

## Some Factors Affecting Brood Rearing Activity in Honeybee Colonies in the Central Region of Saudi Arabia

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**Abstract.** Studies were carried out on some factors affecting brood rearing activity of honeybee colonies in two apiaries of the College of Agriculture, King Saud University at Al-Deriyah (Northern Riyadh) and Dirab (Southern Riyadh). Colonies of the former site significantly surpassed those of the latter with respect to the monthly pollen storage rate by 26.7%. This had a significant effect on the monthly worker brood rearing rate. High correlation coefficients ( $b=0.7036$  and  $0.5306$ ) existed for worker and drone rearing consecutively. The smallest area of worker brood were obtained during October in Dirab (112.7 sq. in.) and in Al-Deriyah (122.4 sq. in.). There was a single peak of worker brood during March (Al-Deriyah) and/or April (Dirab). In both years colonies at Al-Deriyah showed 25.6% more brood rearing activity than Dirab colonies (F-value 4.57\*\*). About 93% of drones were reared during January-June. The average rate of drone rearing activity in both sites was  $10.49 \pm 2.69$  sq. in/month/colony. Drone brood rearing dropped down to 45.5% and 33% of the previous year in Al-Deriyah and Dirab colonies respectively (F-value 7.79\*\*). This deterioration could be due to the high incidence of honeybee pests and diseases that occurred in the second year. Among the effects of the prevailing weather factors on colony activities, only sunshine showed moderate correlation with worker brood rearing ( $-0.3437$ ), drone brood rearing ( $-0.4762$ ) and pollen collection and storage ( $-0.5358$ ). No significant correlations existed with the maximum and minimum temperatures, relative humidity and wind speed.

### Introduction

Very little is known about the Arabian beekeeping industry and publications dealing with this subject are very few. Morphometrical studies carried out by Ruttner [1, p. 212-214] and El-Sarrag [2, p. 73-83] on the species of honeybee distributed all over the Arabian Peninsula proved that it is *Apis mellifera yemenitica*. In Yemen, El-Sarrag [2] studied the biological and behavioral aspects of the Arabian honeybee race. A brief study on apiculture development in Arab countries, including Saudi Arabia was also carried out by the same author [3, p. 86]. A general survey of the different diseases and pests that affect beekeeping in Saudi Arabia was given by Al-Ghamdi [4]. References with regard to the chemical properties of honey in Saudi Arabia [5 and 6] are also available.

The present work is an attempt to clarify in brief the performance of two groups of honeybee colonies with respect to some of the factors that affect brood rearing activity under Riyadh conditions.

### Materials and Methods

Experiments were carried out in two apiaries of the College of Agriculture, King Saud University; at Dirab (southern Riyadh, 26 N, 46 E, 600 m Alt.) and Al-Deriyah (northern Riyadh, 24 N, 44 E, 600 m Alt.).

Pure carniolan virgin honeybee queens were reared from the progeny of imported *carnica* queens, using the same method adopted by Doolittle [7]. The virgin queens, which were left to mate freely, were kept in swarm boxes. After mating, the nuclei were rehed in Langstroth hives, supplemented with pollen paste and sugar syrup (1:1 w/w.) and allowed to develop for 3 months before evaluation.

Four colonies were tested at each site from 3rd Oct. 1989 to 22nd Sept. 1991. Counts were made at 12 day intervals which is the appropriate date that avoids multimodal curvature of sealed brood.

#### 1. Brood rearing techniques

##### a) Amount

For estimating the amount of brood reared, a modified technique of Tadros [8] and Abou-Zeid [9] was adopted utilizing the planimeter. A transparent sheet of polyethylene was fixed on each comb of the test colonies; the areas of sealed brood on each comb were traced on cellophane paper placed on the transparent polyethylene sheet. The areas of sealed brood were then measured with the planimeter. Results were expressed in square inches for both worker and drone broods.

The estimation of solidness, reach, gradation and arrangement of brood was done according to Laidlaw [10]. Twenty-five readings were taken for each, and counts were made during March, 1990 just prior to the major nectar flow. Results were presented in terms of rating numbers [5-1].

##### b) Solidness or appearance of brood; solid or spotty.

This was determined by counting the number of empty cells per 100 cells of sealed brood taken at random:

5 : 0- 3 empty cells/100 cells of sealed brood.

