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Full Length Research Paper

Morphological characteristics of *Apis mellifera* L. (Hymenoptera: Apidae) in Kwara State, Nigeria

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Honey bee structures play significant role in its foraging and pollination activity making it the most economically valuable insect. The study was conducted at Beekeeping, Training and Research Centre (BTRC), Amberi, Ajasse-ipo, Irepodun Local Government (LGA) Area of Kwara State, Nigeria. Three hundred (300) worker honeybee samples were randomly collected from thirty (30) colonies at study location. In addition, four hundred (400) worker honeybees were randomly selected from eight LGAs of Kwara State, Nigeria. The worker honey bee samples were preserved in 70% ethanol and were dissected to separate body parts. Ten morphologic characters were measured: Head Length (HDL), Proboscis Length (PBL), Thorax Length (TOL), Antenna Length (ATL), Abdomen Length (ABL), Forewing Length (FWL), Hind Wing Length (HWL), Fore-Leg Length (FLL), Mid-Leg Length (MLL) and Hind-Leg Length (HLL). The results for the 10 external morphologic characteristics measured showed the hind-leg length to be 12.07mm, fore-wing length (9.542mm) and the head length (4.53mm). The result of values obtained for the wet season was HLL 12.07mm, FWL 9.542mm and MLL 8.338mm, while for the dry season HLL 12.06mm, FWL 9.530mm and MLL 8.30mm. It is imperative from the result of this study that beekeepers should monitor and be conversant with growth, development and adaptive indexes so as to check the normal development taking place within the bee's population.

Key words: Morphologic characters, adaptive indexes, bee growth, development, *Apis mellifera L.*

INTRODUCTION

The shape of organisms and their biological structures have been of scientific interest for centuries. This interest stemmed from the fact that most of the structures play significant role in the life and activity of most organisms. Also biological structures are the most conspicuous aspects of an organism's phenotype which normally provides a link between the genotype and the environment (Francoy *et al*., 2006). Honey bees morphologic structures showed various adaptations for foraging, nectar collection, feeding the queen and the larvae, cleaning brood cells; removing debris, honey and pollen storage and rearing of larvae in cells made from wax secreted by the worker bees.

Several works with *Apis mellifera* involving morphologic characters and weight showed that there is strong influence of the environment in the morphology of the same species (Adegbola and Onayinka, 1976; Abou-shaara *et al*., 2012). There is often a positive correlation in some characteristics, for instance the length of the wing and altitude, the size of pollen basket and hind-leg and the size of honey stomach and honey production and storage. Such correlation can indicate the importance of the morphologic characteristics in the adaptation of individuals to the environment (Ajao, 2012).

Structures are adapted for grooming such as brushes, combs, scrapers amongst others and grooming behavior patterns are modified to permit manipulation and packing of pollen in the specialized transport structures. The addition and collection of nectar as well as its packaging permits the carrying of pollen of a great variety of sizes. The addition of oils to the nectar and pollen in some bees has resulted in a modified type of scopal structure that has a wooly area basally and stiff guard hairs extending distally and that can

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transport a mixture of oil and pollen (Cornuet *et al.,* 199; Cornuet and Garnery, 1991; Güler and Kaftanoğlu, 1999a; 1999b; Güler, 2001; Güler *et al.*, 2002; and Tekirdağ *et al.,* 2007).

Various methods have been adopted in identification and measurement of honey bee *A. mellifera* characters which had led to the identification of twenty-seven subspecies of *A. mellifera* based on morphometric characters (Cena and Clark, 1972; Bartholomew, 1977; Casey, 1980; Casey, 1981; and Chappell, 1982 and Bookstein, 1991). The common method for the characterization and classification of honey bee subspecies is based mainly on measuring honey bee wing characters, which were considered as strong tool (Bazzaz, 1998). Various honey bee colonies, races and species were discriminated by employing morphometric analysis.

Morphometrical discrimination of *A. mellifera* subspecies were widely reported in literature and several studies. More than 35 honeybee characters were identified and measured. These include: hair size, fore wing length and colour, (Ruttner *et al.,*1978); cubital index, fore wing length and some wing venation angles (Heinrich, 1986; Hatjina *et al*., 2004). The right side fore and hind wings, (Mazeed, 2004; Miguel *et al.*, 2011). The length of the proboscis was considered a very important character because it shows the geographical variability more accurately than all the other characters (Karacaoğlu and Fıratlı, 1998*;* Kandemir *et al*., 2005)*.*

As numerous and varied as studies on morphometrics on honeybee characters are, there exist a paucity of information on morphologic characteristics of *A. mellifera* for most ecotypes in Nigeria generally and specifically in Kwara State. This study is therefore, designed to investigate the morphometrics of *A. mellifera* adaptation to the ecology, vegetation and climatic conditions in parts of the State.

