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AEROBIOLOGY OF INSECT PARTS IN AYETORO, OTA, SOUTH WEST, NIGERIA

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ABSTRACT

The growing unpredictability of causal allergens has been ascribed partly to the prevalence of different biological entities with allergenic potential in the atmosphere. A group among the multiple aeroplankton recovered in aerobiology but mostly ignored is arthropod particles. To evaluate the concentration and distribution of these arthropod parts, an aero-sampler (Gbenga-2) placed on a 2m high location was used to collect aeroplankton at Ayetoro-Itele Ota, Southwest Nigeria from January 2015 – November 2015, straddling the wet and dry seasons. Using acetolysis method, arthropod particles were recovered from the trap solution and were analysed palynologically. Microscopic analysis revealed the recovery of 179 aeroplankton out of which 129 were arthropod related elements while fungal hyphae and some pollen constituted the remaining components. Insect legs and hairs were the most abundant while mouthparts and antennae were the least recorded. Arthropod particles were compared with meteorological parameters including rainfall, wind speed, relative humidity, and temperature. There were noticeable monthly fluctuations in the quantity of arthropod particles recovered. Statistical analysis showed significant correlations between relative humidity and insect hairs and wings; rainfall and insect legs and antennae; and temperature and wings. No significant correlation between wind speed and any arthropod particles. These results indicate that there is need for a more comprehensive investigation of these microscopic arthropod particles with respect to their allergenicity upon appropriate identification using molecular technology.

KEY WORDS: *aerobiology, insect parts, allergenicity, meteorological parameters, Nigeria*

INTRODUCTION

Arthropods colonize land conveniently because they possess jointed exoskeletons, which provide them with support, protect them against desiccation, serves as a means of locomotion and support them against gravity (Cohen, 2000). When arthropods die, they make up a portion of the aeroplankton because of the action of wind, hence, occurring as suspended particles in the atmosphere. Essien and Agwu (2013) noted that the atmosphere contains many suspended inorganic and organic particles of varying sizes, diversity, sources and shapes.

Aerobiology has become important because of the link between allergic reactions and suspended biological particles. It has also been used to show how rainfall, relative humidity, temperature, wind speed and direction affect the relative concentration of palynomorphs in the atmosphere (Agwu & Osibe, 1992; Agwu, 1997; Adeniyi *et al*. 2014; Ianovici, 2016; Adeonipekun *et al.* 2016). Gregory & Hirst (1952) initially used the term "airspora" to describe fungal and pollen flora suspended in the air. Subsequently, other biological particulates such as plant fragments, insects and insect parts, protozoan cysts, and seeds were included in the study of aerobiology (Agashe, 2006).

Pollen grains and fungal spores are the commonest suspended bioparticles and this therefore makes them the most studied. Some pollen grains are allergenic and this makes them responsible for some respiratory diseases (Ianovici *et al,* 2013; Adeniyi *et al.,* 2014). Out of all the aerobiological works published in Nigeria, none investigated the presence of arthropod parts, even outside Nigeria, no publication was found with any consideration of the insect components. Adeonipekun (2012), Adeonipekun & John (2011), and Adeonipekun *et al* (2016) are the only major works published on the aeropalynology of the Ayetoro area. All these works focused on pollen and spores mainly. Similarly, other aeropalynological investigations in Nigeria have also concentrated on the popular pollen and fungal spores (Agwu & Osibe, 1992; Agwu, 2001; Agwu *et al.*, 2004; Njokuocha & Osayi, 2005; Njokuocha, 2006; Adekanmbi & Ogundipe 2010; Adeonipekun & John, 2011; Adeonipekun, 2012; Adeonipekun, 2016; Ezike *et al.*, 2016; Adeniyi *et al.,* 2017).

Therefore, considering the regular recovery of these insect parts from atmosphere and their possible implication in allergy, the present effort aims to evaluate their concentration and distribution in the atmosphere in relation to meteorological parameters and seasons. We hope that this will stimulate more attention to these particles and increase our knowledge of their allergenicity.

