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THE BURDEN OF RODENT-BORNE DISEASES IN AFRICA SOUTH OF THE SAHARA

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Abstract. There are many vector-borne diseases in Africa which cause a heavy toll in human morbidity, mortality, economic loss and suffering. Plague remains endemic in several countries in Africa; 1,269 cases of plague were reported in Africa in 1994 and these represent 43.2% of the 2,935 human cases of plague from all the world and 50% of the mortality. The 6 countries which have reported human cases of the disease as recently as 1994 are Madagascar, Malawi, Mozambique, Tanzania, Zaire and Zimbabwe. Natural foci of the infection remain in others.

However, in addition to plague, other infections and human diseases with rodent reservoirs account for a great deal of morbidity and mortality in Africa though little actual data are available on the number of cases. The rodent-borne infections include the virus diseases Lassa fever, Crimean-Congo haemorrhagic fever, and, possibly, Rift Valley fever. Bacterial infections include brucellosis, leptospirosis, plague, rat-bite fever, tick-borne relapsing fever and tularemia. Rickettsial infections are common and include murine typhus, tick typhus, Q-fever. There are also several helminthic infections which may be passed from rodents to man and the most important of these is schistosomiasis. One must take into account the fact that serious rodent depredations on man's foodstuffs can also lead to malnutrition.

Key words: Africa, rodents, diseases, viruses, plague, leishmaniasis, infections.

INTRODUCTION

Rodent-borne infectious diseases are a serious burden on man's health causing a great deal of morbidity and mortality. Many such infections are found in Africa south of the Sahara and the following paper will review the diseases with rodent reservoirs or hosts known to be present in this part of of the continent and provide an overall view of what is known of the magnitude and public health importance of the infections.

It must be emphasized that many of the reports of infectious agents of this group include data from surveys in which rodents have been found serologically positive with antibodies for a particular infectious agent or in which a parasite has been identified in a rodent host; in a substantial number of cases, the epidemiology of the infectious agent and the role of the rodent as a reservoir is still unclear. As will be seen a great deal of research remains to be done to ascertain the importance of this group of diseases in both actual or potential rodent reservoirs as well as in man.

Table 1 lists the diseases with rodent reservoirs which have been reported from Africa with a listing of some of the rodent species or genera found positive.

TABLE 1

Rodent-borne diseases affecting man in Africa

Human disease	*Infectious agent*	*Rodent host(s) partial listing*	*vector (if any)*
Rodent-borne haemorrhagic fevers			
Crimean-Congo Haemorrhagic fever	Congo virus	*Mastomys* sp ?	*Hyalomma* ticks *Rhipicephalus* ticks *Boophilus* ticks
Lassa fever	Lassa virus	*Mastomys natalensis* (Smith, 1834)	none
Hemorrhagic fever with renal syndrome	Hantavirus	*Rattus* spp. *Mus musculus* L. 1758	none
Rift Valley Fever		*Arvicanthis niloticus* (Desmarest, 1822)	*Culex* mosquitoes
Rodent-borne viruses			
West Nile fever		*Acomys cahirinus* (Desmarest, 1819)	*Culex* mosquitoes
Quaranfil virus		*Acomys cahirinus* *Rattus* spp. *Mus musculus*	
Omo virus fever	Bunyavirus	*Mastomys erythroleucus* (Temminck, 1853)	*Onithodorous* spp.
Sandfly fevers	Saboya virus	*Tatera kempi* Wroughton, 1906	*Phlebotomus* sp.
		Mastomys sp.	*Sergenomyia* sp
Rodent-borne rickettsial diseases			
Spotted fever	*Rickettsia conorii*	*Mastomys* sp.	ticks
Murine typhus	*Rickettsia typhi*	*Rattus* spp.	*Xenopsylla cheopis* (Rothschild, 1903)
African tick bite fever	*Rickettsia africae*	?	ticks
Q-fever	*Coxiella burnetti*	*Acomys* sp. *Mastomys* sp.	direct contact
Rodent-borne bacterial diseases			
Brucellosis	*Brucella suis*	*Arvicanthis* sp. *Mastomys* sp.	direct contact
Rat bite fever	*Spirillum minus*	*Meriones* sp.	direct contact
Relapsing fevers	*Borrelia* spp.	*Rattus* spp. *Meriones* spp. *Arvicanthis* spp.	*Ornithodoros* ticks
Lyme disease	*Borrelia burgdorferi*	*Rattus* spp.	ticks