4 : 4- 7 empty cells,

3 : 8-11 empty cells,

2 : 12-20 empty cells, and

1 : over 20 empty cells.

**c) Reach** or the extent to which the queen extends egg-laying towards the comb edges.

- 5 : No rows of empty cells between brood and lower comb edges or stores, overlay bees,
- 4 : one row of empty cells,
- 3 : two rows of empty cells,
- 2 : three rows of empty cells and
- 1 : over three rows of empty cells.

**d) Gradation**

Brood becomes progressively younger from the center to the edges, sealing starts at the center and eggs are laid at the outside:

- 5 : broods, of same age at center, evenly smaller towards edges,
- 4 : brood, almost of the same age at center and smaller towards edges, some scattering,
- 3 : brood of the center (same age), mixed with those of other ages, considerable scattering,
- 2 : \_\_\_\_\_
- 1 : brood of no definite shape. Those of the same age are scattered and mixed with other ages.

**e) Arrangement**

- 5: compact broodnest: Brood connected together regardless of amount of room and strength of colony. All brood combs become well filled before queen starts laying in others.
- 4 : brood cells, almost joined together.
- 3 : some combs being partially filled.
- 2 : brood, considerably scattered, with many partially filled combs.
- 1 : most combs partially filled. Brood excessively scattered.

**2. Pollen collection and storage**

**a) Amount**

Pollen cells were counted by means of a scale represented by an empty Langstroth frame divided by wire intersecting curves into square inches. This scale was fixed to each comb containing pollen. The figures obtained were multiplied by 26 which is the average number of cells in a square inch and each cell was multiplied by 183 which is the average mg/cell [11 and 14].

**b) Arrangement**

Storage of pollen may be towards sides of the comb or among brood. The estimation procedure followed that of laidlaw [10].

- 5 : Storage being towards sides, and between brood and honey, very few cells are present among brood.
- 4 : Storage towards sides, and between brood and honey, small amounts are found among brood.

3 : ———

2 : considerable pollen among brood.

1 : solid combs among brood.

### **Statistical analysis**

Data were statistically analyzed using the analysis of variance and, the differences between the means were determined for significance using SAS computer and correlation matrix programs.

## **Results and Discussion**

### **1. Brood rearing activity**

#### **a) Worker brood**

The monthly average area of sealed worker brood at Dirab and Al-Deriyah apiaries during 24 months are tabulated in Table 1. and graphically represented in Fig. 1.

The least amount of worker brood was obtained during October in Dirab (112.7 sq. in.) and Al-Deriyah colonies (122.4 sq. in.). Brood rearing activity then increased progressively.

As far as the brood rearing activity is concerned, colonies in both sites followed almost one and the same trend. Only one major peak during March (Al-Deriyah) or April (Dirab) was encountered in the two years. Peaks of diminishing size fluctuated between June and August in Al-Deriyah colonies (Fig. 1).

There was no significant difference between the mean worker brood reared during the first and the second years. However, significant differences existed within-groups (F-value 4.98\*\*) and between-groups (F-value 4.57\*\*). Al-Deriyah colonies showed extra brood rearing activity and reared more brood (25.6%) than Dirab colonies. That means that the former colonies surpassed the latter in the monthly worker brood rearing rate (616.96 sq. in./month/colony in Al-Deriyah and 458.85 sq. in./month/colony in Dirab colonies) (Table 1). The average performance of the colonies at the two sites in worker brood rearing was  $537.91 \pm 52.48$  sq. in./month/colony which represents about 14-15 thousand workers per month per colony.

In both sites, the honeybee colonies were found to have solid brood, the rating number being 5/5 (Table 2). The queens were observed to extend egg laying leaving none or only one row of empty cells towards the comb edges. With few exceptions, brood of the same age were arranged at the center of the comb, while the edges were occupied by younger brood. Broodnest was observed to be compact. All brood combs were filled before queens lay in others (Table 2).

### b) Drone brood

The area of sealed drone brood was measured at 12 day intervals for 24 months. The monthly averages over the two years for Dirab and Al-Deriyah colonies are presented in Table 1 and Fig. 2.

Colonies at Al-Deriyah were unable to rear drones during June, July, August and September 1990. However, they started their activity during October, reaching their maximum during April 1991 after which drone rearing decreased gradually. A similar trend was observed in Dirab colonies with slight drone rearing activity during summer.

