Nigerian Field **81:** p. 58-66 (2016)

To Conserve or Control? Recent Studies Provide Vital Information for a Balanced Management of Rats in Nigeria and Some Other Countries in West Africa

Ayodeji Olayemi

Natural History Museum
Obafemi Awolowo University, HO 220005
Ile-Ife, Osun State, Nigeria
aolayemi@oauife.edu.ng

Abstract

Rats are commonly associated with filthy environments and reviled as pests and carriers of terrible diseases that affect people. But research also discloses that rats are beneficial to the ecosystem and by extension to humans. Balanced information about these animals can help us appreciate their positive qualities and possibly enhance their conservation in the natural environment. And where they prove harmful, more information can assist to evaluate and control the effects rats have on man. This article reviews the studies that have been carried out on wild rats in Nigeria and other parts of Africa. The studies reviewed in this article, on the one hand, showcase the vital contribution rats make to maintaining biodiversity across various ecological zones within the country. On the other hand, the article recognizes the role of certain species of multimammate rat and the African wood mouse as reservoirs of the deadly Lassa virus. Based on these parallel lines of evidence, it is concluded that while it is crucial to control commensal rats that dwell in close proximity to humans, it is equally important to conserve wild rats in the natural environment.

Introduction

Rats! They never fail to elicit a strong reaction: alarm, disgust, or in certain cases, fascination. We read in history of whole civilizations almost being wiped out by rodent-borne diseases. Because of their innate reproductive prowess and resilience, rats can survive in very tough environments.

Rats, however, support the health of ecosystems because they are so numerous and diverse, driving natural processes such as seed dispersal and energy transfer in the

carbon cycle. They have a physiology similar to that of man, hence they are often used in experimental research targetted against diseases that affect people including cancer, liver malfunction and neurological disorders.

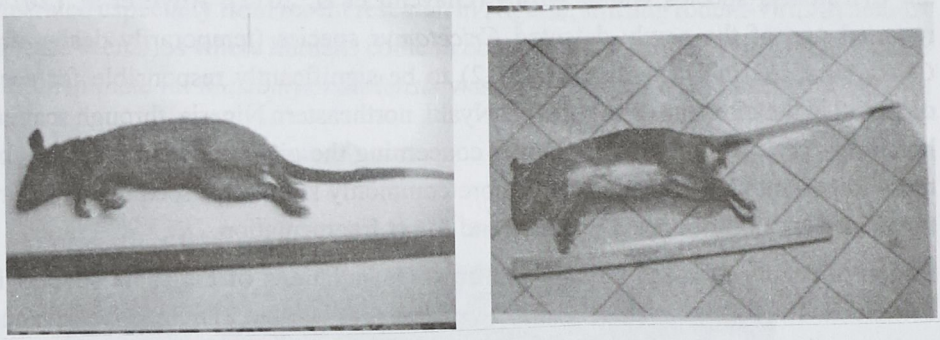

Figure 1. Morphological forms of the giant pouched rat: *Cricetomys gambianus* [left] and *C. emini* [right].

This paper examines the pros and cons of rats within Nigeria, with particular reference to recent findings concerning their diversity across various spatio-temporal scales and also their role as hosts of deadly zoonotic arenaviruses like Lassa fever. This review refers to 'rats' in a very broad sense, but cites many examples of rodents from the superfamily Muroidea (Happold, 2013).

Diversity of rats in Nigeria

Rodents are the most numerous species among mammals, which, as mentioned previously, enables them provide a host of ecological services. Thus, the higher the diversity of these animals in the natural environment, the better. Happold (1987, 2013) has described an enormous amount of rodent diversity within Nigeria. More recently, the DNA sequencing technique has helped uncover even further diversity across various genera (Nicolas et al, 2010a&b; Olayemi et al, 2010).

For instance, the giant pouched rat of the genus *Cricetomys* is a popular rodent in Nigeria and across Africa. It is known as *okete* in Yoruba, *gafiya* in Hausa and *ewi* in Igbo. Traditionally, two species have always been recognized: *Cricetomys gambianus*, with a more thickset torso and a cream-coloured belly, distributed in the

savanna and forest clearings; and *C. emini*, relatively slimmer, with a pure white belly, in the deeper forest (figure 1) (Genest-Villard, 1967; Rosevear, 1969).

