

Review

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## Review

# Mosquito-Borne Arboviruses Occurrence and Distribution in the Last Three Decades in Central Africa: A Systematic Literature Review

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**Abstract:** Arboviruses represents a real public health problem globally and in the Central African subregion in particular that represents a high risk zone for the emergence and re-emergence of arboviruses outbreaks. Furthermore, an updated review on the current arboviruses burden and associated mosquito vectors is lacking for this region. To contribute in filling this knowledge gap, the current study was designed with following objectives: (i) to systematically review data on the occurrence and distribution of arboviruses and mosquito fauna and (ii) to identify potential spillover mosquito species in Central African region in the last 30 years. Web search enabled the documentation of 2454 articles from different online databases. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and The Quality of Reporting of Meta-analyses (QUORUM) steps for a systematic review enabled the selection of 164 articles that fulfilled our selection criteria. Of the six arboviruses (Dengue Virus (DENV), Chikungunya Virus (CHIKV), Yellow Fever Virus (YFV), Zika Virus (ZIKV), Rift Valley Fever Virus (RVFV), and West Nile Virus (WNV)) of public health concern studied, the most frequently reported were Chikungunya and Dengue. The entomological records showed >248 species of mosquitoes and regrouped under 15 genera with *Anopheles* (n= 100 species), *Culex* (n= 56 species) and *Aedes* (n=52 species) having high species diversity. Three genera were rarely represented with only one species and included: *Orthopodomyia*, *Lutzia*, and *Verrallina*, but individuals of the genera *Toxorhynchites* and *Finlayas* were not identified upto the species level. We found that two *Aedes* species (*Ae. aegypti* and *Ae. albopictus*) colonised the same microhabitat and were involved in major epidemics of the six medically important arboviruses and other less frequently identified mosquito-genera consisted of competent species and were associated with outbreaks of medical and zoonotic arboviruses. The present study reveals high species richness of competent mosquito-vectors that could lead to the spillover of medically important arboviruses in the region. Although epidemiological studies were found, they were not regularly documented and this also applies to vector competence and transmission studies. Future studies will consider unpublished information in dissertations, technical reports from different countries to enable it more consistent. A regional project entitled: Ecology of Arboviruses (EcoVir) is underway in three countries (Gabon, Benin and Cote d'Ivoire) to generate a more comprehensive epidemiological and entomological data on this topic.

**Keywords:** arboviruses; mosquitoes; epidemics; transmission; Central Africa

## 1. Introduction

Mosquito-borne arboviruses are viruses that are transmitted by mosquitoes [1]. Arboviruses are maintained in nature by a cycle of biological transmission between a susceptible host and blood feeding arthropods [2]. The clinical symptoms range from a mild febrile state to severe forms accompanied by haemorrhagic shock or encephalitis [3]. Arboviruses cause mortality rate of 50% and an estimated 200,000 cases and 30,000 deaths each year and Yellow Fever (YF) alone is of major public health concern [4]. In addition to YF, dengue (DENV) accounts for over 390 million infections per year [5]. Others such as CHIKV, ZIKV, RVFV, and WNV have also caused epidemics in Central Africa [6] and are also considered as arboviruses of major public health concern in this region [7].

Landscape modifications and climate change as a result of an upsurge in anthropic activities over time in the tropics have modified the natural life cycle and occurrence of major arboviruses and their vectors [8]. It appears that tropical species are now invading temperate zones, leading to the emergence of arboviruses that were only confined to well defined regions of the globe. There are more than 3600 species of mosquitoes of the family Culicidae that occurs globally [9]. In the Central African Region, two major invasive arboviruses vectors (*Ae. aegypti* and *Ae. albopictus*) have been frequently reported and in some countries of this region, they are main drivers of arboviruses spillovers [10].

Although arboviruses and its vectors represents a real public health danger in endemic settings, they are still a neglected topic and limited studies have been reported to present updated information on it for the Central African Region. To fill this knowledge gap, the present study aimed to conduct a systematic literature review to update on the occurrence and distribution of arboviruses of major public health concern and associated spillover vectors in Central African region in the last 30 years to guide control and identify avenues for future studies.

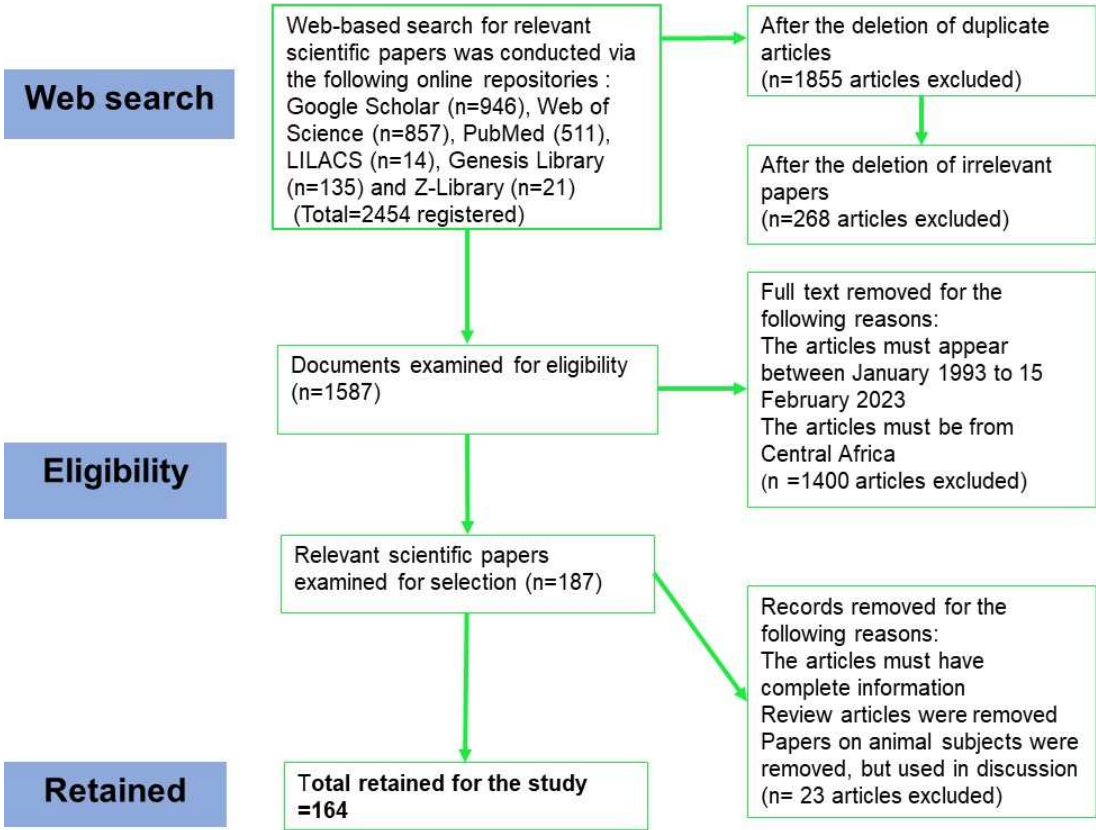
## 2. Materials and Methods

### 2.1. The study region

The present study was conducted in eight countries (Angola, Cameroon, Chad, Central African Republic, Democratic Republic of Congo, Equatorial Guinea, Gabon, and Republic of the Congo) of the Central African region. This region is located in the heart of the African continent. Central Africa is home for the second largest tropical rainforest in the world with annual rainfall that ranges from 100-400 mm per year in the Sahel and over 1600 mm in the tropical rainforests. This ecosystem promotes the survival and proliferation of mosquitoes [1] and the propagation of the diseases they harbour.

### 2.2. Literature search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [11] and The Quality of Reporting of Meta-analyses (QUORUM) [12] criteria were applied in paper selection (Figure 1). The search for article was conducted in the following database: Google Scholar, Web of Science, PubMed, LILACS, Genesis Library and Z-Library. The following combinations of search keywords were used: "Gabon" OR "Cameroon" OR "Cameroun" OR "Belgian Congo" OR "Democratic Republic of the Congo" OR "Zaire", "Republic du Congo" OR "Republic of the Congo" OR "Angola" OR "Tchad" OR "Chad", "Republic Centre Afrique" OR "Central African Republic" OR "Guinée Equatoriale" OR "Equatorial Guinea", AND ("Mosquitoes" OR "mosquito-borne virus" OR "arbovirus" OR "arthropod-borne virus" OR "yellow fever" OR "chikungunya" OR "dengue" OR "Rift Valley Fever virus" OR "West Nile virus" OR "Zika" OR "alphavirus" OR "flavivirus" OR "bunyavirus"). Additional information was searched from the World Health Organization (WHO) (<http://www.who.int>) and Centers for Disease Control and Prevention (CDC) ([www.ecdc.europa.eu](http://www.ecdc.europa.eu)) databases.



**Figure 1.** Flow chart of the steps in the reviewing process.

2.3. Inclusion and exclusion criteria

All the papers collected were screened following the relatedness to the topics of the study and the inclusion/exclusion criteria were defined by consensus. The inclusion criteria were: (i) studies conducted in Central Africa, (ii) references from review articles enabled the obtention of more relevant papers. The exclusion criteria were: (i) arboviruses detected in animals were not considered but were used in the discussion, (ii) incomplete information such as articles with only abstract with no relevant information, (iii) studies conducted outside central Africa and reports published before 1993.

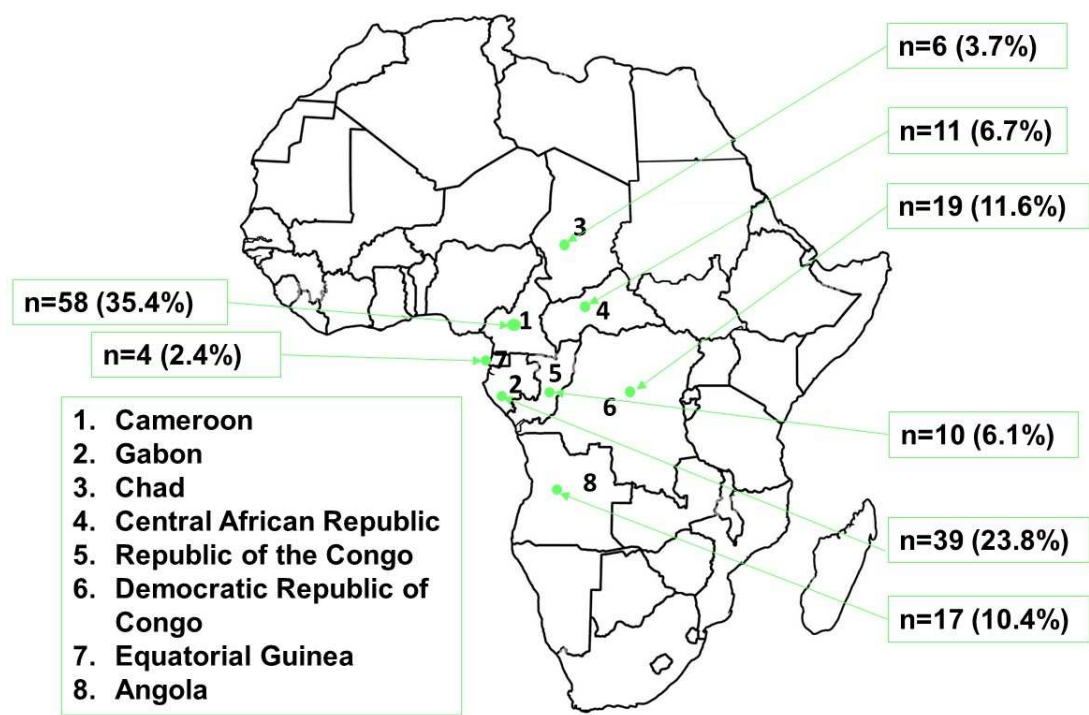
3. Results and Discussion

3.1. Papers selected for the review

The internet search resulted in the collection of 2454 papers and only 164 responded to the stipulated selection criteria (Figure 1). A complete database was created for the 164 relevant articles selected for this study (Supplementary file 1).