An average of 93% of the drones were reared during January-June i.e. winter, spring and early summer, and ceased during summer. The average areas of drones reared per month in Al-Deriyah and Dirab respectively, were 10.84 and 10.13 sq. in. per colony. The general average for both sites was  $10.49 \pm 2.69$  sq. in./month/colony.

The mean total drones reared during the first year was greater than that of the second year. This was common in both sites. Drone brood rearing dropped down to 45.5% and 33% of the previous year in Al-Deriyah and Dirab colonies respectively (F-value 7.79\*\*) (Table 1). This could be due to the severe attack of *Varroa jacobsoni* occurred in the second year of the experiment.

## 2. Pollen collection and storage

The honeybee colonies in Dirab stored the least amount of pollen during July 1990 with a monthly average of 53.9 gms (Table 1 and Fig. 3). The amount stored then increased gradually to form a peak in March 1991 (159.8 gms). The storage rate of pollen grains then sharply decreased by 46.6% in the following month (April 1991). In the first year, a similar trend was observed and a peak was formed in April (323.5 gm) and decreased by 63.7% during May.

Dirab colonies averaged a total of 1483 gms in the first year and 1202.7 gms in the second year with an apparent decrease of 18.9% (Table 1). The average monthly storage rate was however 111.9 gms (Table 1).

In Al-Deriyah, the least amount of pollen stored by the honeybee colonies during September 1990 averaged 80.9 gms. The amount of pollen fluctuated considerably forming a peak during March 1991 which averaged 455.2 gms (Table 1 and Fig. 3). Al-Deriyah colonies stored similar amounts of pollen (1829 and 1834.4 gms in both years respectively). The average monthly storage rate was 152.64 gms/colony.

As a general concept, it could be concluded that Al-Deriyah colonies significantly surpassed Dirab colonies with respect to the monthly pollen storage rate and the monthly worker rearing rate. This phenomenon is quite obvious because brood rear-

**Table 1. Monthly average area of sealed worker and drone brood and pollen stored in the honeybee colonies in Al-Deriyah and Dirab.**

Date	Worker brood (sq.in.)		Drone brood (sq.in.)		Pollen storage (gm)	
	Al-Deriyah	Dirab	Al-Deriyah	Dirab	Al-Deriyah	Dirab
October 1989	669.0	366.1	0.0	13.3	140.5	103.0
Nov.	452.1	293.1	0.0	1.5	117.7	86.3
Dec.	511.5	306.0	0.0	0.0	187.1	135.1
Jan. 1990	827.3	364.1	9.0	0.8	116.8	122.4
Feb.	1077.0	564.8	18.0	7.0	251.1	146.5
Mar.	1402.0	991.0	45.0	70.0	294.9	165.2
Apr.	1079.4	1565.6	75.0	77.0	195.1	323.5
May	665.1	641.2	20.0	13.0	125.1	117.8
Jun.	225.1	396.0	0.0	7.0	127.2	62.0
Jul.	287.3	313.6	0.0	0.0	97.4	53.9
Aug.	182.9	147.0	0.0	1.5	95.2	79.5
Sep.	490.3	137.1	0.0	4.5	80.9	88.1
Oct.	122.4	112.7	1.0	1.5	93.8	101.2
Nov.	127.4	161.3	2.0	3.0	106.7	114.6
Dec.	152.8	155.2	2.0	1.5	132.5	90.4
Jan. 1991	515.6	237.8	6.5	1.0	112.3	66.2
Feb.	413.1	336.9	8.5	2.0	158.0	136.2
Mar.	1345.5	754.5	15.0	16.0	455.2	159.8
Apr.	526.2	873.2	20.0	22.0	235.6	85.3
May	770.8	774.5	11.0	14.0	115.7	68.1
Jun.	1133.3	628.9	8.0	3.0	116.8	150.2
Jul.	538.4	192.7	2.0	0.5	94.7	59.7
Aug.	739.6	455.3	0.0	0.0	110.8	67.1
Sep.	553.0	243.8	0.0	0.0	102.3	103.9
Mean	616.96	458.85	10.84	10.13	152.64	111.90
Average $\pm$ SE	537.91 $\pm$ 52.48		10.49 $\pm$ 2.69		132.27 $\pm$ 10.67	
LSD.	150.300		6.7399		30.533	
F-Value	(Site)	4.57**	0.05		7.44**	
	(Month)	4.98**	7.48**		4.87**	
	(Reps.)	1.39	7.79**		0.58	

**Table 2.** Some biological aspects regarding brood appearance and pollen arrangement in rating numbers, of honeybee colonies under Al-Deriyah and Dirab conditions.