More species have been proposed based on variations of these two morphological forms, but recently, using DNA sequencing data, it was determined there are at least six *Cricetomys* species within Africa (Olayemi et al, 2012). Aliyu et al. (2014) reported one of the newly detected *Cricetomys* species (temporarily designated *Cricetomys* sp3 in Olayemi et al, 2012) to be significantly responsible for seed dispersal in the montane forest of Ngel Nyaki, northeastern Nigeria, through scatter-hoarding. They noted that this finding concerning the giant pouched rat is all the more important as larger frugivores more commonly known for seed dispersal are threatened by anthropogenic pressure and forest fragmentation.

Rodent diversity between species and across populations of the same species is beneficial. The spotted grass rat *Lemniscomys striatus* (figure 2) lives in the savanna and secondary woodland along the edge of the forest. Nicolas et al, (2008) carried out biogeographical studies, delineating four major genetic clusters across the distribution range of this species. The genetic clusters occupy the Republic of Benin and Nigeria in West Africa; central Africa; and east Africa. Nicolas et al, (2008) also found that the location of these genetic clusters in several cases corresponds to historical animal *refugia* shaped by rivers such as the Niger and Volta in West Africa, mountain ranges such as the Rift Valley system in eastern Africa, and climatic and vegetation fluctuations occurring up to 1.6 million years ago in the Pleistocene Epoch. Therefore studying genetic diversity within widely distributed rodents, such as the spotted grass rat, can provide information on the evolutionary history of the African continent and helps define biotic zones where conservation activities need to be especially focused.

Another positive reason for conserving the diversity of rodents is that it makes them suitable as indicator taxa for gauging changes in the ecosystem. Olayemi and Akinpelu (2008) encountered sites in southwestern Nigeria once known to be rainforest, but in which the general rat diversity had decreased; and as a result a number of forest species have virtually disappeared. This helps demonstrate even more vividly the southward encroachment of the derived savanna into areas formerly known as forest within southwestern Nigeria. It also shows that while Nigeria possesses quite an assortment of rat species, a lot of it is being lost before one can comprehend its full extent.

Rats as carriers of pathogens that are dangerous to man

In Nigeria and certain other countries within West Africa the Lassa fever virus causes a deadly zoonotic illness which kills thousands of people every year. The evolving role of rats as carriers of this disease-causing virus is not new. As illustrated especially from recent research in Nigeria, shifting rodent-virus dynamics increase scenarios where humans come in contact with Lassa-carrying rodents. The multimammate rat *Mastomys natalensis* was first detected as the host of the Lassa

Figure 2. The beautiful spotted grass rat *Lemniscomys striatus*.

virus in Sierra Leone (Monath et al, 1974). More recently, Olayemi et al, (2016a) reported new reservoirs of the virus in the Guinea multimammate rat *Mastomys erythroleucus* both in Nigeria and the Republic of Guinea, and the African wood mouse *Hylomyscus pamfi* in Nigeria. Ecologically, *M. natalensis*, the long-known host of the Lassa virus, is commensal, living close to people (figure 3). Conversely, *M. erythroleucus* is a generalist while *H. pamfi* is forest-dwelling, extending the potential for Lassa fever epidemics to emerge in new areas.

Figure 3. Trapping rats in an area endemic for Lassa fever. Poor sanitation conditions in households attract virus-carrying rodents that like to live close to humans.

Lassa fever epidemics in humans occur more readily during the dry season. Again, the varying abundance of rats in diverse habitats through different periods of the year might play a part. In Guinea, Fichet-Calvet et al, (2007) sampled a significantly higher number of *M. natalensis* within human dwellings than outdoors during the dry season. The authors surmised these rats moved indoors to take advantage of human food during the dry season—less rains and less crops in the fields, heightening rodent-human contact. Olayemi (et al, under review) also found that *M. natalensis* populations also peaked indoors during the dry season in Nigeria. Olayemi (under review) however found that an alternate host of the Lassa virus, *M. erythroleucus,* is found in greater numbers indoors during the rainy season. This maintains the possibility of year-round rodent-to-human transmission of the Lassa virus within Nigeria.

Another aspect of the threat that rats carry as hosts of viruses such as Lassa is the frequency with which these viruses mutate and switch between host species. To date

among rats in Nigeria Olayemi et al, (2016a&b) have detected a potential new Lassa virus lineage (the Kako strain) in *H. pamfi*, Osun State, and in the forest zone west of the Niger River; Lassa lineage II in *M. natalensis*, Edo State, in the forest zone west of the Niger River; Lassa lineage III in *M. erythroleucus*, Benue State; in the Guinea savanna east of the Niger River; and a novel Mobala virus-like arenavirus in *M. natalensis*, Taraba State, in the Guinea savanna east of the Niger River (figure 4).