3.2. Papers retained by country

The current study found that the majority of the papers available online on arboviruses and vectors are from Cameroon (58 (35.4%)) followed by Gabon (39 (23.8%)) and the least number recorded was from Equatorial Guinea (4 (2.4%)). The details on the distribution of the number of papers published within the study period by country can be found in Figure 2.



**Figure 2.** Number of articles retained by country from 1993 to 2023.

3.3. *The periodic trend in publication of epidemiological and entomological data by country*

The number of relevant scientific papers on arboviruses and vectors published for the Central African Region has improved for some countries and still remain scant for others. We made a graphical presentation of the situation by country and we found for Cameroon that more papers appeared online between 2019 and 2022 with higher entomological studies than epidemiological and both (Figure 3). In Gabon, more publications appeared online between 2020 and 2021 and dominated by entomological studies (Figure 3). In the Democratic Republic of Congo (DRC), more papers were published between 2018 and 2021 and rather dominated by epidemiological studies (Figure 3). In Angola most papers appeared online in 2006 and were mostly epidemiological studies. For the other countries like Central African Republic (CAR), Chad, Republic of the Congo (RoC) and Equatorial Guinea (EG), both epidemiological and entomological data were sparse and most of them were cross sectional. The low publication turnover for the different countries partly supports the fact that arboviruses are a neglected subject and that studies available were conducted to confirm cases in suspect outbreak areas in the different countries. The weak trend in publication indicates the lack of regular surveillance of the diseases and vectors and lack of conjoint and coordinated regional studies.

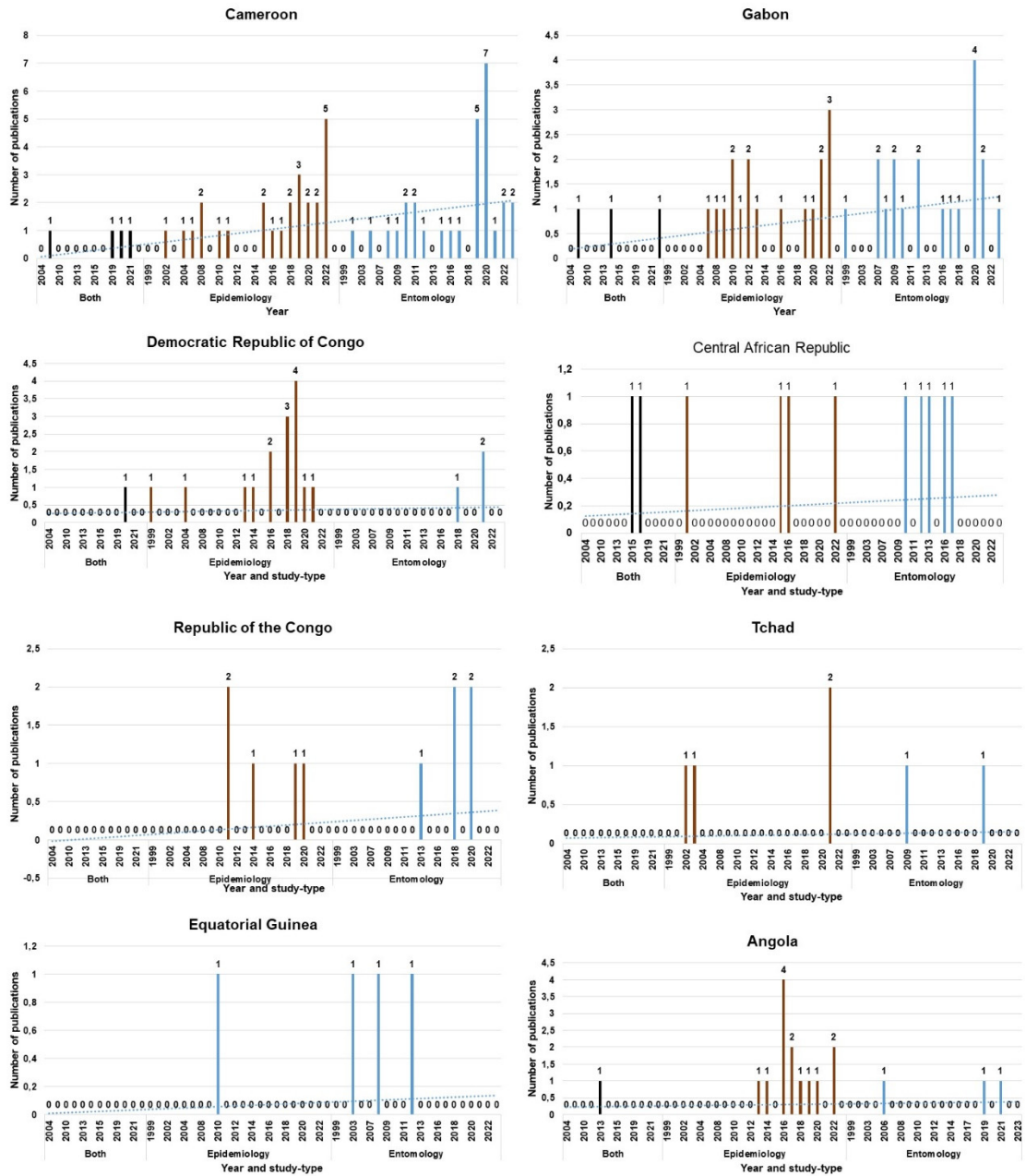


Figure 3. The periodic trend in publication of entomological and epidemiological data by country.

3.4. Occurrence of arboviruses in the Central African Region

The six arboviruses of public health importance considered in this review belonged to three genera notably i) *Alphavirus* (CHIKV), ii) *Flavivirus* (DENV, WNV, YFV, ZIKV), iii) *Phlebovirus* (RVFV). Of this six arboviruses reported to be circulating in the Central African Region, CHIKV and DENV have been detected in all the countries of this region [13] and the other four appears to variably occur in the different countries as follows:

i. Angola

The available and relevant information on arboviruses and associated vectors for Angola was documented in 17 papers. The details on each arbovirus targeted for this review is presented (Table 1) as follows:

DENV

Dengue circulation in Angola was first announced in the 1980s by infected travellers returning from Angola to the Netherlands [14]. In 2013 Angola reported its first locally acquired DENV cases [15]. During the 2013 epidemic, about 10% of case and random cluster participants in Luanda, Angola's capital city, had evidence of recent DENV infection [16]. Furthermore, the genetic study by Neto et al.[17] reported the circulation of DENV2 in Luanda.

#### *YFV and CHIKV*

In 1970 in Angola, outbreaks of YFV and CHIKV were reported [18]. The first YFV cases in Angola were reported in Luanda. On April 13th 2016, the WHO declared a YFV outbreak in Angola and at the same period the WHO also notified the case of RVFV in a man from China working in Luanda, the capital of Angola. Again, in May 2016, a 21 year old woman traveller from Luanda to Tokyo tested positive for CHIKV. According to the distribution map proposed by Adam and Jassoy [13], Angola is endemic for YF and CHIKV.

### **ii.Cameroon**

All the six medically important arboviruses targeted in this review have been reported in Cameroon (Table 1). This study found 58 papers published online on these arboviruses and associated vectors. The situation of the different arboviruses of Cameroon is as follows:

#### *CHIKV*

In Cameroon, CHIKV was reported in most regions and high prevalence reported in the North West (51.4%) [19], and others recorded varying prevalence as follows: Littoral region (12.6-59.4%) [20], Center (3-59.4%) [19] and South West regions (4-63%) [21]. However, Cameroon has already been reported as CHIKV endemic area with high transmission risk [13].

#### *DENV*

Dengue was found in all the epidemiological studies for Cameroon and was detected in all the 10 regions of the country. The prevalence by region reporting this virus is as such: Littoral (3.8-68.3%) [22-24], Far North (6.7-14.36%) [25,26], West (6.14-14.36%) [26,27], Center (3-45.45%) [26,28], South West (2.5-74%) [6,21] and South (0.5-14.28%). Similar to CHIKV, Dengue is also endemic in the whole of Cameroon with high transmission risk [13].

#### *YFV*

Yellow Fever Virus was detected in two hotspot regions with following prevalences notably: North (25.5%) [29] and South West region (4-72%) [6,21]. YFV is endemic in Cameroon with high risk of transmission[13].

#### *ZIKV*

Most of the studies found online about arboviruses of Cameroon frequently reported ZIKV. Prevalence differed with region as such: Southwest (11.4%) [6], Littoral (10-26.2%) [15,25], East (7.6%) [30], Far North (2-4.8%) [30] and Adamawa (2%) [30]. Zika virus has already been reported to be endemic in Cameroon and with high transmission risk [13].

#### *WNV*

The report on WNV for Cameroon is scant and was only reported in the south west region of Cameroon with prevalence range of 3-82% [21].

### **iii.Central African Republic**

The CAR has been victim of attacks of 19 arboviruses in the past and recently, 3 arbovirus were involved in fatal cases: in 1983 WNV was isolated in four patients, two serious cases of YFV occurred

in 1985 and 1986, and from 1983 to 1986 RVFV was identified in patients who died from hemorrhagic fever [31]. The details on the different arboviruses are presented (Table 1) in the following paragraphs:

#### *CHIKV*

Genetic analysis by Tricou et al. [32] confirmed the circulation of CHIKV in the 1970s and 1980s. A serological survey of antibodies to arboviruses was carried out in the human population of the south-east part of CAR in April 1979 and CHIKV was detected to be actively circulating in adult population [33]. The distribution map of CHIKV by Adam and Jassoy [13] shows that CAR is an endemic country for this virus.

#### *RVFV*

A RVFV study conducted in cattle and humans in Bangui reported an overall seroprevalence of anti-RVFV IgM antibodies of 1.9% and that of IgG antibodies of 8.6%. IgM antibodies were found only during the rainy season, but the frequency of IgG antibodies did not differ significantly by season. No evidence of recent RVFV infection was found in 335 people considered at risk; however, 16.7% had evidence of past infection [34]. In another study conducted on cattle, it was found that antibodies to RVFV virus were found in about 8% of adult cattle [35]. The presence of antibodies of CHIKV in cattle indicates their possible role as reservoir of the disease in Bangui.

#### *YFV, DENV and ZIKV*

In the Central African Republic since 2006, YFV cases have been notified in the provinces of Ombella-Mpoko, Ouham-Pende, Basse-Kotto, Haute-Kotto and in Bangui the capital which is also an *Aedes* spp. endemic area. However, the presence of the YFV vectors in this capital city of CAR represents a risk for the spread of the disease. To the best of our knowledge, little or no updated information on YFV, DENV and ZIKV has been published on the burden of these arboviruses in CAR. However a distribution map on these three arboviruses of public health concern by Adam and Jassoy [13] showed that CAR is an endemic country for these arboviruses and its vectors.

#### **iv. Chad**

Three important arboviruses (DENV, YFV and RVFV) have been reported to occur in Ndjamen (Table 1), the capital city of Chad. Only six papers were found eligible for Chad and were included in the study.

#### *DENV*

Information on Dengue in Chad is not documented and no available evidence on its occurrence was found for the period from 1993 to 2023, but the distribution map of Adam and Jassoy [13] indicates the presence of this arbovirus in this country.