Site	Brood solidness	Brood reach	Brood gradation	Brood arrangement	Pollen arrangement	Total (25)
Al-Deriyah	5.0	4.5	4.2	5.0	4.9	23.8
Dirab	5.0	4.1	4.0	5.0	4.6	22.7

**Table 3.** Correlation coefficients for some honeybee biological activities and some meteorological records in Al-Deriyah and Dirab.

	WB	DB	PC
WB	1.000 (0.0)		
DB	0.7136 (0.0001)	1.0000 (0.0)	
PC	0.7036 (0.0001)	0.5306 (0.0001)	1.0000 (0.0)
MXT	0.0259 (0.8614)	-0.0712 (0.6308)	-0.1691 (0.2506)
MNT	-0.0104 (0.9440)	-0.0487 (0.7426)	-0.2708 (0.0627)
MXRH	0.1556 (0.2908)	0.2073 (0.1574)	0.3756 (0.0085)
MNRH	-0.2035 (0.1653)	-0.0702 (0.6352)	-0.1104 (0.4551)
SUSH	-0.3437 (0.0168)	-0.47624 (0.0006)	-0.5358 (0.0001)
WSP	0.1191 (0.4200)	0.0832 (0.5739)	0.0413 (0.7807)

WB = Worker brood.

DB = Drone brood.

PC = Pollen collection.

MXT = Maximum temperature.

MNT = Minimum temperature.

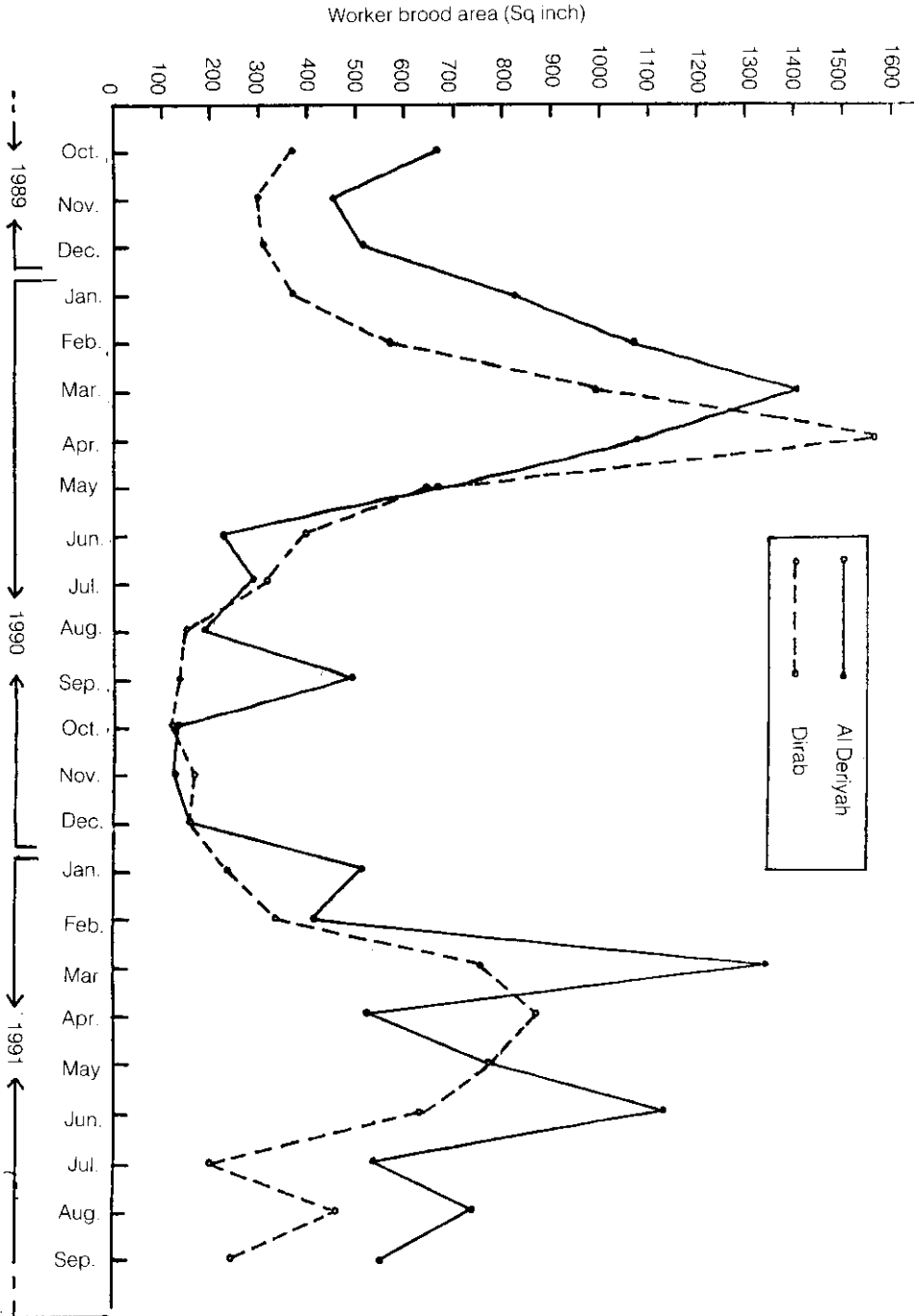
MXRH = Maximum relative humidity.

