4. ACTIVITY AND BEHAVIOUR OF HONEYBEES IN COMMERCIAL SUNFLOWER FIELDS

4.1. INTRODUCTION

The tendency of honeybees to visit flowers of the same specie (flower constancy) make them very efficient pollinators. Large quantities of nectar and pollen are needed for colony survival, which results in very energetic nectar and pollen collection. Branched setae make honeybees morphological well adapted for pollen collection, while their management in hives make them economically imminently suitable as crop pollinators.

While several good accounts of numbers of honeybees in sunflower fields exist (Free, 1964; Krause and Wilson, 1981; Langridge and Goodman, 1974; Parker, 1981; Radford, et al. 1979b), the only accounts of honeybee behaviour on sunflower heads are by Brown and Parker (1984) and Free (1964). Knowledge of honeybee activity and behaviour in fields is essential to maximize their pollination function e.g. better colony management or weed control. It is also needed to calculate the number of honeybees required during pollination. This chapter reports honeybee activity activity as revealed by the conventional strip count method and by observations on returning foragers. The behaviour and movement of bees on and between heads will also be reported, as this is a very important aspect for good cross-pollination.

Temperature and humidity are the most important environmental factors influencing honeybee visits to sunflowers (Birch, 1981; Deshmukh, 1977). Periods of continued low or very high temperatures or rainy weather result in low honeybee activity with a reduction in seed set. Both of these factors also have a direct influence on nectar secretion, thus influencing honeybee foraging indirectly. Other factors include wind, predators, field size, availability of water and competing nectar and pollen sources.

4.2. MATERIAL AND METHODS

Daily and seasonal abundance

The daily and seasonal changes of honeybee numbers on sunflower capitula were recorded by strip counting at hourly intervals as described in Chapter 3, page 12. In the Springbok Flats, 153 strip counts involving 100 receptive heads each were carried out during March 1985-1987. Data of the three seasons were combined to present mean activity graphs.

Foraging activity

Foraging activity of honeybees in managed hives, located adjacent to a commercial sunflower field was determined. Two hives were used 50 meters apart, on the western side of the field and with their entrances facing north-west. The colonies were about equal in size, amount of brood and stores. Sixty production hives were situated a hundred meters away on the northern side of the field. The sixty hectare sunflower field was surrounded on the southern and eastern sides by post-bloom sunflower and on the northern and western sides by natural veld grazed by cattle.

The experimental hives were closed at certain intervals, by inserting a piece of foam plastic into the entrance. Sampling was carried out during the flowering period on days 5 (10% flowering stage; 9 (45%); 12 (65%) and 16 (85%) after flowering commenced. Sixty returning foragers were collected at the entrance by scooping them into a 500 ml glass ethyl acetate killing bottle. Such samples were collected at 07h30 (half an hour after foraging started) and then at two-hourly intervals, viz. 08h30, 10h30, 12h30, 14h30 and 16h30.

To investigate nectar and water foraging, the honey stomachs were pulled out with a tweezer. The content was then identified as either water or nectar with the aid of an Atago 500 hand refractometer. Water loads gave readings of between 0 and 5% dissolved solids, whereas nectar loads had a wide range of sugar concentrations, between 20 and 65%. Honey crop sizes, pollen and propolis loads were estimated using the method of Johannsmeier (in press), fig 7.

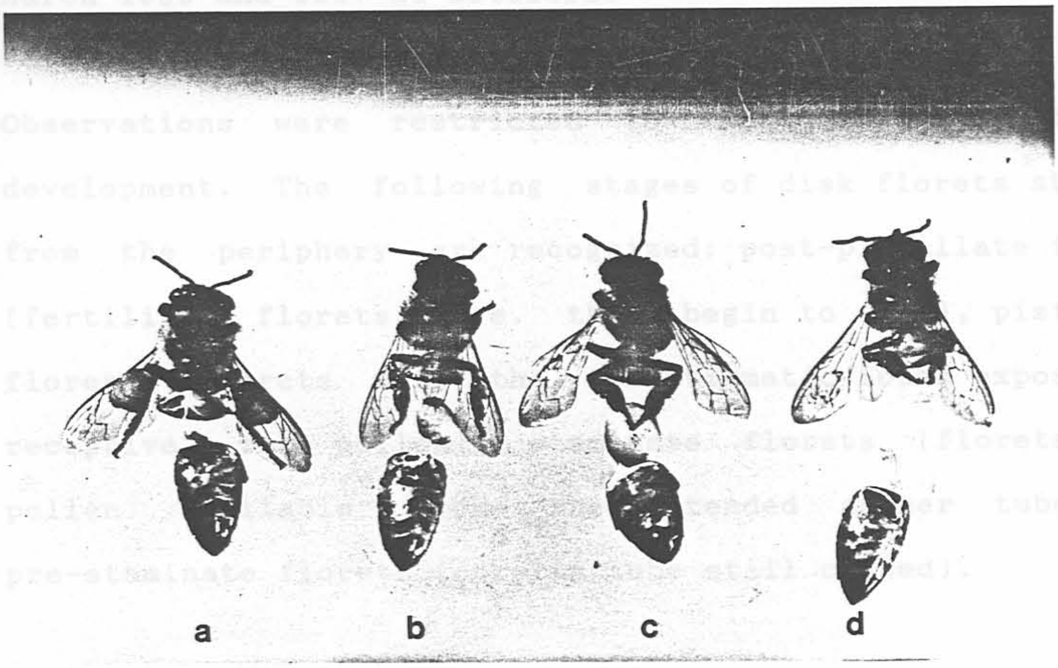

Fig. 7. Honey crop sizes as estimated by Johannsmeier (in press). a. forager with honey crop size 0, but with a size 4 pollen load, b. honey crop size 2, c. honey crop size 3, d. honey crop size 4. 2x life size.

Movement and behaviour of honeybees on the capitulum

The pattern of movement and behaviour of a single honeybee on a head was recorded on a schematic sunflower head drawn on paper (Brown and Parker, 1984). The movements of a hundred honeybees were studied in detail for the entire period from the time they landed on a head until they took for the next head. These observations were carried out on randomly taken heads, at irregular times between 09h00 and 15h00. Observations were made on consecutive days during March 1986 and 1987 at Settlers.

Observations were restricted to heads of the same stage of development. The following stages of disk florets starting from the periphery are recognized: post-pistillate florets (fertilized florets, i.e. they begin to wilt), pistillate florets (florets with the two stigmatic lobes exposed and receptive for pollen), staminate florets (florets with pollen available from the extended anther tube) and pre-staminate florets (corolla tube still closed).

The following events were recorded for honeybee visits: part of capitulum where honeybee lands, time per floret probing for nectar, stage of visited floret, whether collecting pollen, pollen dusted or not, grooming (transferring pollen into pollen basket or discarding pollen), time spend on grooming and whether contact with the stigma is made. The total time of a single honeybee visit was also recorded.

Movement of honeybees between heads

A schematic commercial sunflower field, consisting of three rows with ten plants per row was drawn on paper, to study the movement of a single honeybee between different heads.

This size is convenient for one person to work and will give an indication whether foragers work along a single row of sunflower or change rows frequently. The activity pattern of the honeybee was reproduced on the schematic field, and the following information was recorded: time spend at a single head, collecting nectar or pollen, pattern of movement between heads.

4.3. RESULTS

Daily activity

Daily activity of honeybees in sunflower fields at Settlers is represented in fig. 8. Honeybee activity commenced after sunrise, as soon as flight temperature (10xC) was reached. This occurred as early as 06h30 at Settlers.

The number of foragers in fields showed a rapid increase until 10h00, when a level of 38 foragers / 100 receptive sunflower heads was reached. From 10h00 onwards a slight decrease in foragers was observed, with a mean of 32 foragers / 100 receptive heads between 10h00 and 17h00. At 17h00 foraging activity reached a peak of 40 honeybees / 100 flowering heads. This was followed by a very steep decline in forager numbers, dropping to a level of 4 honeybees / 100 heads at 18h00, with no foraging activity at 19h00. The sun set between 18h00 and 18h30. Honeybees were well dusted with pollen throughout the day. The large deviation of the mean

