

Smallpox Inoculation (Variolation) in East Africa with Special Reference to the Practice Among the Boran and Gabra of Northern Kenya

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Abstract Smallpox inoculation (variolation) was widely reported in sub-Saharan Africa before, during, and after the colonial era. The infective smallpox materials and techniques used, as well as the anatomical sites for inoculation, varied widely among different ethnic groups. The practice among the Boran and Gabra pastoralists of northern Kenya resembled that which was prevalent in a number of areas of Ethiopia. This is not surprising as the Boran also live in southern Ethiopia, and Gabra herdsmen frequently cross the border into this region. The Boran and Gabra technique for smallpox inoculation consisted of taking infective material from the vesicles or pustules of those with active smallpox, and scraping it into the skin on the dorsum of the lower forearm. Although the intent was to cause a local reaction and at most a mild form of smallpox, severe cases of the disease not infrequently resulted. Also, variolated individuals were capable of infecting others with smallpox, thereby augmenting outbreaks and sustaining them. The limited known reports of smallpox inoculation among the Boran and Gabra are presented in this communication. The expansion of vaccination with effective heat stable vaccines, the development of medical and public health infrastructures, and educational programs all contributed to the eventual disappearance of the practice among the Boran and Gabra.

Keywords Smallpox inoculation (variolation) · Variolation in East Africa · Luo variolation · Boran and Gabra variolation · Kenya · Tanzania

Introduction

Smallpox inoculation, also known as variolation, was the purposeful insertion of the smallpox virus into the skin. This technique for preventing smallpox was probably fairly widespread in Africa south of the Sahara at least by the seventeenth century. While techniques varied from one ethnic group to another, based on the available evidence, it appears that it was primarily practiced during times of epidemics [1].

The historical record concerning smallpox inoculation in Europe and North America began in the early eighteenth century. It was then that the first reports concerning the practice in China and in the near and Far East were widely disseminated in Europe [2]. In North America, the Reverend Cotton Mather of Boston learned of the technique from his slave, Onesimus, in 1706. In 1721, Mather promoted inoculation in Boston during a severe epidemic of smallpox. The procedure was controversial from the outset, with many in the medical establishment opposing it on the grounds that it could spread the disease to others who were not inoculated. However, Mather enlisted the help of a number of prominent clergymen, including Benjamin Colman, who had independently confirmed the practice in Africa from other slaves. They were joined by Dr. Zabdiel Boylston, who performed the inoculations [3].

Despite the verbal attacks launched against Mather, Colman and Boylston, they inoculated 300 people of whom only two percent died. These individuals may well have acquired smallpox before they were inoculated [4]. By

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Fig. 1 Smallpox inoculation (variolation) scar on the dorsum of the left wrist of a health care worker, Cercle of Tominian, Mali

comparison, 14 % of those who acquired smallpox through exposure to others with the disease died. Despite this dramatic evidence of the protective effect of inoculation, it would take a few decades before the practice was widely adopted in North America.

In England, the wife of the British Ambassador to Turkey, Lady Mary Wortley Montague, began reporting on the practice there soon after her arrival in 1717. Her crusade to have the practice more widely adopted was in part driven by the fact that she had come down with smallpox in 1715 and was left severely scarred. So strong was her belief in the value of inoculation, that she had her own son inoculated by the embassy surgeon, Charles Maitland. Although Lady Mary promoted the practice in England, it was already widely known at least in theory [5].

Smallpox Inoculation Practices in Africa

Reports from several observers in North Africa documented smallpox inoculation there during the early seventeenth century [6]. Evidence of its existence in various

areas of sub-Sahara Africa continued to accumulate throughout the remainder of the eighteenth century and during the nineteenth century [7]. With specific reference to East Africa, these reports became more detailed, often linked to descriptions of smallpox outbreaks by travelers and explorers [8]. However, once colonial rule took hold in East Africa in the late nineteenth and early twentieth centuries, smallpox outbreaks were more completely documented by medical authorities, smallpox inoculation practices described, and vaccination programs launched primarily with the use of liquid vaccines [9–16]. Smallpox inoculation (variolation) was also documented in West and Central Africa, and continued to be practiced into the 1960s in countries such as Mali where it was well described in detail among several ethnic groups [17, 18].

