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Performance Evaluation of Local Honey Bee Races (Apismellifera Wayi Gambella) in Sheka Zone

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***Abstract* – The study was conducted in Tepi National Spice Research Center from 2015 to 2017 on performance evaluation of *Apis mellifera Weyi gambella* honey bee races with the aim of the study were to determine and select the best performing honey bee races in terms of defensive, hygienic, absconding, foraging, swarming and higher on hive product area measurement parameters. A total of 21 colony were selected and situated on station and all relevant data was collected in appropriate season to issuer the accuracy of the result.**

The study reveled that the races were aggressive and made stings on the examiner (mean ± sd) maximum count up to 80 ± 5.09 and minimum to 19.54 ± 4.20 stings on the manipulator while the distance followed by them reaches long to 115 ± 26.59 to 72 ± 8.04 m away from the entrance. Absconding percentage from total twenty one colonies reaches maximum to 26% (July) and minimum 8% (April). Early and late foraging behavior of the colony was also recorded and early to 6:25 am for 15% of them and 50% were moves at 6:40 am for foraging. Whereas late foraging time fixes at 6:17 pm for 22% and 6:35 pm the rest 33% of the colony come back to their nest in the evening. Thus colony much enough to swarming and construct an average of 4.66 ± 4.72 (mean ± sd) swarm cell count. The rest hive products measured in 5x5 cm^2 comb area cell during production season within 21 day interval for brood area. Those scored in mean ± *sd* recorded maximum to minimum for adult, brood, pollen, nectar, and honey area in cm^2 were 94.39 ± 24.80 (December) - 37.79 ± 9.76 (June), 127.72 ± 34.05 (december, 2016) - 21.60 ± 24.13 (June, 2017), 63.38 ± 23.53 (November) - 2.16 ± 1.24 (April), 31.61 ± 17.50 (November) - 0.55 ± 0.61 (June), and 91.83 ± 21.67 (December) - 37.55 ± 19.60 (April) respectively. There was significant difference (p = 0.05) among season for all parameters. This indicates that the race was perform better towards swarming and hygienic above 90% to unpleasant condition this engaged to their resistance for pests like bee beetle and wax moth and disease caused by parasitic varroa and also predators however, hardly defend to show their aggressiveness behavior.

***Keywords* – *Apis Mellifera Weyi Gambella,* Behavior, Performance and South Western Ethiopia.**

I. 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 [18]. [9] Reported that honeybees of the highland areas are larger in size, docile in behavior and less productive compared to the small lowland honey bees that are very aggressive and more productive.

A.m. scutellata is the second darkest and largest honey bee race next to a.m. bandasii. It is distributed in the western, southern and southwestern humid mid-land parts of the country [2]. Though the color, size and distribution of this race is documented, its performance was not well studied so far. Therefore, performance evaluation of this honey bee 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. Corresponding Author: [24].

The variations include all the desired and undesired traits in terms of production, productivity and behavior. It is known that the physical environment such as altitude, climate and vegetations greatly affect the behavioral and the productivity of colonies. [18] Indicated that honey bee colonies do not perform equally even under the same environmental conditions and managerial practices. However, beekeeping as any other sector has to be a profitable one. For this to happen good quality stocks have to be established in apiaries; then multiplied and maintained Therefore, performance evaluation of honey bee colonies among different races and ecotypes is very critical to lay foundation for future selection and improvement of the best productive races. The evaluated activities include foraging, absconding, pollen, nectar and honey storing activities.

II. Material and Methods

2.1. Description of the Study Area

Tepi national Spice research center is located in Sheka zone of the Southern Nation, Nationalities, and peoples Region (SNNPR), at Tepi National Spice Research Center (TNSRC) and 611 km far away from Addis Ababa, the capital city of the country. It has an latitude of 1200 m.asl. with minimum 600 mm and maximum 1500 mm annual rain fall and also 20 to 28°c maximum and minimum annual temperature, respectively. The area has high humidity and rich in fauna and flora biodiversity (www.toiquiviensdethiopie.com).