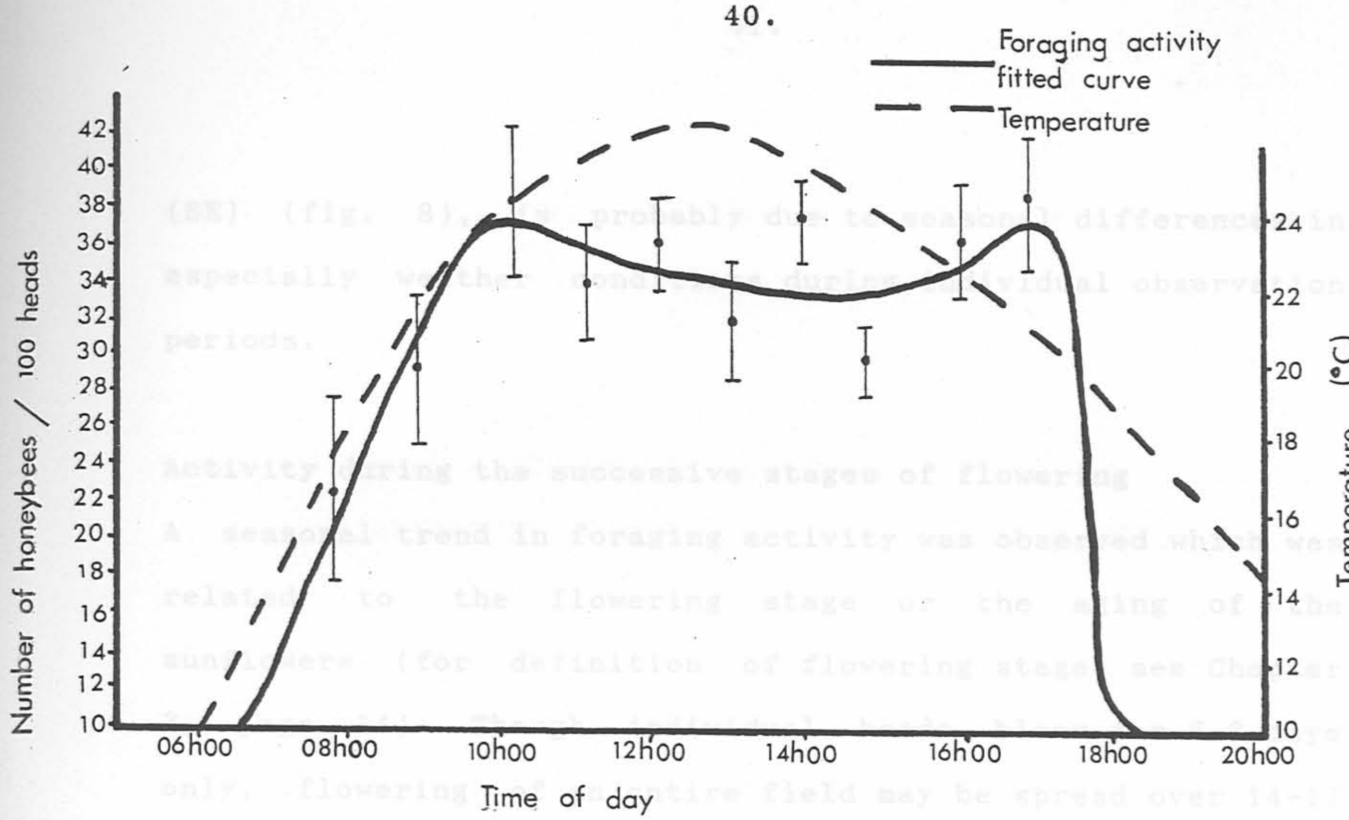

Fig. 8. Mean daily activity of foraging honeybees in commercial sunflower fields at Settlers.

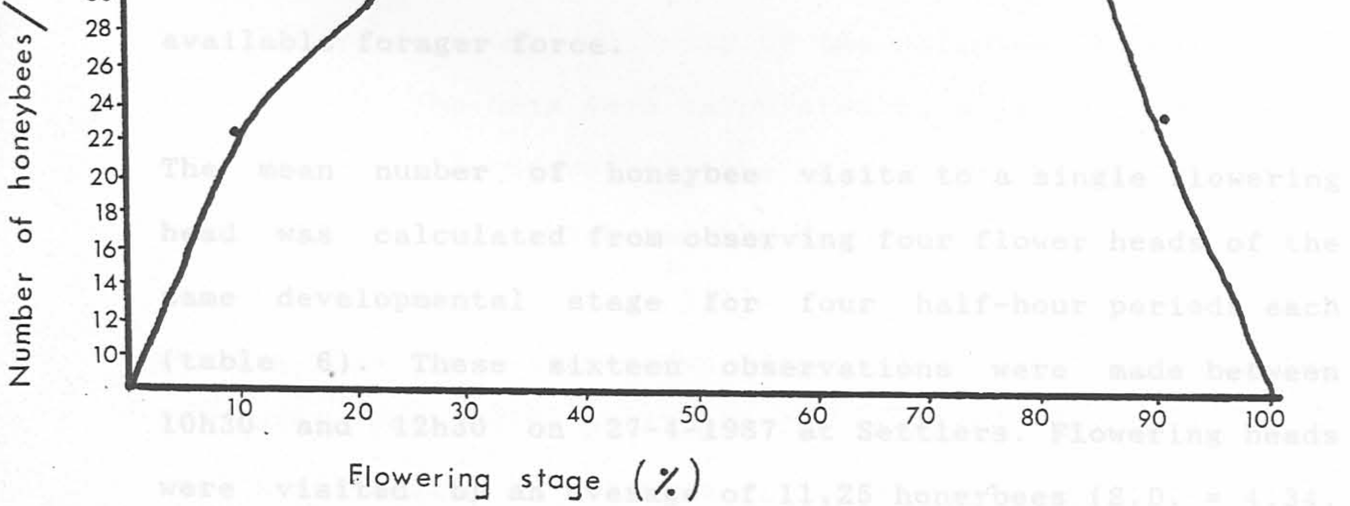

Fig. 9. Mean seasonal activity of foraging honeybees in commercial sunflower fields at Settlers.

(SE) (fig. 8), is probably due to seasonal differences in especially weather conditions during individual observation periods.

Activity during the successive stages of flowering

A seasonal trend in foraging activity was observed which was related to the flowering stage or the aging of the sunflowers (for definition of flowering stages see Chapter 3, page 14). Though individual heads bloom for 6-8 days only, flowering of an entire field may be spread over 14-17 days. With the onset of bloom there were few foragers in the fields (fig. 9), but their numbers increased markedly as more heads opened. After the 80% flowering stage, a drastic decrease in flower visitors was experienced. The slightly downward gradient in forager activity observed between 50 and 70% flowering stage, is due to a maximum number of florets available, resulting in a saturation of the available forager force.

The mean number of honeybee visits to a single flowering head was calculated from observing four flower heads of the same developmental stage for four half-hour periods each (table 6). These sixteen observations were made between 10h30 and 12h30 on 27-4-1987 at Settlers. Flowering heads were visited by an average of 11,25 honeybees (S.D. = 4,34, SE = 1,08, n = 16) during the 30 minute period. From these results a theoretical calculation of the number of honeybees required for efficient pollination can be made (see Appendix B, page 141).

TABLE 6. MEAN NUMBER OF HONEYBEE VISITS TO A SINGLE SUNFLOWER HEAD DURING FOUR 30 MINUTE PERIODS.

Time period	Number of heads observed	Mean	Standard deviation	Standard error
10h30 - 11h00	4	10.25	5.56	2.78
11h00 - 11h30	4	12.75	6.13	3.06
11h30 - 12h00	4	10.50	1.00	0.50
12h00 - 12h30	4	11.50	4.43	2.22
Mean		11.25	4.34	1.08

Daily activity of returning foragers

The daily foraging activity of two colonies is represented in fig. 10. The data were calculated as a mean of the number of returning foragers of the two experimental colonies. Sunflower pollen, which was the main forage source available to the honeybees (fig. 11.), is released in the early morning. As the stigma grows through the anther tube, pollen is pushed out and is available for foraging bees to collect. The availability of pollen early in the morning is reflected in the percentage of pollen gatherers, which was high (57%) when foraging started, and showed a steady decrease until it

