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*GJSFR-D Classification : FOR Code: 070101, 070102, 070105*

MORPHOMETRIC AND LANDMARK BASED VARIATIONS OF APIS MELLIFERA L. WINGS IN THE SAVANNAH AGRO- ECOLOGICAL ZONE OF NIGERIA

*Strictly as per the compliance and regulations of :*

# Morphometric and Landmark Based Variations of Apis mellifera L. Wings in the Savannah Agro-Ecological Zone of Nigeria

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*Abstract* - This study was aimed at identifying the ecotype *Apis mellifera* subspecies in the savannah vegetation zone of Nigeria based on wing morphology and landmarks variations of samples collected from five States of savannah agro-ecological zone in the country. The measured variables were subjected to analysis with parametric statistic tools of mean, standard deviation and standard error. The distribution and relation between them were subjected to two step cluster analysis. Morphoclusters means were presented in centroids and also the simultaneous confidence intervals (95%) of means values of wing morphometric and landmarks were expressed. Savannah vegetation honeybee samples were classified into two distinct morphoclusters. Morphoclusters 1 constituted 56.4% of honeybees in the region while morphoclusters 2 had 43.6%. The within cluster percentage of state of honeybee showed all honeybee samples collected from Kebbi (100%) State were of morphoclusters 1 and also, morphoclusters 2 in Kaduna (100%) and Kwara (100%) States. On the contrary, Abuja (88%) and Adamawa (94%) recorded majority of their honeybees in morphoclusters 1. Twenty as well as six landmarks occurred on the fore and hindwings of the two morphoclusters respectively. The outcome of this research revealed that variations in wing morphometric features and landmarks of honeybee workers can serve as a veritable tool for grouping *Apis mellifera* species in savannah agro-ecological zone of Nigeria into subspecies.

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## I. Introduction

Systematic is a part of the scientific practice known as taxonomy, it involves the use of evolutionary relationships to classify organisms. Classification of insect is done with varying different techniques based on the methods adopted by the taxonomist. Methodology of engaging differences in wing morphology and landmarks by insect taxonomists gave successful identification of insect population into specified races and portray the variations within the specific discriminants (Mendes *et al.*, 2007).

Apiculture entails the management and maintenance of colonies of honeybees (Parker, 1981). Honeybees especially members of the family Helictidae are social insects that exist in colonies. They are kept for highly desirable products such as honey, comb/wax, pollen, propolis, bee venom and royal jelly (Ojeleye, 1999). Historically, anywhere from six to eleven species of honeybees have been recognized (Engel, 1999).

Determination of the subspecies of honeybee in Nigeria is necessary based on the existing discordance of records on the races of honeybees reared in modern apicultural practices in the country. Also, studies on the influence of vegetation distribution on the diversity of honeybee races in the savannah agro-ecological zone of the country have not yet been conducted. This study was aimed at identifying the ecotype *Apis mellifera* subspecies in the savannah vegetation zone of Nigeria based on wing morphology and landmarks variations of samples collected from five savannah agro-ecological zone of the country.

## II. Materials and Methods

### a) Study Site and Collection of Sample

Samples of 7500 honeybee workers were collected from 250 colonies of the savannah agro-ecological zone of Nigeria. Thirty honeybee workers were collected from 50 colonized hives from apiaries in Ilorin (Kwara State), Abuja (FCT), Katari (Kaduna State), Mayo Belwa (Adamawa State) and Zuru (Kebbi State) of Nigeria. Collection of research bees was done from colonies formed by captured swarms and unmanaged for queen replacement. The samples were stored and labelled separately in 70% ethanol container according to their State of collection. These were used for wing morphology and landmarks multivariate analysis in the laboratory.

### b) Morphometric Studies

Laboratory analysis of the wing morphology and landmarks was performed on ten randomly selected samples of honeybee workers obtained from the five savannah vegetation States based on methods used in morphometric analyses of *A. mellifera* (Andere *et al.*, 2008) and use of wing landmarks in classifying bumble bees into subspecies (Aytekin, et. al., 2007). Calibrated hand held digitalised MiScope microscope with magnification range of 40-140x was used in measurement of wing morphometric and landmarks

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features in millimetres and replicated trice. The measured variables includes : The length of the hindwing (LHW), width of the hindwing (WHW), length of the forewing (LFW), width of the forewing (WFW), number of landmarks on the forewing (NLF), number of landmarks on the hindwing (NLH), number of landmarks on the radial cell of the forewing (NLR), length of radial cell (LRC) and width of radial cell (WRC). Raw data for the statistical analysis was obtained from the carefully recorded wing morphometric and landmarks data measured per hive.

