after the collection of specimens by the variolators, but Afghanistan has maintained freedom from smallpox for five years since the last case was recorded in 1973. In Ethiopia, once smallpox outbreaks stopped, the practice of variolation also ceased.

8. Immunization Against Smallpox

8.1 History

Man's oldest weapon against smallpox was variolation, the practice of which was first recorded in China and India before the Christian era. It had also been practised in the Middle East and Africa before the practice gained popularity in Europe and North America in the 17th and 18th centuries. In China, one form of variolation involved the inhalation of a powder made from the crusts shed by recovering patients. Other methods ranged from simple exposure to a mild case to the rubbing of material freshly taken from a patient's pustules into a cut or scratch. These practices usually caused a mild smallpox infection which afforded protection against a second, more serious attack. As persons thus inoculated were contagious, however, they were often the source of true smallpox cases. Thus, variolation failed to control the spread of the disease.

At the end of the 18th century, Edward Jenner initiated the use, for immunization, of material extracted from the lesions of cowpox, instead of variola material.(11) During the following 100 years Jenner's "vaccine", the immunizing antigen of which is today believed to have been live cowpox virus, was gradually accepted by health services all over the world. Over the years the virus strains subsequently used for vaccine production did not remain identical to those employed by Jenner. In the initial stages of the use of Jenner's vaccine, recipients were often intentionally simultaneously variolated. It is thus believed that the current strain utilized for vaccination, the vaccinia virus, could be a hybrid of cowpox virus and variola virus.

By the 1950's, the existence of an effective vaccine and its coordinated use in vaccination programmes resulted in the interruption of indigenous smallpox transmission in many countries including Australia, Canada, all European countries, Japan, New Zealand and North America. In these smallpox-free countries it was necessary to continue vaccination programmes to guard against importation of the disease, despite the fact that fatal complications,however infrequent,did occur. In 1950, smallpox was still prevalent in many of the tropical countries of the African and South American continents, and in the Middle East, the Asian sub-continent, China, Indonesia and the Philipinnes. One reason was that the smallpox vaccine rapidly lost potency when exposed to tropical climates.

A major breakthrough came, in the early 1950's, when Leslie Collier developed a method of freeze-drying smallpox vaccine.(12) The vaccine, when stored at 37°C, could then retain its potency for at least four weeks. Consistently good results were obtained in the testing of individual batches and the method was readily applicable to mass production. This advance and the resultant stability of vaccine in tropical climates, without refrigeration, greatly enhanced the prospects for smallpox eradication.

8.2 Smallpox Vaccine for the Eradication Campaign

The intensified global smallpox eradication campaign started in 1967. The programme attempted to employ smallpox vaccination to maximum effect. At the inception of the programme, the potency and stability of the freeze-dried vaccine in use for the campaign was low.(13) Only 31% of tested batches from different producers met WHO requirements suggesting that perhaps only a small portion of the vaccine in use in tropical areas was potent when it reached the villagers' arms. The remedy was to distribute a practical production manual to the 76 laboratories then producing vaccine throughout the world, and by monitoring the quality of vaccine batches submitted from all laboratories contributing vaccine to the programme. Two WHO Collaborating Centres have tested 2 707 batches since 1967. By 1970, more than 80% of the tested batches met WHO requirements and in 1973, 95% (Table 5).

The use of "bifurcated needles" since 1969 for the entire eradication programme, except Brazil and West and Central Africa where jet injectors were initially used, promoted rapid inoculation and assured good take rates. With this needle, only a small dose of vaccine is required - 0.0025 ml, a quarter of the usual dose. In order to minimize the wastage of vaccine, standard ampoules or vials of 0.2 to 0.25 ml vaccine fill were universally employed by all producers who donated vaccine to the campaign. There were no contra-indications to vaccination in endemic areas since the risk of smallpox infection far exceeded that of complications.

