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Performance Evaluation of Honeybee (*Apis mellifera scutellata*) in Guji Zone

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ABSTRACT: Performance of a given particular area of honeybees can be tested based on their temperament, hygienic, inclination to swarm, resource hording and absconding behavior. Local honeybee race *Apis mellifera scutellata* was evaluated for its performance in Anna Sorra District of Guji Zone using 28 colonies were evaluated for temperament, hygienic behavior, brood area, pollen and nectar stores, absconding and honey yield. The result indicated that these colonies were not generally aggressive and only 7.14 % of them tried to defend their nest at 0.29m away from the entrance while 92.86% were reacted after hitting the lid twice. They removed from 86±3.16 to 99.62±0.26 % of pin killed pupae in 24 hrs, though there was significant ($P<0.05$) variation in different seasons. The unit area measurement of brood showed that as high as 216.42 unite areas of 5x5 cm^2.Similarly, the area allocated for stored nectar and pollen grains could reach up to 65.57 and 29.28 unit areas of 5x5 cm^2, respectively. The swarming tendency of the *A. m. scutellata* colonies was very low as only in average two queen cells were found during breeding season. However, the absconding behavior of the colonies was higher reaching up to 27 % between August and November, with significant ($p<0.05$) variation in different seasons. The honey yield from the colonies in box hive was 10 kg per colony per harvest. The comparison between two years indicated that there was no difference in yield between the two study years. In general, the study showed that *A. m. scutellata* honeybees are good in hygienic and temperament behavior and also perform well for honey yield under optimum management practices.

KEYWORDS: *Apis mellifera scutellata*, temperament, hygienic, swarming, absconding.

1 INTRODUCTION

Ethiopia is a land of contrast having wide range of topography, climate and vegetation, which favors considerable number of honeybee colonies and diversity of honeybee races. Despite the country's potential to apicultural resource, the production and productivity of the sector is still low. This could be attributed to many factors such as, poor management style, environmental factors and undesirable behaviors of local honeybees. In view of the fact that, no honeybee colony is exactly like other in their performance even in a given particular area especially in brood rearing, inclination to swarm, foraging vigor, stinginess, and susceptibility to diseases (Ruttner,1988).

It is known that the physical environment such as altitude, climate and vegetations greatly affect the behavioral and the productivity of colonies. Honeybees at highland area of Ethiopia were reported as they are less productive, larger in size, docile in behavior compared to relatively more productive small lowland honeybees that are very aggressive (Gebreyesus Mammo 1976). *A.m. scutellata* is the second darkest and largest honeybee race next to *A.m. bandasii.* It is distributed in the western, southern and southwestern humid mid-land parts of the country (Amssalu Bezabeh, 2002).Though the colour, size and distribution of this race is documented, its performance was not well studied so far. Therefore, performance evaluation of this honeybee race in its natural agro ecological distribution zone is very crucial to assess the potentiality of the race and to lay foundation for future selection and improvement of the local race.

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2 MATERIAL AND METHODS

2.1 STUDY SITE

The study was conducted from January 2010 to June 2012 at Peasant Association called Bube Korsa in Anna Sorra District of Guji Zone, Southern Oromia, Ethiopia. The area has about 13% of its land covered by natural forest in which honey plants like *Scheffleria abyssininca, Croton macrostachys* and *Syzygium guineese* are of high importance. The rainfall of the Anna Sorra District ranges between 750 and 1250mm while the annual temperature of minimum 17°C and maximum 21°C. The exact location of the apiary site was situated at 38° 44' 25" E and 6° 7' 90" N, altitude of 2351 m above sea level.