Leptospirosis	*Leptospira icterohaemorrhagie*	*Rattus* spp. *Arvicanthis* spp. *Cricetomys gambianus* Waterhouse, 1840 *Mus musculus*	direct contact
Plague	*Yersinia pestis*	*Mastomys natalensis* *Mastomys coucha* (Smith, 1834) *Rattus* spp. *Tatera* spp.	fleas
Salmonellosis	*Salmonella* spp.	*Rattus* spp	direct contact
Rodent-borne protozoal diseases			
Leishmaniasis	*Leishmania donovani*	Rattus spp *Tatera robusta* (Cretzschmar, 1830) *Arvicanthis niloticus* *Acomys cahirinus*	sandflies
	Leishmania tropica	*Acomys cahirinus* *Tatera* sp. *Arvicanthis niloticus*	
	Leishmania major	*Mastomys natalensis* *Mastomys erythroleucus* *Arvicanthis niloticus* *Aethomys kaiseri* (Noack, 1887) *Tatera kempi* *Tatera robusta* *Taterillus emini* (Thomas, 1892)	
Toxoplasmosis	*Toxoplasma gondii*	*Rattus* spp.	direct contact

That there are many rodent-borne diseases, emphasizes the close contact between man and the commensal and peridomestic rodent populations (GRATZ, 1988). However, despite the importance of this group of diseases and the fact that some have been recognized for a long period of time, their epidemiology and very distribution requires further study. This is particularly the case in Africa where, as will be seen, the group is of particular importance to public health and known to be the cause of much morbidity and mortality. Only the most important of this large group of diseases will be dealt with below.

RODENT-BORNE ZOONOSES

Viral infections

Antibodies to a large number of arboviruses (arthropod-borne viruses) have been detected in rodent populations of many different species and a smaller number of virus isolations have been made. As has been noted above, the actual importance of rodents for

many of these infections is unknown despite serological detection of a virus or even an isolation in a given species. Rodents are known to have a considerable importance as reservoirs of certain arboviruses such as Venezuelan Equine encephalitis in the Americas and Tick-borne encephalitis in Europe. For many of these infections, even the epidemiology relating to the disease in humans has yet to be elucidated.

There are about 500 arboviruses (arthropod-borne-viruses) known. Of this number around 100 cause clinical and subclinical disease in man. Some of these are of great public health importance such as yellow fever, dengue, dengue haemorrhagic fever, Japanese encephalitis, Rift Valley Fever, Crimean Congo Haemorrhagic fever and tick-borne encephalitis.

Haemorrhagic fevers

There is a long and growing list of haemorrhagic fevers being recognized from various regions in the world. There are 14 viruses that are considered to be haemorrhagic fevers. Mammals, especially rodents, are important natural hosts for many haemorrhagic fevers, (LEDUC, 1989).

