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Yellow fever in Ghana, 1977–80

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The 3-year yellow fever epidemic in Ghana that started in 1977 and tailed off in 1980 appears to be the heaviest on record. In all, 827 cases and 189 deaths were reported (a fatality rate of 22.8%), the patients coming from many villages scattered over 4 regions in the country. The distribution of cases and other epidemiological characteristics are described in this article.

In Africa, yellow fever is almost exclusively found between the tropics of Cancer and Capricorn, and urban yellow fever infection appears more in West than in East Africa. The disease has been known to be endemic in Ghana ever since it was documented there in 1901 (*8*), but because of unsatisfactory reporting, the true incidence is not known. There has also been difficulty in making a definitive diagnosis owing to lack of adequate laboratory facilities to confirm suspected cases. In recent times, however, the surveillance system in Ghana has been very much improved and, through international collaboration with specialized laboratories, yellow fever cases are now better diagnosed and reported on.

The data indicate that the country was relatively free from yellow fever outbreaks between 1960 and 1968. Three cases were reported in 1963 from two separate regions: one case from Kumasi in the Ashanti Region, the first ever reported from that region, and two others from Damongo in the Northern Region.

A major epidemic of yellow fever, involving 319 cases and 79 deaths, occurred in 1969–70 and was the heaviest outbreak recorded during any 2-year period since 1901. The outbreak began in 1969 at Pong-Tamale in the Northern Region with 5 cases and 3 deaths. No other cases were found in this region, but in the same year 303 cases and 72 deaths were reported from the Upper Region involving Bolgatanga, Navrongo, Nandom, and Jirapa. In 1970 a single hospital at Akwatia in the Eastern Region reported 11 cases of yellow fever with 4 deaths. These last cases ended the epidemic cycle of 1969–70 because intensive search revealed no new cases.

The first five years of the 1970s were relatively quiet, only 12 cases for the whole country being recorded from Dormaa Ahenkro, Berekum, and Hwidiem in the Brong-Ahafo Region. The present report describes the outbreaks of yellow fever between 1977 and 1980.

METHODS

Case definition

A case was defined as yellow fever if:

(1) the illness was diagnosed by a physician on the basis of a significant association of symptoms and signs such as jaundice, fever, vomiting, abdominal pains, cramps, convulsions, haemorrhagic episodes, and proteinuria.

(2) the case occurred in a defined geographical area that had been declared as "epidemic" for yellow fever.

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The criterion for declaring an outbreak of yellow fever is the occurrence of an excess above the expected levels of cases with the characteristics of yellow fever, together with a high mortality.

Case finding

All physicians in the country were notified of the 1977 outbreak and were requested to carry out special surveillance and to report suspected cases. A questionnaire was to be filled in for each patient admitted to hospital. It called for a statement of signs and symptoms, as well as the patient's age, sex, and place of residence, and the date of onset of the illness.

For confirmation of the diagnosis, paired sera were collected during the acute and convalescent phases of the illness in a small number of easily accessible cases. When it was not possible to obtain paired sera, single specimens were also examined. All blood samples were centrifuged or left overnight and decanted, after which they were transported at −20 °C to the WHO Reference Laboratory in Dakar, Senegal, for serological analysis. Unfortunately, because of the long distance and duration of transportation, a number of serum samples were spoiled. Histopathological studies were carried out on liver specimens obtained either at post mortem or by the use of a viscerotome.

RESULTS

Epidemiological investigations

The four years from 1977 to 1980 were characterized by major outbreaks of yellow fever in the Upper, Eastern, Volta, and Brong-Ahafo Regions. There were more cases of yellow fever reported during this period than the total number between 1901 and 1960. The outbreaks were multiple, focal, and involved many villages.

Upper Region. The epidemic started in Jirapa during the second half of 1977 (Table 1, Fig. 1) and gradually spread south. It reached a peak in October and subsided by February 1978 when yellow fever immunization was instituted. There were a total of 136 cases and 34 deaths with a fatality rate of 25%. Nine of the 136 cases were confirmed as yellow fever by either serology or histopathology of liver specimens. The age distribution of cases in the Jirapa district (Table 2) showed the highest number in the 0–4-years age group, children under 10 years being affected most. About 67% of all the reported cases and 82% of the deaths occurred in the age group below 15 years. Adolescents were less susceptible during this epidemic.

