

Assessment of honey production efficiency of Races of *Apis mellifera adansonii* L. in Nigeria

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Nig. J. Ent. 32: 17-22 (2016)

ABSTRACT: Variations in the morphometric features of honeybees encountered in this study were within the range for *A. mellifera adansonii* (below 8mm), while the mean annual honey yield of the races ranged between 9kg in race 1 in the 2010 and 19kg of honey in race 4 in 2008 season. There were significant differences ($P < 0.05$) in honey production among the respective races. Races 3 and 4 produced higher volumes of honey compared with the other races while the lowest volume of honey was recovered from colonies formed by race 1. In addition, positive correlation ($P < 0.01$) was established between honey yield and antenna length (AL, 0.071) ($P < 0.05$), maximum width of abdomen (MWA, 0.084), proboscis length (PL, 0.078), length of pollen basket (LPB, 0.079), width of pollen basket (WPB, 0.186), length of hind wing (LHW, 0.167), length of Forewing (LFW, 0.164), length of femur (LF, 0.143), length of tarsi (M, 0.229) and length of radial cell of the forewing (LRC, 0.109).

Keywords: Honey yield, morphometric features, *Apis mellifera adansonii*, beekeeping seasons, races.

INTRODUCTION

Honey is the most important primary product of beekeeping, both from quantitative and economic points of view compared with the returns established from other hive products such as royal jelly, beeswax, propolis, pollen, bee venom and pollination services (Ojeleye, 2010).

Hundreds of different uses have been identified ranging from utilization as sweetener in baked products, confectionary, candy, marmalades, jams, spreads, breakfast cereals, beverages, milk products and many preserved products as well as in the production of drugs in some pharmaceutical industries (Olstrom, 1983). It was also the first bee product used by man in ancient times (Hussein, 2000). Health considerations and awareness are some of the driving motives behind increasing honey consumption. Pure raw honey which has not

been filtered and ideally taken directly from the hive is a treasure chest of nutritional values and medicinal remedies (Fatunmise, 1997; Ojeleye, 2010).

Morphometrics is the measurement and analysis of morphological characters. It is widely applied in the study of insect life history, physiology and systematics, and also used in measuring both genotypic and phenotypic characteristics including pigmentation, body size and venation of the forewing angle, which represent 82.1% of the total variation found in *Apis mellifera* (Kekeçoğlu *et al.*, 2007). It is also useful as a tool for assessing subspecies limits in *A. mellifera* (Ruttner, 1988), and in the study of genetic variability of honeybees (Kekeçoğlu *et al.*, 2007). Notwithstanding the enormous uses of honey the world over, and in Nigeria where a rich nectar flow is found, relatively small quantity of honey is produced; up to date, no effort has been made to identify the association between morphometric features and wing landmarks of the bee with the quantity of honey produced by the respective races of *Apis mellifera adansonii* kept in beekeeping

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practices in the country. This study was, therefore, conducted to evaluate the honey production efficiency of the races of honeybees reared in beekeeping practices in Nigeria with a view to documenting the correlation between the variations in morphometric features of the races and honey production.

MATERIALS AND METHODS

Samples of worker bees were collected from 50 colonized hives in thirty (30) apiaries within established honeybee farms in Oyo and Ebonyi States, representing the forest ecological zone, and Kwara State and Abuja (FCT) in the savannah vegetation zone. These were stored separately in plastic containers in which 70% ethanol was added and labeled according to the site of collection within the respective vegetation zone in Nigeria. These were used for morphometric analysis in the laboratory using a digitalized microscope in order to determine the races of honeybees present in the specific locations in Nigeria.

Subsequently, honey harvested from different colonies established by the respective races were weighed on a scale (in kilograms) and the volumes determined. Production was monitored for three concurrent beekeeping seasons.

The mean honey yield of the respective colonies was correlated with the morphometric features identified in the races using the Pearson's correlation method.

RESULTS

Table 1 shows the distinctive morphometry of the identified races of *A. mellifera adansonii* encountered during the study. Recognition of the respective races can be achieved by observing the variations in their morphometric features and wing landmarks. *A. mellifera adansonii* belonging to race 1 group had total body length (TBL) and median length of abdomen (MLA) that measured 5.7 mm and 2.8 mm respectively while race 2 recorded 0.8 mm

length of tarsus (M). Also, race 3 can be identified with the presence of 19 landmarks on forewing and five landmarks on hindwing while race 4 had a proboscis length (PL) of 1.9 mm and also *A. mellifera* of race 5 have length of tarsus less than 0.8 mm or length of forewing (LFW) that measured 3.5 mm.