MATERIALS AND METHODS

Description, climate and vegetation description of study site. The study was carried out in Ayetoro-Itele, Ota in Ado-Odo Local Government Area of Ogun state. Ayetoro-Itele (Coordinates: N 06° 36.391′; E 03° 13.389′′), is a border town to Lagos State, Southwest Nigeria (Adeonipekun, 2012). The study site (Figure 1) is about 200 m from the lush gallery forest along Adanmo River separating Lagos (Ayobo) and Ogun (Aiyetoro-Itele) states in the southern periphery of Ado-Odo Ota Local Government Area (Adeonipekun & John, 2011). Ado-Odo Local Government Area has a population of 526, 565 with an area cover of 878 km^2 (NPC, 2006). Details of the regional and immediate vegetation composition types including the climate of the area are given in Adeonipekun & John (2011).

Sampling design. An aero-sampler - Gbenga-2 (Adeonipekun, 2012, Adeniyi *et al.* 2017) - was placed on a 2 m high stand for eleven months from January 2015 – November 2015 at Ayetoro-Itele Ota, Southwest Nigeria. Each sample was collected at the end of each month. Formalin, water and glycerol were used according to Adeonipekun (2012). Recovered residue was acetolyzed with Acetic anhydride and concentrated Tetra-oxo-sulphate VI acid (H_2SO_4) in the ratio 9:1 according to Erdtman's (1969) method. Sub-samples of the residues were poured gently on glass slides and covered with cover slips. The residue volume was noted (0.1 ml) and a known volume of pure glycerine (0.1 ml) was added in the graduated test-tube.

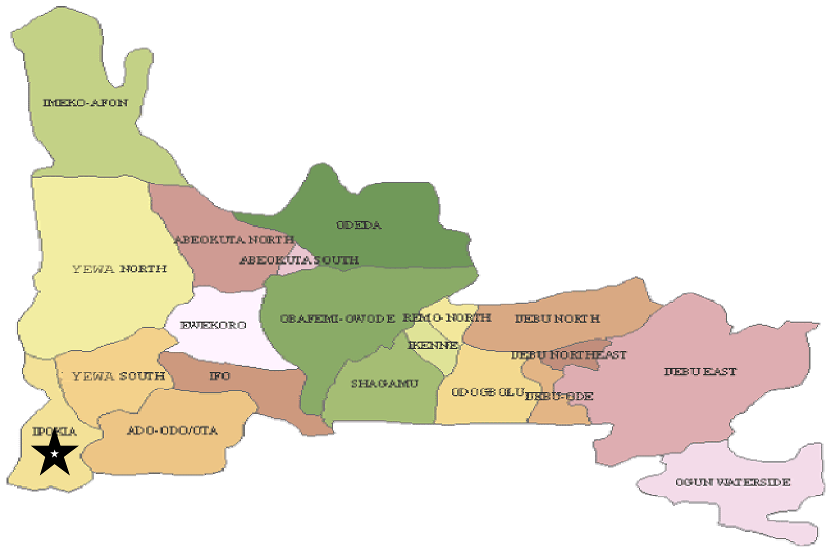

FIG. 1. Map of Ogun State, Nigeria, showing the sampling area.

Identification of arthropods parts. Microscopic study was carried out on each sample with the use of an Olympus CH-2 binocular microscope. Photomicrographs of important insect parts and arthropods were taken with *Motic* Camera Plus 2.0. Identification was done based on the type of mouthpart, wing venation, antennae and other body parts using the works of Martin *et al*. (2007), Choate (2003) and Mathison & Pritt (2014).