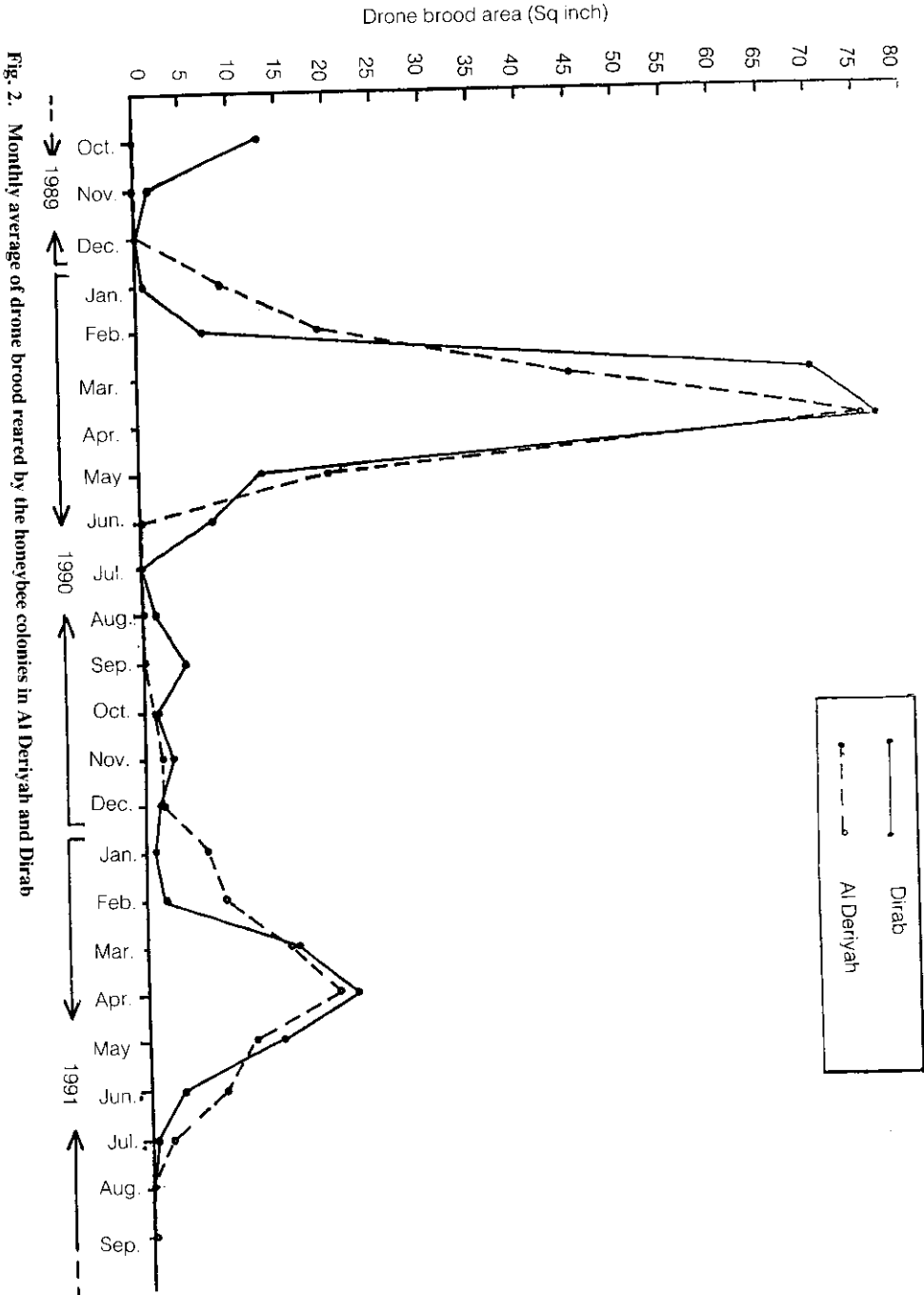
MNRH = Minimum relative humidity.