*c) Data Analysis*

Analysis of the wing morphology and landmarks data was achieved with SPSS statistic 17 software. Parametric statistic tools of mean, standard deviation and standard error were engaged to differentiate the honeybee samples while the distribution and relation between them were subjected to two step cluster analysis. The morphoclusters means were presented in centroids and also, the simultaneous confidence intervals (95%) of means of wing morphometric and landmarks variables were expressed in charts.

## III. Results

Grouping of savannah vegetation honeybee samples based on wing morphometric and landmarks classified all samples into two distinct morphoclusters. Morphoclusters 1 constituted 56.4% of the honeybee's samples encountered in the savannah agro-ecological zone of Nigeria (Table 1) while the remaining 43.6% formed morphoclusters 2. The within cluster percentage of state of honeybee morphoclusters based on wing morphometric features and landmarks (Table 2) showed that all honeybee samples collected from Kebbi (100%) State were of morphoclusters 1 and also, this trend occurred in distribution of honeybees of morphoclusters 2 in Kaduna (100%) and Kwara (100%) States. Abuja (88%) and Adamawa (94%) recorded majority of their honeybees in the morphoclusters 1 while, the remaining percentages of honeybees i.e. 12% and 6% formed morphoclusters 2 respectively.

Wing morphological differences that exist in the two morphoclusters of honeybees from encountered in the zone (Table 3) revealed that LHW (2.44mm), WHW (0.66 mm) LFW (3.59 mm), NLF (20), LRC (1.30 mm) and WRC (0.19 mm) obtained in morphoclusters 1 were higher than the values of morphoclusters 2 while, the remaining morphometric features had their peaks in morphoclusters 2 except, NLR that had a uniform (5) number of landmarks.

Morphoclusters 2 had mean intervals above the overall means and morphoclusters 1 in LHW, WHW, LFW, LRC and WRC, as well as, 20 landmarks that occurred on the forewings while, morphoclusters 1 had higher mean interval in WFW and number of landmarks on the hindwing (Fig. 1). On the contrary, all NLR obtained from the two morphoclusters were the same with the overall mean.

## IV. Discussion

Honeybee taxonomy can be affected by a number of factors, especially agro-ecological zone. Results obtained from this study revealed that honeybee samples collected from various States in the savannah vegetation zones of Nigeria formed two different morphoclusters. The variations that occurred in the wing morphometric features of honeybees from different States and relativity of some of the features from the same state could be deduced to similarity of biology of honeybee species in the same geographical zone (Winston *et al.,* 1981) while, variations of wing landmarks of *A. mellifera* morphoclusters in the savannah vegetation zone is in line with findings of Mendes, (2007) which reported differences in the wing landmarks of bumble bees collected from the same ecological zone.
Two morphoclusters of honeybees obtained in the five savannahs vegetation States indicated high relativity in the wing morphology and landmarks features in the region. This confirmed the influence of geographical location on the distribution of honeybee's subspecies (Sheppard *et al.,* 1997) and portrayed the morphoclusters encountered as having the ability to survive over a wide range of States in the belt. This was in agreement with Amorin and Ribeiro (2001) findings which stated that honeybee species could migrate over wider vegetation belt in search of food (nectar and pollen), water and appropriate nesting site during swarming season or in period of adverse environmental condition.

The number of landmarks (approximately 20) that occurred on the forewing of morphoclusters 1 and 2 (Plate 1) were the same with the findings on bumble bees (Aytekin, *et. al*., 2007) while the record of approximately 6 landmarks (Plate 2) observed on the hindwings of the two morphoclusters showed similarity between the duo. These conform to the result of using morphometric differences of a single wing cell in classifying *Apis mellifera* into racial types (Francoy, *et. al*., 2006). In addition, the wide variations recorded in nearly all the simultaneous confidence intervals of means of morphometric features and landmarks in the two morphoclusters, confirms the existent of differences in the morphometric features and landmarks of the two morphoclusters. Thus, portrays honeybees of the two morphoclusters as having distinct wing morphometric features and landmarks.