Statistical analysis. The statistical package (SPSS version 16.0) was used for data entries. Correlation between the abundance of encountered insect parts and meteorological data was done using Pearson Correlation Coefficient Analysis. Statistical significance was achieved at $p \leq 0.05$. Meteorological data set was secured from the Nigerian Meteorological Agency, Oshodi, Lagos and these data include average temperature, total rainfall, average relative humidity and average wind speed. Seasonal diversity index of recovered arthropod element was computed using PAleontological STatistics software (PAST) version 2.14.

RESULTS AND DISCUSSIONS

Microscopic analysis revealed the recovery of 179 aeroplankton out of which 129 were arthropod related elements while fungal hyphae and some pollen constituted the remaining components (Table 1). They were categorized into legs/limbs (60), wings (16), mouth parts (4), antennae (6), microscopic organisms (19) and hairs (24). Out of the 13 wing types, three were scales of wings belonging to insects of the Lepidoptera order. This was identified based on the work of Martin *et al.* (2007). Six wings were found to belong to the Odonata based on their venations according to the identification manual of Choate (2003).

TABLE 1. Atmospheric particles and their quantity

Particles	Number
Legs	60
Wings	16
Mouth parts	4
Antennae	6
Microscopic organisms	19
Hair	24
Fungal Hyphae	30
Pollen grain	20
Total	**179**

The remaining four were identified as being part of the Diptera. The fragmented legs were suspected to belong to the tarsals of mites. Three mouthparts were identified as that of butterflies, which belong to the Lepidoptera. The other one could not be identified. Two types of antennae were recovered comprising three filiforms (thread-like) and one serrate (saw-like). Hairs also known as setae were identified with reference to internet-based research (www.microlabgallery.com). Seven (7) Psocids (Psocoptera) were identified based on the work of Mathison & Pritt (2014). The identification of the rest could not be achieved.

The most represented arthropod particles were legs/limbs (34%), followed by hairs (13%), organisms (11%), wings (9%), antennae (3%) and mouthparts (2%) as revealed in Figure 2.

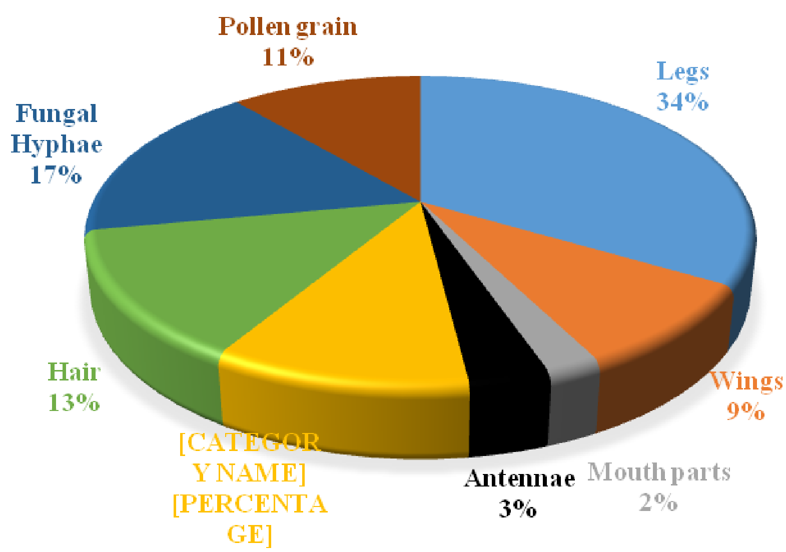

FIG. 2. Percentage composition of the various arthropod particles recovered.