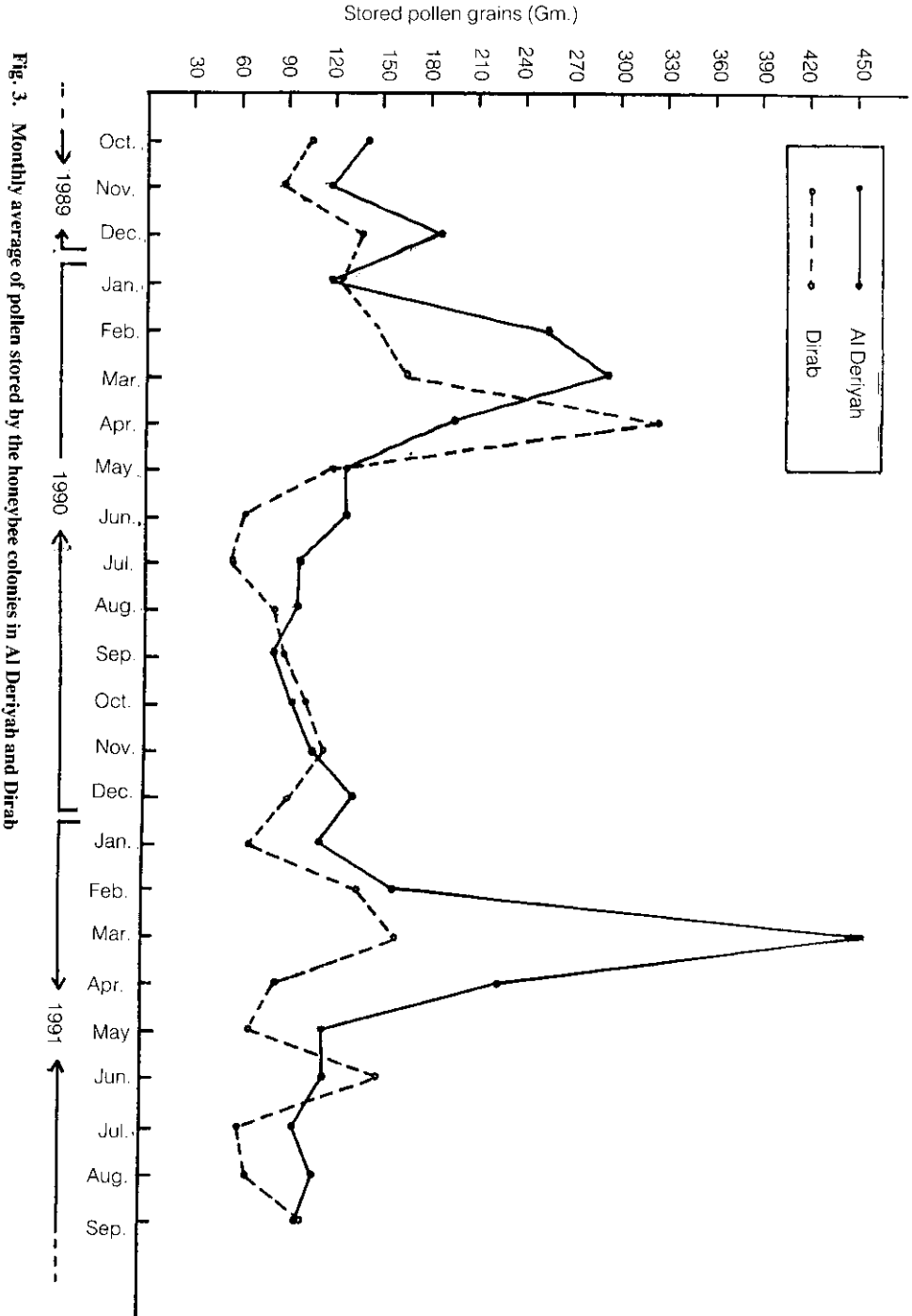
SUSH = Sun shine.

