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Prevalence of Dengue Fever Vector, *Aedes aegypti* Linn. (Diptera: Culicidae) Larvae in Jazan Governorate, Kingdom of Saudi Arabia

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ABSTRACT

Aedes aegypti is considered a major dengue virus transmitter in the Kingdom of Saudi Arabia (KSA). The present study was performed to investigate the prevalence of *Ae. aegypti* aquatic larvae in Jazan Governorate, KSA, as well as the influence of breeding water temperature and potential hydrogen (pH) on its abundance. Six locations in Jazan Governorate were surveyed monthly from January to December 2021. According to the data collected, the highest numbers of collected *Ae. aegypti* larvae (185 and 183) were recorded in January and December from Jizan city, and the lowest numbers of collected larvae (31 and 32) were recorded in May and April from Damad and Ahad Almsarehah cities, respectively. The period from March to June showed the lowest recorded prevalence all over the studied sites. Overall, *Ae. aegypti* larvae recorded the highest prevalence in Jizan city during all months of the study, as compared with other surveyed locations. On the other hand, the lowest water temperature recorded in Jizan City was 24.3±0.4°C in January month. The highest water temperature recorded in Abu Arish city (30.2±0.2°C) was in May, respectively. While in Sabya City, the water temperature varied from 25.3±0.4 to 30.3±0.6°C during the entire study period. Damad City recorded water temperatures at 25.3±0.5 and 29.5±0.3°C in January and July. In addition, the highest water temperature recorded in Ahad EL Masarihah city (31.8±0.1°C) was in July. Moreover, no major differences were found (P>0.05) in the recorded pH values among different months of the study for all surveyed locations. Generally, *Ae. aegypti* has a remarkable prevalence in Jazan Governorate, KSA, throughout all months of the year, and temperature is a reliable factor in its abundance.

Key words: Aquatic Larvae, *Aedes aegypti*, Abundance, Prevalence, Dengue.

INTRODUCTION

Kingdom of Saudi Arabia (KSA) and other countries in the WHO Eastern Mediterranean area account for around 11% of the world's total vector-borne illness burden (WHO 2004). Dengue, malaria, filaria, rift valley fever (RVF) and many other arboviral illnesses are spread by mosquitoes, making them a well-known and unwelcome arthropod vector (Abbas et al. 2014; Elhawary et al. 2021; Shehata et al. 2022). Mosquitoes can harm animals by reducing dairy cows' weight growth and milk output due to the spread of illness (Islam et al. 2017).

Among several mosquito species that have medical importance, the *Aedes* species is becoming the most important worldwide (Alikhan et al. 2014). Many animals and humans are at risk of contracting and spreading arboviruses due to the activities of the *Aedes* species, notably *Ae. aegypti* (Al-Ahmed et al. 2011; Alikhan et al. 2014); however, the dengue fever virus is considered a prime arbovirus disease in KSA (Khater et al. 2013).

The climatic changes, especially rising global temperature, impact the spread of mosquito-borne diseases by increasing mosquito distribution, density and abundance, leading to new diseases, especially in high-temperature regions (Eisen and Moore 2013; Equihua et al. 2017). Understanding and a good knowledge of relevant ecology and biology of different mosquito species become very important for the elimination of mosquito-borne diseases through controlling mosquito vectors' abundance, survival, production, and development (Gimnig et al. 2001; Jemal and Al-Thukair 2016; Shehata et al. 2022).

Insect fauna, especially mosquitoes, which have shown to be essential vectors for many arboviral infections, have been impacted by recent years of intensive societal development and urbanization in the Jazan area. This research was conducted to examine the prevalence of *Ae. aegypti* larvae in Jazan Governorate, KSA, as well as the influence of breeding water temperature and pH on its abundance.

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MATERIALS & METHODS

Ethical Approval

This study was performed according to ethics of Zoology Department, Faculty of Science, Al-Azhar University, Cairo, Egypt.

Study Area

The present study surveyed different locations in Jazan Governorate, Kingdom Saudi Arabia, illustrated in Fig. 1 namely, Jizan city (16°53'05.5"N, 42°33'46.4"E, altitude -40 m), Abu Arish city (16°58'03.0"N, 42°50'17.0"E, altitude -69 m), Sabya city (17°09'14.4"N, 42°37'37.2"E, altitude -36 m), Bish city (17°22'27.2"N, 42°32'13.2"E, altitude -39 m), Damad city (17°06'32.4"N, 42°46'10.9"E, altitude -33 m), and Ahad EL Masarihah city (16°42'38.3"N, 42°57'09.3"E, altitude -71 m). Between January and December of 2022, a poll was conducted.