Materials and Methods

The study Area

The study was conducted at Beekeeping Training and Research Centre (**BTRC**), Amberi, Ajasse-ipo, Irepodun and eight other LGAs of Kwara State, Nigeria. Kwara State lies between latitude 8°10' and 19° 50'N and between longitudes 3° 10'N and 6° 05'E. The area falls within the southern limits of the tropical Savannah zone of Nigeria with mean annual rainfall ranging from 800 mm to 1500 mm, concentrated between the months of April and October with two peaks in July and September (Keay, 1953; Ibiremo *et al*., 2010). The mean annual temperature is between 31.5°C and 35°C. February to April was the hottest months while June to September has the lowest maximum temperature which coincides with the peak of the dry and wet seasons respectively.

The southern savanna zone where Kwara State partly belongs is one of the four major zones into which Keay , (1953) divided the savanna regions of Nigeria. The derived savanna zone extends southwards from the southern guinea zone to the forest zone (Adegbola and Onayinka 1976). Such is the case for some parts of Kwara State such as from Ajasse towards the south which is now described as part of the derived savanna ecological zone.

The State experiences two seasons; the wet season (May-September) and the dry season (October to April). Kwara State lies in two geo-ecological zones; the derived savanna which is characterized by woodland and the Guinea savanna which is characterized by tall grasses growing intermixed with deciduous trees (Adegbola and Onayinka, 1976; Ajao, 2012). The vegetation consists largely of a great expanse of arable land and rich fertile soil. The savannah is characterized by tall grasses intermixed with scattered trees. Economic trees found in the area includes *Citrus sinensi, Parkia biglobosa, Butyrospermum parkii, Azadiracta indica, Mangifera indica, Acacia species, Delonix regia,* and *Anacardium occidentale.* These species of trees provide forage for the honey bees (KWADP, 2008; Ajao, 2012).

Data Collection and Sampling Techniques

The study was conducted in BTRC research centre located in Irepodun LGA, Amberi, Ajasse in 2012 and eight (8) other LGAs in Kwara State, Nigeria. Three hundred (300) worker honeybee samples were randomly collected from thirty (30) colonies in BTRC, Amberi, Ajasse. In addition, fifty (50) worker honey bees were randomly collected from each of the eight LGAs to make a total of four hundred (400) worker honey bees collected in Kwara State, Nigeria. The worker honey bee samples were preserved in 70% ethanol and were then dissected to dismember body parts according to (Ruttner *et al.,* 1978).

All the seven hundred (700) worker honey bee samples were dissected using forceps to separate body parts (head capsules, antenna, thorax, wings, and legs). Ten morphologic characters were measured and recorded: Head Length (HDL), Proboscis Length (PBL), Thorax Length (TOL), Antenna Length (ATL), Abdomen Length (ABL), Forewing Length (FWL), Hind Wing Length (HWL), Fore-Leg Length (FLL), Mid-Leg Length (MLL) and Hind-Leg Length (HLL). All parts which were symmetrical in the honeybee body such as wing and leg were measured on the right organ. Using these variables, the morphometric structure and adaptation of honeybees to vegetation and climatic condition of the area were examined.

RESULTS

The result of the ten major morphologic structures measured in the honey bees of the study area are depicted by acronyms as: Head Length (HDL), Antenna

Table 1. Morphometric structures measured in *Apis mellifera.*

Variables measured (mm)	Abbreviations
Head length	**HDL**
Antenna length	**ATL**
Proboscis length	**PBL**
Thorax length	**TOL**
Abdomen length	**ABL**
Fore-wing length	**FWL**
Hind-wing length	**HWL**
Fore leg length	**FLL**
Mid leg length	**MLL**
Hind leg length	**HLL**

Source: Field survey, 2012, (acronyms adapted by authors).

Table 2. Mean characteristic of 10 external morphological characters of honeybees in Kwara State.

Character	HDL	ATL	PBL	TOL	ABL	FWL	HWL	FLL	MLL	HLL
Mean(mm)	4.53	5.471	6.433	4.736	5.8395	9.542	7.905	8.043	8.338	12.07
Max.(mm)	4.57	5.483	6.466	5.31	6.4433	9.556	7.916	8.056	8.66	12.08
Min.(mm)	4.5	5.4633	6.366	4.617	5.7333	9.533	7.896	8.033	8.44	12.07
STD	0.0092	0.015	0.039	0.4263	0.2798	0.009	0.013	0.013	0.317	0.009

Source: Field survey, 2012, STD (Standard Deviation).