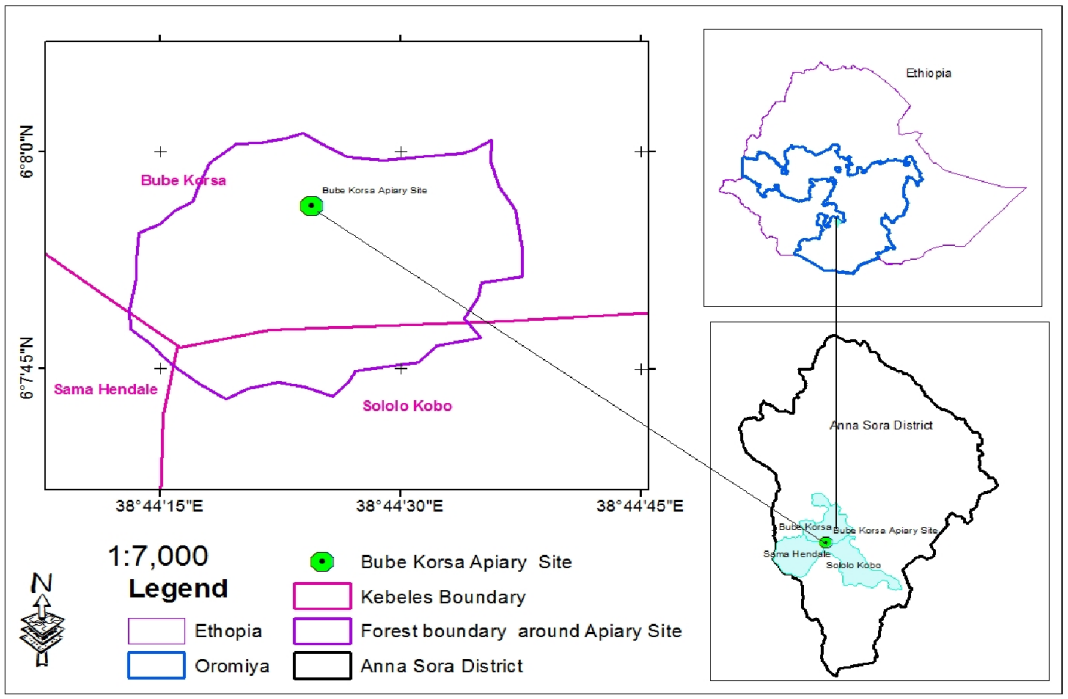

Fig. 1. Map of Apiary site

2.2 EXPERIMENTAL COLONIES

Twenty eight colonies of honeybees were used for this experiment to evaluate for temperament, hygienic, inclination to swarm, resource hording and absconding behavior. The necessary seasonal colony management activities were undertaken throughout the study period. Performance evaluation of the colonies was studied through the following different parameters.

2.3 EVALUATION OF TEMPERAMENT

The temperament of the colonies was assessed by recording time of reaction after hitting the lid twice. The distance the bees try to defend while approaching the hive entrance without any provoking action was also measured. Other subjective observation like calmness during the inspection (tendency to stay on the frames) was evaluated.

2.4 EVALUATION OF HYGIENIC BEHAVIOR

Hygienic behavior was determined by a pin-killed brood assay in which the time was recorded for colonies to detect and remove dead brood from a comb section containing 100 cells (containing approximately 100 capped pupae) on one side of the comb. This section of the comb was marked by removing one entire row of cells surrounding the 100 cells. The number of empty cells within the section was counted and recorded (when available). Then every capped pupae within the section was pin-killed and placed back in to the hive of the test colony. After 24 hrs the frame with the section was taken out and the

numbers of remaining dead brood and removed were recorded. This test was repeated five times for all the colonies to be tested for the hygienic behavior. Finally, the percent of removal of dead brood was calculated as follows the formula used by Kebede, 2006.

$$R = \frac{K - E - C}{T - E} \times 100$$

Where: R = Percent removal of dead brood within 24 hrs
K = Number of dead brood removed within 24 hrs
E = Number of empty cell within the section insert before test
C = Number of brood cell remained capped after 24 hrs
T = Total number of brood within the section of an insert

2.5 EVALUATION OF BROOD AREA, POLLEN AND NECTAR STORAGE AND SWARMING BEHAVIOR

The total brood area was measured during the study periods to determine the brood population using 5cm x 5cm gridded wooden frame and placed over each side of the brood combs. The total brood unit areas were calculated from the area occupied by the brood. In addition to this, the comb areas occupied by pollen and nectar stores were also measured in the same wa y. Swarming tendency of the colonies was evaluated by counting the number of queen cells constructed from all colonies under the study. These counted cells were removed immediately to avoid double counting.