WSP = Wind speed.

Fig. 1. Monthly average area of sealed worker brood in the honeybee colonies in Al Deriyah and Dirab







ing activity is subject to a number of variables. Rashad and Parker [11] mentioned that brood rearing depends upon the incoming pollen and nectar, and weather was the most important factor governing the activity of bees as well as plant growth and blooming. Moeller [12] reported some other factors; viability of the eggs, strength of the colony, diseases and colony morale. Ruttner and Ruttner [13] indicated that colonies were more affected by the environment than by inherited characteristics.

In the present results variations could be due to few reasons. The coincidence between brood rearing activity and pollen collection is among the major reasons. High correlation coefficients ( $b=0.7036$  and  $0.5306$ ) were obtained for worker and drone brood rearing consecutively (Tables 1 and 3). As the stored pollen increased, brood rearing activity increased too under the same prevailing weather factors. Among the effects of the prevailing weather factors on colony activities, only sunshine showed moderate negative correlations with worker brood rearing ( $-0.3437$ ), drone brood rearing ( $-0.4762$ ) and pollen collection and storage ( $-0.5358$ ). No significant correlation existed with the remaining tested factors.

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## بعض العوامل التي تؤثر على نشاط طوائف النحل في تربية الحضنة وتخزين حبوب اللقاح في المنطقة الوسطى للمملكة العربية السعودية

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ملخص البحث. أجرى هذا البحث لدراسة بعض العوامل التي تؤثر على نشاط طوائف نحل العسل في تربية حضنة الشغالات والذكور وجمع وتخزين حبوب اللقاح في منحل الكلية بالدرعية وديراب خلال الفترة من أكتوبر ١٩٨٩م وحتى سبتمبر ١٩٩١م.

أظهرت النتائج تفوق طوائف نحل العسل بمنحل الدرعية على طوائف ديراب في معدل جمع وتخزين حبوب اللقاح الشهري بنسبة ٢٦,٧٪ خلال عامي التجربة مما أدى إلى التأثير الواضح في معدلات تربية الحضنة. وقد بلغت معدلات تربية حضنة الشغالات الشهرية ٩٦, ٦١٦ بوصة مربعة/ طائفة في طوائف الدرعية، بينما بلغت ٨٥, ٤٥٨ بوصة مربعة/ طائفة في طوائف ديراب بمتوسط ٩١, ٥٣٧ ± ٤٨, ٥٢ بوصة مربعة/ طائفة/ شهرياً.

أما في مجال تربية الذكور فقد كانت معدلات التربية ٨٤, ١٠ و ١٣, ١٠ بوصة مربعة/ طائفة في كل من الدرعية وديراب على التوالي. وقد تم تربية نحو ٩٣٪ من الذكور خلال الفترة من يناير وحتى يونيو بينما انعدم نشاط تربية الذكور خلال موسم الصيف (أغسطس وسبتمبر).

لوحظ أن نسب معدلات تربية حضنة الذكور كانت أعلى في العام الأول من عمر الطوائف حيث انخفضت هذه المعدلات إلى ٣٣٪ و ٤٥, ٥٪ في طوائف ديراب والدرعية على التوالي في العام الثاني من عمر التجربة. وقد عزى هذا الانخفاض إلى الإصابة الشديدة بالآفات والأمراض.

أما في مجال جمع وتخزين حبوب اللقاح فقد بلغت أعلى وأدنى كمية لطوائف ديراب ٣٢٣, ٥، ٥٣, ٩ جم خلال شهري يوليو وإبريل على التوالي، أما في طوائف الدرعية فكانت أعلى وأدنى كمية حبوب لقاح ٤٥٥, ٢، ٨٠, ٩ جم تم جمعها خلال سبتمبر ومارس على التوالي.

لم يكن للعوامل الجوية (حرارة ورطوبة ورياح) تأثير كبير على معدلات تربية الحضنة بينما أظهر طول النهار تأثيراً سالباً متوسطاً لجمع وتخزين حبوب اللقاح.