Lassa fever

Lassa fever virus is known only from Africa. The disease which it causes was first recognized during an outbreak at a mission hospital in Jos, Nigeria in 1969. (FRAME *et al.*, 1970). In later investigations it was found that the reservoir of the virus is a rodent, *Mastomys natalensis* (Smith, 1834) whose distribution is widespread in Africa, (MONATH *et al.*, 1974, WULFF *et al.*, 1975) and no vector is known. The virus is spread directly from its rodent host through contamination of foodstuffs by rodent urine and excreta. The infection is now known to be present in many countries of West Africa and central Africa. There have been severe outbreaks of the disease in the last two years in Liberia and Sierra Leone, (WHO, 1996a). In Sierra Leone, Lassa fever accounts for 10% of all febrile illnesses admitted to hospitals and 1.7% of the general death rate (WHO, 1985). Outbreaks have also been reported from Burkina Faso, the Central African Republic, Côte d'Ivoire, Gambia, Ghana, Guinea, Mali and Senegal. Just how serious the disease can be was recognized in a recent study in hospitals and clinics in Imo State, Nigeria; a retrospective study showed that among 34 patients with Lassa fever whose number included 20 patients, 6 nurses, 2 surgeons and one physician and the son of one of the patients, there were 22 deaths, *i.e.* a case fatality rate of 65%. The attack rate in one of the hospitals studied was no less than 55% (FISHER-HOCH *et al.*, 1995)!

In a study of the rodent populations of Lassa fever patient's houses in Sierra Leone, 79% of the rodents caught were *M. natalensis* (KEENLYSIDE *et al.*, 1983). Of this number no less than 39% were viremic. In an effort to control transmission, rodent were trapped in half the case houses but this failed to reduce the seroconversion rate. MCCORMICK *et al.* (1987) also studied the prevalence of Lassa virus in *M. natalensis* in Sierra Leone; this species constituted 50 to 60% of the rodent species captured in houses in the villages but only 10 to 20% of those trapped in the surrounding agricultural areas. Virus prevalence

ranged from 0% to a high of 80%. They calculated that the ratio of fatalities to infection in humans infected with Lassa was about 1 to 2% but the high incidence of the disease makes it a major public health problem in West Africa.

During 1996, a total of 470 cases with 110 deaths (23.4% CFR) were reported from Sierra Leone. Four of these cases were reported from Freetown. In the first four months of 1997, there were a total of 353 cases of Lassa fever with 43 deaths though the civil unrest at the time of writing prevents full reporting (WHO, 1997b). The increased number of cases has been ascribed to crowded conditions, poor sanitation and an increase in the rodent populations (WHO 1997a).

Strains of a closely related virus have been isolated in Mozambique (WULFF *et al.,* 1977) and Zimbabwe (JOHNSON *et al.,* 1981). The virus in both countries has been given the name Mozambique virus. In Zimbabwe it was isolated from both *M. natalensis* and *Aethomys chrysophilus* (de Winton, 1897). It seems quite likely that the infection, or closely related viruses are more widely spread than presently reported but further serological studies must be carried out.

Mobala Virus

This relatively new arenavirus has been isolated from *Mastomys natalensis* and *Praomys* sp. in the Central African Republic; its public health importance and distribution outside of the CAR are, as yet, unknown, (GONZALEZ *et al.,* 1984).

Hantavirus disease-Haemorrhagic fever with renal syndrome

This group of infections caused by a group of hantaviruses is known to be present in many countries in the world and appears to be spreading or being recognized from countries in which they have not been know previously. The infections are known under several names such as Korean Haemorrhagic fever, Tula virus and others but in most cases these are the same virus with different levels of virulence. In China and eastern Russia, the infection is responsible for large numbers of cases and many deaths every year. Recently described new members of the group in the USA and Europe have caused a high level of mortality and great concern, (GLIGIC *et al.,*1992, NILKLASSON *et al.,* 1995, ROLLIN *et al.,* 1995, WARNER, 1996). These newly recognized hantaviruses have been given different names among them Bayou virus, Sin Nombre virus. In Africa, the infection is widespread in human and rodent populations and has been reported in Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Equatorial Guinea, Gabon, Mauritania, Madagascar, Nigeria, Senegal, Uganda, (FISHER-HOCH & MCCORMICK 1985) and Tanzania, in the latter from the island of Zanzibar (NUTI & LEE, 1991). It appears very probable that the virus will be found almost wherever it is looked for but very little information is available on its prevalence, clinical picture or public health importance in man in Africa.