Use of wing morphometric features and landmarks variations in classifying *Apis mellifera* into morphoclusters in this study is an indication that this technique can be adopted in discerning honeybees

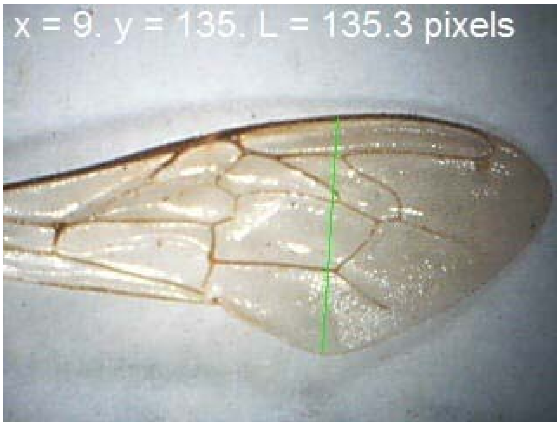


*Plate 1 :* Twenty Landmarks on Forewing

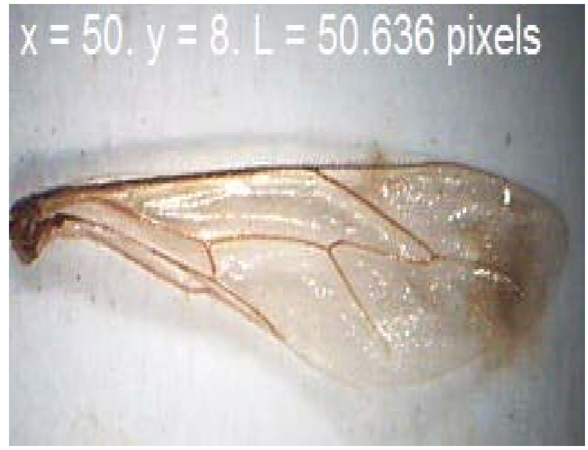


*Plate 2 :* Six Landmarks on Forewing

from this zone into morphoclusters. This is in line with the report of the successful use of morphometric of *A. mellifera* by Andere *et al.,* (2008) and the use of wing landmarks in bumble bees by Aytekin *et al.,* (2007).

## V. Conclusion

The outcome of this research showed that variations in the wing morphometric features and landmarks of honeybee workers can serve as an effective tool for grouping *Apis mellifera* kept in beekeeping practice in savannah agro-ecological zone of Nigeria into subspecies. Research into the genomic variation of the identified morphoclusters need be encouraged, as this will go a long way to trace the phylogeny relationship of the different honeybee morphoclusters in this zone of the country.

## Acknowledgement

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*Table 1 :* Wing Morphology and Landmarks Based Cluster Distribution of Ecotype *Apis mellifera* Species in the Savannah Vegetation Zone of Nigeria

| Cluster | No | % of Combined | % of Total |
|---|---|---|---|
| 1 | 423 | 56.4% | 56.4% |
| 2 | 327 | 43.6% | 43.6% |
| Combined | 750 | 100.0% | 100.0% |
| Total | 750 | | 100.0% |

*Table 2 :* Within Cluster Percentage of State of Ecotype *Apis mellifera* Species Based on Wing Morphology and Landmarks in the Savannah Vegetation Zone of Nigeria

| Cluster | Abuja FCT | | Adamawa State | | Kaduna State | | Kebbi State | | Kwara State | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Frequency | Percentage | Frequency | Percentage | Frequency | Percentage | Frequency | Percentage | Frequency | Percentage |
| 1 | 132 | 88.0% | 141 | 94.0% | 0 | .0% | 150 | 100.0% | 0 | .0% |
| 2 | 18 | 12.0% | 9 | 6.0% | 150 | 100.0% | 0 | .0% | 150 | 100.0% |
| Combined | 150 | 100.0% | 150 | 100.0% | 150 | 100.0% | 150 | 100.0% | 150 | 100.0% |

*Table 3 :* Centroids of Morphoclusters of Ecotype *Apis mellifera* Species Based on Wing Morphology and Landmarks in the Savannah Vegetation Zone of Nigeria

| Cluster | LHW (mm) | | WHW (mm) | | LFW (mm) | | WFW (mm) | | LRC (mm) | | WRC (mm) | | NLF | | NLH | | NLR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| 1 | 2.34 | 0.20 | 0.64 | 0.06 | 3.43 | 0.16 | 1.18 | 0.08 | 1.27 | 0.06 | 0.18 | 0.01 | 19.63 | 0.48 | 5.65 | 0.48 | 5.00 | 0.00 |
| 2 | 2.44 | 0.13 | 0.66 | 0.07 | 3.59 | 0.09 | 1.17 | 0.07 | 1.30 | 0.06 | 0.19 | 0.02 | 20.00 | 0.00 | 5.58 | 0.49 | 5.00 | 0.00 |
| Combined | 2.39 | 0.18 | 0.65 | 0.07 | 3.52 | 0.15 | 1.17 | 0.08 | 1.29 | 0.06 | 0.19 | 0.02 | 19.84 | 0.37 | 5.61 | 0.49 | 5.00 | 0.00 |
| ±SEM | 0.01 | | 0.00 | | 0.01 | | 0.00 | | 0.00 | | 0.00 | | 0.01 | | 0.02 | | 0.00 | |