Collection of *Aedes aegypti* Larvae

Larvae were gathered from the various breeding environments shown in Fig. 2 (water coolers, air conditioner buckets, water reservoirs, animal stripes, automobile tires, and valleys-farms). A rounded net dipper (20cm in diameter) with a stainless-steel handle (150cm in length) was used. Three dips were made randomly in each habitat every month; the larvae were transferred into white pans filled with clean water. Ethyl alcohol 70% was used to sacrifice larvae for identification (Ward et al. 2023). Collected larvae were identified morphologically using a taxonomic key of Rueda (2004).

Temperature and pH of Breeding Water

The ADWA (AD31) instrument was used to take water temperature readings (Waterproof Conductivity-TDS-Temp Pocket Testers with replaceable electrodes). The Hydrogen Potential (pH) was measured with the use of the ADWA (AD11) instrument (Waterproof pH-TEMP Pocket Tester with replaceable electrode).

Statistical Analysis

The results were presented as Mean±SD. ANOVA was used to evaluate the data, as recommended by Bailey (1981). SPSS V.22 was used for data encoding and entry. Quantitative data were reported using mean, median, standard deviation, and standard error; qualitative data were presented with frequency. The threshold for statistical significance was set at $P<0.05$. All stations polled throughout the research period had their parameters' correlation coefficients calculated using the computer application MINITAB V.14. With R-studio 4.1.3, data may be visualized.

RESULTS

Prevalence of *Aedes aegypti* Larvae

The quantity and distribution of *Aedes aegypti* larvae over Jazan Governorate, Saudi Arabia, are shown in Fig. 3. The highest numbers of collected *Ae. aegypti* larvae (185 and 183) were recorded in Jan. and Dec. months from Jizan city. On the other hand, the lowest numbers of collected larvae (31 and 32) were recorded in May and April from Damad and Ahad Almsarehah cities, respectively. Overall, *Ae. aegypti* larvae recorded the highest prevalence in Jizan city during all months of the study, as compared with other surveyed locations.

Fig. 1: Different studied locations in Jazan Governorate, Kingdom of Saudi Arabia.

Heatmap represents the prevalence of *Ae. aegypti* larvae as color-graded cells, as color get darker, the prevalence gets higher; as shown in Fig. 4, Jizan city shows the highest recorded prevalence during January and December. While the period extending from March to June shows the lowest recorded prevalence all over studied sites.

Temperature and pH of Breeding Water

Data in Fig. 5 showed that the lowest water temperature recorded in Jizan city was 24.3±0.4°C in January. The highest water temp. was recorded in Abu Arish region (30.2±0.2°C) in May, respectively. Regarding Sabya City, the water temperature varied from 25.3±0.4 to 30.3±0.6°C during the entire study period. On the other hand, the highest water temperature recorded in Bish City (30.4±0.5°C) was in July.

In Damad city, the lowest and highest water temperatures (25.3±0.5 and 29.5±0.3°C) were recorded in January and July. In addition, the highest water temperature recorded in Ahad EL Masarihah city (31.8±0.1°C) was in July (Fig. 5).

There was no statistically significant difference ($P>0.05$) between any two months, with the exception of January, May, and June, all of which reported statistically significant differences ($P<0.05$) from the other months. In addition, the average monthly temperature of the water used to grow *Ae. aegypti* larvae

Fig. 2: Different studied habitats in Jazan Governorate, Kingdom of Saudi Arabia.