Plate 1a: Strand of hair

Plate 1b: Fragment of an insect's leg

Plate 1c: Fragment of an insect's limb

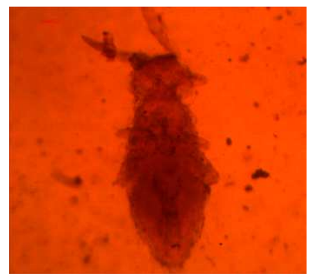

Plate 1d: Unidentified microscopic animal

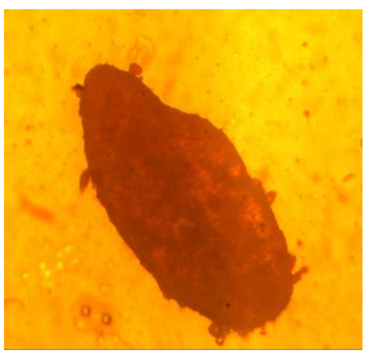

Plate 1e: Microscopic animal

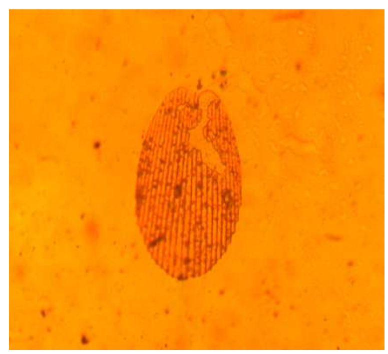

Plate 1f: insect wing

PLATE 1. Photomicrographs of recovered insect parts and microscopic organisms

The highest number of insect parts was recorded in the months of February, January and December while the lowest number was recorded in September, March and June respectively (Table 2). Excluding microscopic organisms, a total of 49 arthropod parts were recorded during the wet season (Table 3) while a total of 63 arthropod parts were recorded during the dry season (Table 4). During the wet season, the highest recovery was recorded in August while lowest was recorded in September (Table 3). However, during the dry season, the highest recovery was recorded in February while the lowest recovery was recorded in March (Table 4). Legs, hairs and wings were more abundant during the dry season while mouthparts were the least recovered. Diversity was observed to be highest during the dry season as compared to the wet season (Table 5).

Significant correlations were observed between different meteorological parameters and insect parts (Table 6). Hairs and wings correlated positively with relative humidity. Antennae and legs correlated positively with rainfall while wings alone correlated positively with temperature. In addition, the species evenness value suggests that arthropod particles are more evenly distributed during the dry season than the wet season.

Eight types of arthropdal elements which totalled 129, were recovered in this study during the dry and wet season (Table 1). The wet season include the months of April, May, June, July, August, September and October while the dry season include the months of January, February, March, and November. Overall, the highest arthropodal elements were recovered during the peak of dry season viz February and January (Table 2). Based on seasonality, more insect parts were recovered during the dry season as compared to the wet season (Table 5). This can be attributed to the influence of climatic factors such as relative humidity, rainfall, temperature, and wind speed on aerofauna dispersal. Observable fluctuations in the abundance or presence of some of the insect parts during the months under study may be attributed to the relative actions of three major meteorological parameters – rainfall, relative humidity and temperature (Table 6). The recovery of insect legs (34%) and hairs (13%) as the largely represented arthropod parts (Figure 2) suggest that these parts are light in weight compared to other parts after being airborne.

TABLE 2. Monthly distribution of recovered arthropod parts

Month	Leg	Antennae	Hair	Wing	Mouth Part	Microscopic organism
January	5	2	4	4	0	0
February	11	2	5	7	1	0
March	2	0	2	1	2	1
April	8	0	2	0	0	0
May	6	0	1	2	0	0
June	0	0	2	0	0	6
July	0	0	1	0	0	9
August	9	1	1	0	0	1
September	5	0	0	0	0	0
October	6	0	3	1	1	0
November	8	1	3	1	0	2

TABLE 3. Distribution of recovered arthropod parts during wet season

WET SEASON						
Insect Parts	**April**	**May**	**June**	**July**	**August**	**September**
Leg	8	6	0	0	9	5
Antennae	0	0	0	0	1	0
Hair	2	1	2	1	1	0
Wing	0	2	0	0	0	0
Mouth Part	0	0	0	0	0	0
Organism	0	0	6	9	1	0
Total	**10**	**9**	**8**	**10**	**12**	**5**