Efforts were made to adopt suitable vaccinia strains of less pathogenicity, which resulted in greater acceptability. In 1968, of 76 producers, 32 (43%) employed the Lister strain, the New York Board of Health strain or EM-63 strain, which were considered to be less pathogenic than other traditional strains. In 1972, 56 (76%) producers employed one of these strains. In terms of quantity of production, more than 90% of all the vaccine batches in use for the programme was produced from one of these strains, except in India, where the Patwadanger strain was used by Indian laboratories, a strain also thought less pathogenic.

8.3 Complications

Smallpox vaccination does cause various complications, although infrequently. A 1968 study in the USA indicated that smallpox vaccination caused four fatal cases of post-vaccinial encephalitis and two fatal cases of vaccinia necrosum in five and a half million primary vaccinees (Table 6).(14) Since 1952, 19 cases of foetal vaccinia caused by vaccination of pregnant women have been reported in publications. The risk of complication became increasingly important as smallpox incidence became low in endemic countries and as the frequency of importations decreased in smallpox-free countries. Now, as there is no evidence of smallpox infected areas, the risk is definite. It is noted that already routine smallpox vaccination has ceased to be obligatory in 44 countries and this number will increase (Figure 2).

8.4 Vaccine Reserve

Considering that difficulties may arise in the future in obtaining vaccine in unexpected circumstances, the WHO has begun to establish a permanent vaccine reserve, sufficient to vaccinate 200 - 300 million persons, in collaboration with donor countries. This reserve will be for use in dealing with any unexpected emergency circumstances, mainly in the developing countries. Developed countries are encouraged to retain vaccinia seed strains and their own vaccine stocks. The sites for the stockpile are in Geneva, to cover Africa, New Delhi, to cover Asia, and a third site yet to be determined, but to cover Central and South America. Vaccine will be kept at $-20^{\circ}C$ which will assure no loss of potency and stability over 15 years (Table 7). There will be regular monitoring of the vaccine potency and stability and the period of 15 years is likely to be extended.

9. Conclusion

Ancient records in China and India imply that smallpox originated in eastern Asia and moved west, north and south. The disease apparently reached the Middle East and Europe early in the Christian era, Japan in the 7th century, the Americas in the 16th century, Siberia in the 17th century, and Australia in the 18th century. Thus, from the 18th century to early this century smallpox was rampant as a form of pandemic almost everywhere people lived. The global eradication efforts appear to have succeeded in interrupting transmission with the last known endemic focus detected in Somalia.

Current evaluation of smallpox nil incidence and of a possible source of infection other than human population indicates the likelihood that the virus has become extinct in nature. However, there are a few areas where further action or scrutiny is necessary to assure the permanence of this status. These include reducing to a minimum the potential danger of stocks of variola virus held in laboratories and further clarification of the ecology of monkeypox virus and the nature of whitepox virus. Those working with variola virus will, of course, maintain their immunity status, but in general it appears that the risk of smallpox vaccination has now considerably increased relative to that of the reintroduction of smallpox.

The Global Commission for the Certification of Smallpox Eradication will further study the situation and announce their evaluation and recommendations by the end of 1979. The result will be reviewed by the World Health Assembly in May 1980.

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TABLE 1 COUNTRIES VISITED BY GLOBAL COMMISSION MEMBERS

Date	Certification or Commission Members' visit	Preliminary Appraisal	Appraisal of Variola Virus Stocks in Laboratories
1977			
Nov/Dec	Burma/Bangladesh		
Dec			Two laboratories in FRG
1978			
Jan/Feb		Southern Rhodesia/ South Africa/Namibia	One laboratory in South Africa
March	Mozambique/Zambia/ Malawi/Tanzania		
April			
May	Thailand		Four laboratories in FRG and the United Kingdom
June		Ethiopia	
August		Angola	
Oct.	Uganda/Syria/ Iraq		
Nov	Sudan	South Africa (repeat visit)/Kenya/Somalia/ Djibouti/Yemen/Democratic Yemen	

NOTE: In addition, WHO STCs or WHO epidemiologists visited Iran, the Regional Office for the Western Pacific, six Arab countries of the Gulf Area (Saudi Arabia, Kuwait, Bahrain, Qatar, Oman and the United Arab Emirates) and three southern African countries (Botswana, Lesotho, and Swaziland).