Rift Valley Fever Virus

Rift Valley fever is known to extend from South Africa northward through Kenya and Sudan and to west Africa. Large, epidemic, outbreaks of the disease have occurred in

Egypt in 1977-1978 and 1993 with a large number of deaths and abortions among herds and some 600 human deaths in the first outbreak. The vector of the disease is a mosquito and the identity of the reservoirs is still uncertain. It has been suggested that rodents are one of the reservoirs of RVF but this requires further verifications, (SCOTT & HEISCH, 1959). KEOGH and PRICE (1981) in their review of the multimammate mice expressed doubt as to whether this group could be the reservoir for RVF.

Rabies or rabies like infections

It has been commonly accepted that rodents do not serve as reservoirs of rabies; there has, however, been a report from South Africa of the presence of a rabies like virus, Mokola virus, in rodents (SWANEPOEL *et al.*, 1993). The significance of this is not yet entirely clear.

Rickettsial diseases

Spotted fevers or «African tick typhus»

In Africa south of the Sahara, the seroprevalence of the spotted fever group of rickettsial infections is higher than anywhere else in the world, (DUPONT *et al.*, 1995). This infection caused by *Rickettsia conorii* , is widely spread throughout Africa. The infection is relatively mild with a low mortality of less than 3% even without treatment. The vectors are ticks of several different genera and strains of *R. conorii* have been recovered in South Africa from *Otomys irroratus* (Brants, 1827) and *Rattus rattus* (L., 1758). A large number of species have been found positive in Kenya including *Arvicanthis niloticus, Rattus rattus, Mastomys natalensis, Aethomys kaiseri, Lophuromys flavopunctatus* Thomas, 1888 and *Lemniscomys striatus* (L., 1758). Rates of human infection may be quite high; in Sierra Leone and the Côte d'Ivoire, 7% of the population was found to be seropositive to rickettsial diseases in some areas, mainly for spotted fever (REDUS *et al.*, 1986) while in Central Africa and Zimbabwe the rate may be as high as 45% (BROUQUI *et al.*, 1992).

Murine typhus

Murine typhus caused by *R. typhi*, is probably present throughout most of coastal Africa or inland cities where the main reservoirs *Rattus rattus* or *Rattus norvegicus* (Berkenhout, 1769) and flea vectors of the genus *Xenopsylla* are present. Little information is available on the incidence of infection with murine typhus. DUPONT (1995) found that antibodies to *R. typhi* ranged from 1% to 20% in the populations studied; as elsewhere, where commensal *Rattus* species are common, murine typhus infections will probably be frequent as well though most of them will go undiagnosed. The disease is relatively mild but an infection usually necessitates a long period of convalescence.

Bacterial diseases

Several of the bacterial diseases with rodent reservoirs in Africa are responsible for a very considerable morbidity and significant mortality. The relapsing fevers, plague and

leptospirosis are important from a public health viewpoint in many foci throughout Africa and the continent has not escaped the spread of Lyme disease.

The various species of *Borrelia*, the agents of relapsing fever, all have tick vectors and of this group of diseases, only the „crocidurae" group have rodent reservoirs. The infection is widely distributed from Senegal to Kenya. In West Africa the infection is classically limited to the Sahel and Saharan region and the reservoirs are peridomestic *Cricetomys gambianus, Rattus rattus* and *Arvicanthis niloticus* among others. TRAPE *et al.* (1991) suggest that the disease is not only very widely spread in Senegal but throughout all of Africa.

Lyme disease

Lyme disease was first recognized in the eastern USA in 1975 though it is now realized that the infection was actually known by its clinical characteristics in Europe from early in the century. The vectors of the infectious agent, the spirochete *Borrelia burgdorferi*, are ticks of the genus *Ixodes*. The disease resulting from the infection can be quite severe and is difficult to treat. The disease has become the most important vector-borne disease in North America and has spread widely in Europe and Asia. Apparently the infection was first recognized in South Africa in 1989 and cases have now been reported from both east and west Africa. Though rodents are known to be the most important reservoir elsewhere, little information is available on the reservoir species in Africa. It would appear, however, that as elsewhere, the infection is spreading and research should be undertaken to determine the rodent hosts. It is reported that *Rattus norvegicus* and *Rattus rattus* are the reservoirs of Lyme disease on Madeira Island (MATUSCHKA *et al.,* 1994).