Eastern Region. The Jirapa outbreak was followed from March to June 1978 by an epidemic in Maase, a small village in the Eastern Region with a population of about 2000. The Maase outbreak (Fig. 1), involving 32 cases and 12 deaths, with a fatality rate of 38.7%, started in the rainy season, unlike the Jirapa outbreak which began at the end of this season.

Table 1. Monthly distribution of yellow fever in the Jirapa epidemic, 1977–78

Month (1977–78)	No. of cases	No. of deaths	Case fatality (%)
August	15	2	13
September	15	4	26
October	44	19	43
November	26	6	23
December	8	0	0
January	16	3	19
February	12	0	0
Total	136	34	25

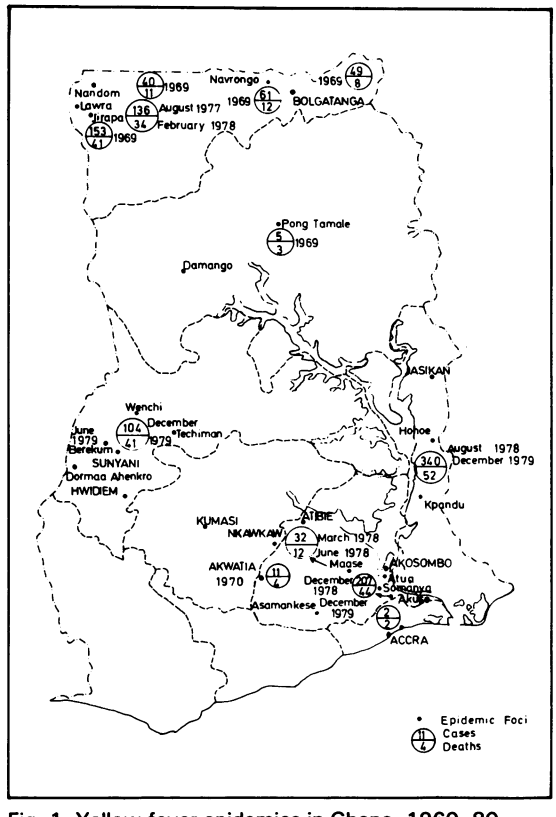

Fig. 1. Yellow fever epidemics in Ghana, 1960–80.

Table 2. Age distribution of yellow fever patients in the Jirapa district, 1977-78

Age group (years)	No. of cases	No. of deaths	Case fatality (%)
0-4	47	14	29.8
5-9	38	13	34.2
10-14	7	1	14.3
15-19	8	2	25.0
⩾ 20	36	4	11.1
Total	136	34	25.0

Histopathological examination was done on specimens from 6 of those that died and the results showed changes in the liver consistent with yellow fever.

In December 1978 more cases of yellow fever started to appear in other parts of the Eastern Region. The peak of this incidence was in the rainy season and by the end of the dry season in September 1979, the epidemic had subsided. There were a total of 207 cases, 44 deaths, and a fatality rate of 21%. The outbreak involved a large number of small villages spread over a wide area, stretching from Nkawkaw and Atibie in the north to Somanya, Akuse, Akosombo and Asamankese in the south (Fig. 1).

Volta Region. At the height of the rainy season in August 1978 another outbreak of yellow fever occurred in two adjacent districts, Hohoe and Kpandu in the Volta Region. The upper boundary of the epidemic was south of Jasikan, and the lower limit 8 miles to the south of Kpandu (Fig. 1). These two districts comprise more than 33 villages, scattered over a wide area, with a poulation of 91 000. There were a total of 340 cases with 53 deaths. The epidemic continued through the dry season and reached a peak in January. There was then a gradual decline in the number of cases after a yellow fever immunization campaign had been started.

The age-specific distribution of 291 of the cases and 48 of the deaths shows that the 15-44-year age group was affected most (Table 3). This is in contrast with the findings in the Upper Region in 1977, where the majority of cases occurred in persons under the age of 14 years. Susceptibility in the southern epidemics was not confined to any particular age group and this is probably because no mass immunization against yellow fever had ever been performed in the affected areas. Table 3 also shows that, with the exception of the 15-44-year age group with twice as many male as female cases, there was no striking difference in the rates of infection between males and females.