#### *YFV*

A low prevalence (0.28%) of YF was obtained from jaundice patients in Ndjamen from 2015 to 2020 during a non-outbreak period [36]. Chad has also been reported to be a yellow fever endemic area with high transmission risk [13].

#### *RVFV*

This is a zoonotic febrile disease that affects livestock and humans and was first reported in Chad in 1967 [37] and in the same period in Cameroon and since then this disease has spread beyond the subregion. Apart from this preliminary report another report by Durand et al. [38] revealed a prevalence rate of 4% in French troops.

#### **v. Democratic Republic of Congo**

The available and relevant information on arboviruses and associated vectors for the Democratic Republic of Congo was documented in 19 papers. The details on each arbovirus targeted for this review is presented (Table 1) as follows:

#### YFV

Post independence of DRC in 1960, YF epidemics has been reported in all the 26 provinces of the country. A two-year survey (2013 to 2014), reported YFV prevalence of 31.5% among children in DRC [39]. From December 5, 2015, to November, 2016, a large YF outbreak has affected Angola and the DRC, with 7334 suspected cases, of which 962 have been confirmed, and 393 deaths reported to WHO as of Oct 28, 2016 [40,41]. According to the updated distribution map of Adam and Jassoy [13], the DRC is YF endemic area with high transmission risk [41,42]. Recent report on YF in DRC was in Kinshasa, its capital city with seroprevalence range of 6-73% [39,43] (Table 1). The occurrence of YFV in the capital city of this country was not astonishing as it is known that densely populated cities, where high densities of mosquitoes coexists with city inhabitants creates a favourable milieu for an epidemic of massive proportions.

#### CHIKV

In the last two decades, Kinshasa, the capital of the DRC experienced CHIKV epidemics in the years 1999 and 2000, with an estimated 50,000 reported cases [44]. Still in Kinshasa, another outbreak occurred in 2012 [45]. Apart from Kinshasa, other provinces where CHIKV has been reported are Kisangani [46] and Matadi [47]. According to the *Aedes* spp. and the CHIKV distribution maps published in Adam and Jassoy [13], the DRC is a CHIKV endemic area with high transmission risk [42].

#### DENV

Dengue fever virus is one of the common mosquito-borne viruses in the DRC and cases of this disease has been reported in some hotspot provinces such as Kisangani [46] and Kinshasa [39,45,48,49] via seroepidemiological studies [39,50]. Furthermore, serotyping information on the circulating DENV in the DRC was not available until a survey reported 16 DENV-1 and DENV-2 cases from 2003 to 2012 [51]. Genetic analysis revealed that the DENV-1 strain that caused the 2013 epidemic in Angola also circulated in the DRC in 2015 [52]. Three serotypes of DENV (DENV-1, DENV-2 and DENV-3) have been recorded in DRC, the most frequent being serotype DENV-1 [39]. In Kisangani, DENV co-circulated with CHIKV during the WNV outbreak of 1998 [46]. In Kinshasa, co-occurrence of dengue and chikungunya was reported during the 2012 outbreak [45]. To conclude, the DENV updated map for sub-Saharan Africa (SSA) published in Adam and Jassoy [13], shows that the DRC is a DENV endemic area with high transmission risk [42].

#### ZIKV

Only few studies presents relevant information on the burden and distribution of Zika in the DRC as only one study reported on its occurrence. A serological study from 2013 to 2014 showed a prevalence rate of 3.5% for ZIKV antibodies in sud-Ubangi [39]. Another study by [51] from 2003 to 2011 showed a negative test result for ZIKV using the polymerase chain reaction (PCR) method. The occurrence of Zika virus in the DRC has also been shown in the updated distribution map for ZIKV for SSA [13].

#### RVFV

In 1998 in Kisangani area of DRC, RVF has been reported in humans with low prevalence of 4% [46]. As a zoonotic arbovirus, it has also been reported in domestic animals such as cattle where in 2009 a seroprevalence of 20% was reported in this animal species in Katanga [53]. Also, a seroprevalence rate range of 2–16% among cattle was reported in the Nord-Kivu, Sud-Kivu, Ituri

provinces from the eastern region [54]. A transmission risk study conducted in 2014 revealed that *Aedes* mosquitoes harbored RVFV [55].

#### WNV

From the available information on WNV of the DRC only one paper presents relevant information on clinical cases of the disease and this was in 1998, when a high seroprevalence of 66% was reported in Kisangani [46]. Other information on this virus are from research on wild animals to establish their potential epizootiological role in its spread to humans where WNV antibodies were detected in Haut-Uelé Province in chimpanzee [56], in buffalo and elephant in the Garamba National Park [54].

### vi. Equatorial Guinea

The available and relevant information on arboviruses and associated vectors for Equatorial Guinea was documented in only four papers. The details on each arbovirus targeted for this review is presented (Table 1) as follows:

#### CHIKV, DENV and YFV

From the best of our knowledge, the only arboviruses that have been reported in EG are: CHIKV, DENV and YFV. Chikungunya was first detected in 2002 and 2003 [57]. In 2006 one of the three travelers returning from EG was diagnosed positive with CHIKV in Spain [58]. In addition, EG is known to be CHIKV endemic [13]. Similarly, only one study presents the distribution map of DENV and YFV of the EG and shows that the country is endemic for the two arboviral types [13].

### vii. Gabon

In Gabon, arboviruses and associated vectors have been reported in 39 papers. The publication trend has evolved positively for epidemiological studies with high number registered in 2022. All the six arboviruses of public health concern have been identified (Table 1), but their prevalence and distribution differed with province as follows:

#### CHIKV

This virus was reported in the whole of Gabon [59] and two important outbreaks occurred i.e. in 2007 and 2010 [60] in the Estuaire province of the capital city (Libreville) of Gabon. In Libreville, the prevalence range was 3-86% [61], followed by Haut-Ogooue (45.2-62.3%) [60], and then Ogooue-Lolo (28.7%) [62]. Recent reports on CHIKV are from Moyen-Ogooue province with prevalence range of 0.6-61.2% [7,63]. Chikungunya is endemic in Gabon and with high transmission risk [13].

#### DENV

Similar to CHIKV, DENV in Gabon was identified in all the regions surveyed [59,64] and has been reported to be endemic [13]. The DENV hotspot areas are: Moyen-Ogooue (12.3-88.24%) [7,65,66], Haut-Ogooue (12.2%) [60] and Estuaire (4-21.4%) [61].

#### RVFV, YFV, WNV, ZIKV

The reports on RVFV, YFV, WNV and ZIKV for Gabon are scant as only one paper reported the presence of these four arboviruses only in the Moyen-Ogooue province with varying prevalences as such: YFV (60.7%), ZIKV (40.3%), WNV (25.3%) and RVFV (14.3%) [7].

### viii. Republic of the Congo

The available and relevant information on arboviruses and associated vectors for the RoC was documented in 10 papers. The details on each arbovirus targeted for this review is presented (Table 1) as follows:

CHIKV

In January 2019, an outbreak of CHIKV fever was reported near Pointe-Noire. This study found a novel CHIKV strain and established the presence of the A226V substitution and close relation with *Aedes aegypti*-associated Central Africa chikungunya strains [67]. Similarly, in February 9th 2019, during the CHIKV outbreak, investigations found two new CHIKV sequences of the East/Central/South African (ECSA) lineage, clustering with the recent enzootic sub-clade 2, showing the A226V mutation. Entomological surveys reported one *Ae. albopictus* pool to RT-PCR positive [68].

DENV

Although DENV is one of the frequently reported arbovirus in the Central African subregion, from the best of our knowledge, no relevant information has been presented on its burden and occurrence in the RoC. However, the distribution map of DENV for SSA by Adam and Jassoy [13] clearly shows that RoC is endemic for this virus and its *Aedes* spp. vectors.

ZIKV

The lone study reporting the occurrence of ZIKV in RoC was that conducted on 386 serum specimens from volunteer blood donors in 2011 from rural and urban areas of Republic of the Congo. The result of this study showed a low ZIKV seropositivity rate (1.8%) [69].

3.5. Distribution of arboviruses in the Central African subregion

Chikungunya and Dengue were the most frequently detected of the six studied arboviruses of medical importance. Indeed, some countries have already witnessed historic epidemic waves of CHIKV for instance in Cameroon in 2006, in Gabon (2007 to 2010), in Congo Brazzaville in 2011 and in the DRC in 2019. The circulating arboviruses in the different Central African countries are presented in Table 1. The widespread distribution of CHIKV and DENV could be attributed to the suitable ecological variables for its vectors and of course it has already been reported that DENV is the most prevalent of all arboviruses [70,71]. Although RVFV cases have already been reported in clinical cases in countries like Chad, CAR, Gabon, and DRC, data is still scant, but in a country like Cameroon information is mostly available for animal species (cattle, sheep and goats) [72,73]. The free circulation of livestock and people in the Central African regional corridor could be the main driver of circulating strains of major arboviruses in countries of this region [6]. The circulation of RVFV in domesticated ruminants in countries of this region could indicate possible risk of human exposure to zoonotic strains [74]. Also, information on WNV was also poorly documented with clinical cases reported in Cameroon, Gabon and the Democratic Republic of Congo. Also, information on WNV in animals is scant and needs to be documented. The detection discrepancies between countries could be multifactorial as follows: (i) lack of knowledge, (ii) low or lack of diagnostic capacity, and (ii) poor surveillance systems. The lack of data from the Central African sub-region makes it difficult to generate robust and quality field epidemiological and entomological information that could inform on the patterns and drivers of arthropod-borne diseases transmission [75,76].

**Table 1.** Occurrence and burden of major arboviruses in different countries of the Central African sub-region from January 1993 to June 2023.

| Country | Site (region, province, city) | arbovirus | Proportions (%) | References   |
|---------|-------------------------------|-----------|-----------------|--------------|
| Gabon   | Estuaire                      | CHIKV     | 3-86            | [60,61,77]   |
|         |                               | DENV      | 4-21.4          | [60,61,77]   |
|         | Moyen Ogooue                  | CHIKV     | 0.6-61.2        | [7,63,78]    |
|         |                               | DENV      | 12.3-88.24      | [7,63,65,66] |
|         |                               | RVFV      | 14.3            | [7]          |
|         |                               | YFV       | 60.7            | [7]          |
|         |                               | WNV       | 25.3            | [7]          |
|         |                               | ZIKV      | 40.3            | [7]          |