Length (ATL), Proboscis Length (PBL), Thorax Length (T0L), Abdomen Length (ABL), Fore-wing Length (FWL), Hind-wing Length (HWL), Fore-leg Length (FLL), Middle-leg Length (MLL) and Hind-leg Length (HLL) respectively (Table 1).

The results obtained for 10 external morphologic characteristics measured at BTRC's honeybees were presented in Table 2. The mean value obtained for head length(HDL) was 4.53mm, maximum and minimum values of 4.57mm and 4.50mm with standard deviation of 0.0092; ABL mean (5.839mm), maximum (6.443mm), minimum (5.733) and standard deviation (0.279) while for HLL mean was (12.07mm), maximum (12.08mm), minimum (12.07mm) and an STD of 0.009. FWL had a mean of (9.542mm), MLL (8.338mm) and STD of 0.009 and 0.317.The standard eviation obtained for all the morphologic characteristics showed that there is slight variation within the features in Amberi study except for TOL whose standard variation show high variance (0.4263) within TOL feature of worker honey bees.

When the size of structures were compared per seasons of the year (dry and wet season), the result showed that during the wet season HDL had mean of 4.54mm and standard deviation of 0.0135; PBL mean of 6.433 and STD 0.039; HWL (7.905mm, STD 0.013); HLL (12.07mm); FWL (9.542mm); and MLL (8.338mm). During the dry season, HDL recorded mean of 4.5327mm, STD 0.0092;PBL of 6.3866mm STD 0.0258; HWL mean of 7.493mm, STD 0.886. 12.060mm mean was obtained for HLL; 9.530mm for FWL; and 8.300mm for MLL respectively (Table 3).

Table 4 presents the results obtained when the external morphologic characteristics of honey bees were compared between the eight LGA's and BTRC. For HDL a mean of 4.54mm was obtained for the eight LGAs while 5.53mm obtained for the BTRC bees. PBL similarly had 6.418mm (mean) for the bees of LGAs and 6.38mm for BTRC bees.

8.403mm was recorded as mean measurement of the bees of the LGAs and 8.39mm for those of the BTRC for MLL while 12.071mm was obtained as mean for the bees of the LGAs and 12.06mm for those of the CBTR) for HLL

Table 3. Mean of ten external morphological characters of honeybees per season of the year in the studied location.

	Dry season				Wet season			
	Mean	**Std.**	**Min.**	**Max.**	**Mean**	**Std.**	**Min.**	**Max.**
HDL	4.5327	0.0092	4.5	4.57	4.543	0.0135	4.52	4.563
ATL	5.4613	0.0136	5.443	5.497	5.471	0.015	5.4633	5.483
PBL	6.3866	0.0258	6.3333	6.466	6.433	0.039	6.366	6.466
TOL	4.633	0.0205	4.61	5.31	4.736	0.4263	4.617	5.31
ABL	5.98	0.2562	5.5266	6.4433	5.8395	0.2798	5.7333	6.4433
FWL	9.530	0.009	9.51	9.567	9.542	0.009	9.533	9.556
HWL	7.493	0.886	6.87	7.916	7.905	0.013	7.896	7.916
FLL	7.760	0.603	7.333	8.056	8.043	0.013	8.033	8.056
MLL	8.30	0.007	8.373	8.44	8.338	0.317	8.44	8.66
HLL	12.06	0.010	12.043	12.11	12.07	0.009	12.07	12.08

Source: Field survey, 2012.

Table 4. Comparison of some external characteristics of honeybee in parts of Kwara State.

LGA's/Size (mm)	**HDL**	**ATL**	**PBL**	**TOL**	**ABL**	**FWL**	**HWL**	**FLL**	**MLL**	**HLL**
1.**Asa**	4.53	5.471	6.430	4.736	5.839	9.542	7.905	8.043	8.338	12.07
2.**Ekiti**	4.57	5.483	6.461	5.310	6.443	9.556	7.916	8.056	8.66	12.08
3.**Ifelodun**	4.50	5.463	6.366	4.617	5.733	9.533	7.860	8.033	8.44	12.07
4.**Ilorin South**	4.53	5.470	6.433	4.735	5.839	9.545	7.965	8.043	8.338	12.07
5.**Ilorin West**	4.56	5.471	6.430	4.736	5.835	9.542	7.935	8.043	8.338	12.07
6.**Moro**	4.50	5.464	6.366	4.670	5.733	9.530	7.890	8.033	8.44	12.07
7.**Offa**	4.56	5.470	6.433	4.736	5.835	9.542	7.905	8.043	8.338	12.07
8.**Oyun**	4.53	5.471	6.430	4.730	5.895	9.532	7.975	8.043	8.338	12.07
Mean	***4.540***	***5.470***	***6.418***	***4.658***	***5.769***	***9.540***	***7.918***	***8.042***	***8.403***	***12.071***
STD	0.026	0.006	0.034	0.217	0.228	0.008	0.038	0.007	0.113	0.003
Min.	4.500	5.463	6.366	4.617	5.733	9.530	7.860	8.033	8.338	12.07
Max.	4.570	5.483	6.461	5.31	6.443	9.556	7.975	8.056	8.66	12.08
BTRC	**4.530**	**5.460**	**6.380**	**5.980**	**4.630**	**9.530**	**7.490**	**7.760**	**8.390**	**12.060**