Brong-Ahafo Region. Before the epidemic in the Eastern Region had quite subsided, cases had started appearing in the Brong-Ahafo Region. The first cases were reported in June 1979 from Wenchi, followed by cases in Techiman, Hwidiem, Berekum and Dormaa Ahenkro (Fig. 1). The peak of the epidemic in this region was in August during the rainy season. A total of 104 cases and 41 deaths with a fatality rate of 39% was recorded during this period.

General course of the epidemic

Table 4 shows the chronological manner in which the outbreaks of 1977-80 were distributed. By the end of 1979 the wave of outbreaks appeared to have halted and 1980 showed the tail end of the epidemic with a total of only 8 cases, 2 from the Volta Region and 6 from the Brong-Ahafo Region. A comparison of the cases seen in 1979 with those in 1980 shows a very marked reduction of cases over this two-year period (Table 5).

Laboratory diagnosis

Where possible and practical, sera were taken for serological examinations. All analyses were based on haemagglutination inhibition (HI) and complement fixation (CF) tests. No neutralizing antibodies were tested for. An extract of the results showing significant and non-significant readings is presented in Table 6, which shows high levels of HI antibody titres in the acute and convalescent sera without any

Table 3. Age and sex distribution of the 291 cases of yellow fever in the Volta Region, 1978-79

Age group (years)	No. of cases			No. of deaths			Case fatality (%)
	Male	Female	Both	Male	Female	Both	
0-14	30	33	63	1	6	7	11.1
15-44	131	64	195	30	4	34	17.4
⩾ 45	20	13	33	4	3	7	21.2
Total	181	110	291	35	13	48	16.4

Table 4. Geographical distribution of cases and time sequence of the outbreaks

Month and year	Locality (Region)	No. of cases	No. of deaths
Aug. 1977–Feb 1978	Jirapa (Upper)	136	34
Mar.–Jun. 1978	Maase (Eastern)	32	12
Aug. 1978–Jan. 1979	Hohoe, Kpandu (Volta)	340	52
Dec. 1978–Sep. 1979	Somanya, Akuse (Eastern)	207	44
Jun.–Sep. 1979	Wenchi, Dormaa Ahenkro (Brong-Ahafo)	104	41
Jan.–Dec. 1980	Brong-Ahafo and Volta Regions	8	6
Total		827	189

significant changes except in one case (case 4) which showed a fourfold decrease in titre. This change in titre may be considered to be diagnostic of a recent yellow fever infection.

The complement fixation test showed two cases of yellow fever infection; one with a fourfold increase (16/64) and the other with a fourfold decrease (2048/512). The other 5 cases were presumptively diagnosed as yellow fever infection on the basis of a single serum specimen with yellow fever CF antibody titre equal or higher than 1:32 (*6*). These patients also had HI antibody to yellow fever, usually in high titres.

The serological pattern developed by the patients was considered to be compatible with infection caused by yellow fever virus. Yellow fever antibody titres in the sera tested were many times higher than titres to the other flaviviruses tested. There was a higher degree of specificity to yellow fever antigen in the CF test, but still some cross-reactions were observed.

Table 5. Notification of yellow fever cases in 1979–80, by months

Year	Months												Total
	Jan	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1979	112[a]/9	49/9	33/6	61/10	53/10	49/19	34/9	30/10	27/3	22/6	14/4	10/9	494/104
1980	3/1				1/1	1/1	1/1		1/1		1/1		8/6

[a] Cases/Deaths

Table 6. Haemagglutination inhibition and complement fixation titres in sera from suspected yellow fever cases in the Eastern, Volta, Brong-Ahafo and Upper Regions

Cases	HI titres	CF titres
1	1280/1280[a]	16/64[a]
2	5120/5120	2048/512
3	10240/10240	256/256
4	2560/640	64/32
5	5120	32
6	20480/20480	512/8192
7	2560	64
8	5120	32
9	20480	–

[a] Acute/convalescent titres.

Histopathological examinations

Histopathological examinations were carried out on specimens of liver taken at post mortem. The results showed that about 80% of all the specimens examined had changes suggestive of yellow fever (Table 7).

Survey of yellow fever vectors

A survey of the yellow fever vectors was carried out in some of the affected areas in the 1977–80 outbreaks. The localities studied are shown in Table 8. Larval and adult population studies of *Aedes aegypti* were done so that the risk of transmission of yellow fever in the affected areas could be assessed. The methods used included the determination of larval indices and man–vector contact.