The deeply rooted belief that smallpox inoculation was a valuable preventive measure ensured its persistence in African societies. To some extent, this reflected its earlier persistence in Europe and North America following the introduction of modern vaccination against smallpox by Edward Jenner in 1796 [19]. Eventually, smallpox inoculation was banned by the British government with The Vaccination Act of 1840 [20]. However, it persisted in sub-Sahara Africa (Fig. 1).

The Role of Ineffective Liquid Vaccines in Sustaining Interest in Smallpox Inoculation in Africa

The early use of liquid vaccines made from the vaccinia virus gave excellent results in temperate climates. In these areas, a reliable cold chain based on refrigeration, good transportation infrastructures, and well-developed public health and medical services assured the success of vaccination campaigns [21]. However, these vaccines sometimes produced unpredictable outcomes in tropical climates where breakdowns in the cold chain and shipping delays often resulted in inactivation of the vaccine.

One of us (PJI) experienced this problem in the North Mara District of Tanganyika Territory (later Tanzania) in 1961 [22]. A routine vaccination program against smallpox was launched in the district in the summer of 1961. Liquid vaccine was distributed to the few health facilities in the district by the territorial government in Dar-Es-Salaam, some 1,100 km away. The focus of this vaccination program was on school-age children who were largely unimmunized and therefore vulnerable to smallpox. We kept the vaccine well refrigerated in a kerosene-operated refrigerator once we received it at the Kowak Catholic Hospital. It was also kept cold in thermos containers filled with ice when we went out into the field to vaccinate children.

Despite these local efforts to keep the vaccine cold, none of the children developed successful skin reactions to vaccination. This indicated that the vaccine had been rendered



Fig. 2 Left to right Pascal James Imperato and Sister Edward Marie of the Kowak Catholic Hospital vaccinating school children against smallpox at Utegi, North Mara District, Tanganyika Territory

ineffective before it reached us. Since it had been shipped overland by road from the capital of Dar-es-Salaam to the district headquarters in Tarime, it is probable that there was a breakdown in the cold chain somewhere en route (Fig. 2).

The Luo, who then comprised the majority of the population in the district, were very familiar with smallpox, which in their language is called *nundu*. They were also familiar with smallpox inoculation, which had generally fallen into disuse. However, older people remembered the technique used to inoculate people. They also believed that those inoculated usually developed mild cases of smallpox, but conceded that severe cases sometimes occurred. They recognized that vaccination was preferable to inoculation. However, in pointing to the recent failure of our vaccine to produce the known skin reactions, they said that they might resort to inoculation in case of a smallpox outbreak.

Smallpox inoculation among the Luo was performed by a traditional healer known as a *Jathieth* [23]. These healers took vesicular fluid from someone with a mild case of smallpox and mixed it with a dry powder made from the burned leaves and pulverized roots of a tree. The powder was sprinkled on the vesicular fluid and then placed on small incisions on the deltoid area of the arm. The choice of anatomic location documented in 1961 was probably influenced by smallpox vaccination techniques which healers themselves had observed.

It is of interest that some 36 years earlier, the venerable Archdeacon W. E. Owen documented a similar inoculation practice among the Luo in southwestern Kenya adjacent to the North Mara District of Tanganyika. In addition to making incisions on the upper arm, he documented additional incisions on the side of the forehead. These were

done on the left side with women and on the right side for men [24]. Owen reported that the fee charged for the procedure was a cow, and that there was a great deal of competition between traditional practitioners when it came to inoculation. He also noted that one of the most renowned inoculators had been sentenced to 3 months in prison in Kisumu some 10 years earlier. However, arresting inoculators only served to drive them underground [25].