TABLE 2

AVERAGE NUMBER OF VILLAGES COVERED IN EACH SEARCH IN INDIA AND BANGLADESH IN TWO-YEAR SURVEILLANCE PERIOD BEFORE CERTIFICATION

Country	No. of searches	Target villages	Villages searched	Target towns	Towns searched	Total villages and towns		Percent searched
						Targeted	Searched	
India	3	660 866	651 647	1 446	1 362	662 312	653 009	98.6
Bangladesh	8	64 493	60 744	6	6	64 499	60 750	94.2
TOTAL	3*	725 359	712 391	1 452	1 368	726 811	713 759	98.2

* Number of searches conducted in all areas.

TABLE 3 SPECIMENS TESTED BY WHO COLLABORATING CENTRES

Country	No. of specimens received (No. positive for smallpox)					
	1973	1974	1975	1976	1977	1978**
AFRICA						
Angola	-	-	-	-	1	1
Benin	-	-	-	1	-	-
Botswana	14(5)	9	8	2	43	100
Burundi	4	3	1	-	-	-
Congo	-	-	-	-	2	1
Ethiopia	27(4)	39(9)	112(32)	431(60)	565	971
Gambia	-	-	-	1	-	-
Ghana	-	-	1	-	-	-
Ivory Coast	-	-	9	1	-	-
Kenya	2	9(3)	2	1	147(4)	101
Lesotho	-	-	-	-	-	2
Liberia	-	-	9	-	-	-
Malawi	2	2	-	3	296	24
Mauritania	-	-	1	2	1	2
Mozambique	-	-	4	-	62	13
Niger	-	-	-	1	-	-
Nigeria	-	-	4	3	-	1
Rhodesia	-	-	-	-	-	15
Rwanda	2	-	-	-	3	-
Senegal	-	-	-	1	-	-
Sierra Leone	-	-	5	3	1	-
South Africa	-	-	-	-	-	8
Swaziland	-	-	-	-	1	25
Uganda	-	-	1	1	-	119
United Republic of Tanzania	1	-	2	-	3	77
Zaire	92*	63*	207*	125*	181*	110*
Zambia	-	-	2	-	50	50
EASTERN MEDITERRANEAN						
Afghanistan	4(1)	-	1	5	4	-
Bahrain	-	-	-	-	-	51
Democratic Yemen	-	-	-	1	-	17
Djibouti	-	7(1)	-	-	17	44
Dubai	-	-	-	-	-	1
Iran	-	-	-	-	-	346
Iraq	-	-	-	-	-	13
Kuwait	-	-	-	-	-	78
Lebanon	1	-	-	-	-	-
Oman	-	-	-	-	-	53
Pakistan	11(6)	21(11)	52	116	7	1
Qatar	-	-	-	-	-	24
Saudi Arabia	1(1)	-	-	-	22	116
Somalia	-	-	-	56(33)	864(265)	1 342
Sudan	9	22	9	15	14	25
Syrian Arab Republic	-	1	-	-	-	7
United Arab Emirates	-	-	-	-	-	52
Yemen	7	6	3	2	2	23
SOUTHEAST ASIA						
Bangladesh	-	1(1)	18(3)	183	664	-
Burma	-	-	-	12	-	-
India	39(9)	39(20)	404(120)	358	977	-
Indonesia	3	12	-	1	-	-
Nepal	37(27)	48(40)	16(8)	5	3	-
Sri Lanka	1(1)	-	-	-	-	-
OTHERS						
Italy	-	-	-	-	1	-
Switzerland	-	-	-	1	-	-
Viet Nam	-	1	-	-	-	-
TOTAL	257(54)	283(85)	871(163)	1 332(93)	3 931(269)	3 813

*Monkeypox diagnosed: 1973 (3), 1974 (1), 1975 (2), 1976 (3), 1977 (6), 1978 (6).