Length of Hindwing (**LHW**), Width of Hindwing (**WHW**), Length of Forewing (**LFW**), Width of Forewing (**WFW**), No of Landmarks on Forewing (**NLF**), No of Landmarks on Hindwing (**NLH**), No of Landmarks on Radial Cell (**NLR**), Length of Radial Cell (**LRC**), Width of Radial Cell (**WRC**)

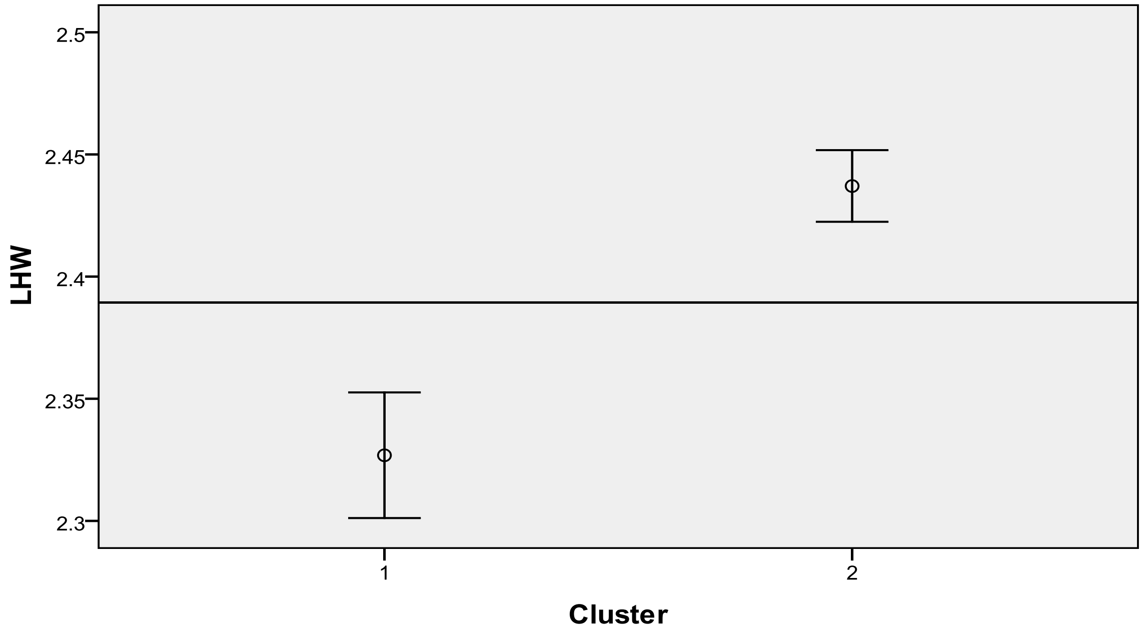



*Figure 1a:* Within Cluster Variation of Means of Length Hindwing (LHW)