Owen collected a small amount of the powder which was analyzed by the government analyst W. Colet Birch. He reported that it was yellow brown in color with a neutral pH. He also reported that the powder was bitter in taste and gave general reactions for alkaloids. Birch was unable to identify the specific alkaloid in the preparation.

Luo informants in the North Mara District of Tanganyika made no mention of inoculation on the side of the forehead. This could be accounted for by variations in practices between the two geographic areas or by changes in the technique over a few decades. The use of a powder with the inoculum was significant for it was perceived as a secret ingredient known only to the *Jathieth*. The example presented above is not the only recorded instance in which interest in inoculation was sustained by either the unavailability of vaccination or by a perception that it was ineffective in protecting people against smallpox.

Documentation of Smallpox Inoculation in East Africa

As previously noted, Herbert has provided an overall summary of smallpox inoculation in Africa and specific



Fig. 3 Statue (height 14½ inches) of Shopona, the Yoruba god of smallpox. Collected in Lagos, Nigeria in 1967 by Pascal James Imperato

details about the practice in East Africa [26]. It appears that the practice was limited to times of smallpox outbreaks among most groups. There is scant evidence that traditional practitioners in East Africa, except in Ethiopia, stored smallpox scabs in which the virus can survive for several years under ideal conditions. However, as Hopkins has summarized, the Yoruba of Nigeria held a strong belief in Shopona, the god of smallpox (Fig. 3). The priests of this cult practiced smallpox inoculation and some of them stored smallpox scabs from victims which they then used to start epidemics at a later date [27]. Their motive was monetary since they were well paid for inoculating people. As a result, they became a barrier to vaccination campaigns well into the early 1970s in the southern parts of Dahomey (now Benin), Togo, and western Nigeria where belief in Shopona was strong [28].

The storage of variolation materials, often in the form of scabs, was also well documented in China and Afghanistan. In China, and adjacent parts of Inner Mongolia, variolators kept their material stored with honey in sealed jars. Some maintained the potency of their supplies by periodically inoculating family members and then harvesting fresh material. This storage issue was also of concern in Afghanistan where stored smallpox material (scabs or

pustule material) was tested and found viable after 9 months. When kept out of the sun and in a cool place, the variola virus can survive for several years. However, such ideal conditions were generally not the rule in those areas where most variolators stored smallpox materials.

In 2014, six vials of the variola virus dating to 1954 were found by chance at a National Institutes of Health laboratory where no one knew of them for decades. Two of the six vials were found to contain live virus capable of causing smallpox. This finding demonstrated that the variola virus could survive for 60 years, without special attention, when stored under properly refrigerated conditions [29].

In East Africa, smallpox inoculation was usually done with fresh material during times of epidemics or outbreaks. However, in Ethiopia, smallpox materials were occasionally stored as well by itinerant variolators who used preserved pustular or scab material [30].

Pankhurst has provided a very detailed history of smallpox and its prevention and treatment in Ethiopia. Concerning inoculation, he summarized the observations of early travelers to Ethiopia noting that the practice was widespread [31]. Mérab [32], the owner of a pharmacy in Addis Ababa, noted in the early twentieth century that smallpox fluid was diluted with either honey or butter in order to make it available to larger numbers of people. Earlier in the nineteenth century, Petit observed that inoculation was performed on the dorsum of the lower forearm, four finger breadths above the wrist. An incision was made with a razor, and the smallpox inoculum introduced by a “magic stick” and the wound then bandaged [33].

The introduction of vaccination into Ethiopia in the late nineteenth century provided an impetus for legal prohibition of inoculation by the Emperor Yohannes IV (1871–1889) [34]. Despite such prohibitions, the practice of smallpox inoculation persisted both because of received cultural beliefs in its efficacy, and because smallpox vaccination was not always available or else rendered ineffective because of poor vaccine handling and storage.