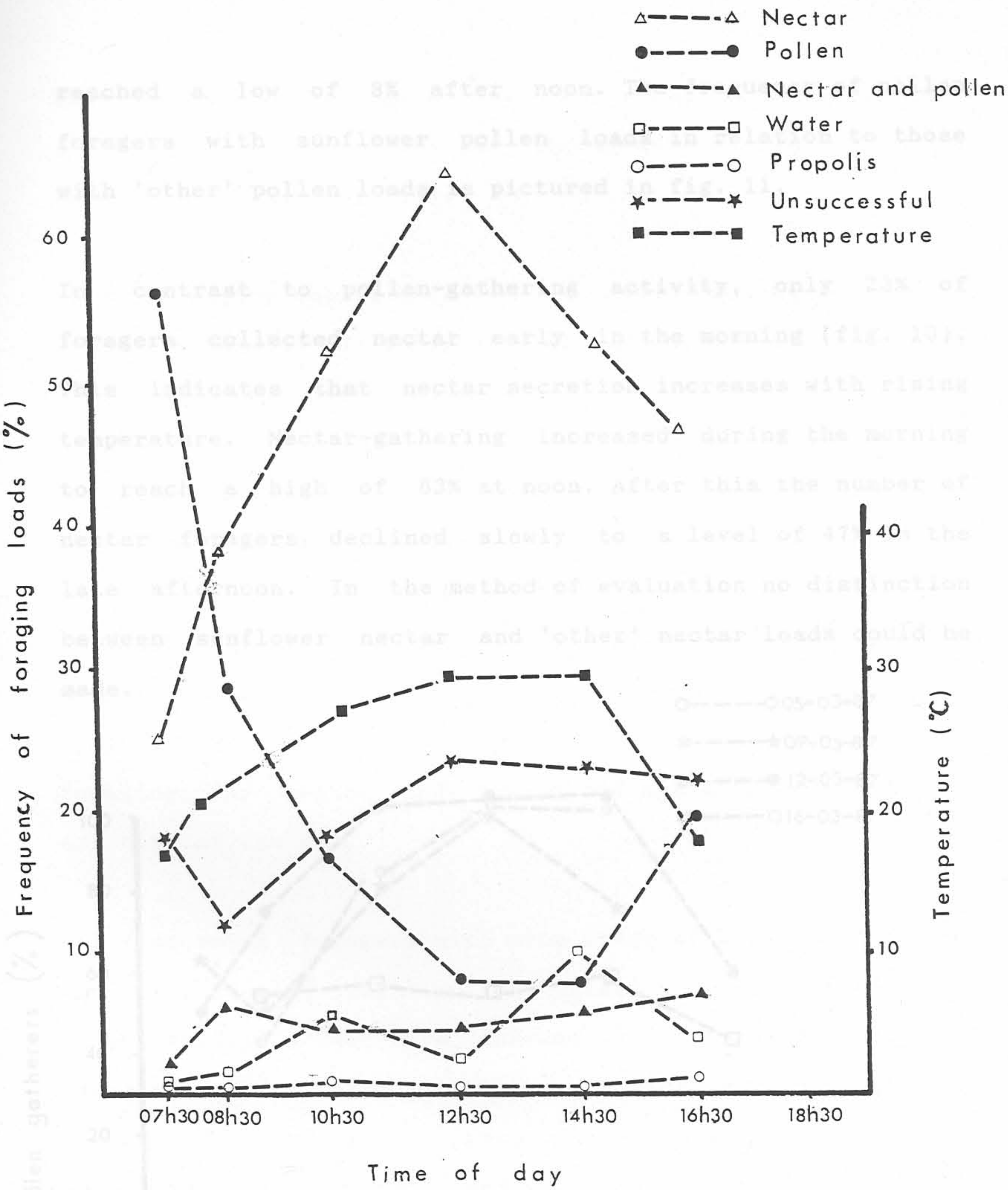

Fig. 10. Mean daily activity of returning foragers throughout the day on sunflowers. Settlers, March 1987.

reached a low of 8% after noon. The frequency of pollen foragers with sunflower pollen loads in relation to those with 'other' pollen loads is pictured in fig. 11.

In contrast to pollen-gathering activity, only 23% of foragers collected nectar early in the morning (fig. 10). This indicates that nectar secretion increases with rising temperature. Nectar-gathering increased during the morning to reach a high of 63% at noon. After this the number of nectar foragers declined slowly to a level of 47% in the late afternoon. In the method of evaluation no distinction between sunflower nectar and 'other' nectar loads could be made.

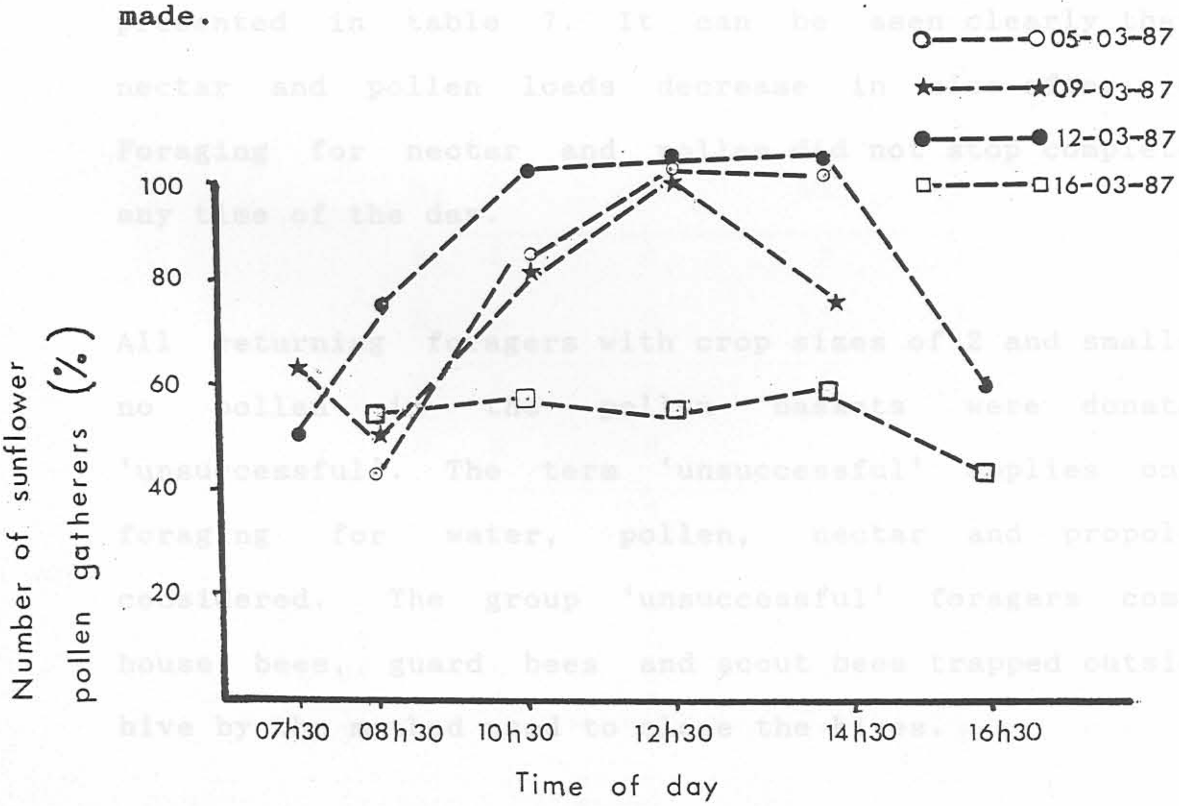

Fig. 11. Returning pollen foragers with sunflower pollen loads in Settlers, March 1987.

TABLE 7. FORAGING LOADS OF RETURNING FORAGERS ON SUNFLOWER AT SETTLERS, MARCH 1987.

Load	time of day		Number of loads Size 1	Size 2	Size 3	Size 4	Size 5	Nectar concentr
Pollen	07h30		5	3	15	81	26	
	08h30		12	10	28	67	33	
	10h30		9	11	18	27	16	
	12h30		3	4	10	15	2	
	14h30		5	7	16	4	1	
	16h30		3	7	9	22	3	
Nectar*	07h30		27	14	34	20	4	38%
	08h30		35	17	58	136	35	38%
	10h30		50	26	90	129	24	44%
	12h30		66	34	121	134	16	46%
	14h30		66	39	114	128	15	47%
	16h30		26	24	40	64	5	37%
Pollen and nectar	07h30	N:	0	0	4	1	0	32%
		P:	0	1	1	2	0	
	08h30	N:	0	0	21	11	0	39%
		P:	4	7	14	2	5	
	10h30	N:	0	0	11	7	0	49%
		P:	3	3	8	2	2	
	12h30	N:	0	0	12	4	0	53%
		P:	5	3	5	3	0	
	14h30	N:	0	0	13	7	0	44%
		P:	7	1	5	7	0	
	16h30	N:	0	0	13	6	0	37%
		P:	4	4	6	5	0	
Water	07h30		0	0	0	0	0	0
	08h30		0	0	3	2	1	3%
	10h30		0	0	6	9	10	1%
	12h30		0	0	7	6	0	2%
	14h30		0	0	14	33	5	2%
	16h30		0	0	0	8	0	2%

Total number of foragers examined: 2280

* All foragers with nectar loads of sizes 1 and 2 were regarded as 'unsuccessful'.

The number of unsuccessful foragers nevertheless showed a predictable pattern. When foraging started, a relatively high percentage of foragers were presumably involved in scouting. Some of the unsuccessful foragers observed at this time could include scouts, resulting in the high of 19% (fig. 10). The number of unsuccessful foragers dropped within the next hour to 11%. Thereafter they showed a steady increase to a noon peak of 23%, a level they maintained for the rest of the afternoon at ca. 22%. This corresponded with the decline in the availability of nectar and pollen in the afternoon.

Activity of returning foragers through the flowering stages

In a single sunflower field a trend in foraging activity was observed as the number of pollen-receptive heads increased (fig. 12). The beginning of flowering is taken as the stage when ray petals of 5% of the heads have unfolded. Five days after flowering started, the heads were in 10% flowering stage. The percentage of nectar foragers was then low (29%). The number of nectar foragers subsequently increased as more florets on heads opened, reaching a high twelve days after flowering started and then declined steadily as more florets on the heads finished flowering (fig. 12). The percentage pollen gatherers was relatively constant throughout the bloom period (fig. 12), with a peak around the ninth day after flowering started (45% flowering stage).