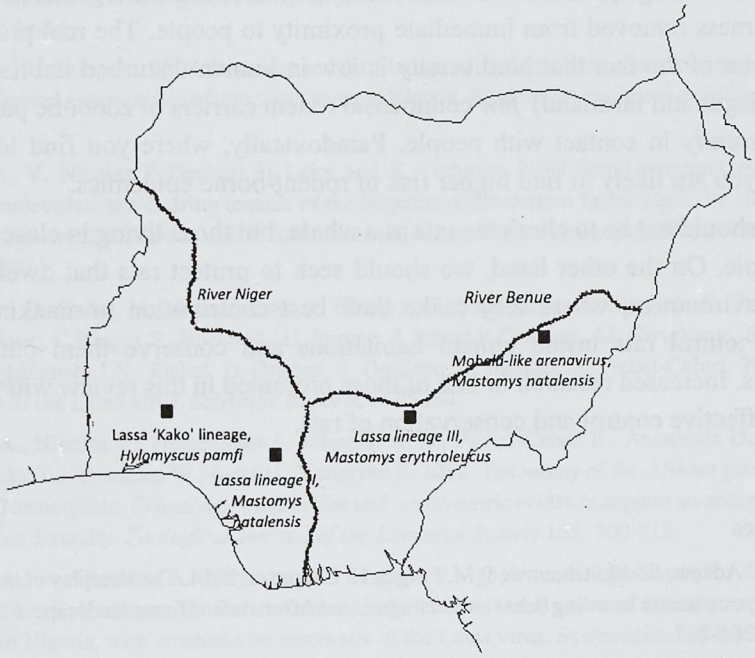

Figure 4. Distribution of lineages for Lassa and other arenaviruses detected so far in rat populations around Nigeria. Within the figure, the name of each virus lineage precedes the name of its rodent host.

We have seen across the world how a virus like influenza has evolved to produce different strains jumping from humans to pigs to birds and back to humans with calamitous consequences (Taubenberger and Kash, 2010). The wide range of Lassa and other arenavirus lineages discovered so far in Nigeria highlights the potential for this virus to evolve and emerge in novel ways that can be even more harmful to humans.

Conclusion

Rats enhance the ecosystem which benefits human populations, but simultaneously they pose an ever-evolving threat, by carrying diseases harmful to people. Scientists have increasingly become interested in the relationship between rat diversity and the emergence of zoonotic diseases.

Mills (2006) hypothesized the 'dilution effect' which points out that the bulk of rat diversity, including species that bear potentially zoonotic microorganisms, lives in the wilderness removed from immediate proximity to people. The real problem is that in spite of the fact that biodiversity is low in human-disturbed habitats (e.g., cities, villages and farmland) *few* commensal rodent carriers of zoonotic pathogens are *persistently* in contact with people. Paradoxically, where you find lower rat diversity you are likely to find higher risk of rodent-borne epidemics.

The aim should not be to eliminate rats as a whole, but those living in close contact with people. On the other hand, we should seek to protect rats that dwell in the natural environment, where they make their best contribution to mankind. In a nutshell: control rats inside human habitations and conserve them out in the wilderness. Increased research in line of those presented in this review will provide data for effective control and conservation of rats.

References

Aliyu B, H. Adamu, E. Moltchanova, P.M. Forget, H. Chapman, 2014. The interplay of habitat and seed type on scatter boarding behavior in a fragmented Afromontane forest landscape. *Biotropica,* 46(3): 264-267.

Fichet-Calvet E., E. Lecompte, L. Koivogui, B. Soropogui, A. Dore, F. Kourouma, O. Sylla, S. Daffis, K. Koulemou, J. Meulen,. 2007. Fluctuation of abundance and Lassa virus prevalence in *Mastomys natalensis* in Guinea, West Africa. *Vector Borne Zoonotic Dis.* 7: 119–128.

Genest-Villard H. 1967. Revision du genre *Cricetomys* (Rongeurs, Cricetidae). *Mammalia* 31: 390–455.

Happold D. C. D. 1987. *The Mammals of Nigeria.* Oxford: Clarendon Press.

Happold, D. C. D. 2013. *Mammals of Africa. Volume III: Rodents, Hares and Rabbits.* London: Bloomsbury.

Mills, J. N. 2006. Biodiversity loss and emerging infectious disease: An example from the rodent-borne hemorrhagic fevers. *Biodiversity*, 7: 9-17.