Schneider’s excellent article on smallpox in Africa during colonial rule details the efforts of the colonial powers to assure the quality and effectiveness of smallpox vaccines. The loss of potency due to heat and the need for transport to remote rural locations remained recurring problems. Despite the local production of vaccine in Africa, take rates after vaccination remained variable. As Schneider points out, there was much debate about the relative value of dried vaccine over the liquid form. Both gave equal success rates provided that the vaccines were kept cool. However, the dried vaccine was more heat stable, but cost six times the price of the liquid vaccine [35]. Consequently, in this setting of unpredictable success rates



Fig. 4 Pascal James Imperato (*right*) and Samburu men (*left*) at Buffalo Springs, Northern Frontier District, Kenya

with vaccination, smallpox inoculation continued to thrive. However, Conacher, in reporting on a 1953–1954 outbreak of *Variola minor* near Lake Rukwa in Tanganyika, noted that spread was facilitated by exposure of unvaccinated individuals to the body of a smallpox victim, but that no evidence of smallpox inoculation was uncovered [36]. Still, he acknowledged that the practice still occurred as documented by Maclean [37]. This spread of smallpox during funeral ceremonies for those who died of the disease was later described by Hopkins et al. [38] in Sierra Leone.

Smallpox Inoculation Among the Boran and Gabra of Northern Kenya

The Boran, also known as the Borana Oromo, are cattle-herding pastoralists who live in northern Kenya and southern Ethiopia [39]. The Gabra or Gabbra are camel-herding nomads who live in the Chalbi Desert of northern Kenya and in the higher elevated areas of southern Ethiopia. They speak the Borana language [40]. In recent years, a number of both Boran and Gabra people have settled in towns that have evolved in northern Kenya.

The smallpox inoculation practices of both groups were strongly influenced by those in Ethiopia. In the case of the

Boran, this was because they often crossed the border into Ethiopia where they have relatives. The Gabra, who live close to the border, not infrequently entered into Ethiopian territory to graze their flocks.

When one of us (PJI) was in the then Northern Frontier District of Kenya in the early 1960s, Boran and Gabra informants freely spoke of smallpox inoculation. However, because of the paucity of cases, they claimed that it was then rarely practiced. Their observation about the small number of smallpox cases is substantiated by the fact that between 1961 and 1964, the period when interviews were conducted, there were only 906 cases and four deaths from smallpox reported in Kenya. In 1959, there were only 316 cases [41, 42].

Informants also stated that some individuals preferred to have smallpox inoculation performed in Ethiopia. Their stated reason for this was that they considered that Ethiopian variolators were more skilled with the procedure that generally produced good results. By good results, they meant that those inoculated did not subsequently develop smallpox either from the procedure or from others who were infected with the disease. Experiences with ineffective vaccines strengthened the belief for some that smallpox inoculation was preferable to smallpox vaccination (Fig. 4).

This preference among some for Ethiopian variolators was also documented in 1979 by members of the World Health Organization International Commission for the Certification of Smallpox Eradication in Kenya. They reported in 1979 that extensive questioning revealed no evidence of variolation in Kenya for the past 20–30 years. They also reported that all persons with more recent variolation scars claimed that they had received smallpox inoculation in Ethiopia [43]. Their comment about a then preference for Ethiopian-based inoculators confirms the information given to one of us (PJI) about this in the early 1960s. However, because inoculation was officially discouraged, especially in the 1960s and early 1970s as the worldwide smallpox eradication program was in progress, it may well be that some were not forthcoming about it having been more recently practiced in Kenya. Those who were inoculated in Ethiopia were most probably members of ethnic groups, such as the Boran, Gabra, Somali, and others who had easy geographic access to variolators there.

In the early 1960s, the Boran and Gabra stated that smallpox inoculation consisted of taking vesicular or pustular material from a case of smallpox and incising it onto the dorsum of the lower forearm. This anatomic location is the same one that was documented by Petit in Ethiopia in the early nineteenth century. This represents some evidence that the Boran and Gabra may have adopted the Ethiopian procedure at some time in the past.