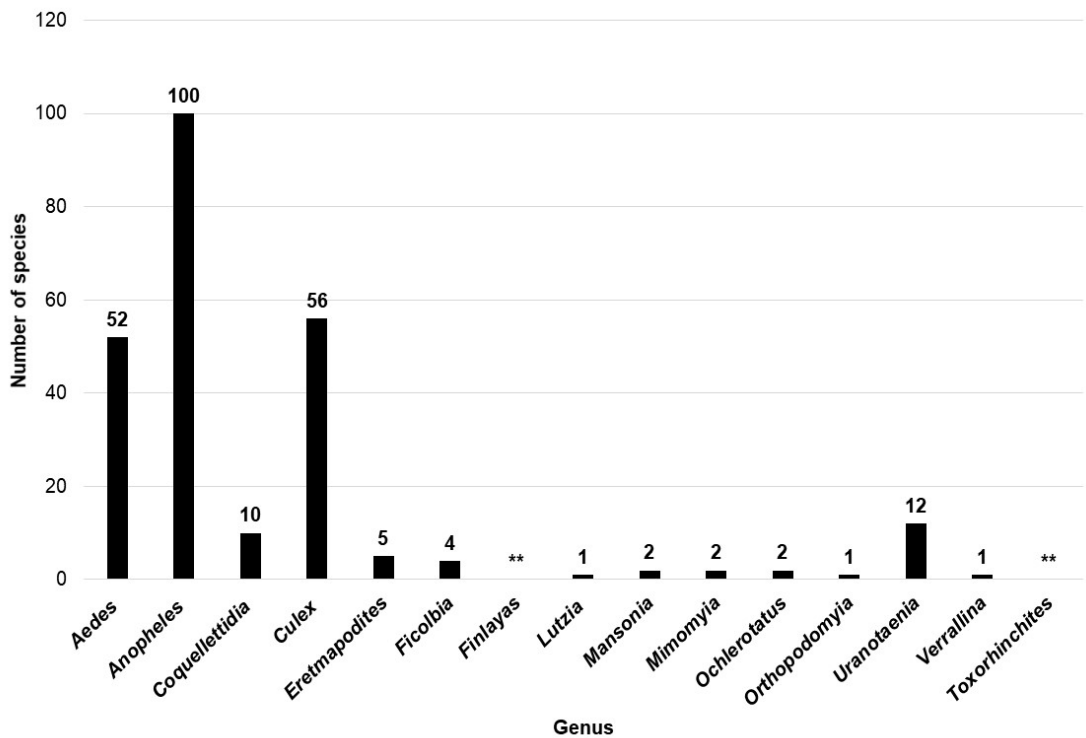
|                                     |                  |       |            |                  |
|-------------------------------------|------------------|-------|------------|------------------|
| <b>Cameroon</b>                     | Haut Ogooue      | CHIKV | 45.2-62.3  | [62]             |
|                                     |                  | DENV  | 12.2       | [62]             |
|                                     | Ogooue Lolo      | CHIKV | 28.7       | [62]             |
|                                     | Woleu Ntem       | CHIKV | 0.5        | [79]             |
|                                     | nationwide       | CHIKV | 35.6-86    | [59,80]          |
|                                     |                  | DENV  | 0.2-94.8   | [59,64]          |
|                                     | 212-220 villages | DENV  | 0.5        | [81]             |
|                                     |                  | RVFV  | 3.3        | [82]             |
|                                     | East             | ZIKV  | 7.6        | [30]             |
|                                     | Littoral         | CHIKV | 12.6-59.4  | [19,20]          |
|                                     |                  | DENV  | 3.9-68.3   | [20,22–26,28]    |
|                                     |                  | ZIKV  | 10-26.2    | [20,30]          |
|                                     | South            | DENV  | 0.5-14.28  | [79,83]          |
|                                     | North            | YFV   | 25.5       | [29]             |
|                                     | Far North        | DENV  | 6.7-14.36  | [25,26]          |
|                                     |                  | ZIKV  | 2-4.8      | [30]             |
|                                     | Adamawa          | DENV  | 4.7-6.89   | [26,84]          |
|                                     |                  | ZIKV  | 2          | [30]             |
|                                     | West             | CHIKV | 15.7       | [60]             |
|                                     |                  | DENV  | 6.14-14.36 | [25–28]          |
|                                     | Center           | CHIKV | 3-59.4     | [19,20,85]       |
|                                     |                  | DENV  | 3-45.45    | [20,25,26,28,85] |
|                                     |                  | ZIKV  | 3.3        | [30]             |
| <b>Democratic Republic of Congo</b> | North West       | CHIKV | 51.4       | [86]             |
|                                     |                  | CHIKV | 4-63       | [6,21]           |
|                                     | South West       | ZIKV  | 11.4       | [6]              |
|                                     |                  | DENV  | 2.5-74     | [6,21]           |
|                                     |                  | YFV   | 4-72       | [21]             |
|                                     |                  | WNV   | 3-82       | [21]             |
|                                     | Matadi           | CHIKV | 83.2       | [47]             |
|                                     | Kisangani        | WNV   | 66         | [46]             |
|                                     |                  | CHIKV | 34         | [46]             |
|                                     |                  | DENV  | 3          | [46]             |
|                                     |                  | RVFV  | 4          | [46]             |
| <b>Republic of the Congo</b>        | kinshasa         | DENV  | 0.4-8.1    | [39,45,48,49,51] |
|                                     |                  | YFV   | 6.0-73     | [39,43]          |
|                                     |                  | CHIKV | 0.1-49.7   | [39,45,51,87–89] |
|                                     | Sud-Ubangi       | ZIKV  | 3.5%       | [39]             |
|                                     | Brazzaville      | CHIKV | 11.7-71    | [90,91]          |
|                                     | Pointe-Noire     | -     | -          | [67,68]          |
|                                     | -                | ZIKV  | 1.8        | [69]             |
|                                     | -                | DENV  | -          | [13]             |
| <b>Angola</b>                       | Luanda           | DENV  | 11.1-94.4  | [17,92,93]       |
|                                     |                  | CHIKV | 7          | [17,94]          |
|                                     | 13 provinces     | YFV   | 70         | [95]             |
| <b>Equatorial Guinea</b>            | Bata             | CHIKV | 1.1-33.3   | [58]             |
| <b>Chad</b>                         | N'Djamena        | YFV   | 0.28       | [13,36]          |
|                                     |                  | RVFV  | 4          | [38]             |
|                                     |                  | DENV  | -          | [13]             |
| <b>Central African Republic</b>     | Bangui           | YFV   | 6.5        | [96]             |
|                                     |                  | RVFV  | 1.9-16.7   | [34]             |
|                                     |                  | CHIKV | -          | [32]             |

Chikungunya virus (CHIKV), Dengue Virus (DENV), Zika Virus (ZIKV), Yellow Fever Virus (YFV), Rift Valley Fever Virus (RVFV), West Nile Virus (WNV); (-) not available.

### 3.6. The mosquito fauna of the Central African Region from 1993 to 2023

After a thorough online search, we documented >248 species of mosquitoes regrouped under 15 genera in decreasing order of magnitude as follows: *Anopheles* (n=100), *Culex* (n=56), *Aedes* (n=52),

*Uranotaenia* (n=12), *Coquillettidia* (n=10), *Eretmapodites* (n=5), *Ficalbia* (n=4), *Mansonia* (n=2), *Mimomyia* (n=2), *Ochlerotatus* (n=2), *Lutzia* (n=1), *Orthopodomyia* (n=1), *Verrallina* (n=1), but *Finlayas* and *Toxorhinchites* species were unidentified (Figure 4) (Table 2).



**Figure 4.** Genera of mosquitoes identified in the Central African subregion from January 1993 to June 2023; (\*\*): unidentified species.

From the current study, it is clear that the genus *Culex* constituted the most diverse group with highest species frequency and this could be accounted for by their high adaptability in different agroecological settings and their ability to colonise diverse microhabitat-types for breeding, survival and proliferation. The genus *Aedes* was the second most frequent group and with invasive species such as *Ae. aegypti* and *Ae. Albopictus* that codominated rural and urban spaces [97]. These two species were frequently identified in all the countries presenting data on potential mosquito fauna of arboviruses. Although *Ae. aegypti* has been frequently reported [98,99], *Ae. albopictus* usually occurs in higher proportions in the Central African Region [89,97] (Table 3). Despite the fact that studies reporting circulating arboviruses in mosquitoes in the Central African Region are scant, papers published elsewhere in West Africa precisely in Ivory Coast reported very low infection rates in local *Ae. aegypti* [100]. The occurrence of different species in countries of this region could be an indication of an eventual spillover of arboviruses [101].

**Table 2.** Mosquito fauna reported in some Central African countries from January 1993 to June 2023.

| Species                 | Countries    |             |           |             |             |        |            |          |  | References                              |
|-------------------------|--------------|-------------|-----------|-------------|-------------|--------|------------|----------|--|-----------------------------------------|
|                         | Came<br>roon | R<br>o<br>C | Ga<br>bon | C<br>A<br>R | D<br>R<br>C | E<br>G | Ang<br>ola | Ch<br>ad |  |                                         |
| <i>Aedes aegypti</i>    | +            | +           | +         | +           | +           | +      | +          | +        |  | [10,16,47,59,62,67,89,90,97–99,101–149] |
| <i>Aedes abnormalis</i> |              |             |           | +           |             |        |            |          |  | [150]                                   |

|                                |   |   |   |   |   |   |   |   |                                                                                                   |
|--------------------------------|---|---|---|---|---|---|---|---|---------------------------------------------------------------------------------------------------|
| <i>Aedes africanus</i>         | + |   |   | + |   | + |   |   | [62,86,101,103–106,116,118,123,150–153]                                                           |
| <i>Aedes albopictus</i>        | + | + | + | + | + | + | + | + | [10,47,59,86,89,90,97–99,101,103,105–112,114–118,120–132,134–138,140,142,145,146,148,151,154–158] |
| <i>Aedes alternans</i>         |   |   |   |   |   |   |   | + | [140]                                                                                             |
| <i>Aedes argenteopunctatus</i> | + |   |   | + |   |   |   |   | [101,103,105,123,152]                                                                             |
| <i>Aedes australis</i>         |   |   |   |   |   |   |   | + | [140]                                                                                             |
| <i>Aedes caspiua</i>           |   |   |   |   |   |   |   | + | [140]                                                                                             |
| <i>Aedes centropunctatus</i>   |   |   |   | + |   |   |   |   | [103]                                                                                             |
| <i>Aedes cineris</i>           |   |   |   |   |   |   |   | + | [140]                                                                                             |
| <i>Aedes circum</i>            | + |   |   | + |   |   |   |   | [101,105,114,123]                                                                                 |
| <i>Aedes circumluteoculus</i>  | + |   | + | + |   |   |   |   | [101,123,152,153,159]                                                                             |
| <i>Aedes contigus</i>          | + |   |   |   |   |   |   |   | [122,151]                                                                                         |
| <i>Aedes cumminsii</i>         | + |   |   | + |   |   |   |   | [103,105]                                                                                         |
| <i>Aedes dalzieli</i>          | + |   | + | + |   |   |   |   | [103,114,153]                                                                                     |
| <i>Aedes dendrophilus</i>      |   |   |   |   |   |   |   |   | [105]                                                                                             |
| <i>Aedes domesticus</i>        | + |   |   |   |   |   |   |   | [101,105]                                                                                         |
| <i>Aedes dufouri</i>           |   |   |   |   |   |   |   | + | [140]                                                                                             |
| <i>Aedes fraseri</i>           | + |   |   |   |   |   |   |   | [101,123,152]                                                                                     |
| <i>Aedes flavifrons</i>        |   |   |   |   |   |   |   | + | [140]                                                                                             |
| <i>Aedes fowleri</i>           | + |   |   | + |   |   |   | + | [103,114,140,150]                                                                                 |
| <i>Aedes furcifer</i>          |   |   |   | + |   |   |   |   | [153]                                                                                             |
| <i>Aedes gibinsis</i>          | + |   |   |   |   |   |   |   | [101,152]                                                                                         |
| <i>Aedes haworthi</i>          |   |   |   |   |   | + |   |   | [105]                                                                                             |
| <i>Aedes ingrani</i>           | + |   |   |   |   |   |   |   | [105]                                                                                             |
| <i>Aedes irritans</i>          |   |   |   | + |   |   |   |   | [132]                                                                                             |
| <i>Aedes longipalpis</i>       |   |   |   | + |   | + |   |   | [105,153]                                                                                         |
| <i>Aedes luteocephalus</i>     |   |   |   |   |   | + |   |   | [103–105]                                                                                         |