**As of 1 November 1978.

TABLE 4 RESULTS OF FACIAL POCKMARK SURVEYS IN CERTIFIED AFRICAN COUNTRIES BEFORE CERTIFICATION (1975 - 1978)

Areas certified (number of countries)	Year of last smallpox case in area	Estimated Population (in thousands)	Number of persons seen				Number of facial pockmarks seen	
			Pre-school age	School-age	Over school-age	Total	Pre-school age children	School-age and older
West Africa (15)	1970	124 600	1 631 918	3 696 932	1 168 400	6 497 250	0	8 390
Central Africa (9)	1971	50 387	122 841	1 108 463	102 239	1 333 543	0	1 566
South-east [a] Africa (4)	1971	36 726	70 621	881 926	275 779	1 228 326	0	5 061
TOTAL	1971	211 713	1 825 380	5 687 321	1 546 418	9 059 119	0	15 017 [b]

[a] Malawi, Tanzania, Mozambique and Zambia.

[b] All facial pockmarks contracted during 1971 or before. No facial pockmarks due to smallpox infections contracted during 1972 or after.

TABLE 5 PERCENTAGE VACCINE BATCHES TESTED WITH SATISFACTORY RESULTS

Year	No. of Batches Tested	Percent
1967	73	31
1968	169	58
1969	235	76
1970	412	82
1971	233	77
1972	324	82
1973	400	95
1974	227	92
1975	185	86
1976	245	96
1977	150	93
1978 (to 30.9.78)	54	89

TABLE 6 MAJOR COMPLICATIONS ASSOCIATED WITH SMALLPOX VACCINATION [a] IN THE USA, ACCORDING TO DIAGNOSIS AND VACCINATION STATUS (1968)

Age (years)	Number of vaccinations	Number of cases (deaths in parentheses)		
		Postvaccinal encephalitis	Vaccinia necrosum	Eczema vaccinatum
Primary vaccinations				
1	614 000	4 (3)	0	5
1 - 4	2 733 000	6	1	31
5 - 9	1 553 000	5 (1)	1 (1)	11
10 - 14	295 000	0	0	1
15 - 19	111 000	0	1 (1)	2
20 +	288 000	1	2	7
Total (all ages)	5 594 000	16 (4)	5 (2)	58 [b]
Revaccinations				
1	0	0	0	0
1 - 4	478 000	0	0	1
5 - 9	1 643 000	0	1 (1)	4
10 - 14	1 440 000	0	0	1
15 - 19	1 217 000	0	1	2
20 +	3 796 000	0	4 (1)	0
Total (all ages)	8 574 000	0	6 (2)	8
Contacts				
1		0	0	4
1 - 4		0	0	38 (1)
5 - 9		0	0	8
10 - 14		0	0	0
15 - 19		0	0	1
20 +		0	0	9
Total (all ages)		0	0	60 (1)
GRAND TOTAL	14 168 000	16 (4)	11 (4)	126 (1) [b]

[a] From Lane J.M. et al. (1969). Complications of smallpox vaccine, 1968. New England Journal of Medicine 281.

