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Assessment of indoor and outdoor Mosquitoes in a designated student's area in Awka, Anambra state Southeast Nigeria

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Abstract
Mosquitoes has lingered as a public health irritant and prime vectors of both animal and human diseases. A survey of indoor and outdoor mosquitoes in student's area Ifite Awka, Anambra State was carried out between the months of October to December, 2024. The study was undertaken to determine the predominant mosquito species, the feeding and resting activities of mosquitoes. Pyrethrum spray catch (PSC) for indoor biting and resting adult mosquito species and human landing catch (HLC) for outdoor biting adult mosquito species collection methods were embraced during the study. Chi-square test was used to check for relationships between mosquito's adundance and other factors in the study. A total of 191 mosquitoes comprising of 46.1% (88/191) indoor biting and resting adult mosquitoes and (53.9% (103/191) outdoor biting adult mosquitoes were collected. Four mosquito species comprising of *Aedes aegypti* (24.1%), *Aedes albopictus* (4.7%), *Culex quinquefasciatus* (47.1%) and *Anopheles gambiae* (24.1%) were collected. The most abundant mosquito species collected through PSC method were 58% (51/88) *Culex quinquefasciatus* followed by 36.4% of *Anopheles gambiae*, 4.5% of *Aedes aegypti* and 1.1% *Aedes albopictus*. Although the most abundant mosquito species collected through HLC method was *Aedes aegypti* with 40.8% abundance, followed by *Culex quinquefasciatus* with 37.9% and *Anopheles gambiae* was 13.6% abundance whereas *Aedes albopictus* recorded 7.8%. The population of mosquitoes come across in this study is of great public health concern with serious significances when derelict. Therefore, wide-ranging vector management and integrated vector control is very important in plummeting the vector population and is consequently strongly recommended.

Keywords: Assessment, Awka, Anambra State, Indoor and Outdoor Mosquitoes, Student's Area

Introduction

Mosquitoes are regarded as very important insects because of their roles in transmission of many parasitic and viral diseases. Parasitic diseases transmitted by mosquitoes include malaria and filariasis while viral diseases transmitted by mosquitoes include Yellow Fever, Dengue Fever, Chikungunya, Japanese Encephalitis, West Nile Fever and Zika Virus Fever [1]. The health and economic burden associated with these mosquito borne diseases are enormous. For instance, malaria is a parasitic infection transmitted by *Anopheles* mosquitoes. It causes an estimated 249 million cases globally, and results in more than 608,000 deaths every year. Most of the deaths occur in children under the age of 5 years [2]. Dengue is the most prevalent viral infection transmitted by *Aedes* mosquitoes. More than 3.9 billion people in over 129 countries are at risk of contracting dengue, with an estimated 96 million symptomatic cases and an estimated 40,000 deaths every year [1]. Yellow fever is an infectious disease transmitted by mosquitoes that bite mostly during the day. As at 2024, 34 countries in Africa and 13 countries in Central and South America are either endemic for, or have regions that are endemic for, yellow fever [3]. Yellow fever virus is estimated to cause 200,000 cases of disease and 30,000 deaths each year, with 90% occurring in Africa [4]. Over 3000 genera of mosquitoes have been recorded worldwide, but the most important man biting mosquitoes belong to the genera; *Anopheles*, *Culex*, *Aedes*, *Mansonia*, *Haemagogus*, *Sabethes* and *Psorophora*. *Anopheles* species are important vectors of human malaria parasites. Mosquitoes also transmit filariasis, caused by *Wuchereria bancrofti* and *Brugia malayi* as well as certain arboviruses including Tataguine and Guaroa. *Aedes* mosquitoes are important vectors of yellow fever, dengue and encephalitis viruses. Certain *Culex* species also transmit Bancroftian filariasis and a variety of arboviruses including West Nile Virus and St. Louis Encephalitis Virus. *Mansonia* species transmit *Brugia malayi* and sometimes *Wuchereria bancrofti*. *Haemogagus* and *Sabethes* species are vectors of yellow fever. *Psorophora* species are important mainly as nuisance mosquitoes, but also transmit arboviruses including occasionally yellow fever [5]. Mosquitoes are major vectors of public health importance and the most common blood sucking arthropods [6]. They are among the major causes of illness and death particularly in tropical and subtropical countries. In Nigeria, mosquitoes are regarded as public health enemies because of their biting annoyance, noise nuisance, sleeplessness, allergic reaction and disease transmission from their bites cannot be overemphasized [7]. Mosquitoes have worldwide distribution and are found in both tropics and temperate regions of the world. *Anopheles*, *Culex*, *Mansonia* and *Aedes* species are common in the tropics and lay their eggs on the open surface of all sorts of both permanent and temporary water collection, just above the water level on walls of containers or attach them to some partially submerged objects depending on the species [8]. Mosquito bites indoor and outdoor. Indoor or endophilic mosquito is a mosquito that rests indoors, inside a human dwelling, during the period between the end of blood-feeding and the onset of searching for an oviposition site. In

