Mosquito-Associated Viruses in West Africa

Subjects: Virology
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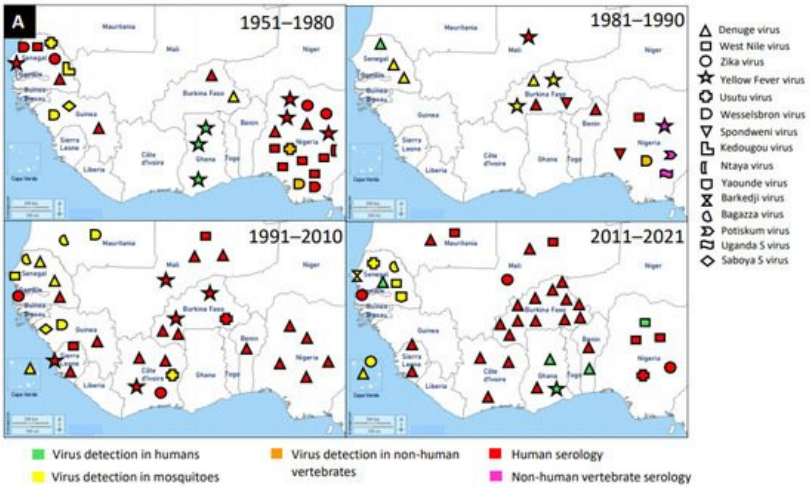
A cumulative number of MAVs are being discovered in hematophagous arthropods all over the world. There is a potential impact on the fitness and competence of the vector. Therefore, more research is needed to expand the knowledge about their prevalence, distribution, and diversity. The trend of MAVs reported in the literature enlightens how researches about MAVs are on the increase. The past decades have shown a dramatic surge in the literature recounting novel MSVs and classical arboviruses. The increase in research interest has provided new understanding about viral diversity and evolution. Finally, the new viruses discovered have created curiosity in their use as potential biological control agents.

Keywords: Mosquito-Associated Viruses

1. Flaviridae

Flaviviruses are enveloped, spherical, and about 50 nm in diameter. The surface proteins of the viral capsid are arranged in an icosahedral-like symmetry. They have a monopartite, linear, ssRNA(+) genome of about 9.7–12 kb [1]. These viruses can be divided into three main groups: those that are maintained in an arthropod–vertebrate cycle and strictly depend on each other are called dual-host flaviviruses [2]; those that are limited to vertebrates with an unknown arthropod relationship are known as vertebrate-specific flavivirus [3]; and those that replicate only in insect cell lines are termed insect-specific flaviviruses [2][4][5]. Flaviviruses and flavivirus-specific antibodies detected in West Africa are shown in Figure 1.



