Filoviridae evolution and Ebola virus outbreaks throughout human history

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Filoviridae family

The *Filoviridae* family includes non-segmented single-stranded negative-sense RNA virus. It belongs to the order *Mononegavirales* and it contains different genera and species (**Fig. 1**)[1].

Filoviruses, which case hemorrhagic fever, are zoonotic and bats seems to be their reservoir. How the virus is transmitted from the reservoir into humans is unclear, but between humans the transmission occurs through personal contact with infected people or their bodily fluids. Moreover, there is no effective treatment or vaccine available against this hemorrhagic fever, reasons why it is essential to interrupt the transmission chain.

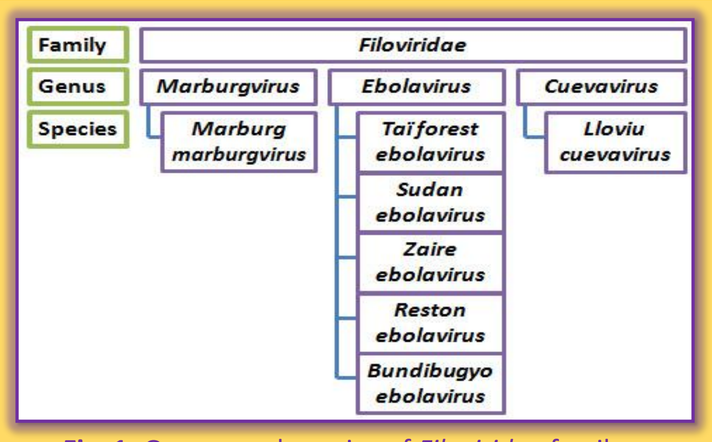

Fig. 1: Genera and species of *Filoviridae* family

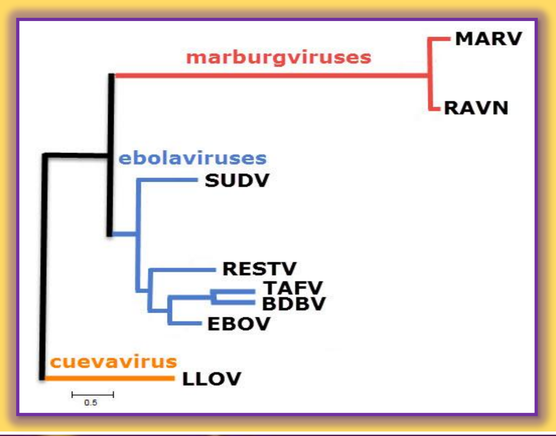

Fig. 2: Evolutionary relationship of Filovirus

Filoviridae evolution

Genetic analyses reveal that *Marburgvirus* and *Ebolavirus* genomes differ ≥50% in a nucleotide level (**Fig. 2**); quite the same to the almost equally evolutionary distance for *Cuevavirus* with them (in particular it is 56 and 51% respectively).

Despite the discussion with the classification of the viruses within the *Marburgvirus* (Marburg and Ravn virus) they are still considered members of the same specie. For *Ebolavirus* species, their genomic sequences differ between 32.2% and 42.3% from one another[2].

Ebola virus outbreaks throughout human history

Outbreaks along the recent history

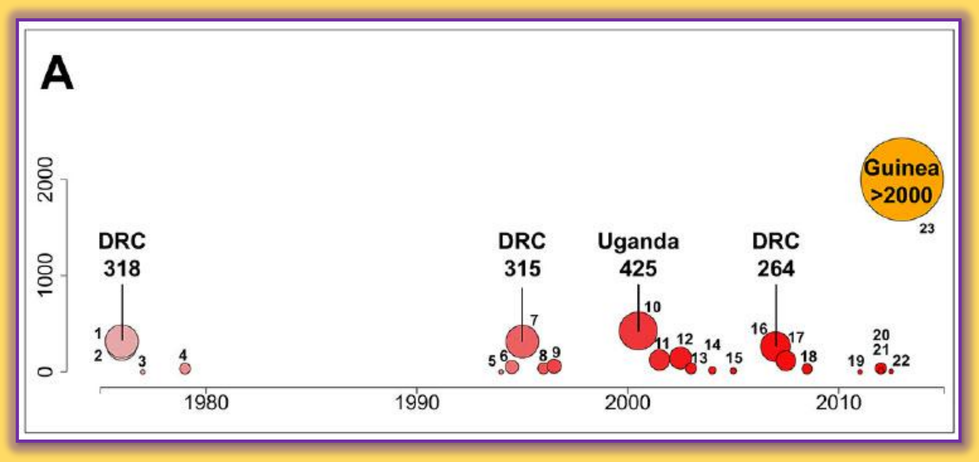

Fig. 3: Chronology and measure of the reported outbreaks of Ebola virus disease through time[3]

In a chronological way, after the first four outbreaks there is an absence of disease from 1979 to 1994 (**Fig. 3**). In contrast, the frequency of outbreaks from 1994 until nowadays is relatively high and constant, and they were mainly produced for *Zaire ebolavirus, Sudan ebolavirus* and *Bundibugyo ebolavirus* but with different fatality rate (**Table 1**). Some of them were individual infections while others were result of different waves of the same epidemic. This information, coupled with some seroprevalence studies, show an occult but permanent circulation of Ebola virus[4].