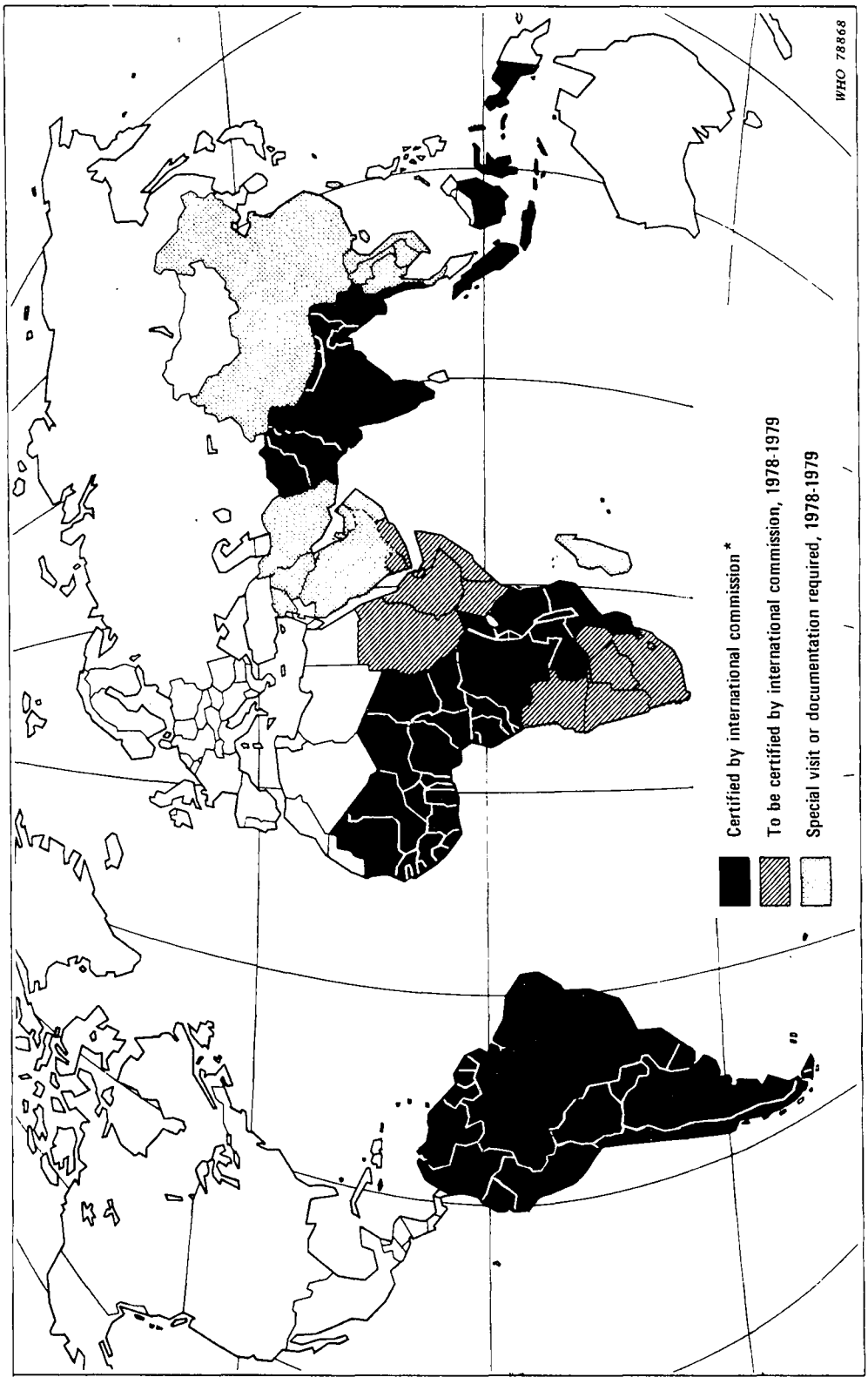
[b] Includes one case of unknown age.

TABLE 7 POTENCY OF VACCINE STORED AT -15 OR -20°C

Producer	Length of storage	Temperature	Potency (pfu/ml log)	
			Before storage	After storage
A	6 years	-20°C	8.0	8.1
	10 years	-20°C	8.4	8.5
B	10 years	-20°C	-	8.1
C	5 years	-20°C	-	8.1
D	13 years	-15°C	8.2*	7.9*

*Average titre of six batches tested.

Fig. I PLAN FOR GLOBAL CERTIFICATION OF SMALLPOX ERADICATION BY THE END OF 1979



* as of 15 November 1978.