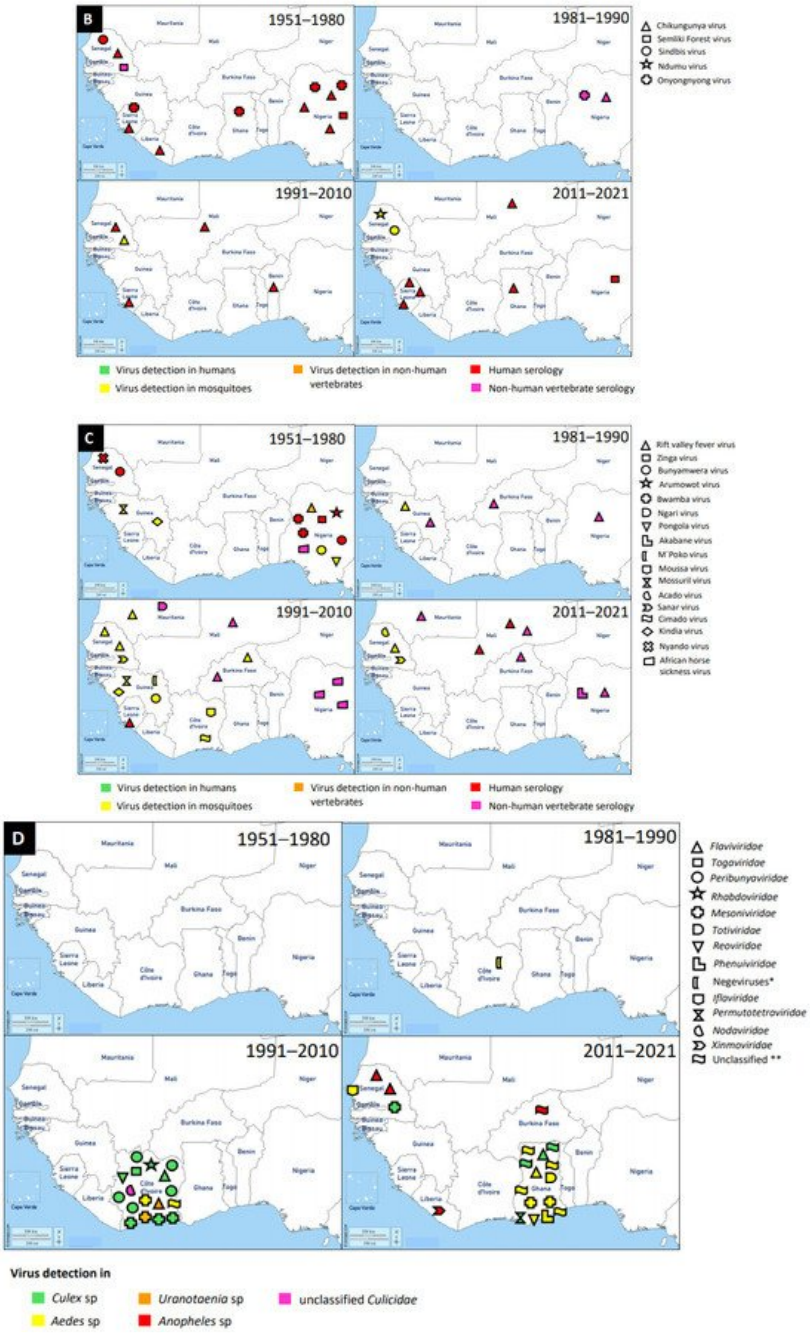


Figure 1. Distribution of MAVs in West Africa. A–C Mosquito-borne viruses (**A**) Flaviviridae; (**B**) Togaviridae; (**C**) Peribunyaviridae, Rhabdoviridae and Reoviridae; (**D**) Mosquito-specific viruses. Location of the signs in the country was chosen randomly and does not refer to the location where the study was performed; * = Proposed taxon; ** = Unclassified viruses.

The application of next generation sequencing (NGS) techniques in virus discovery has led to the identification and isolation of numerous MSVs [6]. West Africa is not left out in this discovery, and MAVs known to cause outbreaks and those which are not associated with human infections are outlined in Table 1. The first mosquito-specific flavivirus isolated was cell fusing agent virus (CFAV) in 1975 [7], but this virus was never identified in West Africa until 2016 in Ghana [8]. CFAV was isolated from mosquitoes collected via a mosquito surveillance field work from 2015 to 2016 in Ghana. Examples of other MSVs identified in West Africa include: Nounane virus and Nienokoue virus (Côte d'Ivoire); Anopheles flavivirus-like virus and Barkedji virus (Senegal); and Culex flavivirus (Ghana) [9][10][8][11][12]. Nounane and Nienokoue viruses were identified in Tai National Park, a tropical rainforest zone, from the *Culex* and *Uranotaenia* mosquitoes respectively [11][12].

Table 1. Mosquito-associated viruses (MAVs) discovered in West Africa from 1951–2021.

Family	Name of Virus	Year of Virus Detection	Country	Source of Virus Detection	Reference
Flaviviridae			**Mosquito-borne viruses**		

Family	Name of Virus	Year of Virus Detection	Country	Source of Virus Detection	Reference
	Dengue	2009	Cape Verde	*Aedes aegypti*	[13]
		2014/15	Cape Verde	*Ae. aegypti*	[14]
		2016/17	Ghana	Serology/Human	[15]
		2016/17	Ghana	Human	[16]
		2014/2016	Ghana	Serology/Human	[17]
		1974	Senegal	*Ae. luteocephalus*, Serology/Human	[18]
		1983	Senegal	Human	[19]
		1990	Senegal	*Aedes* sp	[20]
		2015/19	Senegal	Human	[21]
		1999	Senegal	*Aedes* sp	[22]
		2009/10	Senegal	*Ae. aegypti,* Serology/Human	[23]
		1964	Nigeria	Serology/Human	[24]
		1975	Nigeria	Serology/Human	[25]
		2001	Nigeria	Serology/Human	[26]
		2010 *	Nigeria	Serology/Human	[27]
		2011	Nigeria	Serology/Human	[28]
		2013 *	Nigeria	Serology/Human	[29]
		2014 *	Nigeria	Serology/Human	[30]
		1987/93	Benin	Serology/Human	[31]
		2010	Benin	Serology/Human	[32]
		2019	Benin	Serology/Human; Human	[33]
		2015	Mauritania	Serology/Human	[34]
		2017	Burkina Faso	Serology/Human	[35]
		2016	Burkina Faso	Serology/Human	[36]
		2019	Burkina Faso	Serology/Human	[37]
		1980	Burkina Faso	*Aedes* sp	[38]
		1983/86	Burkina Faso	*Aedes* sp	[39]
		2013/14	Burkina Faso	Serology/Human	[40]
		2015/17	Burkina Faso	Serology/Human	[41]
		2014	Burkina Faso	Serology/Human	[42]
		2016/17	Burkina Faso	Serology/Human	[43]
		2016	Burkina Faso	Serology/Human	[44]