The mean annual honey productions of the identified races of honeybees (Table 2) shows that race 1 had the lowest (9kg) yield of honey in the 2010 season while the highest volume (19kg) was recorded in colonies formed by race 4 in the 2008 season. The average of honey harvested from the respective colonies showed significant differences ($P < 0.05$) among the respective races. Races 3 and 4 produced higher volumes of honey than the other races while the lowest volume of was recovered from colonies formed by race 1. Table 3 shows correlation coefficients of morphometric features of honeybees sampled from the two vegetation belts of Nigeria in which annual honey yield may be correlated with antenna length AL (0.071) ($P < 0.05$) with the annual honey yield.

Maximum width of abdomen (MWA, 0.084), proboscis length (PL, 0.078), length of pollen basket (LPB, 0.079), width of pollen basket (WPB, 0.186), length hindwing (LHW, 0.167), length of Forewing (LFW, 0.164), length of femur (LF, 0.143), length of tarsi (M, 0.229) and length of radial cell of the forewing (LRC, 0.109) showed higher positive significant correlation ($P < 0.01$), implying that the larger the size of these components (above), the more honey the colony could produce.

Table 1: Mean annual honey production of races of *Apis mellifera adansonii* in Nigeria

Races	Honey Production/ Hive (Kg) / Beekeeping Season			Overall Mean	-
	2008 ^a Mean	2009 ^a Mean	2010 ^a Mean		
1	10±0.42	12±0.11	9±0.53	10.33 ^c	1.01
2	13±0.22	10±0.51	10±0.20	11.00 ^b	1.33
3	18±0.12	17±0.18	17±0.32	17.33 ^a	0.44
4	19±0.30	16±0.11	18±0.24	17.67 ^a	1.11
5	13±0.28	12±0.40	11±0.30	12.00 ^b	0.92

a = mean ± standard deviation

Means with same letter within column are not significantly different at 5% level of probability (SNK)

Table 2: Morphometric Features for Identification of Races of *Apis mellifera adansonii* in Nigeria

Race	TBL	MLA	MWA	AL	PL	LF	LT	LM	LPB	WPB	LHW	WHW	LFW	WFW	LRC	WRC
1	5.68	2.75	1.71	1.53	1.54	0.94	0.81	0.65	1.19	0.39	2.35	0.64	3.43	1.18	1.27	0.18
2	5.61	2.68	1.86	1.69	1.81	1.00	0.87	0.77	1.23	0.44	2.51	0.66	3.67	1.19	1.33	0.19
3	5.62	2.29	1.72	1.57	1.68	0.89	0.81	0.70	1.56	0.39	1.79	0.57	3.26	1.17	1.28	0.19
4	5.19	2.25	1.77	1.63	1.90	0.97	0.87	0.72	1.25	0.46	2.42	0.66	3.64	1.19	1.30	0.18
5	5.55	2.52	1.80	1.65	1.84	0.96	0.84	0.70	1.19	0.42	2.39	0.65	3.52	1.16	1.28	0.19

Key: Total Body Length (TBL), Median Length of Abdomen (MLA), Maximum Width Abdomen (MWA), Antennae Length (AL), Proboscis Length (PL), Length of Femur (LF), Length of Tibia (LT), Length of Tarsi (LM), Length of Pollen Basket (LPB), Width of Pollen Basket (WPB), Length of Hindwing (LHW), Width of Hindwing (WHW), Length of Forewing (LFW), Width of Forewing (WFW), Length of Radial Cell (LRC), Width of Radial Cell (WRC).

Also, a significant negative correlation was established between width of forewing WFW (-0.059) and annual honey yield of colonies in the country. The other morphometric variables i.e. total body length (TBL), median length of the abdomen (MLA), width of hindwing (WHW), length of tibia (LT), number of landmarks on forewings (NLF), number of landmarks on hindwings (NLH) and number of

landmarks on radial cell of forewing (NLR) had no significant correlation ($P > 0.05$) with the annual honey yield of the bee races in the country. This means that race 2 with the relatively highest mean values of AL, MWA, PL, LPB, WPB, LHW, LFW, LF, LM and LRC produced more honey than the other four races in Nigeria.

Table 3: Correlations of Honeybee Morphometric Features with Annual Honey Yield in Nigeria