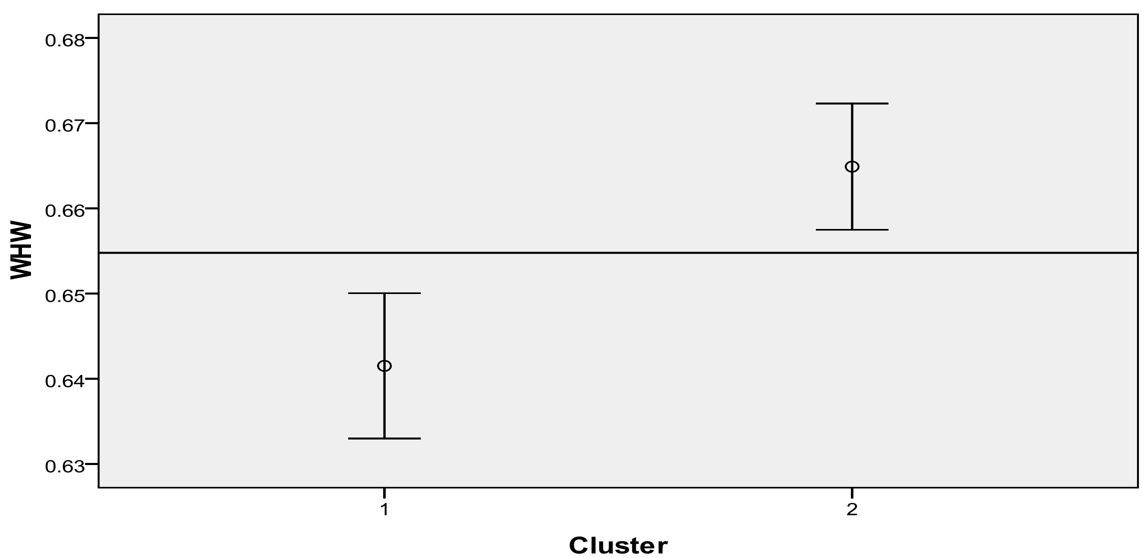
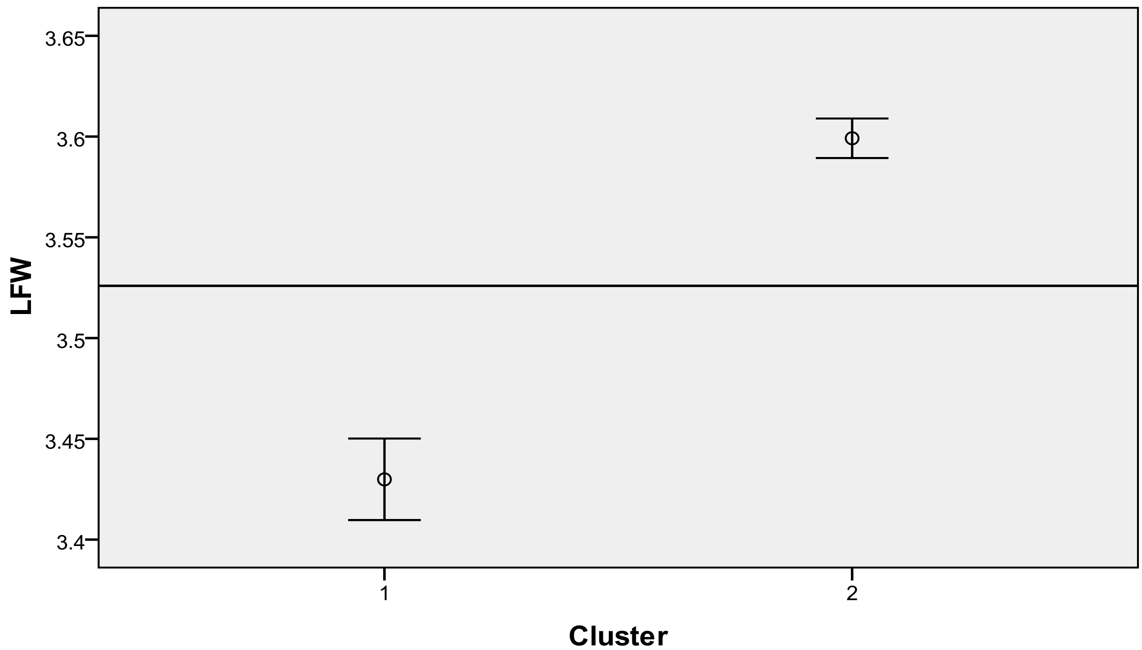
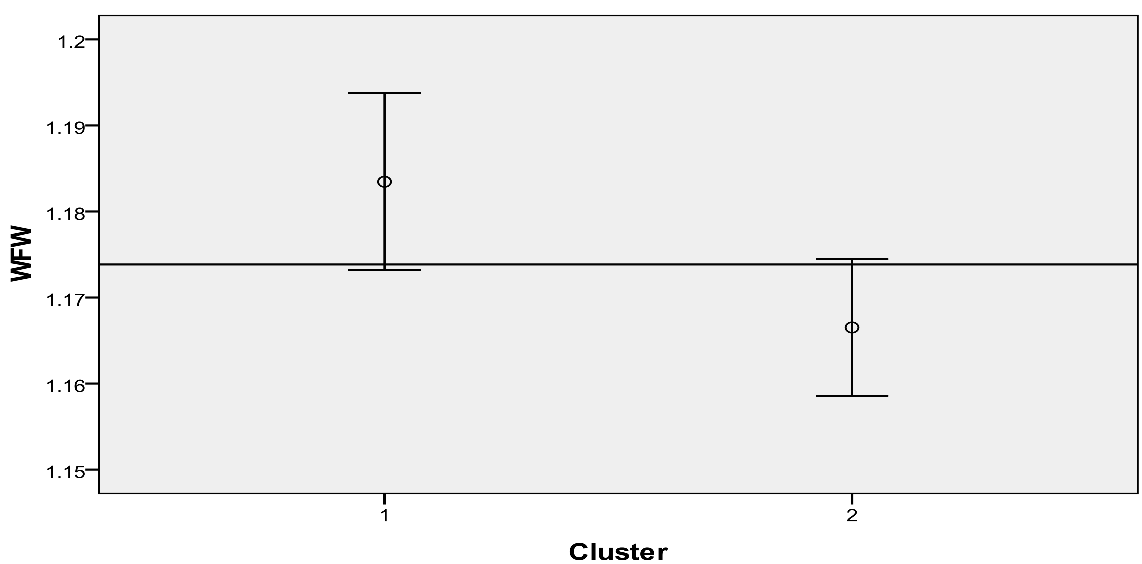