Leptospirosis

Leptospirosis is the most widespread zoonoses in the world. The disease in man, though usually mild, can be quite severe with significant mortality in older people. While many different animals can serve as host to the leptospires, rodents are frequently the source of *Leptospira icterohaemorrhagiae* passing the infection to man through their urine; the infective agent in rodent reservoirs has been reported from many countries in Africa including Benin, Cote d'Ivoire, Kenya, Madagascar; Mali, Reunion, Senegal, Seychelles, Tanzania, Uganda, and Zimbabwe and will probably be found anywhere where there are populations of commensal or peridomestic rodents in close contact with man. The infection in the Seychelles was studied over a two-year period when 80 cases were diagnosed at Victoria Hospital with a 16% mortality; it was considered that the infection was primarily *Rattus* species borne (PINN, 1992). The rodent hosts found positive with Leptospires in Africa include *Arvicanthis niloticus, Cricetomys gambianus, Mastomys* sp., *Mus musculus* and, particularly, *Rattus norvegicus* and *R. rattus* (FIEDLER, 1988). The first human case of leptospirosis has only been recently described from Gabon and confirmed serologically. The rodent fauna of the country is rich, houses are heavily infested and pigs and dogs circulate freely in the villages (PERRET *et al.,* 1994). There seems little doubt that further surveys will find the infection widespread. Studies in Benin (KOUNDE, 1996) showed a high percentage (51.7%) of the rodents examined, mainly *Rattus norvegicus*, positive for leptospires. FERESU & DALU (1996) recently isolated 49 strains of *Leptospira*

in the city of Harare, Zimbabwe, 43 from *R. rattus*, 2 from *Mastomys* sp. and 4 from *Mus musculus*.

Plague

The causative agent of plague is *Yersinia pestis*. The infection is passed from one rodent to another by fleas which have fed on an infected rodent. The infection is maintained in sylvatic rodent populations in natural foci of the disease over long periods of time. If fleas infected from rodents in these foci feed on man, the disease can then be passed on to humans. If untreated the disease can cause a high mortality, particularly if the pneumonic form of the infection develops. If sylvatic rodent fleas feed on peridomestic or commensal rodents, an outbreak of plague can occur in human settlements. Seven countries in Africa have reported plague in 1993 and 1994 as shown in Table 2.

In recent years outbreaks have also been reported in Botswana and Kenya, and probably remains endemic in other countries as well. While the number of cases of human plague is not great as compared with that of other vector and rodent-borne diseases in Africa, the disease is doubtlessly considerably undereported in Africa and the potential for serious outbreaks with a high case fatality rate due to delayed diagnosis and reporting is significant. The principal rodent reservoir in Africa is the multimmate rat, *Mastomys natalensis*. Many different species have been found infected with plague but the principal reservoir species are *M. natalensis* and *Tatera brantsii* (Smith, 1836) in southern Africa. HALLETT and ISAACSON (1975) noted that a rodent die-off preceded a human outbreak if plague in South Africa and that *Otomys unisulcatus* Cuvier (1829) was an important rodent in the plague cycle. SHEPHERD *et al.* (1983) also noted that a rodent epizootic appeared to precede a human outbreak in eastern Cape province in 1982. The rodents involved were *Rhabdomys pumilio* (Sparrman, 1784) and *Otomys irroratus*. In Madagascar, the only reservoir of plague is *R. rattus*, (BRYGOO, 1966); the changing ecology of the country with the destruction of forest habitats, favors the spread of this species The disease is endemic in about 15% of the country and there is evidence that the strains of *Y. pestis* are becoming more virulent, (MICHEL *et al.*, 1989). Both bubonic and pneumonic forms are now appearing and many of the pneumonic cases die. Between 1989 and 1992, 312 cases of plague were serologically confirmed in Madagascar and another 335 were considered as probable. Of these cases, 93% came from the „central triangle" with cases occurring throughout the year but mainly during the rainy season from November to March, (BLANCHY *et al.*, 1993). Two outbreaks have occurred in Mahajanga harbour in 1991 and 1995-1996 where plague had earlier disappeared in 1928. After the human epidemic, the shrew *Suncus murinus* (L., 1766) represented about 90% of captures and one shrew was infected by *Y. pestis* and the role of this species requires further investigation (DUPLANTIER *et al.*, 1996).