The criteria used to assess the risk of transmission by *A. aegypti* depended on the values of the following indices:

Table 7. Histopathological examinations of liver specimens

Locality	No. of cases	No. of deaths	No. of liver specimens examined	No. positive for yellow fever
Upper Region	136	34	1	1
Maase (Eastern Region)	32	12	6	4
Volta Region	340	52	24	19
Eastern Region (excluding Maase)	207	44	14	10
Brong-Ahafo Region	104	41	17	15
Total	819	183	62	49

(*a*) *house index*, expressed as the percentage of houses with at least one positive breeding place;

(*b*) *container index*, expressed as the percentage of containers harbouring *A. aegypti* larvae;

(*c*) *bretaux index*, expressed as the number of positive larval breeding places (containers) per 100 houses.

Where the breteaux index exceeds 50, the house index exceeds 35, and the container index is more than 20, the risk of *A. aegypti*-transmitted yellow fever is considered high. In areas where the breteaux index is between 5 and 50, the density of *A. aegypti* is considered sufficient to promote an outbreak of disease, provided that *A. aegypti* is in association with the wild vectors of the *Stegomyia* group. In a situation where the breteaux index is less than 5, the house index less than 4, and the container index is also less than 3, the area is unlikely to promote the urban transmission of yellow fever through *A. aegypti*. From results of the vector studies (Table 8), it can be concluded that, in all the places surveyed, the vector was sufficient to promote an outbreak but the risk of transmission was highest in Maase with a breteaux index of 96.

In the adult survey to determine the biting rates of the vectors when human baits were exposed, a rate of 7 adult female *A. aegypti* per man-hour was obtained in Jirapa. This was an indication of a significant man-vector contact for risk of transmission of yellow fever in the area. Counts exceeding 2 females per man-hour for any species may be taken as indicating a significant man-vector contact for risk of transmission (*10*).[a]

The biting rate of the vector in Maase and in the Upper Region could not be estimated satisfactorily because of heavy rains and winds. In the Volta Region, because of a lack of flashlights, lanterns were

[a] MOUCHET, J. *Preliminary report on potential yellow fever vectors in Ghana*. Unpublished WHO document AFR/YF/17 (1971).

Table 8. Results of yellow fever vector studies

Region and locality	No. of houses	No. of houses with *Aedes aegypti* larvae	House index	No. of containers	No. of containers with *Aedes aegypti* larvae	Container index	Breteaux index
Upper:							
Jirapa	44	4	9.1	102	6	5.9	14
Doweni	18	3	16.6	52	6	11.5	33
Eastern:							
Maase	77	28	36.4	195	74	38	96
Volta:							
Fodome Xelu	50	8	16	116	8	7	16
Gbefi Tornu	98	7	7	263	7	2.6	7
Fodome Amele	20	3	15	53	3	6	15
Liate Wote	53	2	4	77	2	3	4

used and the smoke from them repelled the mosquitos from the human baits. This resulted in a low biting rate of 0.25–0.5 *A. aegypti* per man-hour.

In all the areas surveyed, the conditions favouring the promotion of an outbreak of yellow fever were found to be present so that non-immunized susceptible individuals were at risk.

DISCUSSION

The epidemiological characteristics of the yellow fever outbreaks that started in 1977 were as follows.

(1) No definite seasonal pattern to the outbreaks was apparent, a number of them occurring during the rainy season or reaching a peak at this time. The outbreak in the northern part of the country occurred at the end of the rainy season and reached a peak in the dry season, unlike the outbreaks in the southern parts which occurred throughout the year with a peak in the rainy season. These two patterns may be related to environmental factors influencing the breeding of *A. aegypti* around the dwelling places. In the north, where there is a long dry season, water is stored in receptacles for long periods; this encourages breeding of the vectors in and around homes and increases the chance of transmission of infection during this period. The southern part of the country does not have a dry season but, during the rainy season, water collects in pools, broken bottles and other receptacles, which favour the breeding of the vectors and, subsequently, disease transmission.

(2) The short intervals between outbreaks in the different regions may be related to disease transmission and population movements, especially in the southern parts of the country where adjacent districts tended to have outbreaks following one another within short intervals.