|                                   |   |   |   |   |                                                 |
|-----------------------------------|---|---|---|---|-------------------------------------------------|
| <i>Aedes mcintoshi</i>            | + |   | + |   | [103,114]                                       |
| <i>Aedes metallicus</i>           | + |   |   |   | [101,123]                                       |
| <i>Aedes minutus</i>              |   |   | + |   | [153]                                           |
| <i>Aedes mixtus</i>               |   |   | + |   | [103]                                           |
| <i>Aedes mucidus</i>              | + |   |   |   | [114]                                           |
| <i>Aedes multiplex</i>            |   |   |   | + | [140]                                           |
| <i>Aedes nigricephalus</i>        |   |   | + |   | [132]                                           |
| <i>Aedes notoscriptus</i>         |   |   |   | + | [140]                                           |
| <i>Aedes ochraceus</i>            | + |   |   |   | [114]                                           |
| <i>Aedes opok</i>                 |   |   | + |   | [105,150]                                       |
| <i>Aedes palpalis</i>             | + |   |   |   | [105,122,150]                                   |
| <i>Aedes polynesiensis</i>        |   |   |   | + | [140]                                           |
| <i>Aedes procax</i>               |   |   |   | + | [140]                                           |
| <i>Aedes simpsoni</i>             | + |   | + | + | [10,59,101,103–105,109,112,122,123,135,136,151] |
| <i>Aedes simulans</i>             |   |   | + |   | [160]                                           |
| <i>Aedes soleatus</i>             | + |   |   |   | [101,123]                                       |
| <i>Aedes stockesi</i>             |   |   | + |   | [105]                                           |
| <i>Aedes subargenteopunctatus</i> |   |   | + |   | [105]                                           |
| <i>Aedes tarsalis</i>             | + |   |   |   | [101,105,123,125,150,152]                       |
| <i>Aedes vexans</i>               | + |   | + | + | [117,128,140,153]                               |
| <i>Aedes vigilax</i>              |   |   | + | + | [140,153]                                       |
| <i>Aedes vittatus</i>             | + | + | + | + | [99,103,105,112,114,125,136,153]                |
| <i>Aedes vittiger</i>             |   |   |   | + | [140]                                           |
| <i>Aedes wellmani</i>             | + |   |   |   | [101,123]                                       |
| <i>Anopheles annuliotus</i>       |   |   | + |   | [105,152]                                       |
| <i>Anopheles annulipes</i>        |   |   |   | + | [140]                                           |
| <i>Anopheles arabiensis</i>       | + |   | + | + | [140,161–163]                                   |



|                                |   |   |   |   |   |   |   |   |  |                                                                                                            |
|--------------------------------|---|---|---|---|---|---|---|---|--|------------------------------------------------------------------------------------------------------------|
| <i>Anopheles demeilloni</i>    | + | + |   | + | + |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles distinctus</i>    |   |   |   | + | + |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles dthali</i>        |   |   |   |   |   |   | + |   |  | [161]                                                                                                      |
| <i>Anopheles domicolus</i>     | + |   |   | + | + |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles dualaensis</i>    | + |   |   |   |   |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles eouzani</i>       | + |   | + |   |   |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles faini</i>         |   |   | + |   | + |   |   |   |  | [160,161]                                                                                                  |
| <i>Anopheles flavicosta</i>    | + |   |   | + |   |   | + |   |  | [103,161]                                                                                                  |
| <i>Anopheles freetownensis</i> | + | + |   | + |   |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles fontenillei</i>   |   |   | + |   |   |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles fuscivenosus</i>  |   |   |   |   |   |   | + |   |  | [161]                                                                                                      |
| <i>Anopheles funestus</i>      | + | + | + | + | + | + | + | + |  | [103,105,113,125,140,150,160–165,167]                                                                      |
| <i>Anopheles gambiae</i>       | + | + | + | + | + | + | + | + |  | [10,59,97,99,101,103,105,107,108,110,112,113,115,118,125,128,131,132,136,140,142,150,151,161–165,167–169,] |
| <i>Anopheles garnhami</i>      |   |   |   | + |   |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles gabonensis</i>    |   |   | + |   |   |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles gibbinsi</i>      |   | + |   | + | + |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles hamoni</i>        |   | + |   |   |   |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles hancocki</i>      | + | + | + |   | + |   |   |   |  | [161,164]                                                                                                  |
| <i>Anopheles hargreavesi</i>   | + | + | + | + | + |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles charperi</i>      |   |   |   |   |   |   | + |   |  | [161]                                                                                                      |
| <i>Anopheles hyrcanus</i>      |   |   |   |   |   |   |   | + |  | [140]                                                                                                      |
| <i>Anopheles implexus</i>      | + | + | + | + | + |   | + |   |  | [105,161,166]                                                                                              |
| <i>Anopheles jebudensis</i>    | + | + | + |   | + |   | + |   |  | [160,161]                                                                                                  |
| <i>Anopheles keniensis</i>     |   |   |   | + |   |   |   |   |  | [161]                                                                                                      |
| <i>Anopheles kingi</i>         |   |   |   | + |   |   |   |   |  | [161]                                                                                                      |

|                               |   |   |   |   |   |   |   |   |                           |
|-------------------------------|---|---|---|---|---|---|---|---|---------------------------|
| <i>Anopheles lesoni</i>       | + | + |   | + | + | + | + |   | [161]                     |
| <i>Anopheles listeri</i>      |   |   |   |   |   |   | + |   | [161,163]                 |
| <i>Anopheles lloreti</i>      |   |   |   |   | + |   |   |   | [161]                     |
| <i>Anopheles longipalpis</i>  | + | + |   |   | + |   | + |   | [161]                     |
| <i>Anopheles maculipalpis</i> | + |   |   | + | + | + |   | + | [161]                     |
| <i>Anopheles maculipennis</i> |   |   |   |   | + |   |   | + | [140,152]                 |
| <i>Anopheles marshallii</i>   | + | + | + | + | + |   |   | + | [159–161,166]             |
| <i>Anopheles melas</i>        | + | + | + | + | + | + | + |   | [117,146,161,163,165,168] |
| <i>Anopheles meraukensis</i>  |   |   |   | + |   |   |   |   | [153]                     |
| <i>Anopheles millecampsi</i>  |   |   |   |   | + |   |   |   | [161]                     |
| <i>Anopheles mortiauxi</i>    |   |   |   |   | + |   |   |   | [161]                     |
| <i>Anopheles moucheti</i>     | + | + | + | + | + | + |   |   | [115,117,151,161,164–166] |
| <i>Anopheles mousinhoi</i>    | + |   |   |   | + |   |   |   | [161]                     |
| <i>Anopheles multicinctus</i> | + |   |   |   | + | + |   |   | [161]                     |
| <i>Anopheles namibiensis</i>  | + |   |   |   |   |   |   |   | [161]                     |
| <i>Anopheles natalensis</i>   | + | + | + | + | + |   |   | + | [105,160,161]             |
| <i>Anopheles nili</i>         | + | + | + | + | + | + | + | + | [103,105,151,160–165]     |
| <i>Anopheles njombiensis</i>  |   |   |   |   | + |   |   | + | [161]                     |
| <i>Anopheles obscurus</i>     | + | + | + | + | + | + | + |   | [159,161]                 |
| <i>Anopheles okuensis</i>     | + |   |   |   |   |   |   |   | [161]                     |
| <i>Anopheles ovengensis</i>   | + |   |   |   |   | + |   |   | [161,165]                 |
| <i>Anopheles paludis</i>      | + | + | + | + | + |   |   | + | [105,151,153,159,161,164] |
| <i>Anopheles pharaoensis</i>  | + |   |   | + | + | + |   | + | [103,131,140,161–163]     |
| <i>Anopheles pretoriensis</i> | + | + | + | + | + |   |   | + | [161]                     |
| <i>Anopheles rageaui</i>      | + | + |   |   | + |   |   |   | [161]                     |

|                                 |   |   |   |   |   |   |   |                       |
|---------------------------------|---|---|---|---|---|---|---|-----------------------|
| <i>Anopheles rhodesiensis</i>   | + | + | + | + | + | + |   | [161]                 |
| <i>Anopheles rodhaini</i>       |   |   |   |   | + |   |   | [161]                 |
| <i>Anopheles rivulorum</i>      | + | + |   |   | + | + |   | [161]                 |
| <i>Anopheles rivulorum-like</i> |   |   |   |   |   | + |   | [161]                 |
| <i>Anopheles ruarinus</i>       |   |   |   |   |   | + |   | [161,163]             |
| <i>Anopheles rufipes</i>        | + | + | + | + | + | + | + | [103,140,161–163]     |
| <i>Anopheles schwetzi</i>       |   |   | + |   | + | + |   | [160,161]             |
| <i>Anopheles seydeli</i>        |   |   |   |   | + |   |   | [161]                 |
| <i>Anopheles smithii</i>        | + |   | + | + |   | + |   | [160,161]             |
| <i>Anopheles somalicus</i>      | + |   |   |   |   |   |   | [161]                 |
| <i>Anopheles squamosus</i>      | + | + | + | + | + | + | + | [114,161–163,]        |
| <i>Anopheles symesi</i>         |   |   |   |   | + |   |   | [161]                 |
| <i>Anopheles tchekeidii</i>     |   |   |   |   |   | + |   | [161]                 |
| <i>Anopheles tenebrosus</i>     | + |   | + | + | + | + | + | [115,117,128,159,161] |
| <i>Anopheles theileri</i>       |   |   | + |   | + | + |   | [161]                 |
| <i>Anopheles vanhoofi</i>       |   | + |   |   | + |   |   | [161]                 |
| <i>Anopheles versus</i>         |   |   |   |   | + |   |   | [170]                 |
| <i>Anopheles vinckei</i>        |   |   | + |   |   |   |   | [161,166]             |
| <i>Anopheles walravensi</i>     |   |   |   |   | + | + |   | [161]                 |
| <i>Anopheles wellecomei</i>     | + |   | + | + | + | + | + | [140,161,162]         |
| <i>Anopheles ziemmani</i>       | + | + | + | + | + | + | + | [103,115,140,161–163] |
| <i>Anopheles zombaensi</i>      |   |   | + |   |   |   |   | [160]                 |
| <i>Coquelettidia spp.</i>       | + |   |   | + |   |   |   | [103,105,151]         |
| <i>Coquelettidia annettii</i>   | + |   |   |   |   |   |   | [101]                 |
| <i>Coquelettidia aurites</i>    |   |   | + |   |   |   |   | [159,160]             |

|                                    |   |   |   |   |                                                              |
|------------------------------------|---|---|---|---|--------------------------------------------------------------|
| <i>Coqueleltidia cristata</i>      |   | + |   |   | [105]                                                        |
| <i>Coqueleltidia fraseri</i>       |   | + |   |   | [105]                                                        |
| <i>Coqueleltidia maculipennis</i>  | + |   |   |   | [101,123]                                                    |
| <i>Coqueleltidia microannulata</i> |   | + |   |   | [160]                                                        |
| <i>Coqueleltidia pseudoconopas</i> |   | + | + |   | [105,160]                                                    |
| <i>Coqueleltidia richiardii</i>    |   |   |   | + | [140]                                                        |
| <i>Coqueleltidia versicolor</i>    |   | + |   |   | [160]                                                        |
| <i>Coqueleltidia xanthogaster</i>  |   |   |   | + | [140]                                                        |
| <i>Culex albiventris</i>           | + |   | + |   | [123,171]                                                    |
| <i>Culex annulioris</i>            | + |   | + | + | [103,105,123,153,160,161]                                    |
| <i>Culex annulirostris</i>         |   |   |   | + | [140]                                                        |
| <i>Culex antenatus</i>             | + |   | + |   | [112,114,118,123,132,171]                                    |
| <i>Culex andersoni</i>             |   |   | + |   | [160]                                                        |
| <i>Culex argenteopunctatus</i>     | + |   |   |   | [171]                                                        |
| <i>Culex australicus</i>           |   |   |   | + | [140]                                                        |
| <i>Culex cineris</i>               | + |   | + | + | [103,107,132,159,160,171]                                    |
| <i>Culex cinerellus</i>            | + |   | + | + | [97,132,160,171]                                             |
| <i>Cx.duttoni</i>                  | + |   | + | + | [97,101,106,112,115,117,118,122,123,125,128,150–153,171,172] |
| <i>Cx.decens</i>                   | + |   | + |   | [97,106,107,112,117,118,128,131,132,150,159]                 |
| <i>Culex eouzani</i>               | + |   |   |   | [171]                                                        |
| <i>Culex fatigans</i>              | + |   |   |   | [125]                                                        |
| <i>Culex guiarti</i>               | + |   |   |   | [171]                                                        |
| <i>Culex horridus</i>              | + |   |   |   | [171]                                                        |
| <i>Culex individiosus</i>          | + |   |   |   | [101]                                                        |