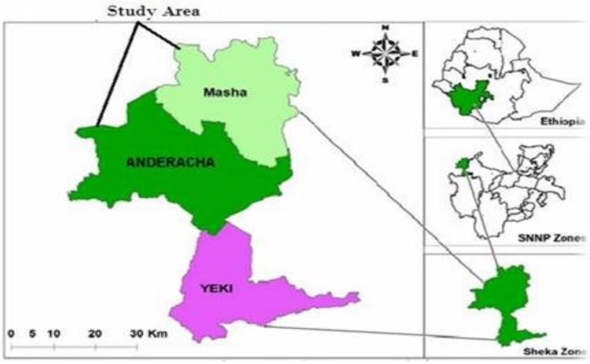

Fig. 1. Map of study area

2.2. Expermental Colonies

A total of twenty one colonies occupied on station and examined via internal and external observation for their efficiency and those data like pollen, nectar, brood, adult and honey area, aggressiveness, swarm cell and foraging behavior were collected and evaluated as follow in different season.

2.3. Evaluation of Defense Behavior

Aggressiveness of the colony examined by hanging and hitting entrance and lid by using black ball and necessary parameter like time taken to be aggressive and first sting made and also distance followed to the examiner was evaluated.

2.4. Evaluation of Hygienic Behavior

A comb with a good pattern of brood was taken which contains at least 100 well cupped brood cells and the brood larva or pupa were killed by a long needle (pin) then after 24 hours the hygienic behavior of the colony had analyzed by counting the number of dead brood cells which was already cleaned by the workers.

Both of these tests had been repeated (three times at different times) on the same colony, and was noticed. Finally, the percent of removal of dead brood was calculated as follows the formula used by [12].

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

Where :-

R = Per cent removal of dead brood within 48 hrs.
K = Number of dead brood removed within 48 hrs.
E = Number of empty cells on both sides of insert before test.
C = Number of brood cells remained capped after 48 hrs.
T = Total number of brood cell on both sides in an insert (5cm X 5cm brood area).

2.5. Evaluation of Absconding Behavior

Absconding behavior of the colony evaluated by exposing the colony to heat and starving them at different season and it calculated as the ratio to the whole colony including absconding during colony transferring.

2.6. Evaluation of Foraging Behavior

The foraging behavior of honeybees was assessed by counting the number of bees flying out of the hives for five minutes in late evening. Moreover early foraging and late foraging time were also recorded.

2.7. Evaluation of Swarming Behavior

Swarming tendency was evaluated by counting queen cells at 9-days intervals during active season.

2.8. Evaluation of Brood and Adult Area; Pollen, Nectar and Honey Storing Behavior

Those were evaluated to individual colony by using square partitioned frame (5x5 cm) and total brood area evaluated every 21 day interval. The remaining comb occupied to each parameters were determined and measured appropriately in different season.

2.9. Statistical Analysis

The data collected in different parameters were analyzed by using SPSS software version 20, 2002. And the mean comparisons done by using one-way analysis of variance (ANOVA) via LSD and Tukey's test at ($\ddot{\alpha} = 0.05$) level of significance.

III. Result and Discussion

3.1. Evaluation of Defense Behavior

The study was reveled that most of the colony reacted to the examiner with highly defend to made sting during the movement of black ball at the entrance and during opening the lid and scored (mean $\pm$ SD) in maximum 80 $\pm$ 5.09 and minimum 19.54 $\pm$ 4.20 stings recorded in January and March respectively, 2015-2017. Thus colony moves 115 $\pm$ 26.59 to 72.00 $\pm$ 8.04 meters toward the observer in respective to the maximum and minimum distance (fig.1). The result was show significance difference at ($\ddot{\alpha} = 0.05$, f = 3.3, df = 3, 18, p = 0.001) via months.

The number of sting and distance followed by the bee directly proportional and the study was quantitatively different to the newly report by [24] which implies 0.29 m away from the hive entrance. This difference might be the variation in agro ecology and honey bee races. There is considerable variation in defensive behavior both between and within honey bee species [25], even in colonies headed by related queens kept under identical conditions in the same apiary [23]-[19]. Factors causing such variability in defensive behavioral phenotypes include social (non-linear) interactions [3]-[10], location [13], weather conditions [5]-[8] and [22] colony size [6]-[10] nectar flow, honey stores and electric charges [25].

Similarly [17] showed several distinct defense behaviors and reactions in response to a disturbance of the colony. Enormously sensitive to the slightest disturbance, especially a jolt [7], an alarm was spread throughout the colony by a worker who immediately ran into the nest to recruit others by opening her sting chamber and extending her sting. Using the scale of [18], the average score for defensive behavior was 1.48 ± 0.63, which represents very aggressive colony behavior.