contrast, outdoor or exophilic mosquito spends this period somewhere outside the human dwelling [9]. Environmental changes due to human activities greatly influence the distribution and survival of many mosquito species [10].

[11] Opined that the recent increase in agricultural activities and urbanization contributed to the breeding of different mosquito species. The present reality of demographic growth and urbanization being experienced in many parts of Nigeria has come with many public health problems [12]. These problems, including unplanned urban growth, inadequate waste disposal, irrigation and poor drainage, usually alter ecosystem and thus promote prolific breeding of mosquitoes. Mosquitoes also transmit animal diseases such as fowl pox of poultry, myxomatosis of rabbits, rift valley fever of sheep, encephalitis of horses and birds, dirofilariasis of dogs [13]. Mosquitoes also transmit the relatively new but deadly threat of West Nile virus and while the disease in humans is been deadly but rare, it has quickly become established as a real threat to horses with 40% of horses that contact the disease dying of illness [14]. All these diseases cause great suffering to man and livestock. They do not only cause high morbidity and mortality in human and animal populations, but also lead to huge economic losses [15]. The proper understanding of the environmental factors that promote the breeding of mosquitoes is imperative for successful planning of mosquito control measures. Studies to identify local mosquito species have been carried out in several parts of Nigeria including Ibadan, Lagos, Zaria, Benin, Enugu and Awka [16]. Nevertheless, constant studies of the biology and ecology of mosquitoes have been observed as important measure in mosquito control [17]. The current study will go a long way to determine the existing and disappearing mosquito species and their diverse distribution [18].

Materials and Methods

Study Area

The study was carried out between October, 2024 and December, 2024 in student's area domiciled in Ifite Awka which is located in Awka South Local Government Area in Anambra State, Nigeria. It is bordered by Amansea, Ukukwa, Egbagu, Agu-Awka and Okpuno Awka towns and located between latitude 6° 14' 40" N and longitude 7° 5' 25" E. Mostly populated by students because of the prestigious Nnamdi Azikiwe University Awka. Ifite Awka which is part of Awka city that is located in tropical rainforest zone of Nigeria experiences two distinct seasons which are wet season which occurs from April to October and dry season which takes place from November to March. The temperature is generally 23-30° between June and December but it rises to 25-33°C between January and April, with the last few months of the dry season market by intense heat [19].