	TBL	MLA	MWA	AL	PL	LPB	WPB	LHW	WHW	LFW	WFW	LF	LT	LM	NLF	NLH	NLR	LRC	WRC	HYL
TBL	1																			
MLA	.754**	1																		
MWA	.148**	.138**	1																	
AL	.117**	.053	.190**	1																
PL	.081**	.017	.068*	.336**	1															
LPB	.002	-.072*	.147**	.055	.141**	1														
WPB	-.106**	-.081**	.048	.177**	.160**	.104**	1													
LHW	-.024	.075**	.227**	.186**	.131**	-.037	.195**	1												
WHW	.125**	.148**	.152**	.216**	.131**	.023	.063*	.213**	1											
LFW	-.098**	-.039	.254**	.351**	.251**	.176**	.338**	.319**	.158**	1										
WFW	.086**	.078**	.124**	.202**	.077**	.175**	.027	.051	.132**	.300**	1									
LF	.082**	.116**	.182**	.148**	-.026	.082**	.108**	.211**	.089**	.281**	.005	1								
LT	.069*	.063*	.213**	.252**	.234**	.084**	.187**	.162**	.137**	.348**	.021	.144**	1							
LM	-.032	-.066*	.110**	.194**	.193**	.150**	.337**	.206**	-.025	.242**	-.098**	.246**	.228**	1						
NLF	-.072*	-.145**	.015	.038	.166**	.006	-.010	.017	.024	.068*	.060*	.023	.081**	-.036	1					
NLH	-.022	-.033	-.012	-.164**	-.199**	-.131**	-.035	-.035	-.206**	-.043	-.035	-.022	-.039	-.103**	-.022	1				
NLR	.013	.004	.040	-.006	-.037	.033	.033	.001	.028	-.002	-.019	-.025	-.033	-.015	-.006	.213**	1			
LRC	-.020	.009	.201**	.225**	.101**	.273**	.241**	.194**	.109**	.508**	.287**	.231**	.197**	.300**	.030	-.056	-.013	1		
WRC	.044	-.016	.111**	.211**	.114**	.046	.026	.109**	.123**	.166**	.273**	.073*	.132**	.080**	.064*	-.045	.013	.181**	1	
HYL	-.040	-.041	.084**	.071*	.078**	.079**	.186**	.167**	.034	.164**	-.059*	.143**	.051	.229**	-.001	.048	.017	.109**	-.024	1

*Correlation is significant at the 0.05 level **Correlation is significant at the 0.01 level

Key: Total Body Length (TBL), Median Length of Abdomen (MLA), Maximum Width of Abdomen (MWA), Antennae Length (AL), Proboscis Length (PL), Length of Femur (LF), Length of Tibia (LT), Length of Tarsi (LM), Length of Pollen Basket (LPB), Width of Pollen Basket (WPB), 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), Honey Yield (HYL)

DISCUSSION

The analysis of morphometric features and wing landmarks data obtained from *A. mellifera* found in the two vegetation zones of Nigeria established five different races. This indicated that there were relationships between the morphometric features and wing landmarks of the established honeybee races from the two vegetation zones, thus, confirming the distribution and diversity of *A. mellifera* in Nigeria (Hussein, 2000). The uniqueness of the respective morphometric features that classified the honeybee's separation into races could be associated with the likeliness of

variations of honeybees in Nigeria. These variations were within the range for *A. mellifera adansonii* (i.e. below 8mm) (David, 2007).

The successful classification of honeybees encountered in beekeeping practice in Nigeria into five races of *A. mellifera adansonii*, which was based on variations that occurred in the different morphometric features and wing landmarks was in line with Greenberg and Szyska, (1984); Liu and Greenberg, (1989); Amorim and Ribeiro, (2001); so was the use of wing morphology and landmarks to

discriminate insect population into species, specifying the variations in the varieties within the intra specific group (Tofilski, 2004; Steinhage *et al.*, 2007; Mendes *et al.*, 2007).

The highest annual honey yield (19 kg) was harvested from colonies formed by honeybees of race 4. This fell below the previous report of annual honey yield of 22 kg per hive in Nigeria (Ayeni, 2002) and may be linked to the incessant bush burning, uncontrolled use of agrochemicals and resultant pest resurgence and Global Warming. In addition, the positive correlation coefficient between antenna length (AL), maximum width of abdomen (MWA), proboscis length (PL), length pollen basket (LPB), width pollen basket (WPB), length of femur (LF), length of hindwing (LHW), length of forewing (LFW), length of tarsus (LM) and length of the radial cell (LRC) with the annual honey yield of honeybees in Nigeria showed that honey yield in the country could be associated with the sizes of AL, MWA, PL, LPB, WPB, LHW, LFW, LF, LM and LRC. From these findings, it could be postulated that the larger the size of AL, MWA, PL, LPB, WPB, LHW, LFW, LF, LM and LRC, the more the races produced honey. This implies that colonies formed by race 3 and 4 will possibly produce more honey than the colonies established by the other three races.

CONCLUSION

Based on the findings from this study, it can be concluded that the races of honeybee that are reared in beekeeping in Nigeria have morphometric features and wing landmarks that positively correlates with honey

production. This implied that existing and intending large scale beekeepers can adopt the race 2 with the highest volume of honey for their queen rearing programmes in their respective zones. This will in turn increase returns on investment in apiculture and also encourage youths' interest in starting up an apiaries for livelihood.

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