Monath T. P., V. F. Newhouse, G.E. Kem, H.W. Setzer, A. Cacciapuoti, 1974. Lassa virus isolation from *Mastomys natalensis* rodents during an epidemic in Sierra Leone. *Science*, 185: 263-265.

Nicolas V, J.F. Mboumba, E. Verheyen, C. Denys, E. Lecompte, A. Olayemi, M. Colyn, 2008. Phylogeographical structure and regional history of *Lemniscomys striatus* (Rodentia: Muridae) *Tropical Africa. Journal of Biogeography* 35:2074-2089.

Nicolas V., B. Akpatou., W. Wendelen, J. Kerbis-Peterhans, A. Olayemi., J. Decher, A. Missoup, C. Denys, P. Barriere, C. Cruaud, M. Colyn. 2010a. Molecular and morphometric variation in two sibling species of the genus *Praomys* (Rodentia: Muridae): implications for biogeography. *Zoological Journal of the Linnaean Society* 160: 397-419.

Nicolas, V., A Olayemi, W. Wendelen, M. Colyn, 2010b. Mitochondrial DNA and morphometrical identification of a new species of *Hylomyscus* (Rodentia: Muridae) from West Africa. *Zootaxa* 2579: 30-44.

Olayemi A., A. Akinpelu . 2008. Diversity and distribution of murid rodent populations between forest and derived savanna sites within south western Nigeria. *Biodiversity and Conservation*. 17: 2411-2425.

Olayemi A., V. Nicolas, P. Gaubert, H. Leirs. and E. Verheyen 2010. Small mammals, morphology and molecules: tale-bearing tenants of the Nigerian southwestern forest block. In: *Advances in Environmental Research*, Vol. 8, Justin Daniels, editor, Nova Science publishers, New York pp. 247-267

Oayemi A., D. Cadar, N. Magassouba., A. Obadare, F. Kourouma, A. Oyeyiola.,S. Fasogbon, J. Igbokwe , T. Rieger, S. Bockholt., H. Jerome , J. Schmidt-Chanasit , M. Garigliany , S.Lorenzen F. Igbahenah, J.N. Fichet, D. Ortsega, S. Omilabu, S. Gunther, E. Fichet-Calvet. 2016a. New hosts of the Lassa virus. *Scientific Reports*, 6: 25280.

Olayemi A., Nicolas V., Hulselmans J., Missoup A. D., Fichet-Calvet E., Amundala D., Dudu A., Dierckx T., Wendelen W., Leirs H., Verheyen E. 2012. Taxonomy of the African giant pouched rats (Nesomyidae: *Cricetomys*): molecular and craniometric evidence support an unexpected high species diversity. *Zoological Journal of the Linnaean Society* 165: 700-719.

Olayemi A., A. Obadare, A. Oyeyiola , A. Fasogbon, J. Igbokwe , F. Igbahenah, D. Ortsega, S. Gunther., E. Verheyen, E. Fichet-Calvet. Under review. Small mammal diversity and dynamics within Nigeria, with emphasis on reservoirs of the Lassa virus. Systematics and biodiversity.

Olayemi A., A. Obadare, A. Oyeyiola , A. Fasogbon, J. Igbokwe , F. Igbahenah, D. Ortsega,, D. Asogun, P. Umeh, I. Vakkai , C. Abejegah, M. Pahlman, B. Becker-Ziaja, S. Gunther, E. Fichet-Calvet. 2016b. Arenavirus diversity and phylogeography of *Mastomys natalensis* rodents, Nigeria. *Emerg Infect Dis*. 22(4): 694-697.

Rosevear, D. R. 1969. The rodents of West Africa. London: British Museum (Natural History).

Taubenberger, J., C. Kash. 2010. Influenza virus evolution, host adaptation and pandemic formation. *Cell Host Microbe* 7(6): 440-451.

Acknowledgments

The author is grateful to a number of institutions which include the Lassa Fever Research Institute, Irrua Specialist Teaching Hospital, Edo State; Department of Geography, Benue

State University, Benue State; the Nigerian Montane Forest Project, Ngel-Nyaki, and the Federal Medical Centre, Jalingo, Taraba State. Others are the Royal Belgian Institute of Natural Sciences, the University of Antwerp, and the Royal Museum for Central Africa, Belgium; and also the Bernhard Nocht Institute of Tropical Medicine, Germany. The author wishes to thank research assistants, postgraduate students and technical staff at the Natural History Museum, Obafemi Awolowo University, for their assistance in carrying out a lot of the research reviewed in this article.