



Ebola evolution during the 2013-2016 outbreak

Sylvain Gandon and Sébastien Lion

CEFE, CNRS -- Montpellier, France

Correspondence to Sylvain Gandon (Sylvain.gandon@cefe.cnrs.fr)

doi: [10.24072/pci.evolbiol.100019](https://doi.org/10.24072/pci.evolbiol.100019)

Open Access

Cite as: Gandon S and Lion S. 2017. Ebola evolution during the 2013-2016 outbreak. *Peer Community in Evolutionary Biology*. 100019 doi: [10.24072/pci.evolbiol.100019](https://doi.org/10.24072/pci.evolbiol.100019)

A recommendation of

Urbanowicz RA, McClure CP, Sakuntabhai A, Sall AA, Kobinger G, Müller MA, Holmes EC, Rey FA, Simon-Loriere E, Ball JK. 2016. Human adaptation of Ebola virus during the West African outbreak. *Cell* 167: 1079-1087. doi: [10.1016/j.cell.2016.10.013](https://doi.org/10.1016/j.cell.2016.10.013)

Published: 31 March 2017

Copyright: This work is licensed under the Creative Commons Attribution-NoDerivatives 4.0 International License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nd/4.0/>

The Ebola virus (EBOV) epidemic that started in December 2013 resulted in around 28,000 cases and more than 11,000 deaths. Since the emergence of the disease in Zaire in 1976 the virus had produced a number of outbreaks in Africa but until 2013 the reported numbers of human cases had never risen above 500. Could this exceptional epidemic size be due to the spread of a human-adapted form of the virus?

The large mutation rate of the virus [1-2] may indeed introduce massive amounts of genetic variation upon which selection may act. Several earlier studies based on the accumulation of genome sequences sampled during the epidemic led to contrasting conclusions. A few studies discussed evidence of positive selection on the glycoprotein that may be linked to phenotypic variations on infectivity and/or immune evasion [3-4]. But the heterogeneity in the transmission of some lineages could also be due to environmental heterogeneity and/or stochasticity. Most studies could not rule out the null hypothesis of the absence of positive selection and human adaptation [1-2 and 5].

In a recent experimental study, Urbanowicz *et al.* [6] chose a different method to tackle this question. A phylogenetic analysis of genome sequences from viruses sampled in West Africa revealed the existence of two main lineages (one with a narrow geographic distribution in Guinea, and the other with a wider geographic distribution) distinguished by a single amino acid substitution in the glycoprotein of the virus (A82V), and of several sub-lineages characterised by additional substitutions. The authors used this phylogenetic data to generate a panel of

mutant pseudoviruses and to test their ability to infect human and fruit bat cells. These experiments revealed that specific amino acid substitutions led to higher infectivity of human cells, including A82V. This increased infectivity on human cells was associated with a decreased infectivity in fruit bat cell cultures. Since fruit bats are likely to be the reservoir of the virus, this paper indicates that human adaptation may have led to a specialization of the virus to a new host.

An accompanying paper in the same issue of *Cell* by Diehl *et al.* [7] reports results that confirm the trend identified by Urbanowicz *et al.* [6] and further indicate that the increased infectivity of A82V is specific for primate cells. Diehl *et al.* [7] also report some evidence for higher virulence of A82V in humans. In other words, the evolution of the virus may have led to higher abilities to infect and to kill its novel host. This work thus confirms the adaptive potential of RNA virus and the ability of Ebola to specialize to a novel host. In this context, the availability of an effective vaccine against the disease is particularly welcome [8].

The study of Urbanowicz *et al.* [6] is also remarkable because it illustrates the need of experimental approaches for the study of phenotypic variation when inference methods based on phylodynamics fail to extract a clear biological message. The analysis of genomic evolution is still in its infancy and there is a need for new theoretical developments to help detect more rapidly candidate mutations involved in adaptations to new environmental conditions.

References

- [1] Gire SK, Goba A., Andersen K.G., Sealfon RSG, Park DJ, Kanneh L, Jalloh S, Momoh M, Fullah M, Dudas G *et al.* 2014. Genomic surveillance elucidates Ebola virus origin and transmission during the 2014 outbreak. *Science* 345: 1369-1372. doi: [10.1126/science.1259657](https://doi.org/10.1126/science.1259657)
- [2] Hoenen T, Safronetz D, Groseth A, Wollenberg KR, Koita OA, Diarra B, Fall IS, Haidara FC, Diallo F, Sanogo M *et al.* 2015. Mutation rate and genotype variation of Ebola virus from Mali case sequences. *Science* 348: 117-119. doi: [10.1126/science.aaa5646](https://doi.org/10.1126/science.aaa5646)
- [3] Liu S-Q, Deng C-L, Yuan Z-M, Rayner S, Zhang B. 2015. Identifying the pattern of molecular evolution for Zaire ebolavirus in the 2014 outbreak in West Africa. *Infection Genetics and Evolution* 32: 51-59. doi: [10.1016/j.meegid.2015.02.024](https://doi.org/10.1016/j.meegid.2015.02.024)
- [4] Holmes EC, Dudas G, Rambaut A, Andersen KG. 2016. The evolution of Ebola virus: Insights from the 2013-2016 epidemic. *Nature* 538: 193-200. doi: [10.1038/nature19790](https://doi.org/10.1038/nature19790)
- [5] Azarian T, Lo Presti A, Giovanetti M, Cella E, Rife B, Lai A, Zehender G, Ciccozzi M, Salemi M. 2015. Impact of spatial dispersion, evolution, and selection on Ebola Zaire Virus epidemic waves. *Scientific Reports* 5: 10170. doi: [10.1038/srep10170](https://doi.org/10.1038/srep10170)
- [6] Urbanowicz RA, McClure CP, Sakuntabhai A, Sall AA, Kobinger G, Müller MA, Holmes EC, Rey FA, Simon-Loriere E, Ball JK. 2016. Human adaptation of Ebola virus during the West African outbreak. *Cell* 167: 1079-1087. doi: [10.1016/j.cell.2016.10.013](https://doi.org/10.1016/j.cell.2016.10.013)
- [7] Diehl WE, Lin AE, Grubaugh ND, Carvalho LM, Kim K, Kyawe PP, McCauley SM, Donnard E, Kucukural A, McDonel P *et al.* 2016. Ebola virus glycoprotein with increased infectivity dominated the 2013-2016 epidemic. *Cell* 167: 1088-1098. doi: [10.1016/j.cell.2016.10.014](https://doi.org/10.1016/j.cell.2016.10.014)
- [8] Henao-Restrepo AM, Camacho A, Longini IM, Watson CH, Edmunds WJ, Egger M, Carroll MW, Dean NE, Diatta I, Doumbia M *et al.* 2016. Efficacy and effectiveness of an rVSV-vectored vaccine in preventing Ebola virus disease: final results from the Guinea ring vaccination, open-label, cluster-randomised trial (Ebola Ça Suffit!). *The Lancet* 389: 505-518. doi: [10.1016/S0140-6736\(16\)32621-6](https://doi.org/10.1016/S0140-6736(16)32621-6)