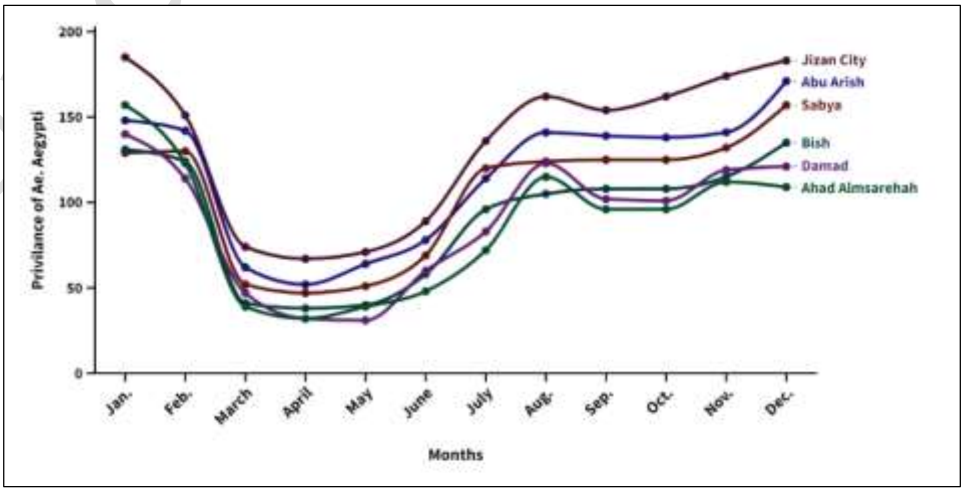

Fig. 3: Gradient line chart represents the prevalence of *Ae. aegypti* larvae in different locations of Jazan Governorate, Kingdom of Saudi Arabia, through the study months.

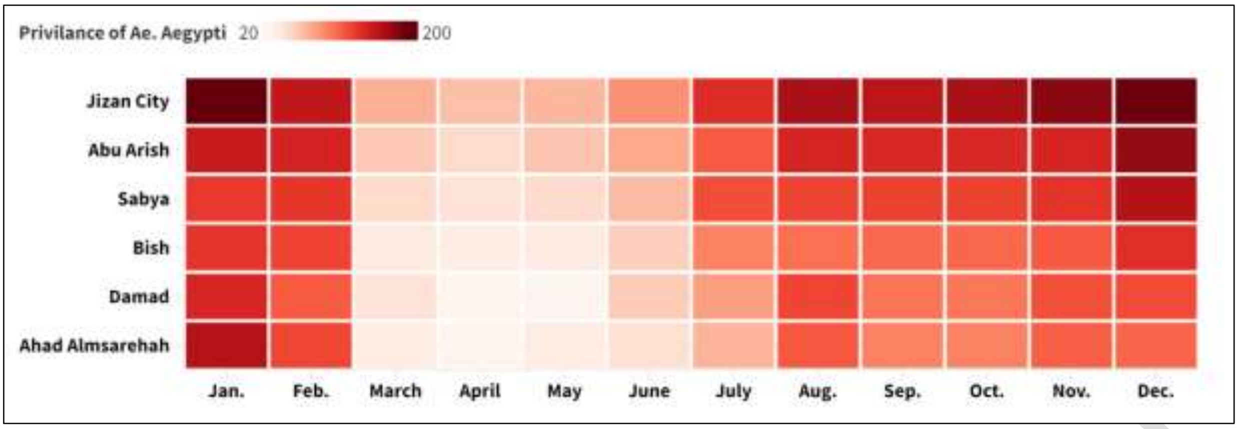

Fig. 4: Heatmap representing the prevalence of *Ae. aegypti* larvae throughout the study period at different locations in Jazan Governorate, Kingdom of Saudi Arabia.