Family	Name of Virus	Year of Virus Detection	Country	Source of Virus Detection	Reference
		1982	Burkina Faso	Serology/Human	[45]
		2004	Burkina Faso	Serology/Human	[46]
		2016	Burkina Faso	Serology/Human	[47]
		2013/14	Burkina Faso	Serology/Human	[48]
		2017	Burkina Faso	Serology/Human	[35]
		2003/4	Burkina Faso	Serology/Human	[49]
		2016	Burkina Faso	Serology/Human	[50]
		2009/13	Mali	Serology/Human	[51]
		2006	Mali	Serology/Human	[52]
		1999	Côte d'Ivoire	Mosquitoes, Serology/Human	[53]
		2010	Côte d'Ivoire	Serology/Human, Human	[54]
		2011/12	Côte d'Ivoire	Serology/Human, Human	[55]
		2017	Côte d'Ivoire	Serology/Human, Human	[56]
		2019	Côte d'Ivoire	Serology/Human	[57]
	Dengue	1978/91	Guinea	Mosquitoes	[58]
		2006/8	Sierra Leone	Serology/Human	[59]
		2016 *	Sierra Leone	Serology/Human	[60]
		2012/13	Sierra Leone	Serology/Human	[61]
	West Nile	2012/13	Senegal	*Culex* sp, *Aedes* sp	[62]
		1972/75	Senegal	Serology/Human	[63]
		1998/99	Senegal	*Masonia uniformis*	[64]
		1951/55	Nigeria	Serology/Human	[65]
		1968/69	Nigeria	Serology/human	[66]
		1963	Nigeria	Serology/Human	[67]
		1975	Nigeria	Serology/Human	[68]
		1987	Nigeria	Serology/Horses	[69]
		2011/12	Nigeria	Serology/Horses	[70]
		2018	Nigeria	Human	[71]
		2015	Mauritania	Serology/Human	[34]
		2009/13	Mali	Serology/Human	[51]

Family	Name of Virus	Year of Virus Detection	Country	Source of Virus Detection	Reference
		2006/8	Sierra Leone	Serology/Human	[59]
	Zika	2016	Cape Verde	*Ae. aegytpi*	[72]
		2016	Mali	Serology/Human	[73]
		1972/75	Senegal	Serology/Human	[63]
		1999	Côte d'Ivoire	Mosquitoes, Serology/Human	[53]
		2010/14	Gambia	Serology	[74]
		1975 *	Nigeria	Serology	[25]
		1951/55	Nigeria	Serology/Human	[65]
		2018	Nigeria	Serology	[71]
	Yellow Fever	1989	Nigeria	Serology/horses	[69]
		1951/55	Nigeria	Serology/Human	[65]
		1968/69	Nigeria	Serology/Human	[66]
		1975	Nigeria	Serology/Human	[68]
		1972/75	Senegal	Serology/Human	[63]
		1976	Senegal	*Aedes* sp	[75]
		2003/8	Burkina Faso	Serology/Human	[76]
		1983/86	Burkina Faso	*Aedes* sp	[39]
		1983	Burkina Faso	*Aedes* sp	[77]
		1999	Burkina Faso	Serology/Human	[78]
		1987	Mali	Serology/Human	[79]
		2006	Mali	Serology/Human	[52]
		1999	Côte d'Ivoire	Mosquitoes, Serology/Human	[53]
		2006/09	Sierra Leone	Serology/Human	[59]
		1977/80	Ghana	Human	[80]
		1963	Ghana	Human	[80]
		1969/70	Ghana	Human	[80]
		2011	Ghana	Human	[81]
	Usutu	2012/13	Senegal	*Culex* sp	[62]
		1972/1977	Senegal	*Aedes* sp	[82]
		1972	Nigeria	*Turdus libonyanus*	[83]
		2018	Nigeria	Serology/Human	[71]
		2004	Burkina Faso	Serology/Human	[83]
		2004	Côte d'Ivoire	*Culex quinquefasciatus*	[83]