2.6 EVALUATION OF ABSCONDING TENDENCY

Absconding tendency was assessed by the ratio of colonies evacuating to the total number of colonies used for the experiment provided that all the colonies are kept under uniform environmental condition.

2.7 EVALUATION OF HONEY YIELD

To obtain honey yield data during the study period first, frames with sealed honey combs were taken out of the hive and each frame with sealed honey was weighed. Then, frames with honey were extracted with centrifugal honey extractor. Empty frames after extracting the honey were weighed. Finally, net honey yield data was obtained by deducting weight after extraction from the weight before the extraction.

2.8 DATA MANAGEMENT AND STATISTICAL ANALYSIS

Data collected were entered into Microsoft excel 2007 and analyzed using SPSS version 20. Normality of the data were checked and they were transformed on Arcsine transformation when necessary. One-way analysis of variance (ANOVA) was run and Tukey's studentized test (HSD) at 5% level of significance was used to make mean separation, whenever significant results were encountered.

3 RESULTS AND DISCUSSION

3.1 EVALUATION OF TEMPERAMENT

The result of observation on unprovoked reaction was revealed that less proportion of the observations showed a reaction. Out of 42 observations made throughout the study period only 7.14% were reacted at a distance 0.29m away the hive entrance while 92.86 % did after hitting the lids twice. The study also showed that there was a significant difference among months ($F = 3.36$; d. f = 5, 36; $P < 0.01$) in the time of reaction after twice hitting of the hives lids. All colonies reacted slowly (19.29 seconds) in June than November, February and April but not in the rest of the months.

Calmness of the colonies during data collections was also observed. The observations indicated that the bees stayed on frames during inspection (Fig. 2), which is not common in bee colonies of other localities. It was observed that someone can easily walk among the colonies during the day time after the colonies were inspected or data collections in the previous nights with no or very few stings. This result contradicts the previous reports that *A. m. scutellata* honeybees had high defensive behavior by different authors Southwick, 1990,Winston, 1992, Schneider and McNally, 1992,Guzman-Novoa and Page, 1993, Collins et al., 1994. The latest report on the aggressive behavior of *A .m. scutellata* indicated that they are more

aggressive in September through November Amssalu,2002.However, results of current study during these months showed that these bees reacted only after provoking them by hitting the lids.

a) b)

Fig. 2. Field photo taken during inspection illustrating the calmness of these bees a) at 10: 30 Am and b) 7:00 Pm

Generally, the aggressive behavior of honeybees is associated with environmental factors, genetics, strength of colonies, large stores and amount of alarm produced (Chandler, 1976). The recent report (Amssalu, 2002) indicates that aggressive behavior of African honeybees is related with environmental conditions and the provocative factors in the region. It is an already established fact that high temperature and pest and/or predator attacks are the major causes of aggressiveness in African honeybees (Fletcher, 1978). In this regard, the very cool temperature of the study area, as it is in high altitude, might have caused the *A. m. scutellata* honeybees of Guji highlands to be very docile and calm.

3.2 EVALUATION OF HYGIENIC BEHAVIOR

The hygienic behavior of honeybees (*Apis species*) is a natural defense against diseases and parasites (Kavinseksan *et.al*, 2004).The result of the hygienic behavior of seven colonies *A. m*. *scutellata* colonies in terms of removing successive pin-killed capped brood in 24 hrs in different seasons is shown in (Table 1). In this test, the mean percent removal per colony varied from 86.57 (June) to 99.62 (December). The test colonies removed significantly less pin-killed capped brood in the month June than in November and December ($F = 6.21$, d.f. = 4, 30; $P < 0.001$). This indicated that there was a significant effect of test time (month) on performance of *A*. *m*. *scutellata* honeybee colonies in hygienic behavior. The variation in removing pin-killed capped brood between June and, November and December could be related to the performance of the colonies during different seasons. Starting from end of November the colonies became relatively stronger compared to June and stronger colonies might be more efficient than the weaker colonies.