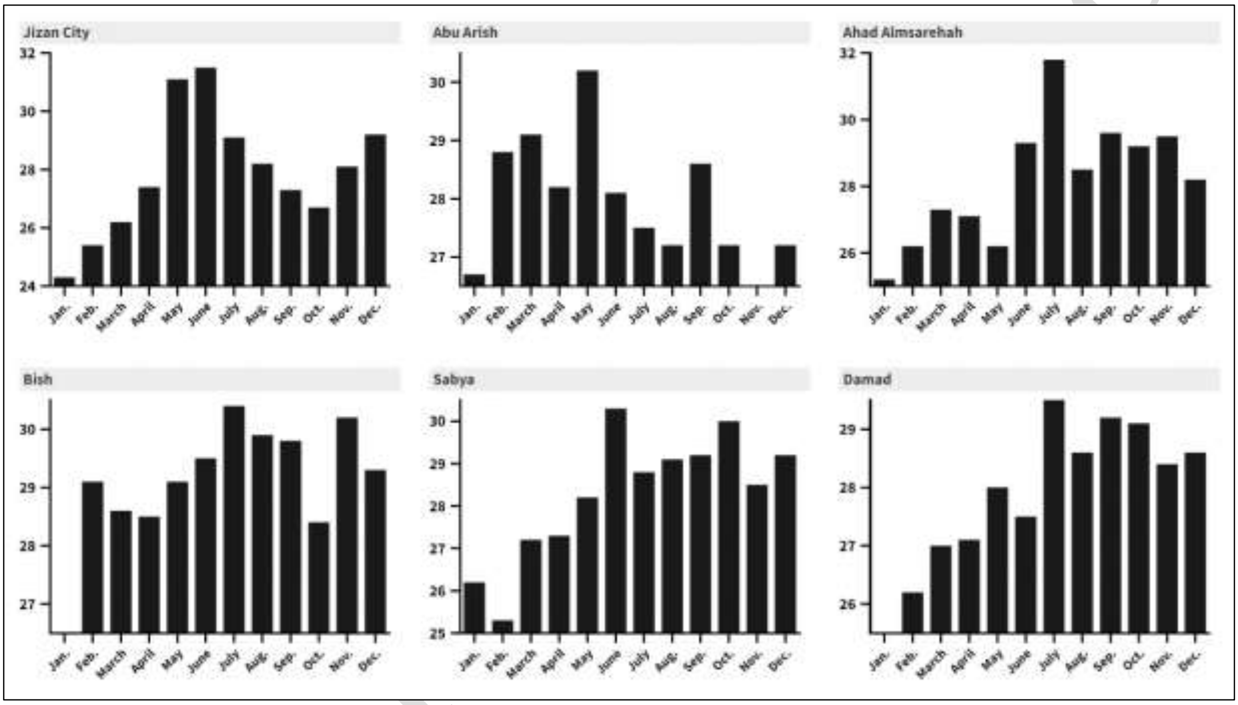

Fig. 5: Gradient column chart of breeding water temperature throughout the study period.

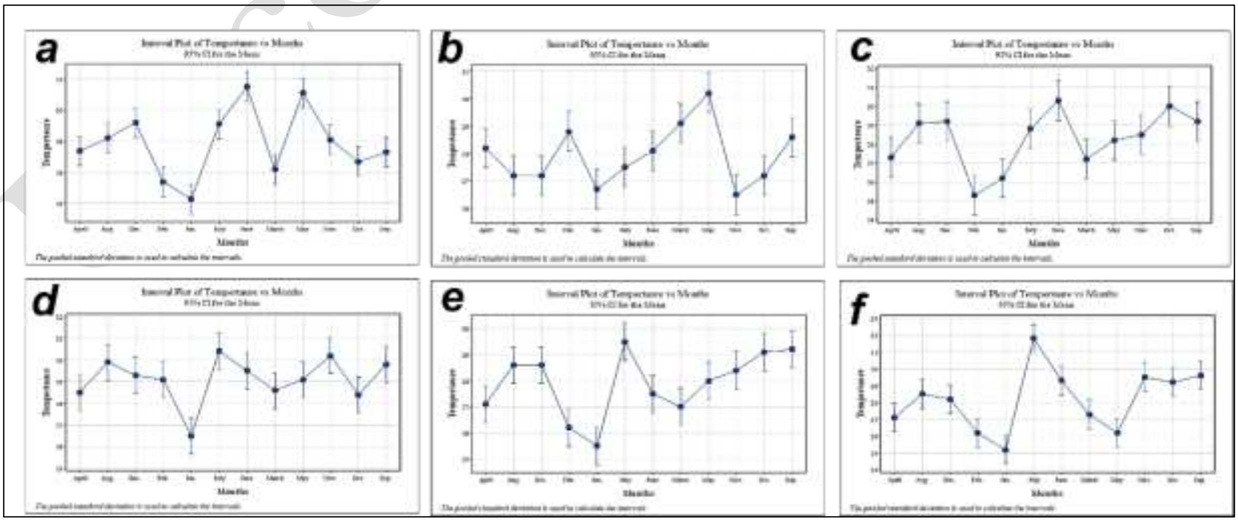

Fig. 6: Interval plot of *Ae. aegypti* larvae breeding water temperature in different locations of Jazan Governorate throughout the study period *(a)* Jizan city, *(b)* Abu Arish city, *(c)* Sabya city, *(d)* Bish city, *(e)* Damad city and *(f)* Ahad EL Masarihah city.