Family	Name of Virus	Year of Virus Detection	Country	Source of Virus Detection	Reference
	Wesselsbron	1972/75	Senegal	Serology/Human	[63]
		1971 *	Nigeria	Serology/Horse	[84]
		1975	Nigeria	Serology/Human	[68]
		1989 *	Nigeria	Serology/Horse	[69]
		1998	Mauritania	*Aedes vexans*	[64]
		1978/91	Guinea	Mosquitoes	[58]
	Spondweni	1982 *	Burkina Faso	Serology/Human	[85]
	Kedougou	1978 *	Senegal	*Aedes* sp	[86]
	Ntaya	1977	Nigeria	Serology/Human	[87]
	Yaounde	2012/13	Senegal	*Culex* sp	[62]
	Bagazza	2012/13	Senegal	*Culex* sp	[62]
		1998/99	Senegal	*Aedes fowleri*	[64]
		1998/99	Mauritania	*Culex neavei*	[64]
	Barkedji	2012/13	Senegal	*Culex* sp, *Aedes* sp	[62]
	Potiskum	1989 *	Nigeria	Serology/Horses	[69]
	Uganda S	1989 *	Nigeria	Serology/Horses	[69]
	Saboya	1978/91	Guinea	Mosquitoes	[58]
Togaviridae					
	Chikungunya	1963	Nigeria	*Aedes* sp	[88]
		1969	Nigeria	Serology/Human	[89]
		1968/69	Nigeria	Serology/Human	[66]
		1989 *	Nigeria	Serology/Horse	[69]
		1974	Nigeria	Serology/Human	[90]
		2009/10	Senegal	Serology, *Aedes* sp	[91]
		1972/75	Senegal	Serology/Human	[63]
		2016/17	Ghana	Serology/Human	[15]
		2006	Benin	Serology/Human	[92]
		2009/13	Mali	Serology/Human	[51]
Togaviridae					
	Chikungunya	2012/13	Sierra Leone	Serology/Human	[93]
		2016/17	Sierra Leone	Serology/Human	[94]
		2006/8	Sierra Leone	Serology/Human	[59]
		2012/13	Sierra Leone	Serology/Human	[61]
		1975/77	Sierra Leone	Serology/Human	[87]
		1977	Liberia	Serology/Human	[87]

Family	Name of Virus	Year of Virus Detection	Country	Source of Virus Detection	Reference
	Semliki Forest	1971	Senegal	Serology/Horses	[95]
		1951/55	Nigeria	Serology/Human	[65]
		2014 *	Nigeria	Serology/Human	[96]
	Sindbis	2012/13	Senegal	*Culex* sp	[62]
		1972/75	Senegal	Serology	[63]
	Ndumu	2012/13	Senegal	Several mosquitoes	[63]
	Onyongnyong	1989 *	Nigeria	Serology/Horses	[69]
		1974	Nigeria	Serology/Human	[87]
		1975	Nigeria	Serology/Human	[87]
		1954	Ghana	Serology/Human	[87]
		1975/77	Sierra Leone	Serology/Human	[87]
Phenuiviridae					
	Rift Valley fever	1993/96	Burkina Faso	*Aedes* sp	[39]
		1987	Burkina Faso	Serology/Sheep	[97]
		2005/7	Burkina Faso	Serology/livestock	[98]
		1985/87	Burkina Faso	Serology/livestock	[99]
		2006/8	Sierra Leone	Serology/Human	[59]
		1987 *	Guinea	Serology/Bats	[100]
		1978/91	Guinea	Mosquitoes	[58]
		2016	Mali	Serology/Human	[101]
		2015	Mali	Serology/Human	[102]
		2005/14	Mali	Serology/Bovine	[103]
		2016	Niger	Serology/Human/ Livestock	[104]
		1959	Nigeria	Serology/Sheep	[105]
		2016	Nigeria	Serology/Camels	[106]
		1989	Nigeria	Seroloy/Horses	[69]
		1998	Senegal	*Culex* sp, Serology	[107]
		2012/13	Senegal	*Aedes ochraceus*	[62]
		1998/99	Senegal	*Culex poicilipes*	[64]
		1998	Mauritania	*Culex poicilipes*	[64]
		2015	Mauritania	Serology/Human	[34]
Peribunyaviridae					
	Zinga	1975/1977	Nigeria	Serology/Human	[87]
	Bunyamwera	1978 *	Senegal	Serology/Human	[63]
		1951/55	Nigeria	Serology/Human	[65]