Table 1. Mean± SE percent removal of pin-killed capped brood within 24 hrs

Months	Removal of pin-killed brood
June	86.57±3.16B
August	94.50±2.81AB
November	98.25±1.14A
December	99.62±0.27 A
February	94.87±1.20AB

Values followed by different letters within a column are significantly different at $\alpha=0.05$ using Tukey Student Test (HSD).

3.3 EVALUATION OF BROOD AREA, POLLEN AND NECTAR STORAGE AND SWARMING BEHAVIOR

The analysis of data recorded in different months between April 2011 and February 2012 is depicted in table 2. The results indicated that the highest brood rearing activity was observed from December to February that covered up to 216 unit areas of 5cm x5cm per colony while the least was observed during November 2011. The smallest brood area coverage for these colonies coincided with seasons of rainfall. The brood rearing pattern of *A. m. scutellata* honeybee colonies showed fast build up of population between December and February. However, the fast colony build up was not accompanied by

swarm initiation as the case in other honeybee populations in the country and the tropics as a whole. In fact, these populations produced almost no swarm in the study period.

The storage of nectar and pollen grains by *A*. *m*. *scutellata* honeybees showed no significant variation in different seasons (Table 2). The highest nectar and pollen grain storage was recorded in February while the least nectar was stored between November and December and the least for pollen grains was in November. In general, it was observed that the general trend of nectar and pollen grains storing coincided with the brood rearing pattern for these colonies.

The *A*. *m*. *scutellata* honeybees in Guji highlands showed very small reproductive swarming tendency (Table 2). The maximum number of queen cells encountered throughout the study period was only two per colony. These results are totally not consistent with the previous reports of (Seeley, 1978, Winston, 1980, Winston et.al., 1983, Schneider and Blyther, 1988, Winston, 1992, and Schneider and McNally, 1994) that declared tropical honeybees generally have a strong reproductive swarming impulse and tendency to increase population very quickly leading to rapid multiplication of colonies. The recent report (Amssalu Bezabeh 2002) revealed that *A m*. *scutellata* had higher tendency to reproductive swarming than *A*. *m*. *jemenitica* and *A*. *m*. *woyi-gambella* as 36.6% of the populations of the former race swarm every year and issuing multiple swarms commonly 3 to 6 per colony per annum.

Table 2. Mean± SE (number of 5x5 cm^2 unit area) of brood, nectar, pollen and number of queen cells observed per colony

Time	Brood area	Nectar area	Pollen area	Number of queen cells per colony
April 2011	13.17±6.49B	4.29±0.42A	0±0A	0±0A
June 2011	11.33±2.28B	26.33±9.53A	1.00±0.82A	0±0A
August 2011	66.67±28.85B	29.50±11.66A	4.33±1.02A	0.5±0.5A
November 2011	6.60±4.69B	0±0A	0±0A	0±0A
December 2011	111.71±33.37AB	0±0A	20.57±19.91A	0±0A
February 2012	216.43±48.32 A	65.57±37.39A	29.29±14.98A	2.00±2.00A

Values followed by different letters within a row are significantly different at α=0.05 using Tukey Student Test (HSD).

3.4 EVALUATION OF ABSCONDING BEHAVIOR

Absconding is abandoning of a nest by a colony which forms a swarm and presumably reestablishes itself elsewhere (Winston 1987). Shortage of resources and other factors could cause the absconding behavior of African honeybees (Schneider, 1990). Accordingly, absconding behavior of *A*. *m*. *scutellata* honeybee's colonies in Guji highland was pronounced (Fig. 3). The highest absconding rate (27%) was recorded between August and November while the least was observed between April and June. Our observation also indicates that there is a resource shortage and unfavorable weather condition (high rainfall and very chilly) temperature from July to November in Guji highland (Table 2).

Despite this, there is a plenty of bee forages and suitable weather condition for bee colonies at the nearby midland of the same area of Guji zone. This could be the major causes for the high percentage of absconding (bee migration) from the highland to midland of Guji zone. Earlier study conducted on *A*. *m*. *scutellata* in Botswana (Schneider, 1992) also supports the idea that colony movement is related with seasonally shifting resource pattern. Moreover, informal personal communications with local beekeepers around the study area also supported our observation. A study conducted on the behavioral aspects of *Apis m. bandasii* at central highland of Ethiopia (Zewdu, 2012) also coincide with the result of our study at Guji highlands. It was also observed that common hive operation (both during active and dearth periods) and disturbance due to predator and pests might not be a cause for colony absconding in the study area.