The cases which occurred in Mozambique are the first to be reported in that country in 15 years and they occurred in Tete Province which is known to be plague-endemic. Investigations on the plague reservoirs in Zimbabwe during an outbreak in 1983 showed that *Tatera leucogaster* (Peters, 1852) and *Mastomys coucha* were very susceptible to *Y. pestis*, usually dying quickly after infection which makes it unlikely that they can act as

the reservoirs. *Aethomys chrysophilus* and *Mastomys natalensis* are relatively resistant to the infection and are much more probable sylvatic reservoirs. Both species of *Mastomys* are semi-domestic in their habits and may act as a link between man in villages and the true sylvatic foci (WHO, 1983).

TABLE 2

Human cases of plague in Africa in 1993-1994. Deaths indicated between parentheses (WHO, 1996b)

Country	*1993*	*1994*
Madagascar	127(23)	126 (15)
Malawi	9	-
Mozambique	-	216 (3)
Tanzania	?	444 (50)
Uganda	167 (18)	-
Zaire	636 (89)	82 (10)
Zimbabwe	-	392 (28)

As can be seen in Table 2, the largest number of cases in Africa have been reported from Tanzania. KILONZO (1992) in a survey of 6 regions of the country, found that of 5,638 small animals captured, 2.4% contained agglutinating antibodies for the infection. Antibody positive rodents were found in Lushoto, Mbulu, Chunya and Monduli districts and in Tanga seaport. The disease may be spreading in Tanzania as KILONZO & MHINA (1982) described a plague epidemic of 49 cases and 11 deaths in the Tanga region in 1980 where the disease had never been recorded before. Further investigations on endemic areas in Tanzania and improved surveillance, both laboratory and clinical are a priority.

Much research remains to be carried out on the epidemiology of plague in Africa particularly on the nature of the sylvatic foci that enable plague infections to persist over long periods of time. The continuing presence of such natural foci of plague imply a constant threat of outbreaks of the disease among human populations. SHEPHERD & LEMAN (1983) found three species of rodents antibody positive in South Africa, *Desmodillus auricularis* (Smith, 1834), *Tatera brantsii* and *Rhabdomys pumilio*, and positive rodents were found in 1972, 1974, 1975 and 1979 showing that the infection continues to circulate over long periods of time even in the absence of human cases.

Protozoal diseases

Leishmaniasis

The causative agents of the various forms of leishmaniasis are protozoa of the genus *Leishmania*. The vectors are all sandflies of the genera *Phlebotomus* and *Sergentomyia*. Most of the leishmaniasis are zoonoses and among the most important of the reservoir vertebrate hosts are rodents. There are two main clinical forms of the disease which may be caused by one of several species. Visceral forms of the infection frequently cause of death

if untreated. Endemic visceral leishmaniasis, or kala azar, in East Africa is caused by *L. donovani*. In Kenya parasites of *L. major* causing dermal or cutaneous leishmaniasis have been isolated from *Tatera robusta, Arvicanthis niloticus, Mastomys natalensis, Taterillus emini* and *Aethomys kaiseri* (GITHURE *et al.,* 1986).