*Figure 1b :* Within Cluster Variation of Means of Width Hindwing (WHW)



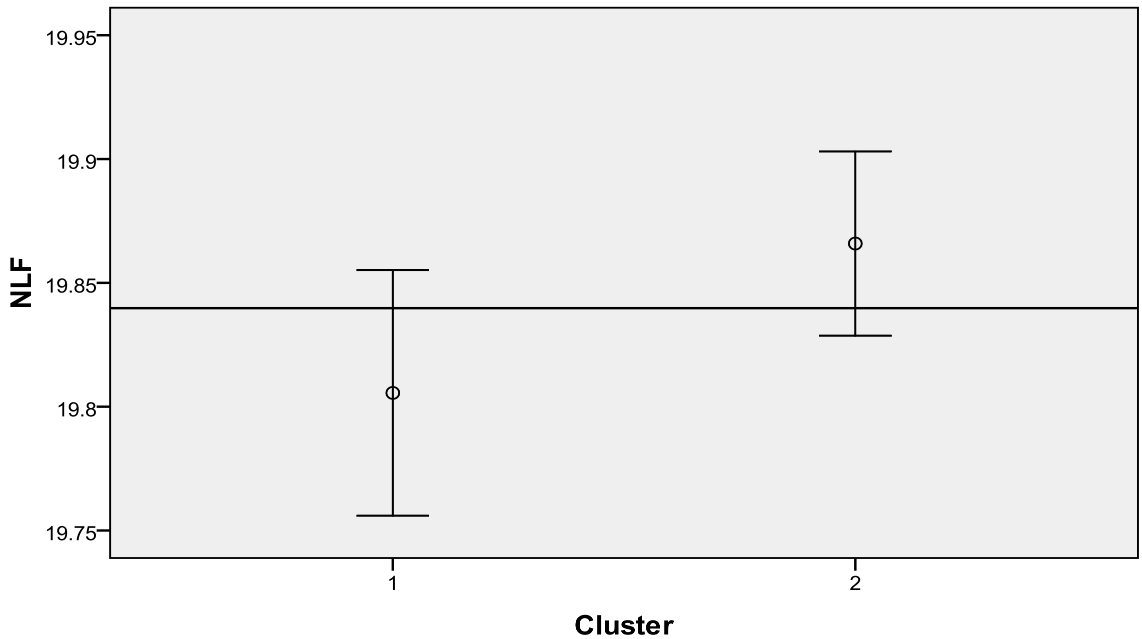

Reference line is the overall mean = 3.53

*Figure 1c :* Within Cluster Variation of Means of Length Forewing (LFW)