(3) All age groups were susceptible to infection, as shown by the data obtained. The age differences observed between the northern and the southern outbreaks could be due to modification of the susceptible population as a result of previous immunization. No important difference in the rate of attack between the sexes was noted.

The above epidemiological features and the prevailing ecological and entomological factors suggest that the disease was the urban type of yellow fever, which may have been precipitated by the introduction of yellow fever virus from an unknown source into an immunologically susceptible population.

A total of 827 cases and 189 deaths were recorded during the period under study, 1977–80. The fatality rate (23%) was much higher than the rates in similar outbreaks in Nigeria (1.6–2.9%) (*1*), the high rate in Ghana being due to the severity of the disease, especially among the patients who were admitted to hospitals. A number of unconfirmed cases, mainly anicteric infections, were also encountered during active surveillance. Such infections have been noted in yellow fever outbreaks reported elsewhere (*2–4*, *7*).

Unlike the reported outbreaks in rural Ethiopia (*9*) and Nigeria (*1*, *5*) where mostly adults were affected, the outbreak in Jirapa in the Upper Region of Ghana involved mainly children under 15 years of age, 67% of the cases and 82% of the deaths being in this age group. This unusual finding was due to previous yellow fever immunization of Jirapa's population during the outbreak in 1969. The outbreaks in the south of Ghana (Eastern and Volta Regions), however, affected more of the adult population who had never been immunized. The incidence of cases throughout the country declined as a result of massive immunization carried out selectively in the affected areas during the 1977–80 outbreak.

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RÉSUMÉ

LA FIÈVRE JAUNE AU GHANA, 1977-1980

Au cours des poussées épidémiques de fièvre jaune survenues au Ghana de 1977 à 1980, on a relevé au total 827 cas et 189 décès, ce qui fait de cette épidémie la plus importante qu'ait jamais connue ce pays. Dans tous les cas, il s'agissait de fièvre jaune "urbaine".

On a observé deux principales périodes au cours de cette épidémie. La première a commencé en 1977 à Jirapa, dans l'Upper Region, et s'est achevée en 1978. La seconde, qui constituait en fait la poursuite de l'épidémie de Jirapa, a duré jusqu'en 1980, s'étendant aux parties méridionales du

Ghana où de nombreux villages ont été atteints (dans l'Eastern Region, la Volta Region et la Brong-Ahafo Region).

Le tableau de morbidité et de mortalité observé dans l'Upper Region montre que 67% des cas et 82% des décès ont concerné des enfants de moins de 15 ans, ce qui s'explique du fait que les sujets plus âgés avaient été vaccinés contre la fièvre jaune au cours d'une épidémie précédente, en 1969. Dans le sud du Ghana, en particulier dans l'Eastern Region et dans la Volta Region, les poussées de fièvre jaune ont principalement touché les adultes, qui n'avaient pas été vaccinés au cours des dix années précédentes.

A la différence de la poussée épidémique de Jirapa, qui avait commencé à la fin de la saison des pluies, les poussées observées dans le sud se sont produites au cours de cette saison, atteignant leur maximum d'intensité avant la fin des pluies.

Une campagne sélective de vaccination de masse a été effectuée dans toutes les zones touchées et c'est sans doute ce qui explique la baisse brutale d'incidence en 1980. L'épidémie a été confirmée par des épreuves sérologiques, des examens nécropsiques histopathologiques et des études entomologiques dans les zones touchées.

Les études entomologiques montrent que les populations d'*Aedes aegypti* avaient partout un effectif suffisant pour favoriser ce type de poussée épidémique. Le taux de morbidité s'est donc montré corrélé avec l'étendue de l'infestation ou avec l'effectif des moustiques proliférant dans les zones touchées par la fièvre jaune. La morbidité a atteint son maximum à Maase, un village de l'Eastern Region, où 28 des 77 maisons inspectées abritaient des larves d'*Aedes aegypti*, ce qui correspond à un indice d'infestation des maisons de 36,4; par ailleurs, 74 récipients sur 95 contenaient des larves de cette espèce de moustique (soit un indice de 38) tandis que l'indice de Breteaux (nombre de gîtes larvaires actifs pour 100 maisons) s'élevait à 96.

Dans toutes les autres régions où une enquête sur les moustiques a eu lieu au cours de l'épidémie, on a enregistré des indices positifs.

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