Family	Name of Virus	Year of Virus Detection	Country	Source of Virus Detection	Reference
		1963	Nigeria	*M. africana*	[88]
		1978/91	Guinea	Mosquitoes	[58]
	Arumowot	1968/69	Nigeria	Serology/Human	[66]
	Bwamba	1969/72	Nigeria	Serology/Human	[108]
		1951/55	Nigeria	Serology/Human	[65]
	Ngari	2010	Mauritania	Serology/Goat	[109]
	Nyando	1972 *	Senegal	Serology/Human	[110]
	Pongola	1963	Nigeria	*M. africana*	[88]
	Akabane	2015	Nigeria	Serology/Livestock	[111]
	M'Poko	1978/91	Guinea	Mosquitoes	[58]
Rhabdoviridae					
	Mossuril	1978/91	Guinea	Mosquitoes	[58]
Reoviridae					
	Acado	2012/13	Senegal	*Culex sp*	[62]
	Sanar	2012/13	Senegal	*Culex neavei, M. uniformis*	[62]
		1998/99	Senegal	*Culex poicilipes*	[64]
	Kindia	1978/91	Guinea	Mosquitoes	[58]
	African horse sickeness	1971 *	Nigeria	Serology/Horse	[84]
		1993 *	Nigeria	Serology/Camels/Donkey/ Dogs/Horses	[112]
		1993 *	Nigeria	Serology/Horse	[113]
		1995 *	Nigeria	Serology/Horse	[114]
Flaviviridae			Mosquito-specific viruses		
	Culex flavivirus	2016	Ghana	*Culex* sp	[115]
	Cell fusing agent virus	2016	Ghana	*Aedes aegypti*	[115]
	Anopheles flavivirus-like 2	2012	Senegal	*Anopheles* sp	[116]
	Anopheles flavivirus-like 1	2012	Senegal	*Anopheles* sp	[116]
	Nienokoue	2004	Côte d'Ivoire	*Culex* species mosquitoes	[117]
	Nounane	2004	Côte d'Ivoire	*Uranotaenia mashonaensis*	[118]
Togaviridae					
	Taï Forest alphavirus	2004	Côte d'Ivoire	*Culex decens*	[119]
Peribunyaviridae					
	Ferak	2004	Côte d'Ivoire	*Culex decens*	[120]
	Jonchet	2004	Côte d'Ivoire	*Culex* sp	[120]
	Herbert	2004	Côte d'Ivoire	*Culex nebulosus*	[121]

Family	Name of Virus	Year of Virus Detection	Country	Source of Virus Detection	Reference
	Tai	2004	Côte d'Ivoire	*Culex* sp	[121]
Rhabdoviridae					
	Moussa	2004	Côte d'Ivoire	*Culex decens*	[122]
Mesoniviridae					
	Odorna	2016	Ghana	*Aedes aegypti*	[115]
	Dianke	2013	Senegal	*Culex poicilipes*	[123]
	Cavally	2016	Ghana	*Aedes aegypti*	[115]
	Cavally	2004	Côte d'Ivoire	*Aedes harrisoni*	[124]
	Nse	2004	Côte d'Ivoire	*Culex nebulosus*	[125]
	Meno	2004	Côte d'Ivoire	*Uranotaenia chorleyi*	[125]
	Hana	2004	Côte d'Ivoire	*Culex* sp	[125]
	Moumo	2004	Côte d'Ivoire	*Culex* sp	[125]
Totiviridae					
	Aedes aegypti totivirus	2016	Ghana	*Aedes aegypti*	[115]
Reoviridae					
	Aedes pseudoscutellaris reovirus	2015	Ghana	*Aedes aegypti*	[115]
	Cimodo	2008	Côte d'Ivoire	*Culex nebulosus*	[126]
Phenuiviridae					
	Phasi Charoen-like phasivirus	2016	Ghana	*Aedes aegypti*	[115]
	Gouleako	2004	Côte d'Ivoire	*Culex* sp	[127]
Negeviruses **					
	Dezidougou	1984	Côte d'Ivoire	*Aedes aegypti*	[128]
Iflaviridae					
	Aedes vexans iflavirus	2017	Senegal	*Aedes vexans*	[129]
Permutotetraviridae					
	Culex permutotetra-like virus	2016	Ghana	*Culex* sp	[115]
Nodaviridae					
	Mosinovirus	2004	Côte d'Ivoire	*Culicidae*	[130]
Xinmoviridae					
	Bolahun virus variant 2	2012/15	Liberia	*Anopheles gambiae*	[116]
Unclassified ***					