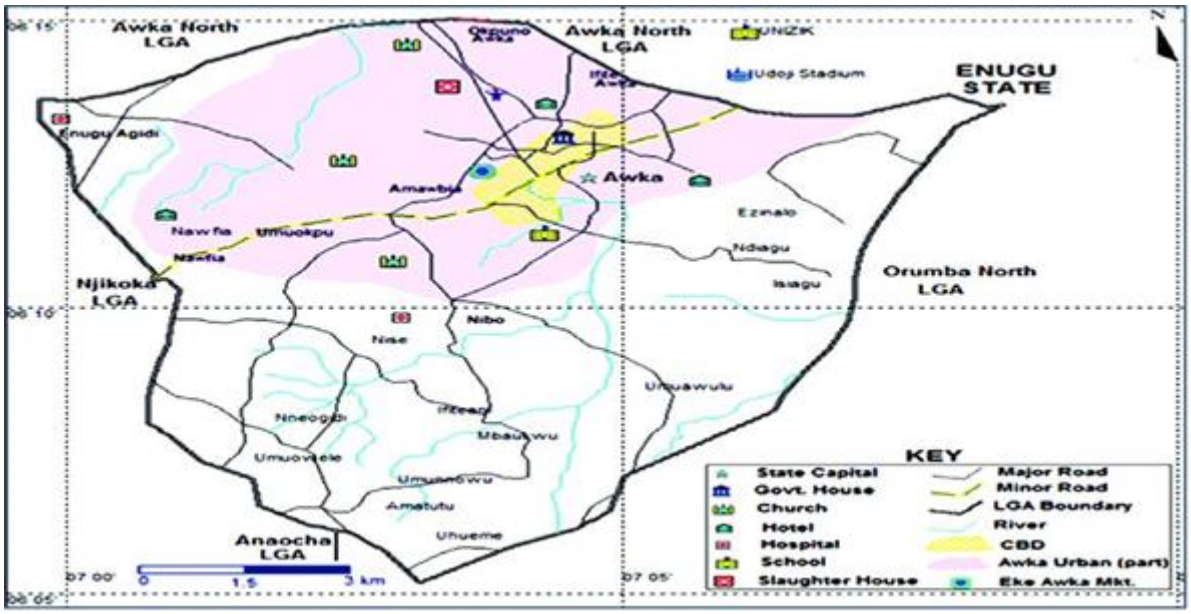

Fig 1: Map showing Ifite Awka in Awka South Local Government Area in Anambra State, Nigeria. Source: Department of Geography, University of Nigeria, Nsukka

Study Design and Sampling Technique

The study design was a cross-sectional descriptive study which was conducted within the dry season and the rooms were randomly sampled during the study.

Advocacy and Mobilization

A letter of introduction was obtained from the Head, Department of Parasitology and Entomology, Nnamdi Azikiwe University Awka. This was presented to individuals whose rooms were used during the indoor spray so to obtain their consent before the commencement of the study.

Collection of Outdoor Mosquitoes Human Landing Catch (HLC) Collection Method

Outdoor biting and resting mosquitoes was collected using the Human landing catch method (HLC). This was carried out according to the World Health Organization standard procedure. Two human volunteers had the sleeves of trousers and shirts rolled to their elbow and knees respectively to expose their hands and legs to mosquitoes bite. The baits sat on low stools at a little distance away from each and search for mosquitoes all over their body with torchlight especially at their lower extremities. Mosquitoes alighting on their body to take blood meal were collected into a test tube and covered with a ball of cotton

wool. At the end of the collection, the mosquitoes were taken to the laboratory for identification.

Collection of Indoor Mosquitoes

Pyrethrum Spray Catch (PSC)

Indoor mosquito collection was done using pyrethrum spray catches (PSC) method as described by [20]. The rationale behind selection of this method is that it is considered most successful in capturing anthropophagic (human biting) and endophilic (indoor resting) mosquitoes. In each selected households, PSC took place between 06.00 am and 09.00 am using pyrethroid (BNC) mosquito spray which contains the following active ingredients (0.26% esbiothrin, 0.28% permethrin, 0.1% beta-cypermethrin and 0.31% lemon). Food and water were removed from the house and white sheets spread out on the floor and over the furniture in the house and all the doors and windows closed. The room was then sprayed with pyrethriod based insecticide and allowed to remain closed for 20 minutes after which the white sheets were brought outside (where there is sufficient light to recover and count the dead and dying mosquitoes). Knocked down mosquitoes were collected with entomological forceps and placed in a damped petri dish before taking to laboratory for proper identification [21].

Fig 2: Image of *Anopheles* Mosquitoes. Source: European Centre of Disease and Control. Accessed on 01/03/2025

Preservation of Adult Mosquitoes

All adult mosquitoes collected were temporarily preserved on moist filter papers in petri dishes as described by [22] and transferred to the laboratory for identification and further analysis.

Morphological Identification of Collected Mosquitoes

The mosquitoes were identified using morphological features as the body colour, nature of the antennae, palps and the markings on the back of the thorax. The *Aedes* species were separated from *culex* species by the presence of alternating white silvery and dark marking on the body surface and legs while the *culex* were pale dull grey coloured mosquitoes with no conscipicous body markings. The *aedes aegypti* were differentiated from *aedes albopictus* by sickle shaped marking at the back of the thorax while *aedes albopictus* has a broad white silvery marking at the back that bifurcates towards the scutellum. The male and female of each species was separated by the presence of plumose antennae in the male and pilose antennae in the female.