TABLE 4. Distribution of recovered arthropod parts during dry season

DRY SEASON					
Insect Parts	**January**	**February**	**March**	**October**	**November**
Leg	5	11	2	6	8
Antennae	2	2	0	0	1
Hair	4	5	2	3	3
Wing	4	7	1	1	1
Mouth Part	0	1	2	1	0
Organism	0	0	1	0	2
Total	**15**	**26**	**8**	**11**	**15**

TABLE 5. Seasonal diversity index of recovered arthropod elements

	WET SEASON	**DRY SEASON**
Individuals	54	75
Shannon_H	1.761	1.531
Evenness_e^H/S	0.9694	0.9248

TABLE 6. Summary of Pearson's Correlation Coefficient between arthropod elements and meteorological data.

	Relative humidity	**Rainfall**	**Temperature**	**Wind Speed**
Hairs	-.682*	-	-	-
Wings	-.920**	-	-.745*	-
Antennae	-	-.783*	-	-
Legs	-	-.679*	-	-

* Correlation is significant at the 0.05 level (2-tailed)
* Correlation is significant at the 0.01 level (2-tailed)

According to the remark of Wolda (1978), areas with a well-defined rainfall pattern should lack insects during the dry season. However, the result from this work did not support this as we recorded lower abundance of airborne insect parts during the wet season while its abundance peaked during the dry season (Tables 3 and 4). Given that the area under study has a well-defined rainfall pattern, we suspect that insect populations normally increased during the wet season, however due to death during the dry season, their body parts became light and were readily carried by wind during the dry season. This may account for the high recovery during the dry season.

Furthermore, statistical analysis showed that there was a significant correlation between relative humidity and insect hairs and wings; between rainfall and insect legs and antennae; between temperature and wings (Table 6). There is need for more detailed investigation of these relationships so as to determine more accurately the roles each of these meteorological parameters play in the selective recovery of the arthropod parts. The recovery of relatively high proportion of fungal hyphae (Table 1) can be attributed to the cosmopolitan nature in their distribution. Njokuocha & Ukeje (2006) remarked that fungal spores including hyphae make up a good percentage of trapped palynomorphs in the air in lots of aeropalynological studies. This justifies the recovery of fungal hyphae in its observed numbers. In addition, diversity was higher during the dry season (H' 1.384 and evenness 0.7981) than the wet season (H' 0.8648 and evenness 0.4749) (Table 6). Siddiki (2015) observed no significant difference in the effect of seasonality on diversity but recorded higher abundance value during the wet season. Conversely, in this study, arthropod parts were more abundant during the dry season. This may be attributed to the point earlier made that increased insect parts during the dry period could be as a result of death and subsequent incorporation of arthropodal elements into the airspora.

Although, other organisms were not identified, we suspect, based on inferences drawn from morphological features of the recovered arthropod elements that the organisms majorly represented are mites belonging to either the family of Pyroglyphidae or Acaridae and or psocids (Psocoptera). Also supporting this inference was the recovery of recognisable mite parts during the wet season, a period of high relative humidity. Studies have revealed that mites survive in areas with relative humidity higher than 50 % (Bronswijk, 1981; Potter, 2010).

No correlation was observed between wind speed and any of the arthropdal parts. Additionally, the presence of arthropod particles in the atmosphere of the study environment may mean that these insect parts may have served, as vectors of parasites (El-Sherbini, 2011). Arthropod particles may have also been responsible for different forms of allergy when inhaled through the nose as well as exacerbation of asthmatic conditions (Essien & Agwu, 2013).

Allergic reactions in humans may occur when inhaled arthropod particles cause the release of proteins that form antigens to which the immune system reacts, provoking allergic symptoms (Essien & Agwu, 2013). Although this link has not been clinically established, there is therefore a need to use molecular techniques to identify such arthropod particles in order to characterize their protein content. This kind of information will excite allergists who will be able to deploy such information in understanding and accessing the ever-increasing health burdens placed on humans by allergenic cases in order to plan for better response or medication.