|                                      |   |   |   |   |   |                                                      |
|--------------------------------------|---|---|---|---|---|------------------------------------------------------|
| <i>Culex sunyaniensis</i>            | + |   |   |   |   | [171]                                                |
| <i>Culex subaequali</i>              | + |   |   |   |   | [171]                                                |
| <i>Culex tigripes</i>                | + | + | + | + |   | [99,103,105–107,112,113,118,122,123,125,131,132,152] |
| <i>Culex trifilatus</i>              | + |   | + |   |   | [101,160]                                            |
| <i>Culex univittatus</i>             | + |   | + |   |   | [101,118,123,151,152,160]                            |
| <i>Culex watti</i>                   |   |   | + |   | + | [140,160]                                            |
| <i>Culex wiggleworthi</i>            | + |   |   |   |   | [101,123,151,152,171]                                |
| <i>Culex taufliebi</i>               |   |   | + |   |   | [97]                                                 |
| <i>Culex thalassius</i>              | + |   |   |   |   | [171]                                                |
| <i>Culex theileri</i>                |   |   | + |   |   | [160]                                                |
| <i>Culex trifoliatus</i>             | + |   | + |   |   | [97,101,171,]                                        |
| <i>Culex umbripes</i>                |   |   | + |   |   | [97,161]                                             |
| <i>Eretmapodites spp.</i>            | + |   | + | + | + | [101,122,123]                                        |
| <i>Eretmapodites quinquevittatus</i> | + |   | + |   | + | [10,106,112]                                         |
| <i>Eretmapodites chrysogaster</i>    | + |   | + |   |   | [101,105,123,152,160,]                               |
| <i>Eretmapodites grahami</i>         |   |   | + |   |   | [160]                                                |
| <i>Eretmapodites inornatus</i>       |   |   | + | + |   | [97,105,153]                                         |
| <i>Eretmapodites plioleucus</i>      | + |   |   |   |   | [101]                                                |
| <i>Ficolbia spp</i>                  |   |   |   | + |   | [123]                                                |
| <i>Ficalbia Flavopicta</i>           | + |   |   |   |   | [101]                                                |
| <i>Ficalbia malfeyi</i>              |   |   | + |   |   | [159]                                                |
| <i>Ficalbia mediolineata</i>         |   |   | + |   |   | [132]                                                |
| <i>Ficalbia uniformis</i>            |   |   | + |   |   | [160]                                                |
| <i>Finlayas spp.</i>                 |   |   | + |   |   | [160]                                                |
| <i>Lutzia tigripes</i>               | + |   | + | + | + | [97,101,107,123,140,150,151,160,172]                 |

|                                    |   |   |   |   |                                             |
|------------------------------------|---|---|---|---|---------------------------------------------|
| <i>Mansona africana</i>            | + | + | + | + | [10,59,103,105,106,108,114,132,151,153,159] |
| <i>Mansona uniformis</i>           | + | + | + | + | [10,59,103,105,108,110,114,131,132,140,151] |
| <i>Mimmonyia</i> spp               | + |   |   |   | [123]                                       |
| <i>Mimmonyia flavopicta</i>        | + |   |   |   | [101]                                       |
| <i>Mimmonyia plumosa</i>           |   | + |   |   | [160]                                       |
| <i>Ochlerothatus rusticus</i>      |   |   |   | + | [140]                                       |
| <i>Ochlerothatus excrucians</i>    |   |   |   | + | [140]                                       |
| <i>Orthopodom yia reunionensis</i> |   |   |   | + | [140]                                       |
| <i>Uranotaenia</i> spp.            | + | + | + |   | [123]                                       |
| <i>Uranotaenia bilineata</i>       | + | + |   |   | [101,152,159,160]                           |
| <i>Uranotaenia cavernicola</i>     |   | + |   |   | [159,160]                                   |
| <i>Uranotaenia nigromaculata</i>   |   | + |   |   | [159,160]                                   |
| <i>Uranotaenia nigripes</i>        |   | + |   |   | [160]                                       |
| <i>Uranotaenia caliginosa</i>      |   | + |   |   | [159]                                       |
| <i>Uranotaenia caeruleocephala</i> |   | + |   |   | [160]                                       |
| <i>Uranotaenia machadoi</i>        |   | + |   |   | [160]                                       |
| <i>Uranotaenia pallidocephala</i>  |   | + |   |   | [160]                                       |
| <i>Uranotaenia balfoui</i>         |   | + |   |   | [160]                                       |
| <i>Uranotaenia chorleyi</i>        |   | + |   |   | [160]                                       |
| <i>Uranotaenia alboabdominalis</i> |   | + |   |   | [160]                                       |
| <i>Uranotaenia mashonaensis</i>    | + | + |   |   | [101,132,159,160]                           |
| <i>Verrallina funerea</i>          |   |   |   | + | [140]                                       |
| <i>Toxorhinchites</i> spp          | + |   |   |   | [122,123]                                   |

+: presence of species; RoC: Republic of the Congo; CAR: Central African Republic; DRC: Democratic Republic of Congo; EG: Equatorial Guinea.

3.7. Arboviruses and associated mosquito vectors in the Central African Region from 1993 to 2023

The spillovers of arboviruses of public health importance have been reportedly being associated to the following mosquito genera of medical and zoonotic importance such as *Aedes*, *Culex*, *Anopheles*, etc. The vector competence of *Ae. aegypti* [101,173–175] and *Ae. albopictus* [174,176] in the transmission of major arboviruses has been well documented. The vector competence and the association of some *Aedes* spp. as potential vectors of important viruses is still unknown. For the *Culex* mosquitoes already identified in studies of the Central African Region, they have been frequently reported to be associated with zoonotic arboviruses such as RVFV and WNV [9,175,177,178]. Of the *Culex* spp. involved in the spread of zoonotic arboviruses, *Culex pipiens* was reported to be associated with CHIKV [9,177,179,180]. The genus *Anopheles* has also been reported to be associated with some medically important arboviruses such as YFV (*An. gambiae* s.l.) [181], ZIKV (*An. moucheti*) [179] and CHIKV (*An. funestus*) [175]. Moreover, other mosquitoes that are not well known in the region are associated with arboviruses and include: *Eretmapodites* spp. (ZIKV) [123,175], *Coquelettidia* spp. (YFV and RVFV) [173,175,177] and *Lutzia tigris* that was reported to be potential vector of YFV, DENV, and WNFV [101,159,175]. The occurrence of these competent and potential vectors in the different countries of this sub-region of Africa could indicate the risk of spillover of the different viruses highlighted in Table 3. Therefore vector competent studies and transmission studies together with clinical diagnosis is required to keep track of the patterns of occurrence and spread of arboviruses of medical and zoonotic importance in the Central African Region.

**Table 3.** Arboviruses and associated mosquito vectors in the Central African Region from January 1993 to June 2023.

| Species                     | Virus                                                                                                                                                                                   | References                            |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| <i>Ae.aegypti</i>           | Dengue, Chikungunya, Zika, Yellow Fever, Rift Valley fever virus, Ross River, Murray Vallée, Wesselsbron, Encephalitis, Dugbe, Orungo, Bakanki, O'nyong Nyong                           | [101,108,114,116,138,173–175,182,183] |
| <i>Ae.abnormalis</i>        | n.a                                                                                                                                                                                     | /                                     |
| <i>Ae.africanus</i>         | Bouboui, Chikungunya, Orungo, Wesselsbron, West Nile, Yellow fever, Zika, Bozo, Wamba, Uganda, Bouboui, Bozo, Middelburg, Orungo, Saboya, Semliki Forest, Yaoundé, ArB 28215            | [116,150,153,173,175,184,185]         |
| <i>Ae.albopictus</i>        | Dengue, Chikungunya, Zika, Yellow fever, Usutu, Weeselsbron, Ross River, Rif Valley fever, West Nile virusl, Murray Vallée, Japonese encephalitis, St-Louis encephalitis, sindbis virus | [108,114,116,138,174,176]             |
| <i>Ae.alternans</i>         | n.a                                                                                                                                                                                     | /                                     |
| <i>Ae.argenteopunctatus</i> | Middelburg, Semliki Forest, Ndumu, Kedougou,                                                                                                                                            | [101,153,175,179]                     |

|                           |                                                                                                                                                                  |                       |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
|                           | Wesselsbron, Bunyamuera, Shokwe, Simbu, Pongola, Zinga, Zika, Yellow Fever, Sindbis, Chikungunya, Nkolbisson, Ngari, Pongola                                     |                       |
| <i>Ae.australis</i>       | n.a                                                                                                                                                              | /                     |
| <i>Ae.bromelia</i>        | Yellow Fever                                                                                                                                                     | [186]                 |
| <i>Ae.caballus</i>        | Wesselsbron, Rift Valley fever, Middelburg                                                                                                                       | [175,187]             |
| <i>Ae.cordeleri</i>       | Chikungunya                                                                                                                                                      | [175]                 |
| <i>Ae.caspiua</i>         | Usutu                                                                                                                                                            | [175]                 |
| <i>Ae.centropunctatus</i> | n.a                                                                                                                                                              | /                     |
| <i>Ae.cinerus</i>         | n.a                                                                                                                                                              | /                     |
| <i>Ae.circumluteocus</i>  | Wesselsbron, Pongola, Bunyamwera, Rift Valley Fever, Ndumu, Spondweni, Simbu, Middelburg, Shokwe, West Nile                                                      | [101,114,153,175,187] |
| <i>Ae.contigus</i>        | n.a                                                                                                                                                              | /                     |
| <i>Ae.cumminsii</i>       | Middelburg, Nkolbisson, Rift Valley fever, Shokwe, Sindbis, Spondweni                                                                                            | [175,188]             |
| <i>Ae.dalzieli</i>        | Zika, Yellow Fever, Rift Valley Fever, Sindbis, Middelburg, Semeliki forest, Ndumu, Kedougou, Chikungunya, Wesselsbron, Bunyawera, Shokwe, Simbu, Pongola, Zinga | [114,153,179,189]     |
| <i>Ae.dendrophillus</i>   | n.a                                                                                                                                                              | /                     |
| <i>Ae.dentatus</i>        | Yellow Fever, Rift Valley Fever, Wesselsbron                                                                                                                     | [173,175]             |
| <i>Ae.domesticus</i>      | Wesselsbron, Bunyamwera                                                                                                                                          | [101]                 |
| <i>Ae.dufouri</i>         | n.a                                                                                                                                                              | /                     |
| <i>Ae.fraseri</i>         | n.a                                                                                                                                                              | /                     |
| <i>Ae.flavifrons</i>      | n.a                                                                                                                                                              | /                     |
| <i>Ae.fowleri</i>         | n.a                                                                                                                                                              | /                     |
| <i>Ae.furcifer</i>        | Yellow Fever, Bouboui, Chikungunya, Bunyawera, Bouboui, Dengue, Rift Valley Fever, Zika, Bwamba                                                                  | [153,173,175,190]     |
| <i>Ae.gibinsis</i>        | n.a                                                                                                                                                              | /                     |
| <i>Ae.haworth</i>         | n.a                                                                                                                                                              | /                     |
| <i>Ae.ingrani</i>         | n.a                                                                                                                                                              | /                     |
| <i>Ae.irritans</i>        | n.a                                                                                                                                                              | /                     |
| <i>Ae.lili</i>            | Yellow Fever                                                                                                                                                     | [8]                   |
| <i>Ae.longipalpis</i>     | Uganda                                                                                                                                                           | [153]                 |
| <i>Ae.luteocephalus</i>   | Yellow Fever, Chikungunya, Bouboui, Bweyawera, Zika                                                                                                              | [173,175,179]         |
| <i>Ae.mcintoshi</i>       | Pongola, Ndumu, Chikungunya                                                                                                                                      | [175]                 |