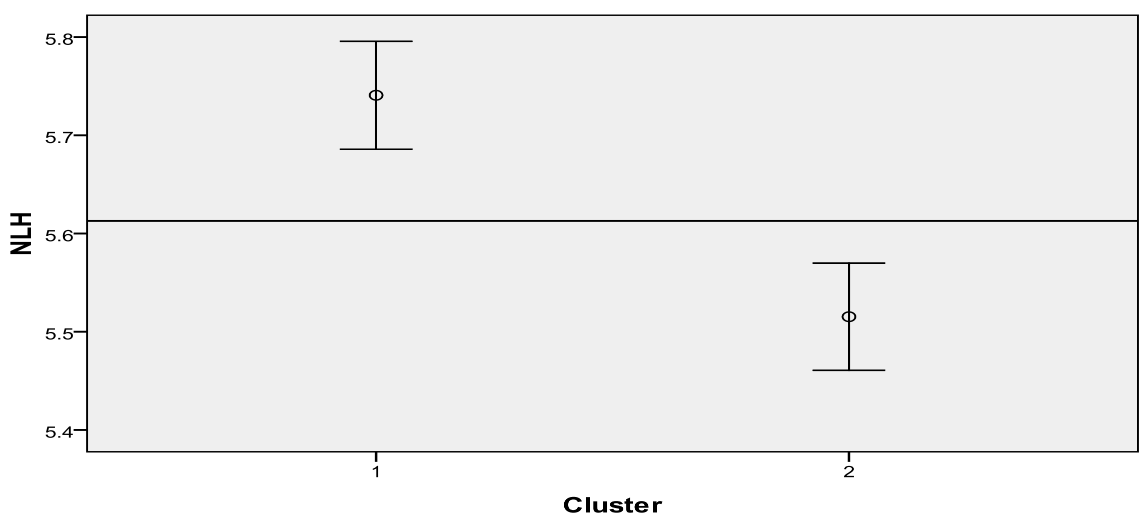

Reference line is the overall mean = 1.17

*Figure 1d :* Within Cluster Variation of Means of Width Forewing (WFW)




Reference line is the overall mean = 19.84

*Figure 1e :* Within Cluster Variation of Means of No of Landmarks on Forewing (NLF)




Reference line is the overall mean = 5.61

*Figure 1f :* Within Cluster Variation of Means of No of Landmarks on Hindwing (NLH)