CONCLUSIONS

The amount of arthropods recovered varied quantitatively from month to month. The variations in the monthly count of the different parts also suggest that the atmospheric concentration of insect parts vary with the seasons, with the dry season containing more than the wet season. From microscopic and statistical analysis of meteorological effect on insect parts in the atmosphere, it can be said that parameters such as rainfall, relative humidity and temperature confer selective influence on the concentration of insect parts in air. Investigation into the clinical implications of different insect parts that can cause allergies requires experts who can work within an interdisciplinary research frame. This work provides useful information that could be used to establish a correlation between clinical observations, meteorological data sets and variations in types and concentration of insect parts in air.

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REFERENCES

- Adekanmbi O., Ogundipe O. 2010. Aeropalynological studies of the University of Lagos campus, Nigeria. *Not Sci Biol* 2(4): 34–39. DOI: https://doi.org/10.15835/nsb245393
- Adeniyi T., Adeonipekun P., Olowokudejo J., Akande I. 2014. Airborne pollen records of Shomolu Local Government Area in Lagos State. *Not Sci Biol* 6(4): 428–432. DOI: http://dx.doi.org/10.15835/nsb649355

- Adeniyi T.A., Adeonipekun A.P., Olowokudejo J.D. 2017. Annual records of airborne pollen in five areas in Lagos, Nigeria. *Grana* ;1–8 DOI: https://doi.org/10.1080/00173134.2017.1356865
- Adeonipekun A.P., Agabalaya A.E., Adeniyi T. 2016. Aeroplaynology of Ayetoro-Itele, Ota Southwestern Nigeria: A preliminary study, pp. 130-154. In: Oyelaran, PA, Alabi RA, Adeonipekun PA. Human Paleoecology in Africa: *Essays in Honour of M. Adebisi Sowunmi*, University Press Printery, Ibadan, 480 p.
- Adeonipekun P.A., John M. 2011. Palynological investigation of haze dust in Ayetoro, Itele-Ota, Southwest Nigeria. *J Ecol Nat Environ* 3(14): 455–460. DOI: https://doi.org/10.5897/JENE11.082
- Adeonipekun P.A. 2012. Comparative aeropalynology of Ota, Nigeria. *J Ecol Nat Environ* 4(12): 314–320. DOI: https://doi.org/10.5897/JENE12.031
- Agashe S.N. 2006. *Palynology and its Application: Melissopalynology and Floral Phenology*, Oxford and IBH co. Pvt. Ltd, New Delhi, 250pp.
- Agwu C.O.C., Njokuocha R.C., Mezue O. 2004. The study of airborne pollen and spores circulating at 'Head Level' in Nsukka environment. *Bio Res* 2(2): 7–14.
- Agwu C.O.C., Osibe E.E. 1992. Airborne palynomorphs of Nsukka during the months of February-April, 1990. *Nig J Bot* 5: 177–185.
- Agwu C.O.C. 2001. A study of Niger Delta environment through air-borne palynomorphs, Port-Harcourt, Nigeria. *Palaeoecol Afr* 27: 191–205.
- Agwu C.O.C. 1997. Modern pollen rain in Nsukka: An indicator of the vegetation of Nsukka Plateau. *Wurzburger Geogr Arb* 92: 97–115.
- Bronswijk J.E., Van M.H. 1981. House Dust Biology (For Allergists, Acarologists and Mycologists), N.I.B. Publishers, Zoelmond, The Netherlands.
- Choate P.M. 2003. Introduction to the identification of insects and related arthropods. Available from: http://entnemdept.ifas.ufl.edu/choate/insectid.pdf