Boran and Gabra Smallpox Inoculation Practices During the 1934 Smallpox Epidemic in Kenya

Smallpox epidemics and outbreaks were fairly common in Kenya during the first two decades of the twentieth century [44]. During the 1920s, there were occasional outbreaks comprised of small numbers of people. Most of these outbreaks were traceable to imported cases coming into the country through Mombasa from India [45]. Prior to 1934, there had not been a major epidemic in Kenya for 16 years. In part, this was due to the buildup of immune populations through the routine vaccination of large groups of individuals. These included police, military personnel, and labor recruits as well as children and the general population [46]. Despite these measures, some occasional cases occurred. However, the last of these were diagnosed in 1931. The 3-year period of the total absence of reported smallpox in Kenya ended in 1934 when an epidemic broke out among Somali herders coming into the colony's Northern Frontier District from Italian Somaliland (Somalia) [47, 48].

The northern part of Kenya, where the Boran and Gabra live, is generally sparsely populated. Also, in 1934, medical services in this area were absent in many locales, and thus cases were not quickly documented and reported. Once the medical authorities in Kenya became aware of this epidemic in the vast north of the colony, they quickly sought to contain it there. They did so through barrier vaccination and in the interests of preventing the spread of smallpox to more densely populated areas to the south. These areas included the Central Highlands and the districts to the west, close to Lake Victoria [49]. A total of 408,000 vaccinations were administered to contain this epidemic in which there were 1,781 cases and 645 deaths making for a mortality rate of 36 % [50].

Some of the vaccine used to contain this epidemic was delivered by air transport to remote infected districts [51]. However, not everyone in the Northern Frontier District was willing to be vaccinated. M. W. Low, the District Commissioner of the Marsabit District, reported that some of the Turkana people at South Horr completely refused to be vaccinated on the grounds that they were not cattle. Their neighbors, the Samburu, who had at first been agreeable to vaccination, then followed the Turkana in refusing to be vaccinated [52].

Despite the refusal of some Turkana and Samburu to be vaccinated, Low reported that most people participated in the vaccination program. These included 7,826 Boran and Gabra, 5,315 Rendille, 152 Samburu, and 508 from other groups [53]. Thus, overall, the vaccination program was highly successful in the Marsabit District. However, Low also reported that the Boran and Gabra practiced variolation [54].

The Boran and Gabra practice a kind of home-made vaccination. They were, therefore, very keen on being vaccinated as also were the Rendille, but to a lesser extent.

This was an interesting observation for two reasons. It confirmed that the Boran and Gabra were still practicing smallpox inoculation. However, it also indicated that some perceived vaccination as at least equivalent if not preferable to variolation. It is unclear from Low's brief comment why some Rendille resisted vaccination.

Low also made some interesting epidemiologic observations on the smallpox outbreak in the Marsabit District [55].

In June, there was an outbreak of smallpox in this district. A small infected manyatta of six persons was discovered at Horadera some 20 miles from Marsabit. In July, there was a fresh outbreak in the Huri Hills. In a manyatta of 35 persons, nine had contracted the disease, and two eventually died. It was astonishing that more people in the manyatta had not contracted the disease, as it had been prevalent for more than a month. The children also who were suffering from it did not seem too sorry for themselves. Altogether, four people died.

Low's description of the smallpox outbreak in a settlement in the Hurri Hills is of interest because of the small proportion (26 %) of the population that had contracted the disease over the period of a month. He did not provide any data on the ages of the 35 people living in the manyatta. Thus, we know nothing of the age distribution of the cases. However, from his final statement, it is clear that both children and adults were affected. The low attack rate of the disease could have been due to previous vaccination, variolation, or natural immunity from the disease among the adults. However it is also possible that the outbreak was due to a milder form of smallpox known as *Variola minor*. This form of smallpox was well known in Kenya. Stott described two outbreaks of this form of smallpox that occurred in Kenya in 1943 [56].