|                                |                                                                                                                                                         |                       |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <i>Ae.metallicus</i>           | Yellow Fever, Zika, Bagaza                                                                                                                              | [173,175,185]         |
| <i>Ae.minutus</i>              | Zika, Yellow Fever, Sindbis, Middelburg, Semeliki Forest, Ndumu, Kedougou, Chikv, Wesselsbron, Bunyawera, Shokwe, Simbu, Pongola, Zinga                 | [153,175,179]         |
| <i>Ae.mixtus</i>               | n.a                                                                                                                                                     | /                     |
| <i>Ae.mucidus</i>              | n.a                                                                                                                                                     | /                     |
| <i>Ae.multiplex</i>            | n.a                                                                                                                                                     | /                     |
| <i>Ae.neoaffricanus</i>        | Yellow Fever                                                                                                                                            | [8]                   |
| <i>Ae.nigricephalus</i>        | n.a                                                                                                                                                     | /                     |
| <i>Ae.notoscriptus</i>         | n.a                                                                                                                                                     | /                     |
| <i>Ae.ochraceus</i>            | Ndumu, Rift Valley Fever                                                                                                                                | [175,189]             |
| <i>Ae.opok</i>                 | Yellow Fever, Chinkungunya, Bouboui, Orungo, Wesselbron, Zika, Bozo, Wamba, Uganda, Bouboui, Bozo, Middelburg, Orungo, Saboya, Semeniki Forest, Yaoundé | [116,150,173,175,185] |
| <i>Ae.palpalis</i>             | Rift Valley Fever, Simbu, Uganda                                                                                                                        | [150]                 |
| <i>Ae.polynesiensis</i>        | n.a                                                                                                                                                     | /                     |
| <i>Ae.procax</i>               | n.a                                                                                                                                                     | /                     |
| <i>Ae.simpsoni</i>             | Yellow Fever, Chinkungunya, Babanki, Ngari, Bwamba, Uganda, Bouboui, Bozo, Middelburg, Orungo, Saboya, Semeniki Forest, Yaoundé                         | [101,173,175,185,186] |
| <i>Ae.simulans</i>             | n.a                                                                                                                                                     | /                     |
| <i>Ae.soleatus</i>             | n.a                                                                                                                                                     | /                     |
| <i>Ae.stockesi</i>             | n.a                                                                                                                                                     | /                     |
| <i>Ae.subargenteopunctatus</i> | n.a                                                                                                                                                     | /                     |
| <i>Ae.tarsalis</i>             | Pata, Pangola, Kedougou, Wesselbron, Zika                                                                                                               | [150,175]             |
| <i>Ae.tricholabic</i>          | Ndumu                                                                                                                                                   | [175]                 |
| <i>Ae.vexans</i>               | Eastern Equine Encephalitis, Batai, Banna, Japanese Encephalitis, West Nile, Zika, Semiliki Forest, Trivittatus, wesselsbron                            | [153,191]             |
| <i>Ae.vigilax</i>              | Edge                                                                                                                                                    | [153]                 |
| <i>Ae.vittatus</i>             | Yellow Fever, Chikungunya, Sindbis. Middelburg, Semiliki Forest, Ndumu, Kedougou, Wesselsbron, Bunyamwera, Shokwe, Simbu, Pongola, Zinga, Zika, Usutu   | [153,173,175,179,184] |

|                           |                                                                                          |               |
|---------------------------|------------------------------------------------------------------------------------------|---------------|
| <i>Ae.vittiger</i>        | n.a                                                                                      | /             |
| <i>Ae.wellemani</i>       | n.a                                                                                      | /             |
| <i>An. annuliotus</i>     | n.a                                                                                      | /             |
| <i>An.annulipes</i>       | n.a                                                                                      | /             |
| <i>An.arabiensis</i>      | n.a                                                                                      | /             |
| <i>An.ardensis</i>        | n.a                                                                                      | /             |
| <i>An.argenteolobatus</i> | n.a                                                                                      | /             |
| <i>An.austeni</i>         | n.a                                                                                      | /             |
| <i>An.azevedoi</i>        | n.a                                                                                      | /             |
| <i>An.bambusae</i>        | n.a                                                                                      | /             |
| <i>An.barberellus</i>     | n.a                                                                                      | /             |
| <i>An.berghei</i>         | n.a                                                                                      | /             |
| <i>An.bervoetsi</i>       | n.a                                                                                      | /             |
| <i>An.brohier</i>         | Sindbis                                                                                  | [179]         |
| <i>An.brunnipe</i>        | n.a                                                                                      | /             |
| <i>An.buxtoni</i>         | n.a                                                                                      | /             |
| <i>An.caliginosus</i>     | n.a                                                                                      | /             |
| <i>An.carnevalei</i>      | n.a                                                                                      | /             |
| <i>An.caroni</i>          | n.a                                                                                      | /             |
| <i>An.christyi</i>        | n.a                                                                                      | /             |
| <i>An.cinctus</i>         | n.a                                                                                      | /             |
| <i>An.cinerus</i>         | n.a                                                                                      | /             |
| <i>An.claviger</i>        | n.a                                                                                      | /             |
| <i>An.coluzzii</i>        | n.a                                                                                      | /             |
| <i>An.confusus</i>        | n.a                                                                                      | /             |
| <i>An.concolor</i>        | n.a                                                                                      | /             |
| <i>An.coustani</i>        | Bwanba, Chikungunya                                                                      | [175,179]     |
| <i>An.cydippis</i>        | n.a                                                                                      | /             |
| <i>An.dureni</i>          | n.a                                                                                      | /             |
| <i>An.deemingi</i>        | n.a                                                                                      | /             |
| <i>An.demeilloni</i>      | n.a                                                                                      | /             |
| <i>An.distinctus</i>      | n.a                                                                                      | /             |
| <i>An.dthali</i>          | n.a                                                                                      | /             |
| <i>An.domicolus</i>       | n.a                                                                                      | /             |
| <i>An.dualaensis</i>      | n.a                                                                                      | /             |
| <i>An.eouzani</i>         | n.a                                                                                      | /             |
| <i>An.faini</i>           | n.a                                                                                      | /             |
| <i>An.flavicosta</i>      | n.a                                                                                      | /             |
| <i>An.freetownensis</i>   | n.a                                                                                      | /             |
| <i>An.fontenillei</i>     | n.a                                                                                      | /             |
| <i>An.fuscivenosus</i>    | n.a                                                                                      | /             |
| <i>An.funestus</i>        | Ckikungunya, Nyonda,<br>Bwamba, Bunyamwera,<br>O'nyong Nyong, Pongola                    | [175,179]     |
| <i>An.gambiae</i>         | Yellow Fever, Ilesha,<br>Bwamba, O'nyong Nyong,<br>Yaoundé, Tataguine,<br>Bangui, Nyando | [101,173,175] |
| <i>An.garnhami</i>        | n.a                                                                                      | /             |
| <i>An.gabonensis</i>      | n.a                                                                                      | /             |
| <i>An.gibbinsi</i>        | n.a                                                                                      | /             |

|                          |                         |           |
|--------------------------|-------------------------|-----------|
| <i>An.hamoni</i>         | n.a                     | /         |
| <i>An.hancocki</i>       | n.a                     | /         |
| <i>An.hargreavesi</i>    | n.a                     | /         |
| <i>An.harperi</i>        | n.a                     | /         |
| <i>An.hyrceanus</i>      | n.a                     | /         |
| <i>An.implexus</i>       | n.a                     | /         |
| <i>An.jebudensis</i>     | n.a                     | /         |
| <i>An.keniensis</i>      | n.a                     | /         |
| <i>An.kingi</i>          | n.a                     | /         |
| <i>An.leesoni</i>        | n.a                     | /         |
| <i>An.listeri</i>        | n.a                     | /         |
| <i>An.lloreti</i>        | n.a                     | /         |
| <i>An.longipalpis</i>    | n.a                     | /         |
| <i>An.maculipalpis</i>   | n.a                     | /         |
| <i>An.maculipennis</i>   | n.a                     | /         |
| <i>An.marshallii</i>     | n.a                     | /         |
| <i>An.melas</i>          | n.a                     | /         |
| <i>Ae.mercaukensis</i>   | Edge                    | [153]     |
| <i>An.millecampsi</i>    | n.a                     | /         |
| <i>An.mortiauxi</i>      | n.a                     | /         |
| <i>An.moucheti</i>       | Bwanba, Tataguine, Zika | [179]     |
| <i>An.mousinhoi</i>      | n.a                     | /         |
| <i>An.multicinctus</i>   | n.a                     | /         |
| <i>An.namibiensis</i>    | n.a                     | /         |
| <i>An.natalensis</i>     | n.a                     | /         |
| <i>An.nili</i>           | Bwanba, Tataguine       | [179]     |
| <i>An.njombiensis</i>    | n.a                     | /         |
| <i>An.obscurus</i>       | n.a                     | /         |
| <i>An.okuensis</i>       | n.a                     | /         |
| <i>An.ovengensis</i>     | Tataguine               | [179]     |
| <i>An.paludis</i>        | Bouboui                 | [153,175] |
| <i>An.pharaoensis</i>    | n.a                     | /         |
| <i>An.pretoriensis</i>   | n.a                     | /         |
| <i>An.rageaui</i>        | n.a                     | /         |
| <i>An.rhodesiensis</i>   | n.a                     | /         |
| <i>An.rodhaini</i>       | n.a                     | /         |
| <i>An.rivulorum</i>      | n.a                     | /         |
| <i>An.rivulorum-like</i> | n.a                     | /         |
| <i>An.ruarinus</i>       | n.a                     | /         |
| <i>An.rufipes</i>        | n.a                     | /         |
| <i>An.schwetzi</i>       | n.a                     | /         |
| <i>An.seydeli</i>        | n.a                     | /         |
| <i>An.smithii</i>        | n.a                     | /         |
| <i>An.somalicus</i>      | n.a                     | /         |
| <i>An.squamosus</i>      | n.a                     | /         |
| <i>An.symesi</i>         | n.a                     | /         |
| <i>An.tchededii</i>      | n.a                     | /         |
| <i>An.tenebrosus</i>     | n.a                     | /         |
| <i>An.theileri</i>       | n.a                     | /         |
| <i>An.vanhoofi</i>       | n.a                     | /         |