Species	*Zaire ebolavirus*	*Sudan ebolavirus*	*Reston ebolavirus*	*Taï Forest ebolavirus*	*Bundibugyo ebolavirus*
Discovered in (year)	1976	1976	1989	1994	2007
Discovered in (place)	Democratic Republic of Congo	South Sudan	Reston (USA)	Côte d'Ivoire	Uganda
Number of outbreaks	15	7	0	Single case	2
Fatality rate	74% (±14.77)	63% (±18.92)	Non-pathogenic for humans	0%	39% (±10.39)

Table 1: Outbreaks characteristics for the different *ebolavirus* species

The most important Ebola virus outbreak, the first reported in West Africa which also had some cases out of this continent, started in December 2013. It was produced by a *Zaire ebolavirus* 97% similar to a previously reported one, and it had cause more deaths itself that all the previous outbreaks together.
Despite that it is still ongoing, on May 9, Liberia was declared free of virus and it seems that the cases in Guinea and Sierra Leone are going down. Nevertheless, surveillance has to keep going to avoid an unexpected upturn of the disease[5].

Mapping Ebola virus outbreaks and areas at risk

With the exception of *Reston ebolavirus* (only found in Philippines, Asia), Africa seems the continent of origin of *Ebolavirus.*
The locations of the outbreaks (**Fig. 4**) have been seriously studied in order to predict risk regions of Ebola virus outbreaks. There are large geographic areas (mainly in the rainforest in West and Central Africa) with the right environmental conditions for the *Ebolavirus* reservoir, and consequently there are susceptible of zoonotic transmission (**Fig. 5**).
Moreover, all the countries where there have been an index case are in areas of high probability of finding bats, although there are also countries in these regions without index cases reported until the moment (**Fig. 5**)[3].

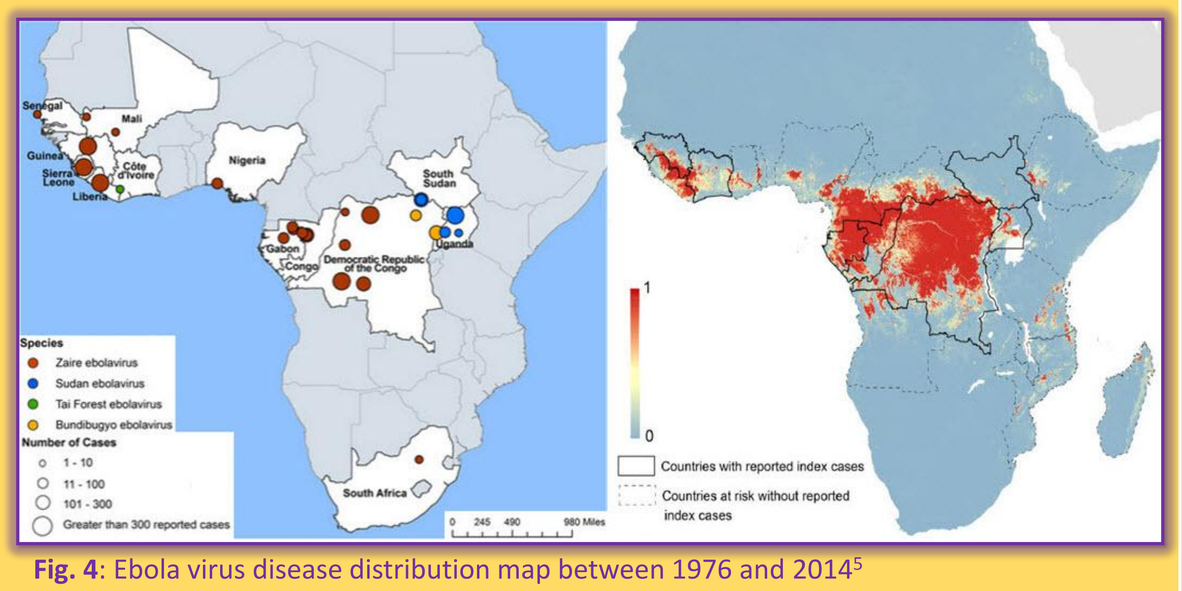

Fig. 4: Ebola virus disease distribution map between 1976 and 2014[5]
Fig. 5: Predicted geographical distribution of zoonotic Ebola virus[3]

Weather influence to the outbreaks

There have been observed seasonal variations in outbreaks in relationship with moderate temperature and wet conditions.
Some studies in bats have shown a high seropositivity rate in adults and pregnant females, suggesting that the mating and fighting (more frequent in rainy seasons) increase the virus transmission and consequently human infections[6].

Conclusions

- Ebola virus is an emerging virus well characterized and studied.
- Although the several outbreaks it has produced, we are not ready to confront it, more information, some treatment and a vaccine, between others, are needed.
- It has been demonstrated constant circulation of the virus among the population.
- In order to predict possible *Ebolavirus* outbreaks in the future, it is necessary to combine the distribution map of its reservoir with the weather conditions.

Bibliography

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