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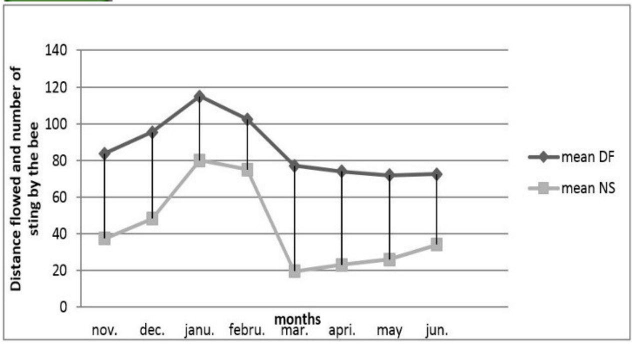

Fig. 1. Distance follow and stings of colony on manipulator

(Source: 2015-2017 Tepi, South Western Ethiopia), Hint: DF = distance followed by the colony and NS = number of sting on the observer.

a. at 2:00 pm

b. at 1:00 pm

Fig. 2. Field photo to illustrate the defensive behavior of the colony

2.4. Evaluation of Hygienic Behavior

Colonies which removed over 90% of dead brood within 24 hours were considered hygienic [14]. In line with this 9 colony of *A.m. weyi gambella* species was seat to test hygienic behavior. The percentage of pin killed removal (mean ± SD) ranges from 98.66 ± 1.08 in January and minimal hygienic level recorded to 85.66 ± 4.66 in June within 24 hours from a total of one hundred pin killed brood cells in addition to this less pin killed cell removed in march (88.11 ± 2.17).

Whereas the remaining season November, December, February and April hygienic as 98.55 ± 1.24, 98.05 ± 3.01, 97.83 ± 2.04 and 90.17 ± 4.25 respectively (Table 1). Those result also implicated the significant difference among different season and more similarly elaborated in [24] the mean percent removal per colony varied from 86.57 (June) to 99.62 (December).

Table1. Percent removal of pin-killed cupped brood within 24 hrs

Months	***mean±SD***
November	*98.55 ± 1.24A*
December	*98.05 ± 3.01A*
January	*98.66 ± 1.08A*
February	*97.83 ± 2.04A*
March	*88.11 ± 2.17C*
April	*90.17 ± 4.25BC*
May	*90.66 ± 5.00B*
June	*85.66 ± 4.66D*

Value in a column followed by the same letter not significantly different at α = 0.05 using LSD and Tukey's Post Hoc Test (TPHT).

2.5. Evaluation of Absconding Behavior

Absconding was compelled by some external forces i.e. diseases, pests, environment and other disturbances [20]. An absconding was the release of colony to leave the nest and searching to another in *A.M Weyi gambella* around 26% from a total colony leave their nest at the time of pollen and nectar shortage mainly at the end of may to July (Fig.3) this result corresponds with [21] absconding occurred during summer and rainy dearth in May and July due to short supply of nectar and pollen, unfavorable climatic conditions and parasitic and predatory pressures. Insured as a result there was not remaining honey, nectar or pollen comb except some brood one in the hive.

Whereas some others 8% of the colony in April moves as a result of transferring to the new hive but according to [21] One-third of A. cerana colonies absconded in summer and about one-sixth in rainy seasons and all colonies slowed their activities during both the seasons and prepared for absconding.

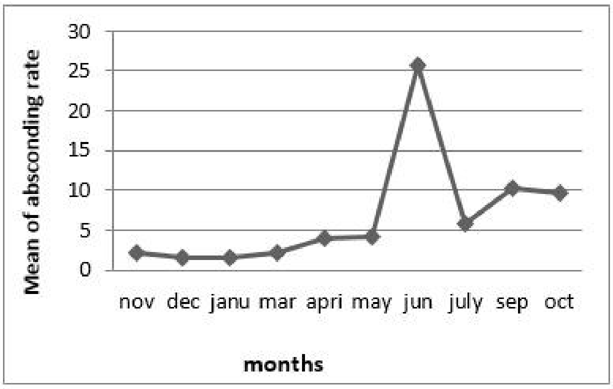

Fig. 3. Colony absconding rate through months

2.6. Evaluation of Foraging Behavior

It is known that the foraging activity of honey bees is initiated in early morning and finishes in the evening. In some studies, honey bee workers started foraging activity at 6.17 am [11]. The result in line with study that generated to foraging behavior 50% of the colony foragers flow earlier at 6:40 am within five minutes and some colony around 15% foragers of them much earlier up to 6:25 am in the morning (Fig.4). However, the foraging activities may be influenced by weather condition and the region of the area associated.