Analysis of Data

Data obtained from the survey were subjected to percentages and Chi-square tests using the SPSS Version 29. P values of <0.05 was considered statistically significant.

Results

A total of 191 mosquitoes different species were collected from the study area out of which 46.1% (88/191) were collected through pyrethrum spray catch (PSC) while 53.9% (103/191) mosquitoes were collected using human landing catch as reported in Table 1. Chi square analysis showed that the association between mosquito abundance with the collection method used is strongly significant ($p = 0.00013$, $p<0.05$).

Table 1: Overall mosquito species abundance in the Student's Area Ifite Awka in Awka South L.G.A., Anambra State

Mosquito species	Human bait	PSC collection	Total	Percentage abundance (%)
Culex quinquefasciatus	39(39.8)	51(58.0)	90	47.1
Aedes aegypti	42(40.8)	4(4.5)	46	24.1
Anopheles gambiae	14(13.6)	32(36.4)	46	24.1
Aedes albopictus	8(7.8)	1(1.1)	9	4.7
Total	103(53.9)	88(46.1)	191	100

$X^2 = 44.576$, df = 3, p = 0.00013

Table 2 shows the abundance of indoor mosquito species collected through pyrethrum spray catch method where 36.4% were *Anopheles gambiae*, 58% were *Culex quinquefasciatus*, 4.5% were *Aedes aegypti* and *Aedes albopictus* had an abundance of 1.1%. A total of 40 rooms were sampled across 5 hostels. In the study section, hostel A (22.7%) and hostel B (22.7%) had the highest abundance when compared to hostel E which had the least abundance of 14.8%. However, chi square analysis of abundance of outdoor mosquito in the study section was statistically insignificant ($p = 0.156$, $p>0.05$).

Table 2: Specie and abundance of indoor mosquitoes in the Student's Area Ifite Awka in Awka South L.G.A., Anambra State

Study section/ Hostel	No of rooms sampled	*Anopheles gambiae* (%)	*Cule quinquefasciatus* (%)	*Aedes aegypti* (%)	*Aedes albopictus* (%)	Total Abundance (%)
A	8	10 (31.3)	7 (13.7)	3 (65.0)	0 (0.0)	20 (22.7)
B	8	6 (18.8)	14 (27.5)	0 (0.0)	0 (0.0)	20 (22.7)
C	8	7 (21.9)	8 (15.7)	0 (0.0)	1(100)	16 (18.2)
D	8	5 (15.6)	13 (25.5)	1 (35.0)	0 (0.0)	19 (21.6)
E	8	4 (12.5)	9 (17.6)	0 (0.0)	0 (0.0)	13 (14.8)
Total	40	32 (36.4)	51 (58.0)	4 (4.5)	1 (1.1)	88 (100)

$X^2 = 21.581$, df = 13, p = 0.156

Key- Hostel A: Las Vegas Hostel, Hostel B: Immaculate Hostel, Hostel C: Marshal Hostel, Hostel D: Stay Bridge Hostel and Hostel E: King Dave Hostel.

Table 3 shows the abundance of outdoor mosquito species collected through human landing catch method. Out of the total outdoor mosquitoes collected during the survey comprising *Aedes albopictus*, *Aedes aegypti*, *Culex quinquefasciatus* and *Anopheles gambiae*. *Aedes aegypti* with 40.8% were more abundance than *Culex quinquefasciatus* with 34.3% and *Anopheles gambiae* with 13.7% abundance. Of the sampled area, mosquitoes were more prevalent Hostel A and D 26(25.2%) respectively as compared to Hostel C which had the least abundance of 11.7%. However, chi square analysis of prevalence of outdoor mosquito in study section was statistically insignificant (p = 0.042, p>0.05).