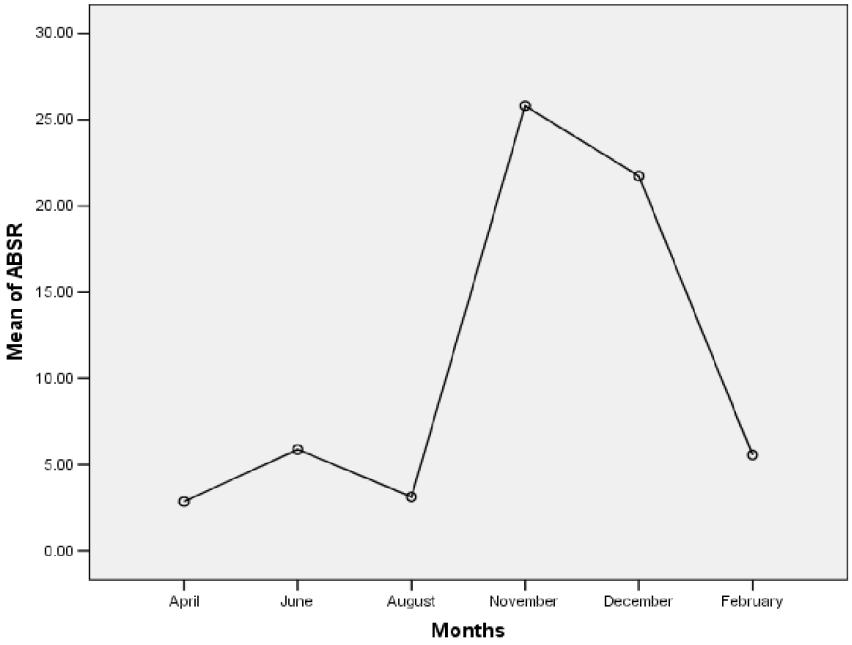

Fig. 3. Colony absconding trend in different periods

3.5 EVALUATION OF HONEY YIELD

The honey yield results per harvest per hive of the *A*. *m*. *scutellata* honeybees colonies in Anna Sorra District indicated that there was no significant (p=0.59) yield difference during the study period. The mean honey yield (kg) per harvest per hive was 9.64±3.02, 11.54±1.87 for the year 2011 and 2012, respectively. These colonies produced significantly less honey compared to the average national yield of colonies in frame hives. The major honey harvesting season for the study area was from mid April to mid May and followed by minor harvesting season in August. In the former harvesting season honey comes mainly from *Scheffleria abyssininca* and *Croton macrostachys* for the latter.

4 CONCLUSION AND RECOMMENDATIONS

This study revealed that *A*. *m*. *scutellata* honeybee colonies in Anna Sorra District (or may be the whole Guji highlands) had generally different behavioral and productive performances. These honeybees displayed very calm defensive behavior and they seem to be unique in their defense behavior as compared to *A.m. bandasii* that is located in the central highland of Ethiopia.

Moreover, the colonies had remarkable hygienic performance in removing pin-killed capped brood that reached up to 100% cleaning of dead broods within 24 hrs in some colonies. This high level of hygienic performance could be important in disease and parasite resistance like varroa as the population of the parasites could be easily kept under threshold by the colonies. As the study was conducted in the highland of Guji, which could not cover the other agro ecology of *A*. *m*. *scutellata* further studies that could address the whole agro-ecology of *A*. *m. scutellata* is recommended to investigate its detail behavioral aspects whether it is due to environmental or genetical factor for future selection and improvement.

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REFERENCES

[1] Amssalu B. (2002). *Multivariate Morphometric Analysis and Behaviour of honeybees (Apis mellifera L.) in the Southern Regions of Ethiopia.* PhD Thesis, Rhodes University, South Africa. Pp.109-214

[2] Chandler, M. T. (1976). The African honeybees - *Apis mellifera adansonii*: The biological basis of its management. *Proceeding of First International Conference on Apiculture in tropical climate,* London, UK, 61-68.