The same way foragers come back to their nest after completing the foraging activities before the sun set in this regard 40% foragers of the colony let until 6:25 pm whereas others 21% foragers of them let up to some differences in fraction of minute at 6:26 pm which was the minimum value of foragers that recorded within five minutes (Fig.5). Even though the time of finishing bound via time there were many factors like seasonal variation as a result of sun direction due to geographical location influences' activities. [16] Found high pollen collection in the early morning while low amounts of pollen were collected in the afternoon. [15] Reported a higher foraging rate mean during the afternoon period (36.02 foragers/min) than during the morning period (17.66 foragers/min).

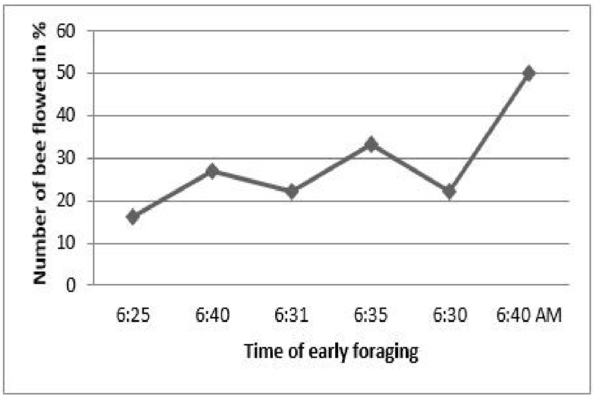

Fig. 4. Early foraging time of colonies

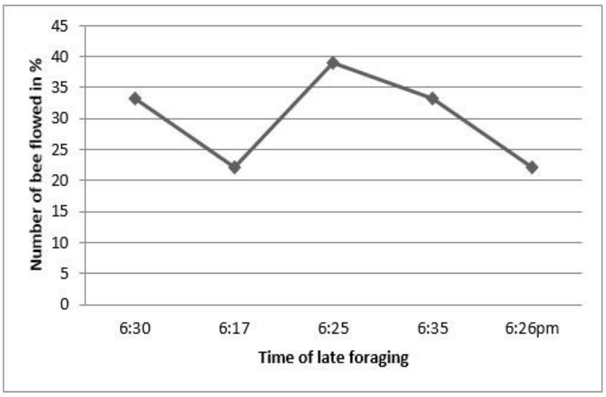

Fig. 5. Late foraging time of colonies

2.7. Evaluation of Swarming Behavior

Africanized honey bees swarm at a rate far greater than European honey bees. They typically produce six to twelve swarms per year [4]. In line to most findings in *A.M Weyi gambella* race (mean ± SD) construct 4.66 ± 4.72 queen cells in January, which was maximum number of queen cells observed month in most colony and not at all in some colonies, like march and June. While others 2.00 ± 0.00, 3.00 ± 2.82, 1.50 ± 0.70, 1.50 ± 0.70, 1.50 ± 1.00, 2.66 ± 2.88 and 1.5 ± 1.00 produce queen cell in November, December, February, March, April, May and June respectively (Fig. 6). The record number of swarms in with an average of 1.0 to 2.6 swarms annually [25].

One year for European bees during one particularly favorable growing season was 3.6 swarm*s*

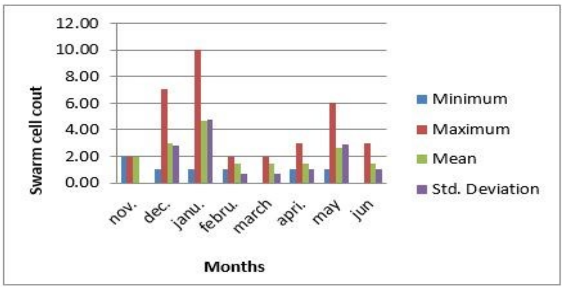

Fig. 6. Colony swarm cell count
Fig. 7. Image of swarm cell illustration

2.8. Evaluation of Brood and Adult Area; Pollen, Nectar and Honey Storing Behavior

In table 2 below shows adult area (cm^2) which was recorded (mean ± SD) 94.39 ± 24.83 $(December)$ and 37.28 ± 9.76 (June) maximum and minimum values respectively. Whereas the remaining in November, June, April and May scored 81.1 ± 25.36, 84.22 ± 25.74, 29.72 ± 28.97 and 29.94 ± 24.13 $unit\ area\ in$ cm^2 respectively this indicate significantly difference through months at (p = 0.05).