Source: Field survey, 2012.

respectively.

DISCUSSION

The data obtained from BTRC were compared with those obtained from eight other Local Government Areas in the state. The result of the study revealed that size of hind-leg (mean 12.065), fore-wing(mean 9.535), mid leg (mean 8.395), fore leg (mean 7.901)and hind-wing(mean 7.704) were generally high compared to the sizes of other morphologic structures measured in study location as shown in Table 1. These structures were found to play prominent roles in the activities of the bees. For example hind-leg bears the pollen basket and pollen brushes, an adaptation for efficiency in pollen collection and transportation. The wings are important for flight during foraging and thermal regulation of comb. These features are frequently used irrespective of period and season of the year and are thus developed as a result of constant use and adaptation to the environment. This finding is indicative of the fact that constant use of certain biological features of organisms aids growth, development and adaptation to environment (Eischen *et al.,* 1982;

Milne and Friars, 1984; Milne *et al.,* 1986).

The value of the sizes of the external morphologic characters showed an increase during the wet than the dry season except for abdomen length. The relatively high measurements obtained for HLL; FWL and MLL during the wet season in Table 2 is likely due to abundant food through flourishing vegetation and water which are perquisite materials for growth. During wet season honey bee of the study area have abundant food, high physiological activity culminating in high growth and development of bee body and parts. This result is in line with those of Kence and Kence (2000) and (Kandemir *et al*., 2005; Mladenovic *et al.,* 2011) who affirmed that environmental changes have a direct influence on honey bee growth and development. A change in climatic conditions is bound to have an impact on the survival of bees in ecotypes and of honey bee species. Therefore, it can be concluded that the value of the external morphologic characters showed an increase during the wet than the dry season.

However, a critical evaluation and comparison of result of measured morphologic characters in BTRC farm with the mean of sampled eight LGAs revealed that the mean values obtained for BTRC farm and the eight LGAs were equal in HDL;ATL;FWL;HWL but differential values were observed for TOL, ABL and MLL. A close observation at the standard deviation of these characteristics will attest to the fact that these features show only very slight variation.

The result on comparison revealed that the HLL mean size obtained for BTRC and the eight LGAs except for Ekiti; FWL obtained for BTRC was while Ifelodun, Moro and Oyun similarly recorded same value while also Asa, Ilorin South, Ilorin West, and Offa recorded same while Ekiti LGA recorded a slightly higher value. The data obtained for the ten morphologic characters were similar in all respects because the vegetation and climatic conditions within the state are not too distinct and the honey bee strains were also similar (Heinrich, 1986; Kandemir *et al*., 1995; Kandemir *et al*., 2000; Kandemir *et al*., 2005; Hatjina et al., 2004; Abou-Shaara *et al.*, 2012).

The result of the measurement of all the external morphologic characters of the honey bees of the BTRC were similarly close to those of the LGA's except for TOL which recorded high value (x = 5.980) in BTRC and ABL which recorded high value (x = 5.980) in 8 LGAs which recorded higher values in all cases (Güler, (2001).

CONCLUSIONS

The study examined the morphometrics of *A. mellifera* adaptation to the ecology, vegetation and climatic conditions in Kwara State. The data obtained for the ten morphologic characters demonstrates very little disparity in size measurement as values were close in all respects because the vegetation and climatic conditions within the state are not too distinct and the honey bee strains were also similar. However, the value of the external morphologic characters showed an increase during the wet than the dry season. It is imperative from the result of this study that beekeepers should monitor and be conversant with growth, development and adaptive traits so as to check the normal development taking place within the bee's population, such growth index as measurement of characters are pointers to adaptive radiation within the prevailing honeybee species of any area. Beekeepers for efficient bee management and production should be cautious of the kind of bee species used for their apiary establishment by having adequate record to properly monitor growth and development.

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