- Cohen A.C. 2000. New oligidic production diet for *Ixgus hesperus* Knight and *L. linocolaris* (Palisot de Beuvoise). *J Entomol Sci* 35: 301–310. DOI: https://doi.org/10.18474/0749-8004-35.3.301
- El-Sherbini G.T. 2011. The role of insects in mechanical transmission of human parasites. *Iran Red Crescent Med J* 13(9): 678–679. DOI: https://doi.org/10.5812/kowsar.20741804.2253
- Erdtman G. 1969. *Handbook of Palynology: An Introduction to the Study of Pollen and Spores,* Hafner Publishing Co., Munksgaard, Copenhagen. DOI: DOI: https://doi.org/10.1002/fedr.19710810815
- Essien B.C., Agwu C.O.C. 2013. Aeropalynological study of Anyigba, Kogi State, Nigeria. *Standard Sci. Res. Essays* 1(13): 347–351.
- Ezike D.N., Nnamani C.V., Ogundipe O.T., Adekanmbi O.H. 2016. Airborne pollen and fungal spores in Garki, Abuja (North-Central Nigeria). *Aerobiologia* 32(4): 697–707. DOI: https://doi.org/10.1007/s10453-016-9443-5
- Gregory P., Hirst J. 1952. Possible role of basidiospores as airborne allergens. *Nature* 170:414. DOI: https://doi.org/10.1038/170414a0
- Ianovici N. 2016. Methods of biological monitoring in urban conditions: quantification of airborne fungal spores, *Annals of West University of Timişoara, ser. Biology*, 19 (1):87-100.
- Ianovici N., Birsan M.V., Tudorică D., Baliţa A. 2013. Fagales pollen in the atmosphere of Timişoara,Romania (2000-2007), *Annals of West University of Timişoara, ser. Biology*, XVI (2), 115-134
- Martin A., Papa R., Nadeau N.J., Counterman B.A., Halder G., Jiggins C., Kronforst M.R., Long A.D., McMillian W.O., Roberts D.R. 2007. Diversification of complex butterfly wing patterns by repeated regulatory evolution of a Wnt ligand. *Proc Natl Acad Sci* 109(31): 12632–12637. DOI: https://doi.org/10.1073/pnas.1204800109
- Mathison B.A., Pritt B.S. 2014. Laboratory identification of arthropod ectoparasites. *Clin Microbiol Rev* 27(1): 48–67. DOI: https://doi.org/10.1128/CMR.00008-13
- MicrolabNW. 2007. Photomicrograph of thousands of things under the microscope. Available from: http://www.microlabgallery.com/
- National Population Commission. 2006. Report of Nigeria's National Population Commission on the 2006 Census. *Popul Dev Rev* 33(1): 206–210.
- Njokuocha R.C., Osayi E. 2005. Airborne pollen survey in reactions to allergy and plant pathogens in Nsukka, Nigeria. *Nig J Biol Res Biotech* 3(1): 77–84.
- Njokuocha R.C., Ukeje H.O. 2006. The study of airborne precipitation in the University of Nigeria Nsukka. *Bio Res* 4(2): 88–93.
- Ogunyemi S.A., Ajileye O.O., Muibi K.H., Alaga A.T., Eguaroje O.E., Samson S.A., Ogunjobi G.A., Adewoyin J.E., Popoola O.S., Oloko-Oba M.O., Omisore O.O. 2017. Geo-Information and Distribution Pattern of Petrol Service

Station in Sango – Ota Metropolis in Ado – Odo Ota Local Government Area, Ogun State, Nigeria. Asian Res. *J Arts & Soc Sci* 2(1): 2456–4761. DOI: https://doi.org/10.9734/ARJASS/2017/30048

- Potter M.F. 2010. Bed Bugs. Kentucky: University of Kentucky. Available from*:* http://www.uky.edu/Ag/Entomology/entfacts/struct/ef636.htm. Accessed April 26, 2017.
- Siddiki A. 2015. Insect diversity and composition during the wet and dry seasons in three forest types of Johor, Malaysia (MSc dissertation). Johor: Universiti Tun Hussein Onn Malaysia.
- Wolda H. 1978. Seasonal fluctuations in rainfall, food and abundance of tropical insects. *J Anim Ecol* 47: 369–381.