In the Moyale District north of the Marsabit, adjacent to the Ethiopian border, the medical officer, D. A. Bullen, documented a number of cases and deaths. He also documented widespread acceptance of vaccination [57].

This disease is epidemic and endemic in Abyssinia and appears to be sporadic in Italian Somaliland. A small outbreak occurred in the Habaswein District in the early part of the year in which 15 convalescing cases were seen by the M. O. and a history of 10 deaths given. The sufferers stated that the local outbreak had originated in Italian Somaliland. Odd cases were seen at a later date at Wajir and Korondil.

Rumors of outbreaks and sporadic cases existing just over both the Italian and Abyssinian borders are constantly coming in and every attempt is made on these occasions to vaccinate our people in the vicinity. Very large numbers of the people of the District have been vaccinated during 1934 (10,704) and the work goes steadily on. The number of vaccinations given do not include the unrecorded vaccinations carried out by Administrative Officers and Police askaris on safari who helped tremendously to prevent the spread of this disease. The people themselves are convinced of the efficacy of vaccination and no difficulty except the wandering habits has been experienced. I believe 70–80 % of the people have been immunized and that a serious epidemic in this District is unlikely.

The District Commissioner for the Moyale District, Richard John Clyde Howes, reported on the practice of smallpox inoculation among the Boran [58].

Many of the Boran vaccinate themselves just above the wrist by scraping the skin and applying the discharge from the smallpox sores of somebody suffering from the disease. This method was violent and in effect sometimes fatal.

It is of interest that Low, the District Commissioner of the Marsabit, reported that previous experience among the Boran and Gabra with smallpox inoculation, which he characterized as “home-made vaccination,” induced them to be more receptive to vaccination. The importance of Howes’ comments about Boran smallpox inoculation lies in the fact that they clearly describe the anatomic site and the method used. This anatomic site and the method for inoculating smallpox vesicular or pustular fluid are what were described to one of us (PJI) 27 years later by Boran and Gabra informants.

The dorsal surface of the lower forearm and the method of inoculating smallpox material into an incised or scraped area was a common form of variolation in Ethiopia for many years. Thus, Howes’ observations provide further evidence of the possibility that the Boran and Gabra adopted the technique from the one in common use in Ethiopia. Howes also documented that Boran inoculation sometimes resulted in fatal outcomes. However, it is not clear if his use of the word “violent” referred to the local inoculation reaction, clinical smallpox that might have resulted, or both.

Varying Perspectives on Smallpox Inoculation

Luise White has provided a comprehensive and reasoned discussion of the varying perspectives on variolation or

smallpox inoculation [59]. As she notes, both colonial officials and some of their historians saw smallpox inoculation as a cause of epidemics of the disease. Allopathic medicine had also taken this position based on the evidence that those inoculated developed smallpox of varying degrees of severity and often transmitted the disease to others. Imperato made some interesting observations on smallpox inoculation among the Songhai people of the remote village of Lellehoi in the Cercle of Ansongo in eastern Mali. Among 258 people vaccinated, no one acquired smallpox. Among 120 people variolated, 22 (18.3 %) acquired the disease. Some 519 (57.8 %) of the population were unvaccinated and unvariolated. Among these 519, 65 (12.5 %) contracted smallpox, and 11 (16.8 %) died [60]. The unanswered question in this outbreak is if any of those variolated caused smallpox in those who were either unvaccinated or unvariolated. Unfortunately, this question cannot be answered because some of those who came down with smallpox had contact with both those who were variolated and with those who had clinical smallpox.

African beliefs about smallpox inoculation were diverse, and, as White points out, in some societies it did not necessarily represent resistance to vaccination. Rather, among some groups, western biomedicine was seen as a complementary system to their own [61]. Thus, some people opted for smallpox inoculation, but not to the exclusion of vaccination. Frakenberg and Leeson documented that smallpox inoculation in Zambia was once employed not merely to protect people against acquiring smallpox, but also to deal with a variety of personal and marital issues [62].