Table 3: Specie abundance of outdoor mosquitoes in the Student's Area Ifite Awka in Awka South L.G.A., Anambra State

Study section/ Hostel	*Anopheles gambiae* (%)	*Culex quinquefasciatus* (%)	*Aedes aegypti* (%)	*Aedes albopictus* (%)	Total Abundance (%)
A	5 (35.7)	7 (17.9)	11 (26.2)	3 (37.5)	26 (25.2)
B	5 (35.7)	10 (25.6)	7(16.7)	1 (12.5)	23 (22.3)
C	1 (7.1)	6 (15.4)	5 (11.9)	0(0.0)	12 (11.7)
D	0 (0.0)	6 (25.6)	16 (38.1)	4 (50)	26 (25.2)
E	3 (21.4)	10 (15.4)	3 (7.1)	0 (0.0)	16 (15.5)
Total	14 (13.6)	39 (37.9)	42 (40.8)	8(7.8)	103 (100)

$X^2 = 21.581$, df = 12, p = 0.042

Key- Hostel A: Las Vegas Hostel, Hostel B: Immaculate Hostel, Hostel C: Marshal Hostel, Hostel D: Stay Bridge Hostel and Hostel E: King Dave Hostel.

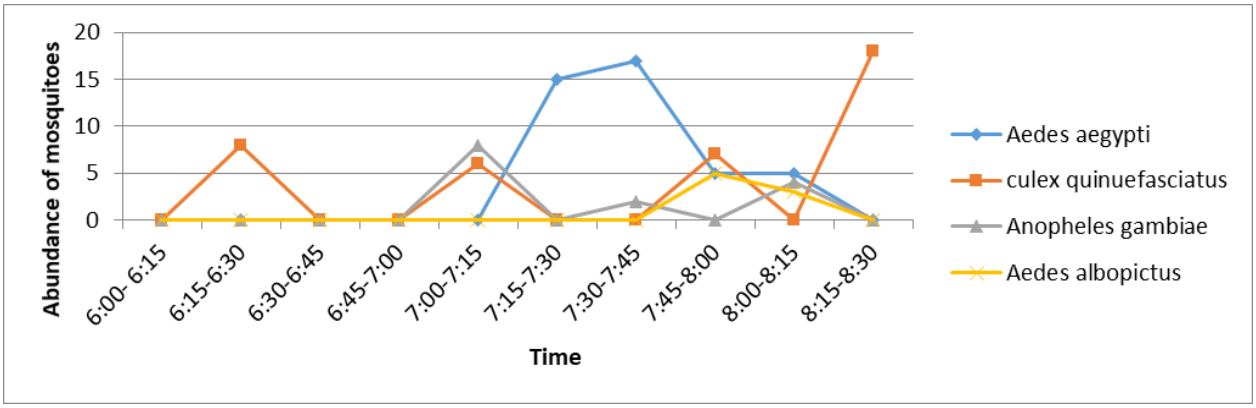

Fig 3: Shows the feeding time of outdoor mosquitos' collection in the Student's Area Ifite Awka in Awka South L.G.A., Anambra State.

NB: Human bait collection carried out between 7:30pm – 7:45pm had the most abundant species of 18.4%. Whereas between 6:00pm-6:45pm, only 7.8% of mosquitoes were collected as against 8:15pm-8:30pm where 17.5% mosquitoes were captured.

Discussion

This study shows the abundance of indoor and outdoor mosquitoes in student area in Ifite Awka using both Pyrethrum Spray Catch (PSC) and Human Landing Collection (HLC). A total of 191 mosquitoes were collected with 47.1% of *Culex quinquefasciatus* having the highest abundant of mosquitoes species collected from the study area. It is observed that there was a low abundance of mosquitoes collected during the dry season of the study as compared with parallel study during the wet season as was earlier reported by [23] in Ohafia, Abia State, Nigeria. This is because rainfall creates water collections and flood pools which increase the numbers of favourable breeding sites for mosquitoes as observed by [24]. Also, [25] observed that mosquito populations in a tropical zoological garden in Enugu, south-eastern Nigeria were least in the dry seasons because most of the larval breeding sites were dried up.

The vector density of indoor mosquitoes observed from the study showed that *Aedes albopictus* alongside with other genera were present in mosquitoes collected. These findings were in agreement with the reports of [26] where a total number of 26,652 mosquitoes of which 17,444 (65.46%) were *Culex* species and 9,208 (34.54%) were *Anopheles* mosquitoes were collected indoors in Kano State, Nigeria. This is in contrast with study done by [27] where Indoor resting density of the mosquito species were*: Cx quinquefascistus* (38.6 mosquito/room), *An. gambiae* (20.5 mosquito/room), *Ae. aegypti* (15.3 mosquito/room), *An. funestus* (7.3 mosquito/room) and *An. nili* (2.9 mosquito/room).