The numbers of foragers that collected both nectar and pollen were fairly constant throughout the day and ranged between 2 and 8% (fig. 10).

Water foraging was at a fairly low level, ranging between 0% with the onset of foraging and 11% during mid-afternoon (fig. 10). Although variable the pattern of water-foraging indicated a slow increase during the day. The number of propolis foragers was very low throughout the day (fig. 10), less than 1% of all foragers.

Sizes of nectar and pollen loads of returning foragers is presented in table 7. It can be seen clearly that both nectar and pollen loads decrease in size after mid-day. Foraging for nectar and pollen did not stop completely at any time of the day.

All returning foragers with crop sizes of 2 and smaller and no pollen in the pollen baskets were donated as 'unsuccessful'. The term 'unsuccessful' applies only if foraging for water, pollen, nectar and propolis is considered. The group 'unsuccessful' foragers comprised house bees, guard bees and scout bees trapped outside the hive by the method used to close the hives.

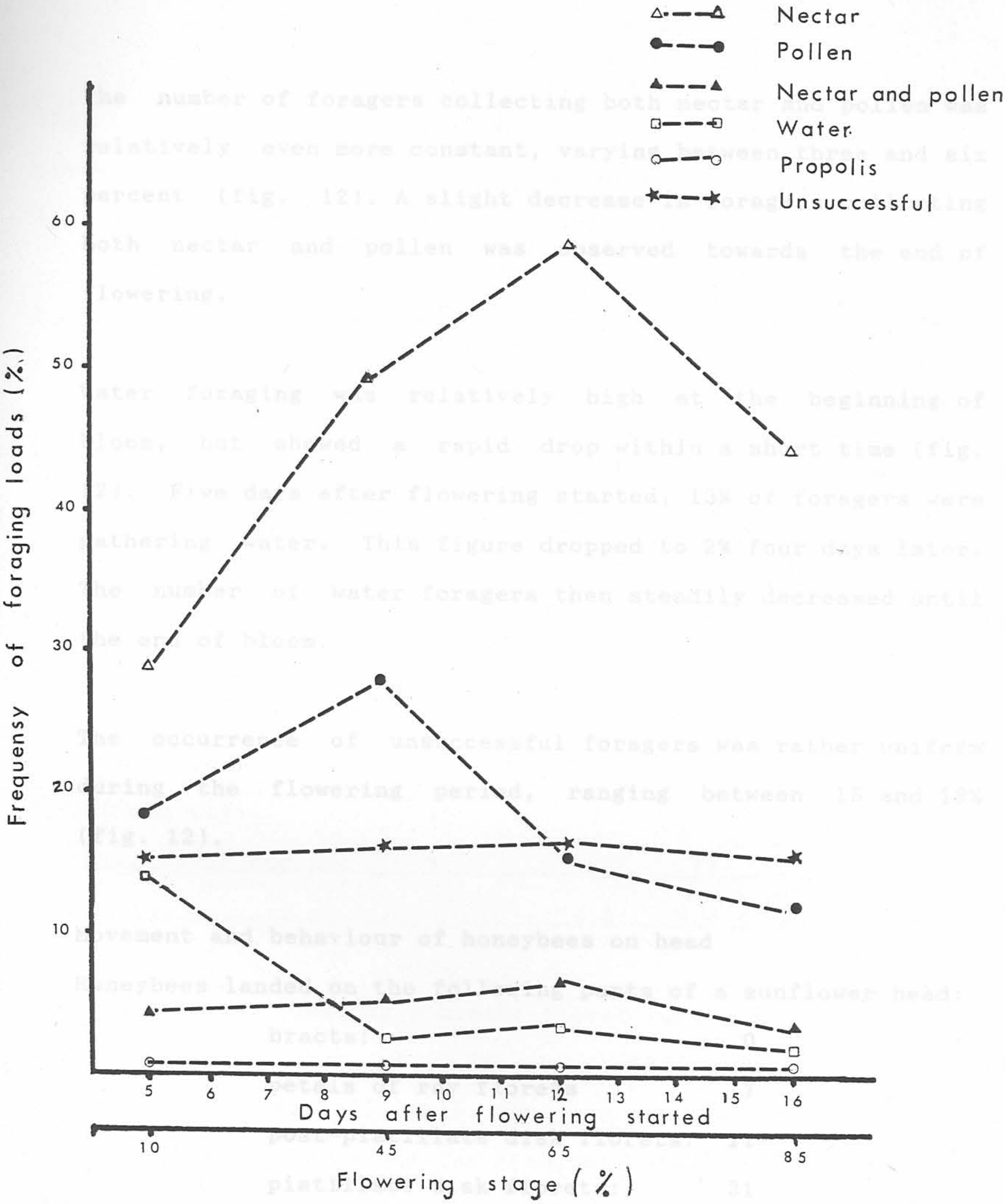

Fig. 12. Mean foraging activity of returning honeybees through the flowering stages of a field of sunflowers. Settlers, March 1987.

The number of foragers collecting both nectar and pollen was relatively even more constant, varying between three and six percent (fig. 12). A slight decrease in foragers collecting both nectar and pollen was observed towards the end of flowering.

Water foraging was relatively high at the beginning of bloom, but showed a rapid drop within a short time (fig. 12). Five days after flowering started, 13% of foragers were gathering water. This figure dropped to 2% four days later. The number of water foragers then steadily decreased until the end of bloom.

The occurrence of unsuccessful foragers was rather uniform during the flowering period, ranging between 15 and 18% (fig. 12).

Movement and behaviour of honeybees on head

Honeybees landed on the following parts of a sunflower head:

bracts:	0
petals of ray florets	7
post-pistillate disk florets:	11
pistillate disk florets:	31
staminate disk florets:	51
pre-staminate disk florets:	0
Total number of observations:	100

The stage of visited florets and the average time of visits are summarized in table 8. The mean time per honeybee visit also included time attributed to walking, grooming and hovering.

TABLE 8. FLORET STAGE AND MEAN NUMBER OF FLORETS VISITED BY A HUNDRED FORAGERS.

Stage of disk floret visited	Number of honeybees	Mean number florets probed per honeybee			Mean time per visit (s)
		p.pist.	pist.	stam.	
Post-pistillate	1	4	-	-	7
Pistillate	25	-	8	-	29
Staminate	42	-	-	12	47
Pist. and stam.	25	-	6	19	128
P.pist and pist.	4	7	7	-	43
P.pist., pist. and sta	3	2	14	29	271
Mean:		4.3	8.7	20	87.5

The time spent visiting a single floret ranged between 1 and eight seconds with a mean of 2,8s (n = 173). On average visits to post-pistillate florets only, were the shortest (7s), while visits which included florets of the staminate stage were the longest (up to 271s) (table 8). The total time spent at one flowering head ranged between 4 and 893 seconds (14 min. 53s).

Walking occurred mostly after the initial landing, but also included floret to floret movement. Walking is therefore a transitional activity, where the forager relocates herself on the head. Walking occurred as part of 47% of all visits to flowering heads, with a mean of 1,8 walks per visit (range 1-8).

Hovering in front of the capitulum by the forager has three distinct functions. A transitional activity to reorientate herself on the flowering head, to clear herself of pollen, or to pack pollen into the baskets. Hovering was observed as part of 49% of visits to flowering heads, with a mean of 3,2 hovers per visit (range 1-25). Hovering lasted on average 5s (Range 2-10s, n = 44).

Grooming while resting on the flowering head, did occur, but the frequency was much lower than for grooming while hovering. Only 4% of foragers observed groomed while perched. In all of the observed grooming incidents, grooming was to remove pollen from the body. Grooming took place on either the petals of the ray florets or on post-pistillate disk florets. The mean number of grooms per visit was 2, with a range of 1-3. On average a forager spent 18s grooming herself on the flowering head. This was considerably longer than the average time spent on grooming while hovering. All foragers involved in grooming while resting on the flowering head, were also involved in hovering.