Visceral leishmaniasis or Kala azar is a serious public health problem in Sudan and is the cause of much morbidity and mortality. The infection is spreading to many areas where it was not previously known to be present. Surveys in the Upper Nile Province of southern Sudan have found *Arvicanthis niloticus* and *Acomys cahirinus* positive for *L. donovani*, (EL-HASSAN *et al.,* 1993). PEREA *et al.,* (1991) carried out a study in the same general area and found a prevalence of *L. donovani* infection of 18.2% and believe that the disease has already killed thousands of persons and is spreading. ASHFORD & THOMSON (1991) believe that the outbreak of visceral leishmaniasis in the western Upper Nile province has killed at least 30,000 people and largely depopulated an area some 50 km in diameter. The great ecological changes in the area, in part as a result of the civil war, may be an important factor in the increase and spread of the infection.

There has also been a great increase in cutaneous leishmaniasis due to *L. major* in Sudan resulting in a major epidemic along the Nile River north of Khartoum in 1985. KADARO *et al.* (1993) sampled the human population and found that 4% had active lesions of cutaneous leishmaniasis, 47% has healed lesions and another 43% had positive reactions to a sensitization test though they showed no lesions. All in all, they found that 91% of the population has a positive reaction. They believe that one of the factors in this very high rate is the increased population density of *Arvicanthis niloticus*.

In west Africa, *L. major* has also been isolated from the livers and spleens of *Mastomys natalensis* and *Tatera kempi* in northern Nigeria (IKEH *et al.,* 1995). As further studies are done, it seems likely that growing recognition will be given to the public health importance of leishmaniasis and hence of the rodent reservoirs of the infection in Africa.

Rodent-borne worm infections

Schistosomiasis

Although schistosomiasis is an important public health problem throughout Africa, the role of rodents as reservoirs of the infection has only been briefly investigated. KAWASHIMA *et al.* (1978) found that in the Taveta area of Kenya *Pelomys* sp. was infected by *Schistosoma mansoni* (Sambon, 1907) and suggested that it might play a role as a reservoir in this area.

In recent studies in a relatively new focus of *S. mansoni* in Senegal, 5% of *A. niloticus* and *Mastomys huberti* (Wroughton, 1908) trapped in ricefields and orchards were positive. While the prevalences and worm loads were low, the Richard-Toll focus is only seven years old and may increase in the future, (DUPLANTIER & SENE, 1996).

Other worm parasites of man have been found in rodents in Africa such as *Capillaria hepatica* in 19 out of 308 (6.2%) *Rattus rattus* and 1 out of 312 (0.5%) *Myomys albipes* (Rüppell, 1842) in Ethiopia (FARHANG-AZAD & SCHLITTER, 1978) and in 48% of *M. natalensis* in South Africa. Trichinosis parasites have also been found in several rodent species

in Africa but the extent to which this infection and other worm parasites found in rodents are important public health problems in man is unknown in Africa.

CONCLUSIONS

Despite the comparative lack of accurate data on the human incidence of most of the rodent-borne diseases in Africa, enough information is available to show that as a group they constitute a serious burden on the human population in those areas in which they are endemic. To the burden of infectious diseases one must add the effect on the nutrition of man which results from rodent depredations on foodstuffs; while relatively little information is available on just how serious these are in economic terms, the many examples presented by FIEDLER (1988) give good reason to believe that the losses in cash and food crops adversely affect the availability of food on a continent where adequate nutrition is already a problem.

It is essential to improve the surveillance of the rodent-borne diseases in Africa; only with more accurate information on their magnitude can one judge the resources that must be devoted to control of the rodent reservoirs. Such information, were it available, would also provide a guide to the areas where greater emphasis must be placed on the control of the reservoir species. Increased surveillance on the incidence of this group of diseases in man must be linked with more detailed studies to determine which rodent species are the most important reservoirs. Studies on the bionomics of the most important rodents will also enable more selective, effective and economic control measures to be undertaken.

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