|                             |                                              |               |
|-----------------------------|----------------------------------------------|---------------|
| <i>An.versus</i>            | n.a                                          | /             |
| <i>An.vinckei</i>           | n.a                                          | /             |
| <i>An.walravensi</i>        | n.a                                          | /             |
| <i>An.wellecomei</i>        | n.a                                          | /             |
| <i>An.ziemmani</i>          | n.a                                          | /             |
| <i>An.zombaensis</i>        | n.a                                          | /             |
| <i>Coquelettidia.spp</i>    | Yellow Fever, Rift Valley,<br>Sindbis, Usutu | [173,175,177] |
| <i>Co.annettii</i>          | n.a                                          | /             |
| <i>Co.aurites</i>           | n.a                                          | /             |
| <i>Co.cristata</i>          | n.a                                          | /             |
| <i>Co.fraseri</i>           | n.a                                          | /             |
| <i>Co.fuscopennata</i>      | Sindbis                                      | [175]         |
| <i>Co.maculipennis</i>      | n.a                                          | /             |
| <i>Co.microannulata</i>     | n.a                                          | /             |
| <i>Co.pseudoconopas</i>     | n.a                                          | /             |
| <i>Co.richiardii</i>        | n.a                                          | /             |
| <i>Co.versicor</i>          | n.a                                          | /             |
| <i>Co.xanthogaster</i>      | n.a                                          | /             |
| <i>Cx.albiventis</i>        | Arumowot                                     | [175]         |
| <i>Cx.annulioris</i>        | Kamese, Edge                                 | [153,175]     |
| <i>Cx.annulirostries</i>    | n.a                                          | /             |
| <i>Cx.antenatus</i>         | Rift Valley Fever,<br>Arumowot               | [175,177]     |
| <i>Cx.andersoni</i>         | n.a                                          | /             |
| <i>Cx.argenteopunctatus</i> | n.a                                          | /             |
| <i>Cx.australicus</i>       | n.a                                          | /             |
| <i>Cx.cinerus</i>           | M'Poko, Sindbis                              | [159]         |
| <i>Cx.cinerellus</i>        | n.a                                          | /             |
| <i>Cx.duttoni</i>           | Usutu, Bagaza, wesselsbron                   | [150,153,175] |
| <i>Cx.dezens</i>            | Sindbis, Usutu, Kamese,<br>M'Poko, West Nile | [150,159,179] |
| <i>Cx.eouzani</i>           | n.a                                          | /             |
| <i>Cx.fatigans</i>          | n.a                                          | /             |
| <i>Cx.guarti</i>            | n.a                                          | /             |
| <i>Cx.horridus</i>          | n.a                                          | /             |
| <i>Cx.individiosus</i>      | Sindbis, Usutu                               | [179]         |
| <i>Cx.ingrani</i>           | Bagaza                                       | [175]         |
| <i>Cx.insignis</i>          | n.a                                          | /             |
| <i>Cx.macfieii</i>          | n.a                                          | /             |
| <i>Cx.muspratti</i>         | n.a                                          | /             |
| <i>Cx.musarum</i>           | n.a                                          | /             |
| <i>Cx.simpliciforceps</i>   | n.a                                          | /             |
| <i>Cx.moucheti</i>          | Ntaya                                        | [101]         |
| <i>Cx.modestus</i>          | West Nile                                    | [9]           |
| <i>Cx.molestus</i>          | n.a                                          | /             |
| <i>Cx.neavei</i>            | Spondweni, Bagaza, West<br>Nile              | [175,189]     |
| <i>Cx.nebulosus</i>         | n.a                                          | /             |
| <i>Cx.orbostiensis</i>      | n.a                                          | /             |
| <i>Cx.ornothoracic</i>      | n.a                                          | /             |

|                            |                                                                                                                                             |                 |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| <i>Cx.perexiguus</i>       | n.a                                                                                                                                         | /               |
| <i>Cx.perfuscus</i>        | Sindbis, Usutu, Bagaza,<br>M'Poko, Tataguine, West<br>Nile                                                                                  | [150,179]       |
| <i>Cx.perfidiosus</i>      | n.a                                                                                                                                         | /               |
| <i>Cx.pipiens</i>          | Chikungunya, Rift Valley<br>Fever, West Nile                                                                                                | [9,177,179,180] |
| <i>Cx.phillipi</i>         | n.a                                                                                                                                         | /               |
| <i>Cx.poecilipes</i>       | West Nile, Bagaza                                                                                                                           | [189]           |
| <i>Cx.poecilipes</i>       | n.a                                                                                                                                         | /               |
| <i>Cx.pruina</i>           | Kamese, Bozo                                                                                                                                | [150,175]       |
| <i>Cx.quasiguiarti</i>     | n.a                                                                                                                                         | /               |
| <i>Cx.quinquefasciatus</i> | West Nile, Wesselsbron                                                                                                                      | [175]           |
| <i>Cx.rubinus</i>          | Banzi, Yaoundé, Ndumu                                                                                                                       | [175]           |
| <i>Cx.rima</i>             | n.a                                                                                                                                         | /               |
| <i>Cx.sitiens</i>          | n.a                                                                                                                                         | /               |
| <i>Cx.schweizeri</i>       | n.a                                                                                                                                         | /               |
| <i>Cx.semibrunerius</i>    | n.a                                                                                                                                         | /               |
| <i>Cx.simpsoni</i>         | Sondbis, West Nile, Usutu,<br>Wanowri                                                                                                       | [101,175]       |
| <i>Cx.sunyaniensis</i>     | n.a                                                                                                                                         | /               |
| <i>Cx.subaequalis</i>      | n.a                                                                                                                                         | /               |
| <i>Cx.tigripes</i>         | n.a                                                                                                                                         | /               |
| <i>Cx.trifolatus</i>       | Sindbis, Usutu                                                                                                                              | [179]           |
| <i>Cx.univittatus</i>      | Sindbis, West Nile,<br>Wesselsbron, Usutu,<br>Spondweni, Bagaza,<br>Japanese Encephalitis,<br>Eastern Equine Encephalitis,<br>Murray Valley | [101,175]       |
| <i>Cx.watti</i>            | n.a                                                                                                                                         | /               |
| <i>Cx.wigglesworthi</i>    | n.a                                                                                                                                         | /               |
| <i>Cx.taufelii</i>         | n.a                                                                                                                                         | /               |
| <i>Cx.tarsalis</i>         | West Nile                                                                                                                                   | [180]           |
| <i>Cx.telesila</i>         | Sindbis, Usutu                                                                                                                              | [179]           |
| <i>Cx.thalassius</i>       | n.a                                                                                                                                         | /               |
| <i>Cx.theileri</i>         | Rift Valley Fever, Shuni                                                                                                                    | [175,178]       |
| <i>Cx. trifolatus</i>      | n.a                                                                                                                                         | /               |
| <i>Cx.umbripes</i>         | n.a                                                                                                                                         | /               |
| <i>Eretmapodites.spp</i>   | Zika Virus, Spondweni,<br>Simbu                                                                                                             | [101,175]       |
| <i>Er.quinquevittatus</i>  | Zika, Arumwot                                                                                                                               | [175]           |
| <i>Er.chrysogaster</i>     | Semliki forest, Middelburg,<br>Ntaya, Simbu, Nkolbisson,<br>Rift valley                                                                     | [101]           |
| <i>Er.grahami</i>          | n.a                                                                                                                                         | /               |
| <i>Er.inornatus</i>        | Zika, Bouboui                                                                                                                               | [153,175]       |
| <i>Er.pliol</i>            | n.a                                                                                                                                         | /               |
| <i>Ficolbia.spp</i>        | n.a                                                                                                                                         | /               |
| <i>Fi.Flavopicta</i>       | n.a                                                                                                                                         | /               |
| <i>Fi.malfeyi</i>          | n.a                                                                                                                                         | /               |

|                           |                                                                                                     |               |
|---------------------------|-----------------------------------------------------------------------------------------------------|---------------|
| <i>Fi.mediolineata</i>    | n.a                                                                                                 | /             |
| <i>Fi.uniformis</i>       | n.a                                                                                                 | /             |
| <i>Finlayas.spp</i>       | n.a                                                                                                 | /             |
| <i>Lu.tiggipes</i>        | Yellow Fever, Dengue,<br>Japanese Encephalitis, West<br>Nile, Kamese, Mossuril,<br>Sindbis, Babanki | [101,159,175] |
| <i>Ma.africana</i>        | Middelburg, Wesselsbron,<br>Spondweni, Banzi                                                        | [153,175]     |
| <i>Ma.uniformis</i>       | Pongla, Bwamba, O'nyong<br>Nyong, Ndumu, Zika,<br>Spondweni                                         | [175,179]     |
| <i>Mimmonyia.spp</i>      | n.a                                                                                                 | /             |
| <i>Mi.flavopicta</i>      | n.a                                                                                                 | /             |
| <i>Mi. plumosa</i>        | n.a                                                                                                 | /             |
| <i>Oc.rusticus</i>        | n.a                                                                                                 | /             |
| <i>Oc.excrucians</i>      | n.a                                                                                                 | /             |
| <i>Or.reunionensis</i>    | n.a                                                                                                 | /             |
| <i>Uranotaenia.spp</i>    | n.a                                                                                                 | /             |
| <i>Ur.bilineata</i>       | n.a                                                                                                 | /             |
| <i>Ur.cavernicola</i>     | n.a                                                                                                 | /             |
| <i>Ur.cavernicola</i>     | n.a                                                                                                 | /             |
| <i>Ur.nigripes</i>        | n.a                                                                                                 | /             |
| <i>Ur.caliginosa</i>      | n.a                                                                                                 | /             |
| <i>Ur.caeruleocephala</i> | n.a                                                                                                 | /             |
| <i>Ur.machadoi</i>        | Yellow fever, Dengue,<br>Japanese Encephalitis, West<br>nile, Wesselsbron                           | [101,159]     |
| <i>Ur.pallidocephala</i>  | n.a                                                                                                 | /             |
| <i>Ur.balfoui</i>         | n.a                                                                                                 | /             |
| <i>Ur.chorleyi</i>        | n.a                                                                                                 | /             |
| <i>Ur.alboabdominali</i>  | n.a                                                                                                 | /             |
| <i>Ur.mashonaensis</i>    | n.a                                                                                                 | /             |
| <i>Ve.funerea</i>         | n.a                                                                                                 | /             |
| <i>Toxorhinchite.spp</i>  | Mosuril, Kamese                                                                                     | [150]         |

n.a/=not available.

#### 4. Conclusions

Of the 164 eligible papers on the topic used in this study, we found that most of them were from Cameroon, followed by Gabon, but least number was recorded in Equatorial Guinea. The most commonly reported arboviruses to cause epidemics were Chikungunya and Dengue. The entomological records showed >248 species of mosquitoes in different studies related to arboviruses and regrouped under 15 genera with *Anopheles* (n= 100 species), *Culex* (n= 56 species) and *Aedes* (n=52 species) having highest species diversity and broad distribution. Three genera were rarely represented with only one species and included *Orthopodomyia*, *Lutzia*, and *Verrallina*, but individuals of the genera *Toxorhinchites* and *Finlayas* were not identified upto the species level. We found that these two *Aedes* species were involved in major epidemics of the six medically important arboviruses and other rare mosquito genera consisted of competent species and associated to outbreaks of zoonotic arboviruses. The present study shows that the widespread of competent mosquito vectors could lead to the spillover of medically important arboviruses in the region presumably via the free movement of animals and people via porous borders. Although epidemiological studies were found,

they were not regularly documented and this applies to vector competence and transmission studies. Future studies will consider raw data from technical, scientific, and administrative reports/archives (Ministry of Scientific Research and Ministry of Health) and unpublished information in dissertations (research institutions and Universities) that could enable the study more complete. A regional project entitled: Ecology of Arboviruses (EcoVir) is underway in three countries (Gabon, Benin and Cote d'Ivoire) by the authors of this current work to generate more comprehensive epidemiological and entomological field data on this topic.

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