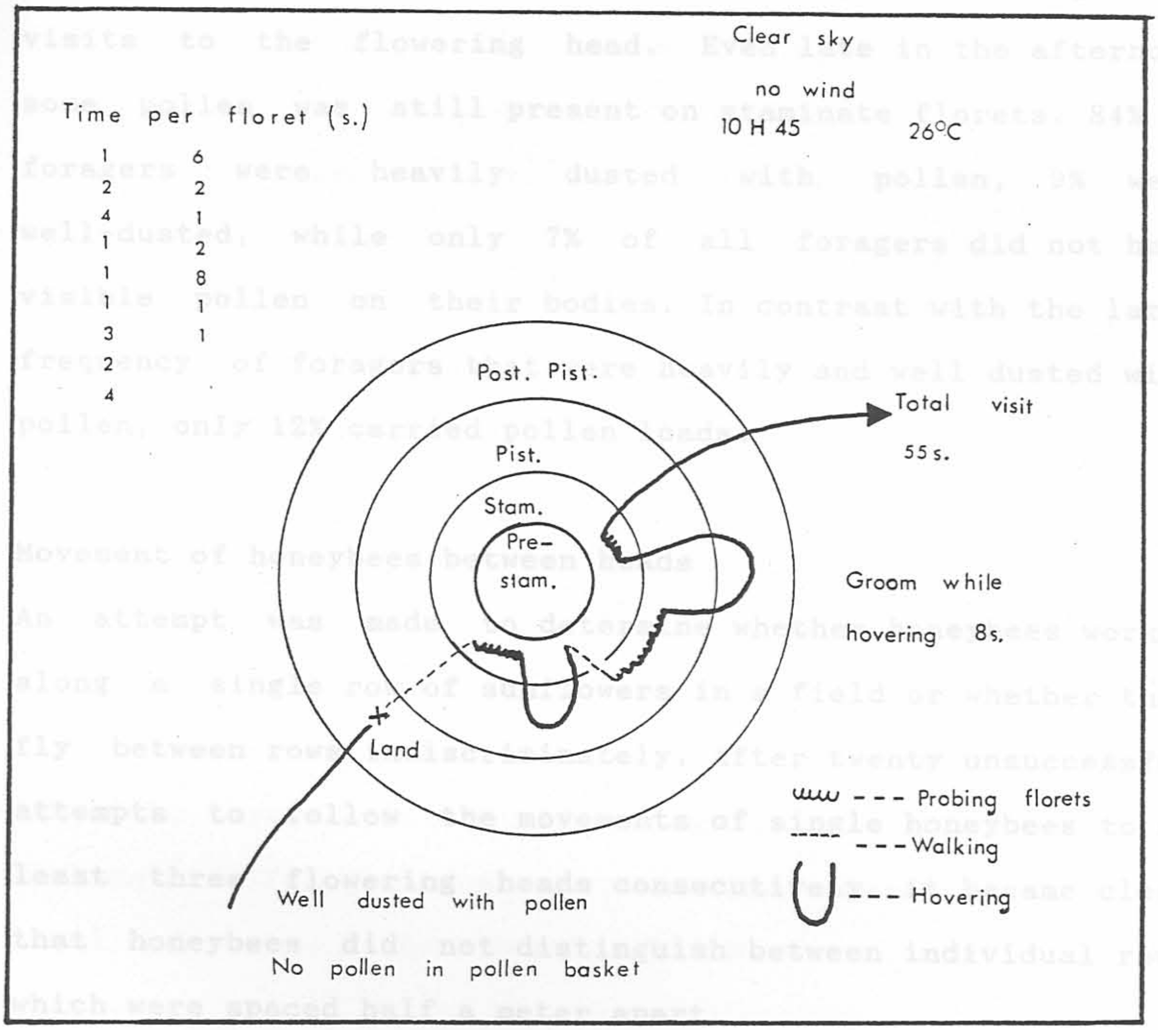

Fig. 13. Datasheet for recording movement and behaviour on a single sunflower head.

No active pollen scrabbling by foragers was observed. Foragers became very well dusted with pollen during their visits to the flowering head. Even late in the afternoon some pollen was still present on staminate florets. 84% of foragers were heavily dusted with pollen, 9% were well-dusted, while only 7% of all foragers did not have visible pollen on their bodies. In contrast with the large frequency of foragers that were heavily and well dusted with pollen, only 12% carried pollen loads.

Movement of honeybees between heads

An attempt was made to determine whether honeybees worked along a single row of sunflowers in a field or whether they fly between rows indiscriminately. After twenty unsuccessful attempts to follow the movements of single honeybees to at least three flowering heads consecutively, it became clear that honeybees did not distinguish between individual rows which were spaced half a meter apart.

4.4. DISCUSSION

In the present study a steep increase in honeybee activity was observed early in the morning after light intensity made flight possible. Temperature rarely seems to restrict flight in the Springbok Flats during the sunflower season. A peak in foraging activity was reached between 09h00 and 10h00, after this activity was fairly constant throughout the day till late in the afternoon when it dropped sharply until it stopped all together. Observations by Krause and Wilson (1981) in Wyoming, USA, showed a stepped increase of foragers to reach a peak only by noon. An unexplained steep decline in forager activity was observed after noon.

Parker (1981) found a seasonal peak of honeybee activity (32 honeybees / 100 heads) eight days after flowering started (40% flowering stage), which then showed a steady decline of foraging numbers to reach a level of 2 honeybees / 100 heads at 80% flowering stage. Krause and Wilson (1981) found less than 5 honeybees / 100 receptive heads until a 35% flowering stage was reached. A rapid increase in forager numbers was then observed to reach a level of 30 honeybees / 100 receptive heads at 50% flowering stage. A very drastic decline in forager numbers was then observed to reach a level of only 5 honeybees / 100 heads at a 60% flowering stage.

In the present study a combination of these various findings, was observed. Honeybee activity reached a peak at 40% flowering, a moderate decline was observed between 50 and 70% flowering, just to reach another peak at 80% flowering, after which a rapid decline is experienced. The moderate decline is believed to be due to saturation of honeybee numbers caused by the large number of open pollen receptive florets at that stage. A high level of foragers is maintained on commercial sunflower in South Africa through the flowering period, where introduced hives are supplied by migratory beekeepers.

Honeybees visiting sunflowers became heavily dusted with pollen, which they either discarded or packed in their pollen baskets. In the present study no honeybees actively scrabbling for pollen was observed, as was observed by Free, 1964. The percentage pollen scrabblers observed by Free (1964) was very low with a mean of 4% throughout flowering. The percentage foragers that collected both nectar and pollen was considerably lower (between 2 - 8%), than the 10 - 25% found by Free (1964).

Free (1964) observed a peak in pollen gathering four days after observations started, when the field had reached a 10% flowering stage. In the present study maximum numbers of pollen gatherers were observed nine days after flowering started (45% flowering stage).

Though grooming to discard pollen was observed in ca. 50% of all foragers, they were nevertheless well dusted with pollen. Good pollen movement which is essential for cross-pollination took place, as not all the pollen was discarded. This is further emphasized by the observation that foragers made contact with a large number of stigmas on the same head, while probing a single floret. This is due to the pumping action of the abdomen while sucking nectar, and also to frequent leg movements.

Free found that between 10 - 12% foragers visited extrafloral nectaries on the bracts when less than 5% of the heads were open. Thereafter it dropped to less than 1%. In this study it was also found that less than 1% of foragers visited extrafloral nectaries after the 5% bloom stage. No counts were made where fewer than 5% of heads had opened.

In his treatise on water requirements of the honeybee colony, Lindauer (1955) stated that water is needed for regulating the temperature and humidity inside the hive. During a nectar flow, the moisture from nectar that is being ripened, may be sufficient for this need. Water collection continues throughout the nectar flow, though on a markedly low level. Water consumption increases with an increase in brood rearing, or after a period of poor weather and flight conditions. Water foraging on any given day is related to the relative humidity of the air. Under normal conditions water foragers will switch to nectar gathering when nectar becomes available (Lindauer, 1955).

Commercial sunflower is rated by Anderson <u>et</u> <u>al</u>. (1983) as a N3P3 honeybee plant, i.e. a good source of both nectar and pollen. When the results of table 7 are evaluated, it becomes clear that modern hybrid sunflower cultivars, grown in the Springbok Flats, can be regarded as N4P4 honeybee plants, i.e. exceptionally good sources of both nectar and pollen. This is due to continuous availability of pollen and climate and soil type probably favouring nectar secretion in the Springbok Flats locality.

Radford <u>et al</u>. (1979b) calculated a theoretical number of 24 honeybees / 100 flowering heads to ensure adequate pollination of commercial sunflower. I made a similarly calculation based on plant density, number of florets visited per honeybee, time of honeybee visits and total time per day available for foraging. A theoretical number of 30 honeybees / 100 flowering heads was calculated, which was then use to calculate the hive density. I made a recommendation of 1 hive / hectare based on these calculations (Du Toit, 1987 - Appendix B, page 141).

Various factors, which influence foraging activity on a daily as well as short-term seasonal basis through the flowering period are demonstrated by graphic models which are based on the fitted curves calculated for foraging activity in figs. 14 to 20. Obviously combinations of these factors are also possible.

The number of honeybees present in a commercial sunflower field is determined by the number of hives placed in the vicinity as well as the presence of feral colonies. As it was established that the number of natural colonies is inadequate to ensure successful pollination in the Springbok Flats (Birch <u>et al</u>., 1985), adequate pollination is largely dependent on the number of hives brought in by beekeepers. A too low number of hives would lead to an inadequate number of foragers for effective pollination either on a daily basis (fig. 14) or seasonal basis (fig. 18).

On a daily basis foraging is influenced by rain showers which occur as short intense thunder showers in the Settlers area (fig. 15). Continuous rain for two or three days will drastically reduce the numbers of foragers to a level of no activity during such a period. This is associated with rings of poor seed set on the flowering head (Birch, 1981). Mechanical irrigation with overhead sprinklers has the same effect on honeybee activity as rain. No honeybee or other insect activity was observed in fields under irrigation in the western Transvaal (09h00 - 12h00, temperature 22 °C).