The objective medical evidence overall sustains the perception that variolation had the potential to cause smallpox in those who received it. They in turn sometimes transmitted smallpox to those who were non-immune to the disease. Some of this medical evidence primarily derives from observations made during smallpox outbreaks and epidemics when variolation was often practiced. A confounding variable in such situations was whether or not people contracted smallpox from those with the natural disease or from those who were variolated. Since the unvariolated and unvaccinated were often in recent close contact with both variolated individuals and cases of smallpox, it was impossible to differentiate the precise source of their illness when they later developed the disease.

The above said, there is very strong medical evidence for the role of variolation in having started outbreaks and epidemics, and sustaining them in situations where clinical smallpox was absent. D. A. Henderson was the director of the World Health Organization’s successful world-wide effort to eradicate smallpox. He cites the observations of Arcot Rangaraj and Abdul Mohammed Darmanger in

Afghanistan which confirmed that variolators started outbreaks and epidemics through their activities, albeit with the best of intentions. Rangaraj and Darmanger found that one-third of all smallpox cases had been started by variolators, and that in some areas greater than 50 % of all adults bore variolation scars [63].

Variolation in Afghanistan was an inherited skill passed down from father to son. It was performed for a fee on request from villages or families, using infective scab material stored unaltered or in powdered form. An important component of the smallpox eradication effort in Afghanistan consisted of the successful transformation of variolators into vaccinators [64].

The observations of Rangaraj and Darmanger, and others over the decades confirm that variolation was responsible for clinical smallpox in some who underwent the procedure. They then initiated and sustained outbreaks and epidemics. For, they were capable of transmitting the disease from either their variolation reactions or from their clinical disease, if they developed it, in situations where no smallpox was then present.

The techniques for smallpox inoculation were varied as were the anatomical sites where the infective material was inserted. While in most instances infective material was chosen from mild cases of smallpox, in some instances, it was taken from more severe cases of the disease. One of us (PJI) documented that among the Da Fing (Bobo Fing) of the Cercle of Tominian in Mali, infective material was taken from a severe case of smallpox [65].

They pick out a severe case, choose a pustule, and cut it open with a knife point. They then take the tip of a plume and rub the material into three scratches on the dorsum of the wrist. They say that a local reaction occurs within 3 days, and eventually a secondary rash. They also claim that transmission from such variolated individuals to non-immunes does not occur.

This last claim is quite doubtful. However, it represents what those who trusted in variolation then believed. In both Mali and East Africa, interest in variolation was sometimes sustained by a perception that smallpox vaccines failed to protect against the clinical disease. This often occurred in earlier years, especially when heat labile liquid vaccines were used and there were breakdowns in the cold chain. However, in Mali, one of us (PJI) observed a young boy in the recovery stage of smallpox after the desquamation of scabs, who also had a successful vaccination reaction to a liquid vaccine. This vaccine had been scarified into three adjacent vertical sites on the upper arm. Unfortunately, the vaccine was not administered within the 4-day period following infective exposure when it can prevent or attenuate clinical illness. As it was, the boy suffered a moderately



Fig. 5 Young boy in the desquamation phase of clinical smallpox also exhibiting three successful local skin reactions to liquid smallpox vaccine, administered by the scarification technique. Village of Tidjana, Arrondissement of Kimparana, Cercle of San, Mali

severe case of smallpox, and also had an excellent primary reaction to vaccination. Once desquamation occurred, the sites of the lesions were depigmented as were the three areas where the vaccine was scarified. These areas of vitiligo eventually re-pigmented (Fig. 5).

The people of this village were quick to assert that vaccination had been effective in producing skin reactions on the boy's arm, but had not prevented the disease. They were still skeptical when it was explained that the vaccine had been administered too late to prevent smallpox, but had nonetheless produced dramatic local reactions.