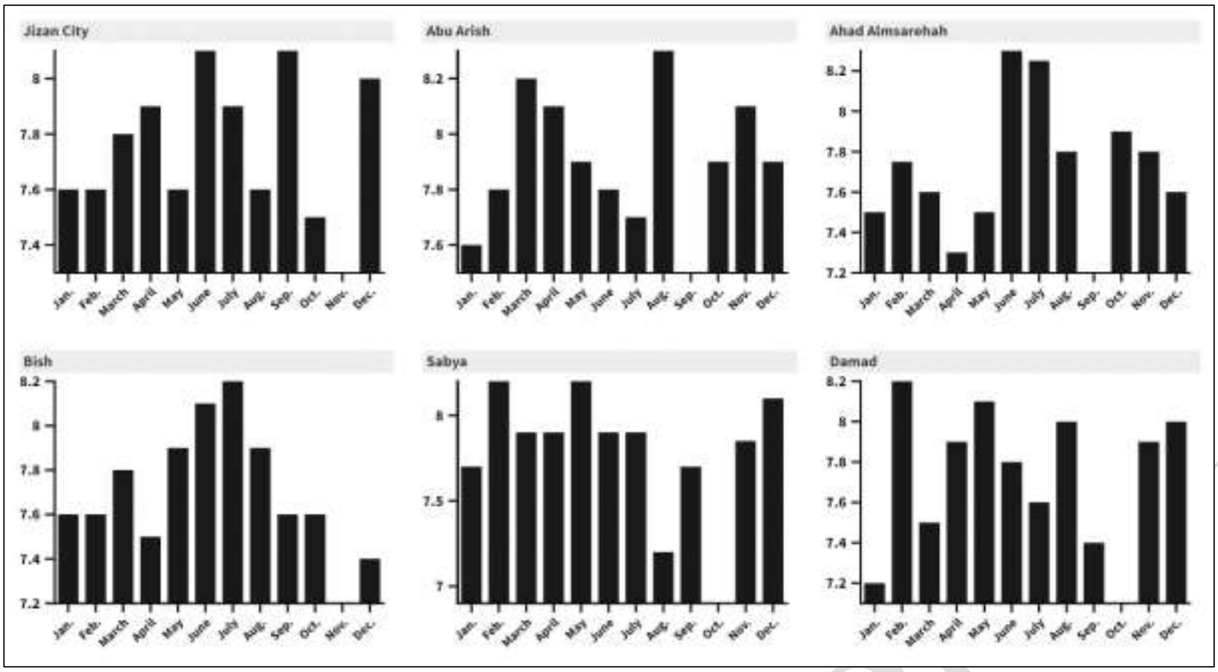

Fig. 7: Gradient column chart of breeding water's pH throughout the study period.

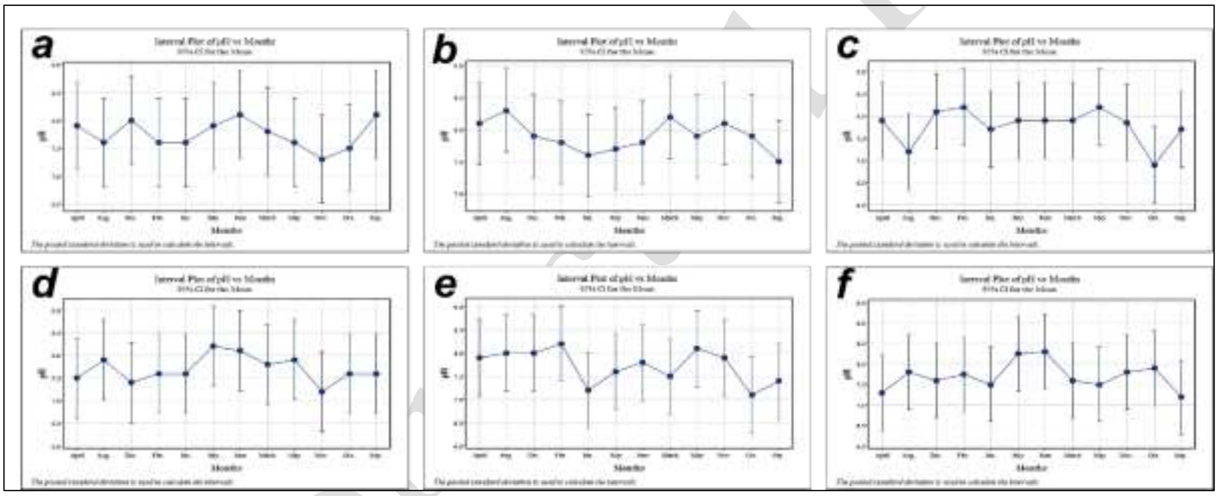

Fig. 8: Interval plot of *Ae. aegypti* larvae breeding water' pH in different locations of Jazan Governorate throughout the study period *(a)* Jizan city, *(b)* Abu Arish city, *(c)* Sabya city, *(d)* Bish city, *(e)* Damad city and *(f)* Ahad EL Masarihah city.