The direct influence of temperature on honeybee activity in the Springbok Flats is believed to be insignificant as temperatures never reach levels where flight activity will cease (fig. 2 page 10). The indirect influence of temperature on foraging activity is of more significance. Temperature negatively influences nectar secretion by the sunflower plant. Too high mid-day temperatures can lead to foragers switching to gathering water (fig. 16.) Water is

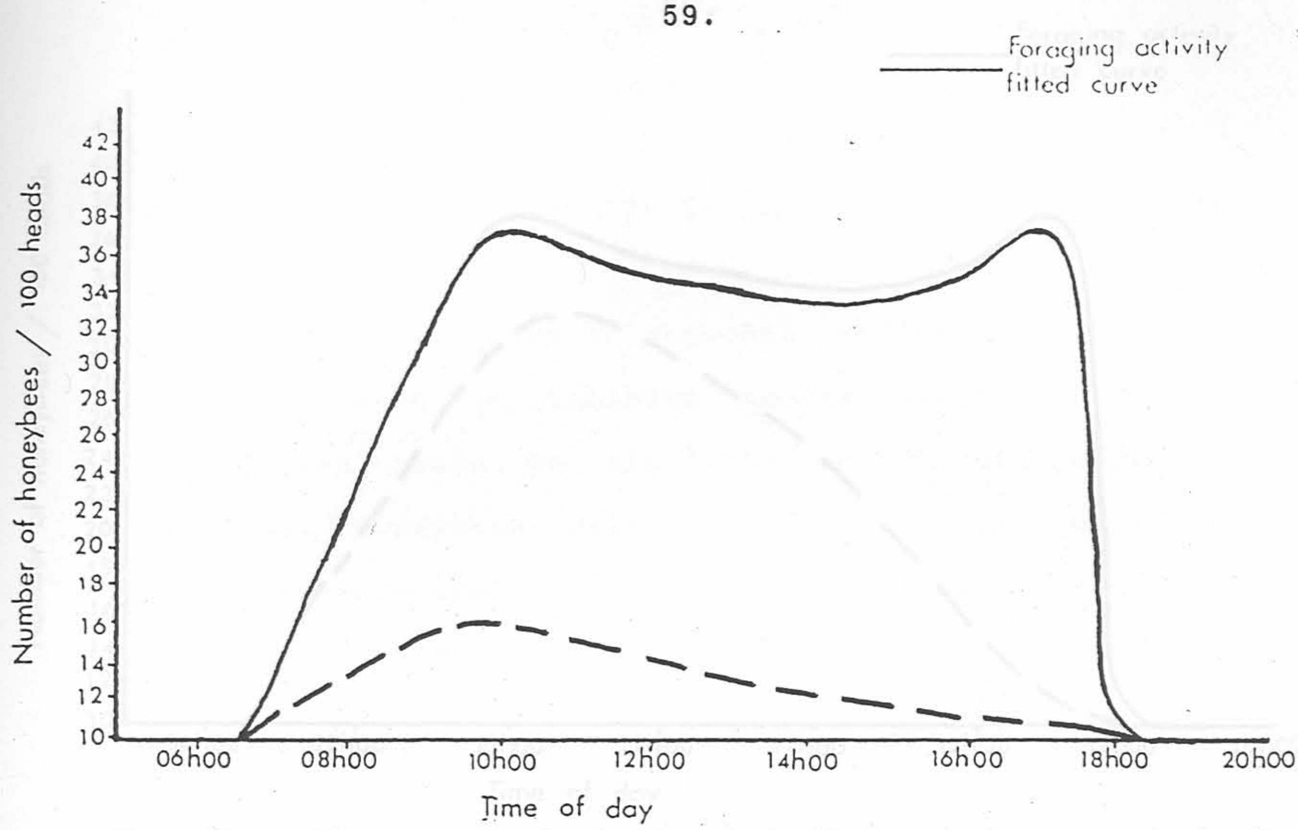

Fig. 14. The effect of a scarcity of foragers on a single day (Herrmann, personal communication 1985). Settlers, 1983-04-24.

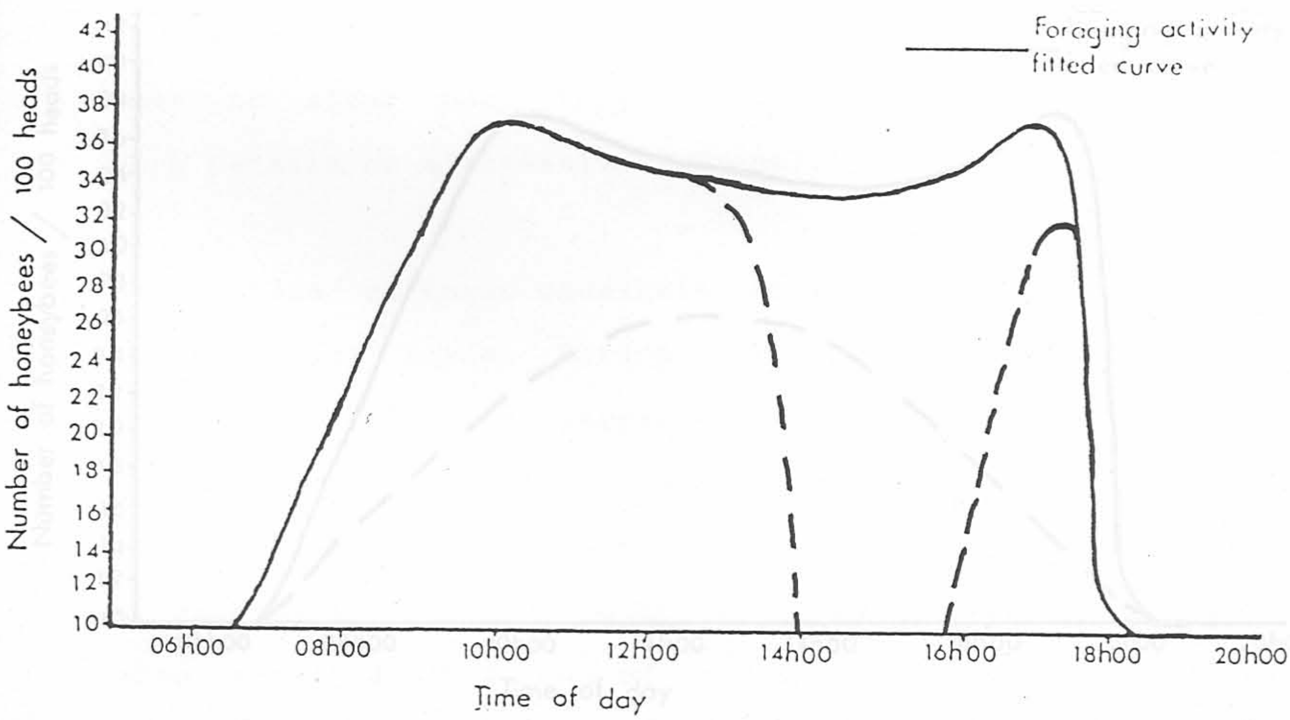

Fig. 15. The influence of a thunder shower on the number of foragers on a single day. Settlers, 1986-03-24 40% flowering stage.