A total abundance of 46.1% indoor mosquitoes were collected during the study period where *Culex quinquefasciatus* (58%) constituted the most abundant species followed by *Anopheles gambiae* (36.4%) and *Aedes aegypti* (4.5%) although there was no insignificant difference between mosquito species and indoor collection. It was also reported by [28] that a high incidence of *Anopheles gambiae* and *Culex quinquefasciatus* occurred in Awka Etiti during their study. This is in contrast with a study conducted by [12] where a total of 2969 mosquitoes which belong to 10 species of mosquitoes were collected during the study period and *Mansonia africana* (35.65%) constituted the most abundant species followed by *Culex quinquefasciatus* (32.23%) and *Anopheles gambiae* complex (13.52%). The high abundance of indoor biting mosquitoes could pose a danger for epidemics if any arthropod-borne virus is introduced into the study area.

The results also observed that *Aedes aegypti* (40.8%) constituted the most abundant species followed by *Culex quinquefasciatus* (37.9%), *Anopheles gambiae* (13.6%) and

Aedes albopictus (7.8%). However, statistical analysis shows that there is no significant difference between the species collected. The availability of these diverse species in these communities studied was due to the presence of ground water pools, domestic containers, poorly drained gutters, plant axils and bushes around household where they breed and readily fly into houses to rest and feed on human host [29]. Available ground water pools, exposed domestic containers around hostels ensured their continuous existence. This is similar to work done by [30] where a total of 1310 outdoor mosquitoes were collected of which *Culex quinquefasciatus* was 73.5% and *Anopheles gambiae* 7.2%.
Biting time of mosquitoes was recorded between 6:15-8:30pm with peak biting activity recorded at 7:30-7:45pm. This is similar to a study carried out by [31] where peak in time of night biting was between 7:00-8:00pm. In the present study, these species bred and fed on human host outdoor which explains their anthropophilic and exophilic behavior. The population of mosquitoes come across in this study is of great public health concern with serious significances when derelict, With its strong research implications and future research work, these mosquitoes with their corresponding molecular species identification is a gap that future research will certainly address. In view of this, wide-ranging vector management and integrated vector control is very paramount in plummeting the vector population and is consequently strongly recommended.

Conclusion and Recommendation

The present study pose a serious epidemiological concern because the mosquito species collected are potential vectors of one mosquito-borne disease or the other. The high population of *Culex* and *Aedes* species of mosquitoes in the area is a danger sign of possible augmentation of any bancroftian or arboviral disease introduced. The need for health education and enlightenment of the residence of the study area on the environmental factors that contribute to mosquito breeding is imperative in the control of mosquitoes which is aimed at plummeting mosquito-man contact and strengthening the health of the people. State Government should also embrace proper ecological sanitation especially in the proper construction and management of drains and implementation of sanctions on sanitary offenders so as to reduce the breeding sites of mosquitoes. Furthermore, increasing environmental modification of the breeding sites of these human disease vectors is of significance and selective vector control measures including larviciding are highly recommended. The current research work suggest that the public should also be advised to employ personal protective measures to prevent mosquito bites. In addition, the State Ministry of Environment should continuously carry out surveillance including monitoring for mosquitoes population to prevent risk of epidemic.

Author contributions: EOO, EOV and OCP wrote the first draft and edited the manuscript, DNA developed the protocol whereas EOO and OCP did the experimental design, oversaw monitoring and study implementation while NFT did the statistical analysis of the work.

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Competing interest: The authors declare that they do not have any conflicts of interest.

Ethical approval and informed consent

We confirm that all methods used in the study were performed in accordance with the relevant guidelines and regulations as approved by the ethical committee. While ethical approval was acquired from the office of the Director, Nnamdi Azikiwe University Human Research Ethics Committee with Reference number: NAU/HREC/2S/02/12/2023/05. The participants were mobilized by a sensitization rally during which the objectives of the study was explained. Participation was voluntary and participants had the liberty to withdraw from the study at any point in time.

Data availability: The data used to support the findings of this study are available upon judicious request.

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