Family	Name of Virus	Year of Virus Detection	Country	Source of Virus Detection	Reference
Unclassified Riboviria	**Bolahun virus variant 1**	**2012/15**	**Burkina Faso**	***Anopheles gambiae***	[116]
Unclassified Riboviria	**Aedes aegypti virga-like virus**	**2016**	**Ghana**	***Aedes aegypti***	[115]
Unclassified Riboviria	**West Accra**	**2015**	**Ghana**	***Aedes aegypti***	[115]
Unclassified Riboviria	**Mole Culex**	**2016**	**Ghana**	***Culex* sp**	[115]
Unclassified Riboviria	**Goutanap**	**2004**	**Côte d'Ivoire**	***Culex nebulosus***	[131]
Unclassified Riboviria	**Goutanap**	**2016**	**Ghana**	***Culex* sp**	[115]
Unclassified Riboviria	**Tesano Aedes**	**2016**	**Ghana**	***Aedes aegypti***	[115]
Unclassified Riboviria	**Korle-bu Aedes**	**2016**	**Ghana**	***Aedes aegypti***	[115]

* = Year of research publication used; ** = Proposed taxon [128]; *** = Unclassified viruses; Year/Year = Study period.

The presence of flaviviruses in West Africa is not limited to MSVs, but also medically important MBVs, such as DENV, WNV, ZIKV, YFV, and Usutu virus (USUV). McNamara et al. seem to provide the first report on mosquito-borne flaviviruses, including YFV, WNV, ZIKV, and Uganda S virus in the 1950s [116]. West Africa has experienced several outbreaks of DENV and it is the main MBV circulating in the human population and posed a major public health threat. It is likely that the first detection of DENV in West Africa was in Ibadan, Nigeria in 1964 from febrile patients [132]. However, the most recent outbreak of DENV was reported in Ouagadougou, Burkina Faso in 2017 [133]. In addition to DENV outbreaks in Burkina Faso, there were reports in other countries, such as Nigeria, Côte d'Ivoire, Senegal, Sierra Leone, Benin, Mali, Cape Verde, Ghana, Mauritania, and Guinea in a decreasing order of incidence. Therefore, Burkina Faso had several DENV reports unlike other West African countries. The main vectors for DENV are *Aedes* mosquitoes (mainly *Aedes aegypti*) through which DENV is transmitted to humans (amplifying host). DENV was mainly detected via serological investigations in humans, although *Ae. aegypti* mosquitoes were also documented as a source of detection.

2. Togaviridae

Members of this family are enveloped, spherical, icosahedral, and 65–70 nm in diameter. They have a capsid with icosahedral symmetry made of 240 monomers. Additionally, they have a monopartite, linear, ssRNA(+) genome of 9.7–11.8 kb [134]. Alphaviruses are mostly transmitted by mosquito vectors and they have amplifying vertebrate hosts. Acute infections in vertebrates are characterised by a high titer of the virus making it possible for mosquitoes to be infected in the course of blood feeding [135].

Tai Forest alphavirus (TFAV), Eilat virus (EILV), Agua Salud alphavirus (ASALV), and Mwinilunga alphavirus (MWAV) are the main mosquito-specific members of this family [136][137]. However, only TFAV was identified and isolated in West Africa. TFAV was isolated from *Culex decens* mosquitoes collected in 2004 in Côte d'Ivoire [136]. TFAV has a relationship with western equine encephalitis virus complex through phylogenetic analyses [136].