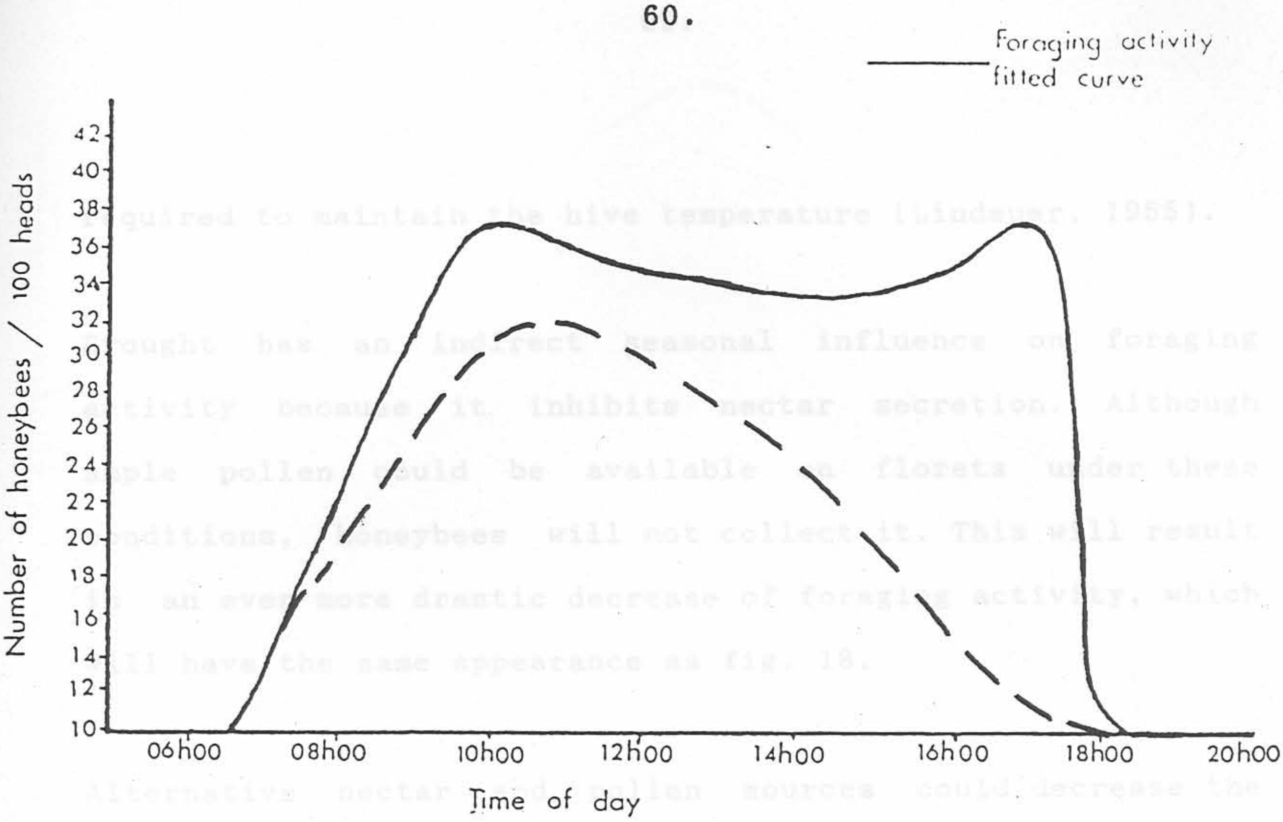

Fig. 16. The assumed indirect influence of temperature on forager activity due to a cease in nectar secretion.

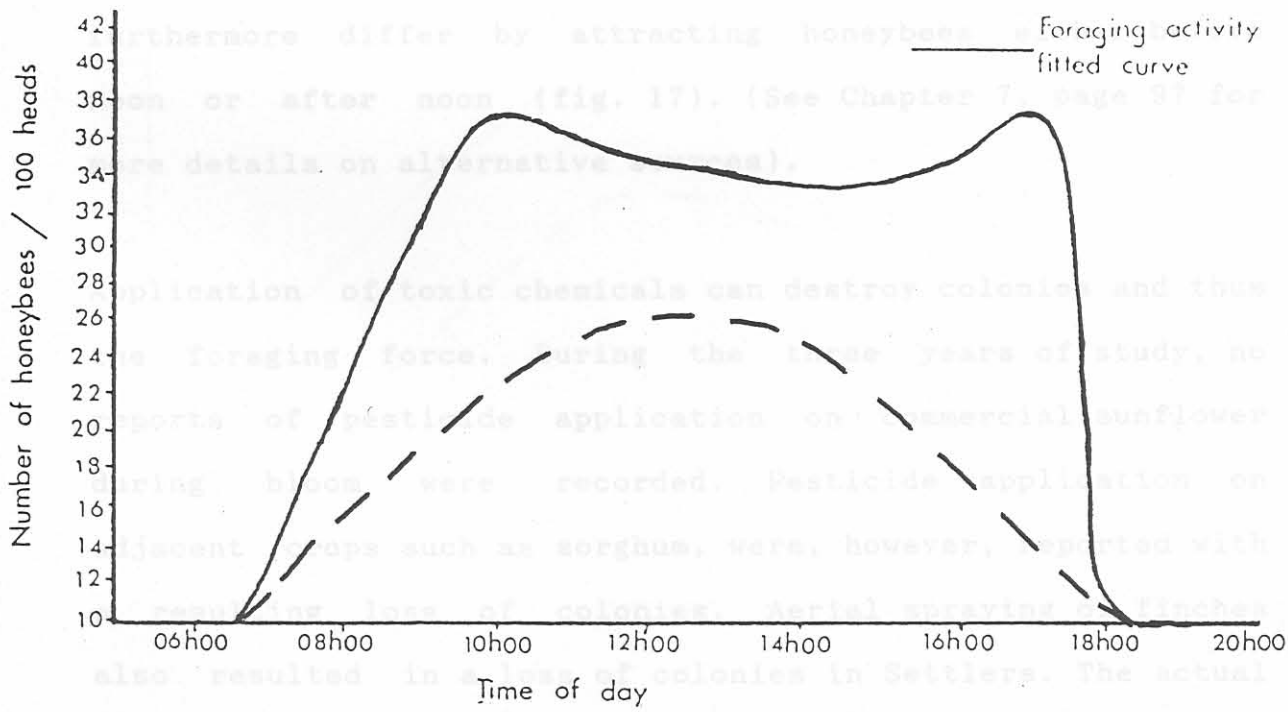

Fig. 17. The influence of alternative nectar and or pollen sources on forager activity. Settlers, March 1987.

required to maintain the hive temperature (Lindauer, 1955).

Drought has an indirect seasonal influence on foraging activity because it inhibits nectar secretion. Although ample pollen could be available on florets under these conditions, honeybees will not collect it. This will result in an even more drastic decrease of foraging activity, which will have the same appearance as fig. 18.

Alternative nectar and pollen sources could decrease the number of foragers on the target crop. These sources influence foraging numbers on the target crop on a daily (fig. 17) or seasonal basis (fig. 19). Their mode could furthermore differ by attracting honeybees either before noon or after noon (fig. 17). (See Chapter 7, page 97 for more details on alternative sources).

Application of toxic chemicals can destroy colonies and thus the foraging force. During the three years of study, no reports of pesticide application on commercial sunflower during bloom were recorded. Pesticide application on adjacent crops such as sorghum, were, however, reported with a resulting loss of colonies. Aerial spraying of finches also resulted in a loss of colonies in Settlers. The actual forager loss for a few days after pesticide application is not known. A model to illustrate possible insecticide action is presented in fig. 20.

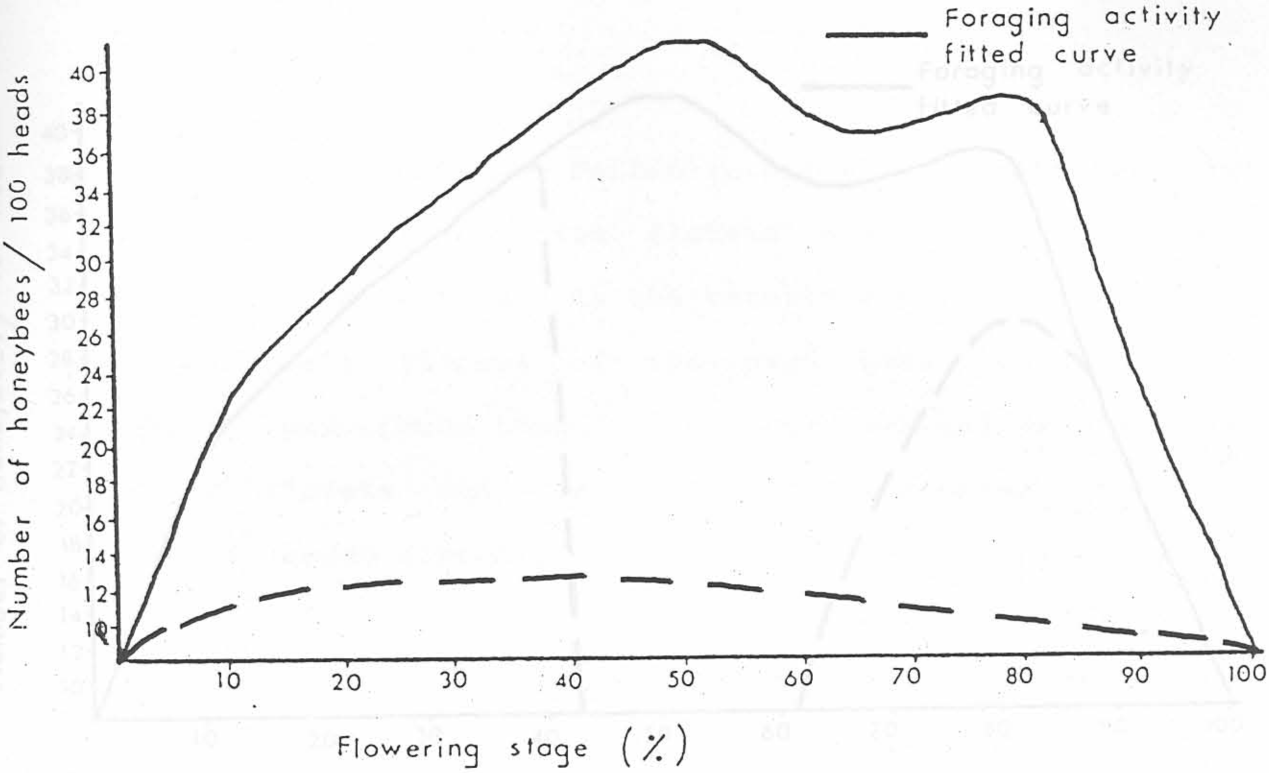

Fig. 18. The influence of a scarcity of foragers during a complete sunflower cycle. (Herrmann, personal communication, 1985. Settlers, April 1984.)