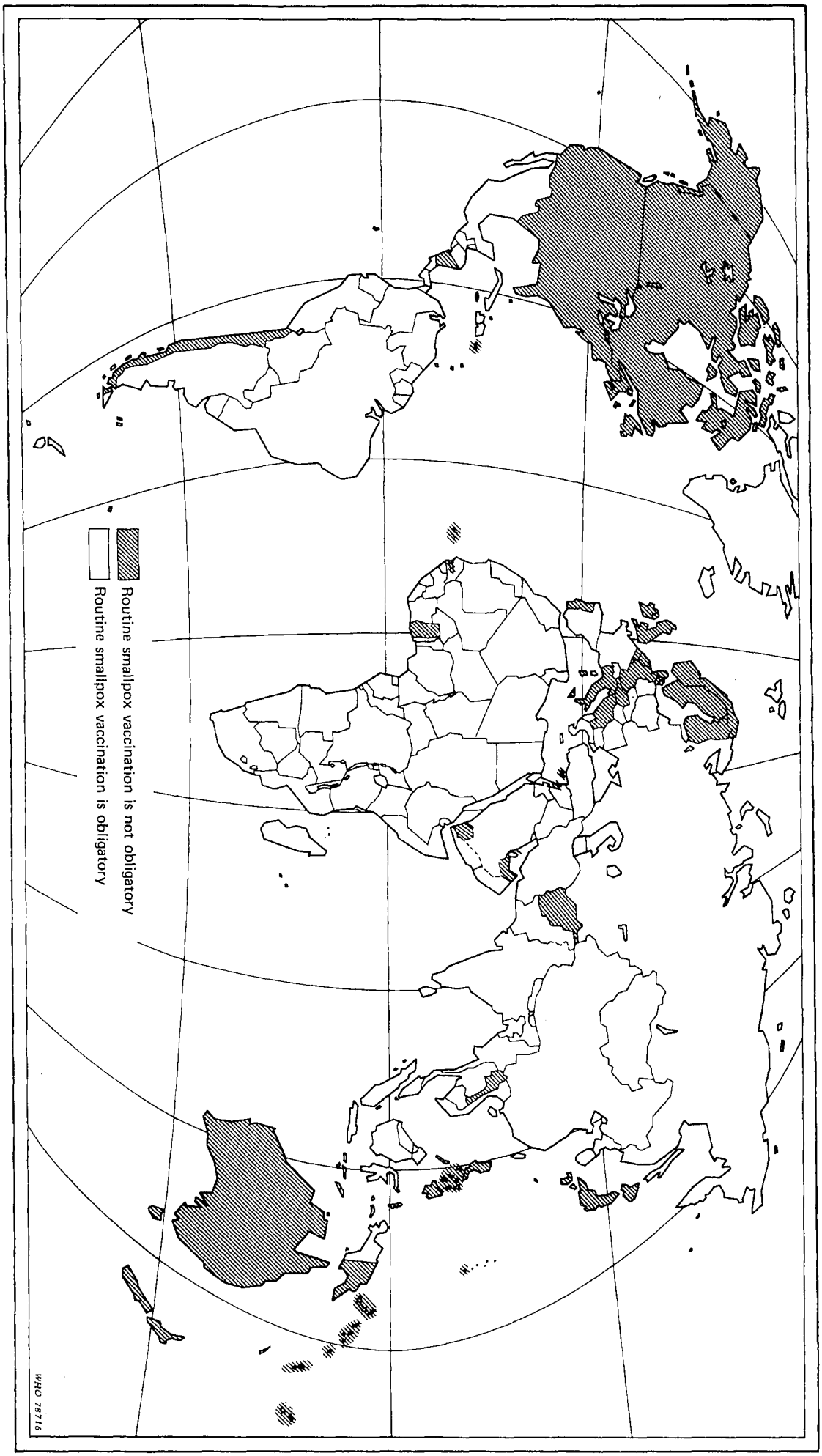


Fig. 2 COUNTRIES WHERE ROUTINE SMALLPOX VACCINATION IS NOT OBLIGATORY