Medically important mosquito-borne alphaviruses that are emerging public health threats include Venezuelan (VEEV) and eastern (EEEV) equine encephalitis viruses, and CHIKV. These viruses can cause outbreaks of severe meningoencephalitis with frequent lethal consequences, or polyarthritis with agonizing and chronic joint pain [135]. Likely, the first epidemic of CHIKV in West Africa occurred in 1969 in Ibadan, Nigeria [138]. It is probable that the virus was first isolated from *Aedes* mosquitoes (*Ae. aegypti*, *Ae. grahami*, and *Ae. taylori*) collected in 1963 in Lagos, Nigeria, and serological survey revealed antibodies in the sera of study participants [139]. The recent detection of CHIKV in West Africa occurred between 2016 and 2017 in Sierra Leone and this was via Ion Torrent semiconductor sequencing to profile pathogen spectrum in archived human yellow fever virus-negative sera [140]. A broader spectrum of pathogens was suggested by the distribution of sequencing reads and must be considered in clinical diagnostics and epidemiological

surveillance [140]. Until now, a greater number of cases of CHIKV were reported in Sierra Leone, Nigeria, and Senegal, compared to the very few cases in Ghana, Benin, Mali, and Liberia. In general, CHIKV was mainly detected by serology in humans, although there were a few *Aedes* mosquito detections.

3. Peribunyaviridae

These viruses are enveloped, spherical, or pleomorphic virions 80–120 nm in diameter. They have a segmented, linear ssRNA(-) genome, with L segment between 6.8 and 12 kb, M segment between 3.2 and 4.9, and S segment between 1 and 3 kb [141]. This is a newly established family which includes four genera for globally distributed viruses: Orthobunyavirus, Herbevirus, Pacuvirus, and Shangavirus. Mostly, peribunyaviruses are maintained in a vertebrate–arthropod transmission cycle [142].

The mosquito-specific members of the family include Ferak virus, Jonchet virus, Herbert virus, and Tai virus. Interestingly, all these MSVs were identified in Côte d'Ivoire [143][144][145]. These viruses were identified via a mosquito surveillance study, where mosquitoes were trapped from February to June 2004 in Taï National Park, Côte d'Ivoire [146]. The mosquito samples were further analysed to identify and isolate these viruses [143][144][145]. However, the viruses were mainly isolated from *Culex* mosquitoes.

The mosquito-borne members of the *Peribunyaviridae* include Zinga virus, Bunyamwera virus, Arumowot virus, Bwamba virus, Ngari virus, Nyando virus, Pangola virus, Akabane virus, and M'poko virus [147][148]. Bunyamwera virus is the prominent MBV of this family. Bunyamwera virus was first detected in 1963 in West Africa, Nigeria, from *Mansonia africana* mosquitoes [149]. The virus was also reported to be detected in humans and mosquitoes in Senegal and Guinea respectively [150][116].

4. Other Virus Families

An increasing number of MAVs, especially the mosquito-specific ones, are distributed globally. MAVs were also classified under the following virus families: *Rhabdoviridae, Mesoniviridae, Totiviridae, Reoviridae, Phenuiviridae, Permutotetraviridae, Iflaviridae*, *Xinmoviridae, Nodaviridae*, and Negeviruses (proposed taxon). The latest mosquito-specific mesonivirus is Dianke virus, which was isolated from mosquitoes in Eastern Senegal [151]. Interestingly, Dianke virus was identified in different species of mosquitoes, including *Aedes* sp, *Culex* sp, *Mansonia* sp, and *Uranotaenia* sp. This explains why mesoniviruses are said to have a broad host range and geographical distribution. Another recent and novel mosquito-specific iflavirus isolated from *Aedes vexans* mosquitoes in Senegal is Aedes vexans iflavirus [3]. *Ae. vexans* mosquito is a competent vector of numerous MBVs, such as RVFV and ZIKV. Therefore, it is possible that Aedes vexans iflavirus could interfere with the replication and transmission potentials of RVFV and ZIKV. This review therefore suggests studies involving the interaction of MSVs with MBVs to answer the search for a probable biological vector control tool against arboviruses.

The medically important mosquito-borne member of the family *Phenuiviridae*, with several reports, is the RVFV. RVFV was reported in Burkina Faso, Sierra Leone, Guinea, Mali, Nigeria, Senegal, and Mauritania. It is likely that the first report of RVFV was in 1959 in Nigeria [13]. However, the latest RVFV case was detected in 2016 in Mali, Niger, and Nigeria [14][15][16], and this is the first occurrence of RVFV in Niger. RVFV was detected in culicine mosquitoes and serological investigations in humans, bats, livestock, horses, and camels.

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