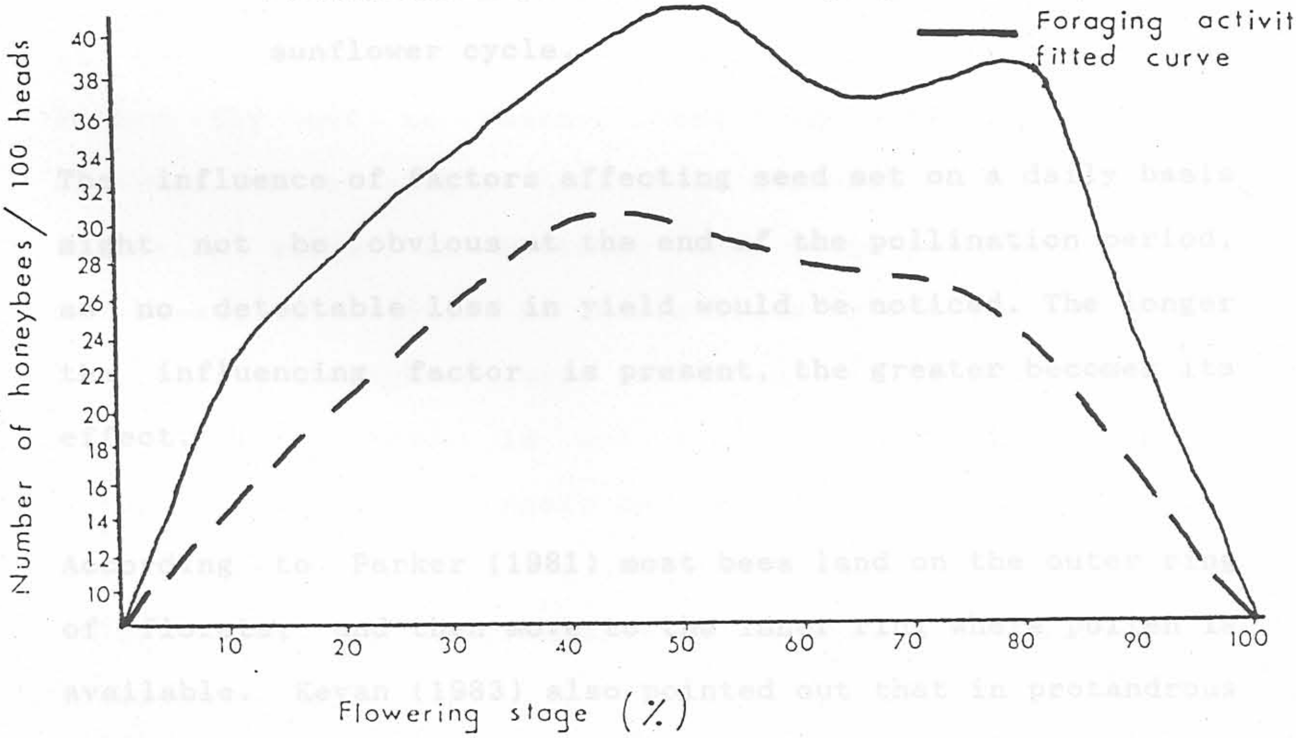

Fig. 19. The influence of alternative nectar and pollen sources during a complete sunflower cycle. Settlers, March 1987.

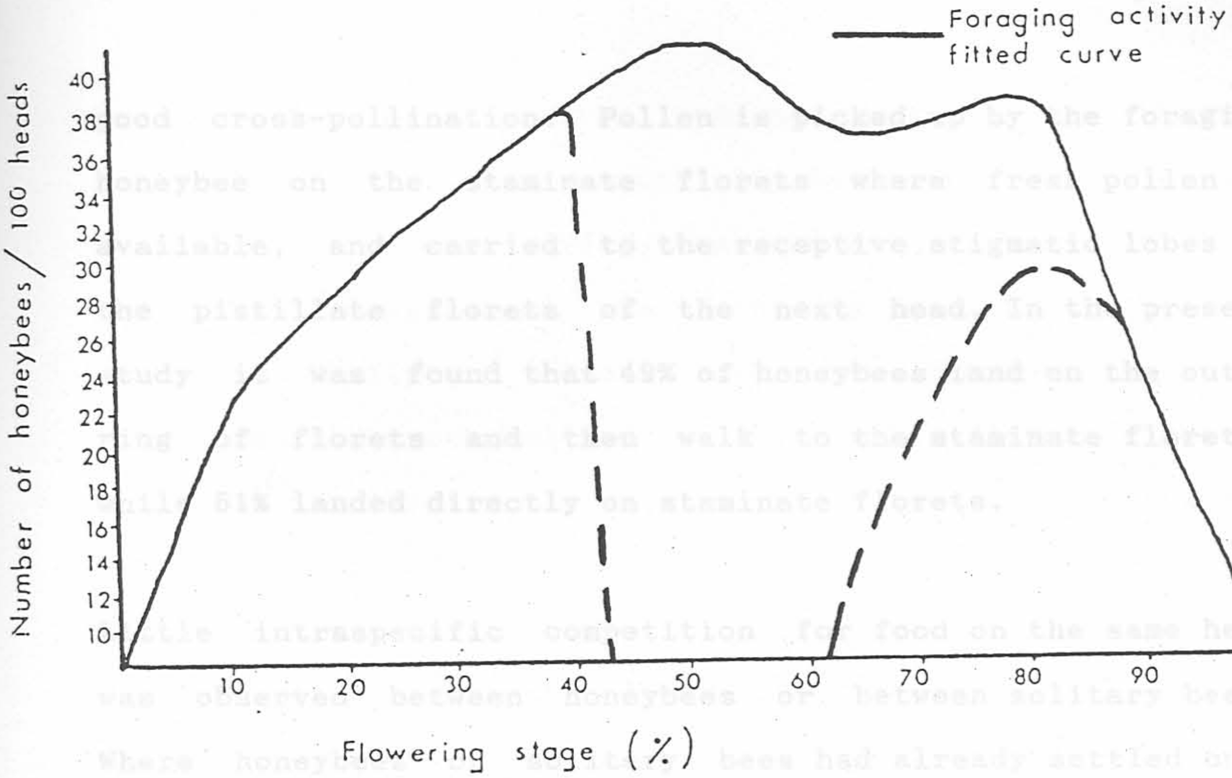

Fig. 18. The assumed influence of pesticides application on the number of honeybees during a complete sunflower cycle.

The influence of factors affecting seed set on a daily basis might not be obvious at the end of the pollination period, as no detectable loss in yield would be noticed. The longer the influencing factor is present, the greater becomes its effect.

According to Parker (1981) most bees land on the outer ring of florets, and then move to the inner ring where pollen is available. Kevan (1983) also pointed out that in protandrous plants such as <u>Helianthus annuus</u>, it is important that bees move from the older florets to the newly opened florets, where pollen is available. This action is very conducive for good cross-pollination. Pollen is picked up by the foraging honeybee on the staminate florets where fresh pollen is available, and carried to the receptive stigmatic lobes of the pistillate florets of the next head. In the present study it was found that 49% of honeybees land on the outer ring of florets and then walk to the staminate florets, while 51% landed directly on staminate florets.

Little intraspecific competition for food on the same head was observed between honeybees or between solitary bees. Where honeybees or solitary bees had already settled on a head, the approach of other honeybees or solitary bees did not disturb the settled ones. Bees which approached a head at the same time did show some interaction and both would rather fly off to another head. Up to 10 honeybees were observed on a single head (head diameter 180 mm., 75-100% flowering stage) at Pretoria (mean range per head: 0 - 5.2 honeybees, n = 64). No interactions between spotted maize beetle and honeybees were observed. It is thus concluded that forager choice is not significantly affected by the presence of other foragers on the head. Tepedino and Parker (1981) reached the same conclusion. No pollen robbing (cleptolecty) by honeybees was observed as described by Thorp and Briggs (1980).

Observations on predators of honeybees were made while conducting the survey of pollinating insects. Only a few incidents of predation on honeybee foragers were observed during the 259 strip counts in Settlers, Pretoria and Hartbeesfontein and during observations on behaviour of individual foragers on the flowering head. Crab or flower spiders (Family : Thomisidae) were observed on four occasions to successfully catch foragers on flowering heads. A robber fly (Family : Assilidae) was once seen to capture a honeybee, similarly an assassin bug (Family : Ruduviidae) positioned on the bracts of a flowering head, was seen feeding on a honeybee. The yellow bee pirate, (Philanthus diadema : Family Sphecidae) was fairly common on flower heads in Pretoria and Hartbeesfontein, though actual attacks on foraging honeybees were never observed. These wasps were only seen to feed on the floral nectar. An exceptional observation was made of eight ants carrying a living honeybee down the stem of a sunflower plant.