[3] Collins, Anita M., T. E Rinderer, and K. W. Tucker. 1988. Colony defence of two honeybee types and their hybrid (F1). Naturally Mated Queens. *Journal of Apicultural Research.* 27:137-140

[4] Collins, Anita M., H.V. Daly, T .E. Rinderer, J.R. Harbo and K. Holmer. (1994). Correlations between Morphology and colony defense in Apis mellifera. *Journal of Apicultural Research*33**:** 3-10

[5] Fletcher, D.J.C. (1978). The African Bee, *Apis mellifera adansonii*, in Africa. *Annual Review of Entomology* 23**:** 151-171.

[6] Gebreyesus M. (1976). Practical aspects of bee management in Ethiopia, in Proceedings of the First International Conference on Apiculture in Tropical Climates, pp. 69-78.

[7] Guzman-Novoa, E. and R. E. Page Jr. (1993). Backcrossing Africanized Honey Bee Queens to European Drones reduces Colony Defensive Behavior. *Annals of the Entomological Society of America.* 86**:** 352-355

[8] Kavinseksan, B., Wongsiri, S., Rinderer, T. E. and De Guzman, L. I. (2004). Comparison of the Hygienic Behavior of ARS Russian and Commercial honey bees in Thailand. *American Bee Journal***:** vol. 144, pp.870 -872.

[9] Kebede D.(2006). Testing colonies of India honey bees *Apis cerana* for hygienic behavior, (MSc Thesis). Bangalore: Department of Apiculture of Agricultural Science, PP.26-28.

[10] Ruttner, F. (1988). Breeding techniques and selection for breeding of the honeybee. The British Isles bee breeders Association by arrangement with Ehrenwirth Verlag Munich.pp.45-78.

[11] Schneider, S.S and Blyther, R. (1988).The habitat and nesting biology of the African honeybee *Apis mellifera scutellata* in the in the Okavango River Delta, Botswana, Africa. Insectes Society 35: 167-181.

[12] Schneider, S.S (1990). Nest characteristics and recruitment behavior of absconding colonies of the African honeybee, *Apis mellifera scutellata*, in Africa." *Journal ofInsect Behavior,* vol.3, pp.225-240

[13] Schneider, S.S and McNally, L.C. (1992). Seasonal cycles of growth, development and movement of the African honeybee, Apis mellifera scutellata, in Africa. *Insectes Sociaux*, vol. 39, pp.167-179.

[14] Schneider, S.S and McNally, L.C. (1994). Developmental patterns associated with founding and swarming in colonies of the African honeybee race, *Apis mellifera scutellata* Lepeletier. *Apidologie*, vol. 25, pp.530-539.

[15] Seeley, T. D. (1978). Life history strategy of the honeybee *Apis mellifera*. Oecologia 32: 109-118.

[16] Southwick, E. E. (1990). The Spread of Neotropical Honey Bees in the Americas by African Swarms. *American Bee Journal*. 130: 413-415.

[17] Winston, M. L. (1980). Swarming, after swarming, and reproductive rate of unmanaged honeybee colonies (*Apis mellifera*). *Insectes Sociaux* 27: 391-398.

[18] Winston, M. L., O. R. Taylor and G. W. Otis (1987). Some differences between temperate European and Tropical African and South American honeybees. Bee World 64: 12-21.

[19] Winston, M. L. (1987). *The biology of honey bee*. London: Harvard University press, PP. 217-220

[20] Winston, M. L. (1992). Killer bees. *The Africanized honeybee in the Americans*. Massachuters: Harvard University Press, pp. 176.

[21] Winston, M. L. (1992). The biology and management of Africanized honeybees. Annual Review of Entomology, 37: 173-193.

[22] Zewdu A. (2012). Study on productivity and behavioral aspects of local honeybee (*Apis Mellifera bandasii*), In: Apicultural Research achievement in Ethiopia, (Gemechis L., Kibebew, W., Amssalu B., Desalegn B., and Admassu A. Eds.), Addis Ababa: Holeta Bee Research Center, pp. 32.