The smallest brood area (20.00 sq.in./colony) was recorded on August, while the largest area (70.00 sq.in./colony) was recorded on November with a general mean value of 36.40 sq.in./colony [1]. Rather in numerical value and seasonal difference the result of the study for *A.M Weyi gambella* race the mean area was scored brood area of 127.72 ± 34.05 cm^2 in December and 21.6 ± 24.13 cm^2 in June to maximum and minimum value respectively (table 2).

Pollen and nectar area on comb cell during flow season recorded highest mean ± SD value of 63.38 ± 23.53 cm^2 pollen and 31.61 ± 17.50 nectar least 2.16 ± 1.24 cm^2 pollen on November and April respectively whereas least nectar area recorded 0.55 ± 0.61 cm^2 on June. Those relate to [1], even though there is difference in races, geographical location and numerical value. Thus smallest pollen area (11.00 sq.in./colony) for AMJ was recorded on September 2nd, while the highest area (96.25 sq.in./colony) was recorded on November 25th. For AMC. [24] Study, 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.

The surplus honey area gradually increased in AMC colonies which exhibited the lowest value (364.25 sq.in./colony) on September 26th and the highest value (438. sq.in./colony) on August 21st. For AMJ, the lowest value (242.75 sq.in./colony) was observed on November 1st, and the highest value (387.50 sq.in./colony) was observed on August 21st. The mean values in this period were 388.10 and 300.30 sq.in./colony for AMC and AMJ, respectively colony [1]. However, the result is highly different for *A.M Weyi gambella* race this variation may be as a result of race and agro ecological zoon and our races more concentrated on swarming than production. The highest amount of honey area mean ± SD recorded on December which was 91.83 ± 21.67 cm^2 and the lowest was 37.55 ± 19.26 cm^2 on April (Table 2).

Table 2. (Mean ± SD) Number of adult, brood, pollen, nectar and honey area of colony per 5x5 cm^2.

Months	Adult area	Brood area	Pollen area	Nectar area	Honey area
November 2016	*81.11 ± 25.36C*	*63.38 ±15.32C*	*63.38 ± 23.53A*	*32.61 ± 17.50A*	*38.33 ± 18.61D*
December 2016	*94.39 ± 24.83A*	*127.72 ± 34.05A*	*3.16 ± 4.30D*	*8.44 ± 9.62C*	*91.83 ± 21.69C*
January 2015	*84.22 ± 25.74B*	*95.11 ± 11.50B*	*3.72 ± 3.02CD*	*10.61 ± 8.24B*	*144.05 ± 39.71A*
April 2016	*69.72 ± 28.97D*	*44.00 ± 18.32D*	*2.16 ± 1.24D*	*3.33 ± 2.95D*	*37.55 ± 19.26D*
May 2017	*69.94 ± 24.13D*	*24.94 ± 9.92E*	*15.77 ± 9.68B*	*1.05 ± 0.99EF*	*111.16 ± 41.61B*
June 2017	*37.28 ± 9.76E*	*21.61 ± 14.14F*	*5.22 ± 3.54C*	*0.55 ± 0.61F*	*37.77 ± 15.89D*

Value in a column followed by the same letter not significantly different at $\alpha = 0.05$ using LSD and Tukey's Post Hoc Test (TPHT).

Figure 7. Hive product area measurement field photo illustration

IV. Conclusion and Recommendation

A.M. Weyi gambella races of honey bee associate in South Western part of Ethiopia, study area mainly in Tepi. Those race have aggressive temperament that follow mean distance up to 115m away the nest and 80 stings counted on their behavior manipulators, this may due to the area is warm, humid and also reach in flora biodiversity and have highly hygienic above 90% pin-killed dead brood within 24 hours in most colonies. This make them to have resistance to any unpleasant situation in their nest like pests wax moth and bee beetle and parasitic varroa and have more swarming tendencies that constructs mean of four queen cell per year which allowed to have population maximization. This in line with (Winston, 1992) Africanized honey bees reproduce frequently and rapidly. Eggs hatch into larvae in three days in contrast to European honey bees which can take over a week to hatch. Larvae increase tremendously in size (900 times the weight of the egg in only four to five days).

These recommend to accomplish further studies on specification in location on the distribution of the race and races identification for breed determination and improvement, which help to select more recommended colony in terms of production temperament and resistances to pest, parasite and disease.

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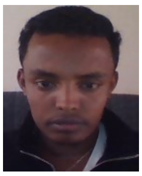

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