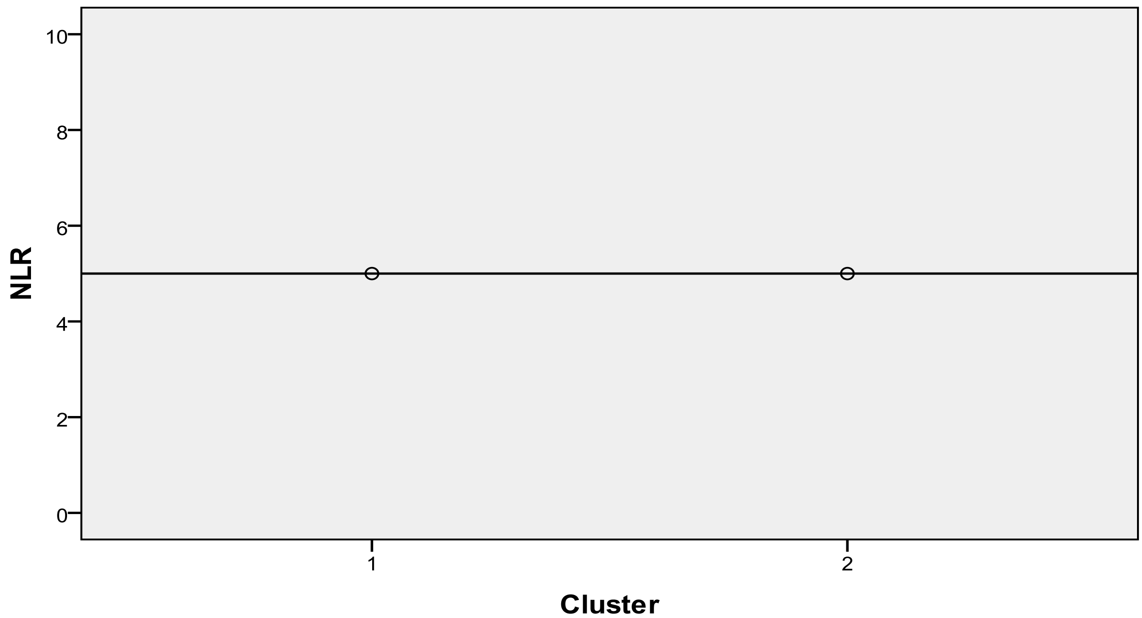



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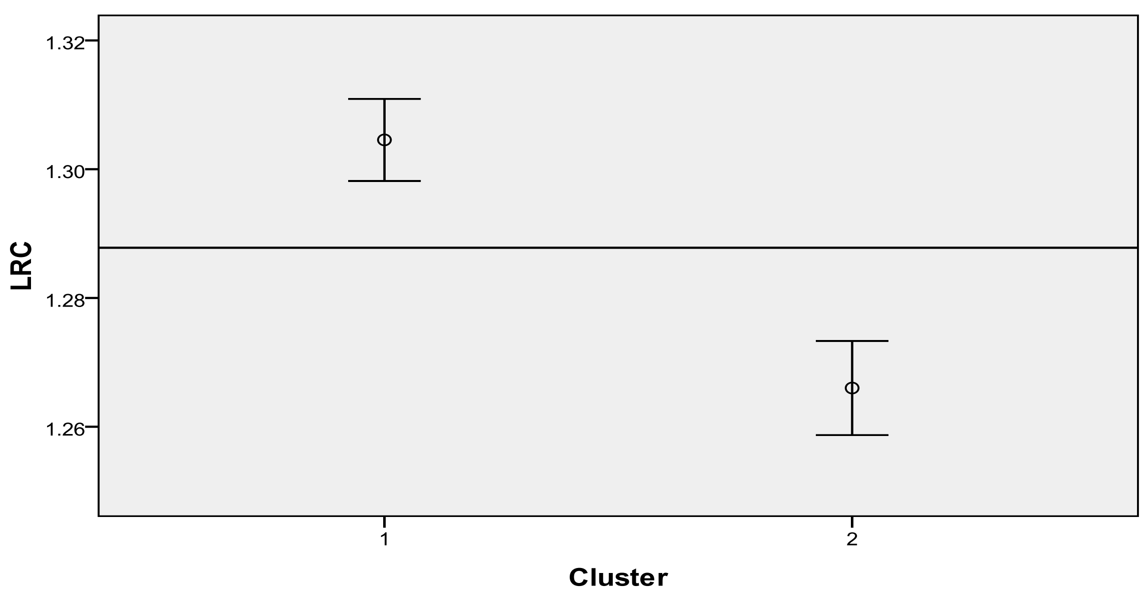
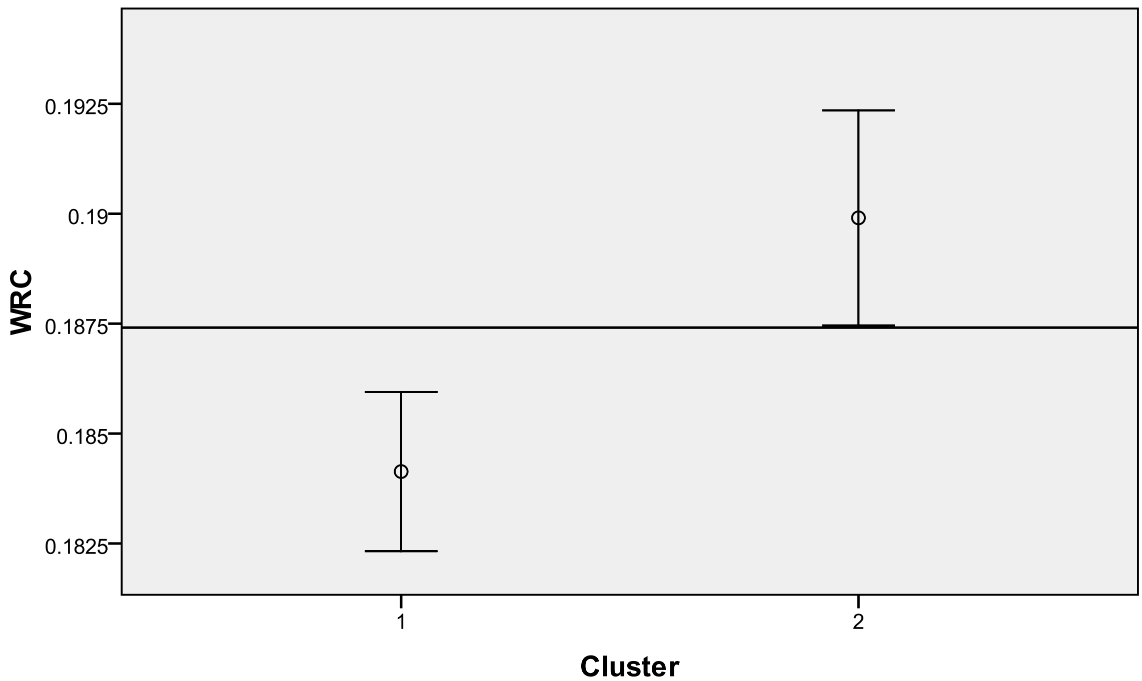
*Figure 1g :* Within Cluster Variation of Means of No of Landmarks on Radial Cell (NLR)




Reference line is the overall mean = 1.29

*Figure 1h :* Within Cluster Variation of Means of Length Radial Cell (LRC)




Reference line is the overall mean = 0.19

*Figure 1i:* Within Cluster Variation of Means of Width Radial Cell (WRC)

*Figure 1:* Simultaneous 95% Confidence Intervals of Means of Mophoclusters Based on Wing Morphology and Landmarks Variables in the Savannah Vegetation Zone of Nigeria