Discussion

Smallpox inoculation (variolation) was once widely practiced in sub-Saharan Africa. Well established within indigenous healing and religious systems, it continued to be employed long after smallpox vaccines became available. Early efforts to suppress it through administrative measures were often unsuccessful. While many availed themselves

of vaccination, they still held on to variolation. They did so because its cultural and religious roots ran deep, and because they saw no incompatibility between variolation and vaccination. The ineffectiveness of heat labile vaccines served to bolster the preference of some for smallpox inoculation. However, improved infrastructures in sub-Saharan Africa and the development of better heat-stable vaccines eventually demonstrated the superior protective effect of vaccination. The expansion of general education, medical and public health services, and public health education programs all served to move large numbers of people away from variolation in favor of vaccination.

The Boran and Gabra of northern Kenya once practiced smallpox inoculation in the context of outbreaks and epidemics. This was well documented by British officials in the colonial era and during a major smallpox epidemic in 1934. It was also described to one of us (PJI) in the early 1960s and its historical existence confirmed by a World Health Organization Commission for the Certification of Smallpox Eradication in 1979.

The Boran and Gabra used a technique for smallpox inoculation that was virtually identical to that employed in many areas of Ethiopia at the time. This consisted of scraping infective material from either vesicles or pustules onto the dorsal surface of the lower forearm. It is of interest that in 1979, the World Health Organization Commission stated that all persons in Kenya with recent variolation scars reported that they had been variolated in Ethiopia [66]. While this may have been true, it is also possible that some informants were hesitant to admit to recent variolation in Kenya.

While the focus of this article is on smallpox inoculation among the Boran and Gabra of northern Kenya, a broader context of the practice in sub-Saharan Africa has also been presented. This permits a better understanding of the open cultural and religious frontiers between various peoples in this area of the world. With specific reference to the Boran and Gabra, it is clear that their close proximity to Ethiopia resulted in cultural and indigenous medical practice exchanges, smallpox inoculation being one of them.

Dedication This article is dedicated to the memory of Terence John Fredrick Gavaghan (1922–2011) and the Reverend Paolo Tablino (1928–2009). Terence Gavaghan served in various capacities throughout Kenya during the colonial era, and twice as a District Commissioner in the Northern Frontier. During the transition to independence, he served as Under-Secretary for Africanization and Interim Permanent Secretary in the Cabinet office. In 1962–1963, he was engaged by the United Nations to chair the Unifying Establishments Commission of the two newly independent Somali states. For some 30 years, he served as

a disaster preparedness and relief or government reform advisor for the United Nations and bilateral voluntary agencies in 17 countries. He also was the Administrator of the Irish Foundation for Human Development. He passed away in London on 10 August 2011 in his eighty-ninth year.

The Reverend Paolo Tablino went to Kenya in 1959 and served there for a half century, primarily in the northern districts. Originally assigned to Nyeri in the Central Highlands, he left for the Marsabit District in 1963 after studying the Gabra culture and language. He and the Reverend B. Venturino opened a Catholic Mission at Marsabit. Later he was posted to Maikona, and North Horr, and finally to Marsabit again. The Gabra people of northern Kenya greatly respected him for his knowledge of their indigenous culture and beliefs, and his command of their language. In 1980, his book on the Gabra, *I Gabbra del Kenya*, was published in Italian. It was later updated and published in English in 1999 under the care of the late Cynthia Salvadori. Father Tablino also authored a number of other publications on the Gabra and the peoples of northern Kenya. He was held in very high esteem by the international community of scholars who studied various aspects of Oromo culture. Because of his excellent rapport with the people of northern Kenya and his vast knowledge of their cultures and histories, he was able to greatly facilitate the field work of many students and scholars. Father Tablino had originally gone out to Kenya from Alba, Italy as a Fidei Donum mission. However, once in Kenya, he worked closely with the Consolata Fathers. In 2002, he was formally accepted into this order of missionaries. He passed away in Nairobi on 4 May 2009 in his eighty-first year, and was buried on the grounds of the Maria Mfariji Shrine at Marsabit.

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