in Abu Arish city did not change significantly (P>0.05) from one month to the next, with the exception of January, May, and November (Fig. 6).

In addition, Jan., July, Sep., and Nov. showed a noteworthy distinction (P<0.05) in *Ae. aegypti* larvae breeding water temperature in Ahad EL Masarihah city compared with other months (Fig. 6).

Data in Fig. 7 revealed that the highest potential hydrogen (pH) values were 8.1±0.5 (recorded in Jizan city during June), 8.3±0.2 (recorded in Abu Arish city during August), 8.2±0.5 (recorded in Sabya city during May), 7.2±0.6 (recorded in Bish city during Nov.), 8.3±0.2 (recorded in Damad city during Feb.) and 8.3±0.3 (recorded in Ahad EL Masarihah city during June), respectively. There was no statistically significant difference (P>0.05) in the recorded pH values among different months of the study for all surveyed locations (Fig. 8).

DISCUSSION

In Jazan Governorate, Kingdom of Saudi Arabia, *Aedes aegypti* larvae were shown to be prevalent during the research period, which spanned the whole year. This opens the door for the transmission of the dengue fever virus. Consistent with these findings, Alahmed (2012) found that *Ae. caspius* was present throughout the eastern part of the Kingdom of Saudi Arabia. In Asir Province, Kingdom of Saudi Arabia, Al Ashry et al. (2014) found that *Aedine sp.* accounts for around 2.0% of all mosquito larvae sampled. Increasing mosquito populations of the *Aedes meigen* species were recorded by Alikhan et al. (2014), while the presence of *Ae. aegypti* (5.26 percent of total collected mosquito species) was reported by Hassan et al. (2017) in the western coastal area Kingdom of Saudi Arabia. Another group of researchers, Shaalan et al. (2017), found *Aedine sp.* in Saudi Arabia's Al-Ahsa Oasis. In addition, Alghamdi et al. (2021) reported the year-round occurrence of *Aedes sp.* in Taif Governorate, Kingdom of Saudi Arabia, with the highest densities and activity levels recorded in the summer and fall (24-30°C), demonstrating the importance of environmental temperature in mosquito existence and distribution.

On the other hand, the temperature in the six breeding sites of Jazan Governorate, Kingdom Saudi Arabia, affected the number of *Ae. aegypti* larvae collected where the highest abundance of larvae was recorded from October to February, where the breeding water temperature ranged from >26 to <29°C (the optimum temperature of larval breeding water). Meanwhile, at temperatures more than 29°C, the number of mosquito larvae decreases. In agreement with the obtained results, Shehata et al. (2022) recorded that the highest abundance of mosquito species in Fayoum Governorate, Egypt, was recorded during summer months when the water temperature was about 28.03°C, respectively. Also, the pH of the studied breeding sites in the six regions ranged from 7.2 to 8.3, indicating water neutrality or slight alkalinity. These results were similar to those of Pelizza et al. (2007), Oyewole et al. (2009), and Elhawary et al. (2020), mosquito larvae prefer water with a pH of 7.0 to 8.0, according to researchers who studied the issue.

Conclusion

In summary, it's obvious that *Aedes aegypti* has a remarkable prevalence in Jazan Governorate, Kingdom of Saudi Arabia, throughout all months of the year, and temperature is a reliable factor in its abundance. However, more research is needed on the role of *Ae. aegypti* in disease transmission in Jazan Governorate.

Conflict of Interest

The authors of the current work declare that they have no conflicts of interest in this work.

Author's Contribution

Ahmed S. Bream and Ahmed Z.I. Shehata: Planned and designed the study and assisted in methodology, formal analysis, and drafting the paper. Ahmed N.G. Abdel-Aziz: sharing in study conception, samples collection and preparation, and participated in drafting the manuscript. All authors read and approved the final manuscript.

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