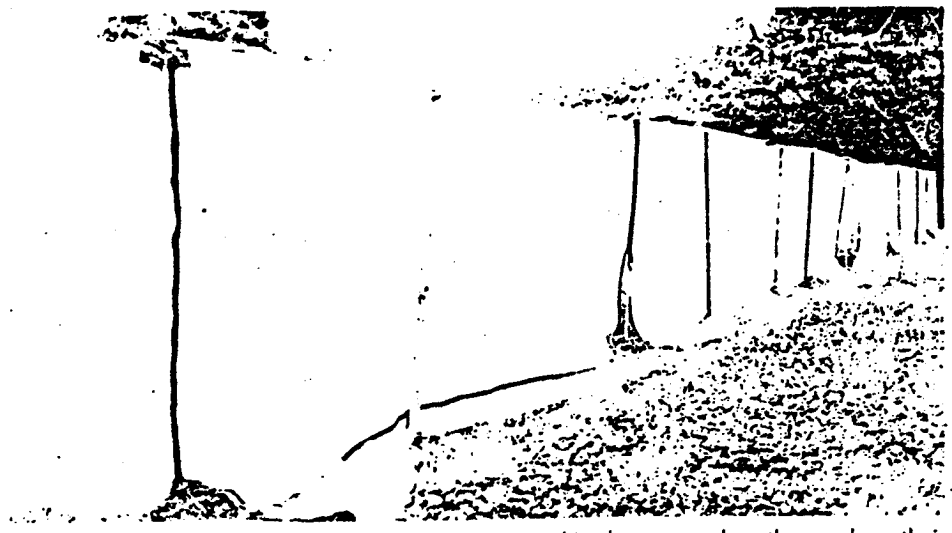

Some 8,000 bees were released in each of 24 screened enclosures, such as these, where their behavior was observed during the experiments.

Evaluating honey bees for white clover pollination

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WHITE CLOVER (*Trifolium repens* L.) is a cross-pollinated, self-incompatible forage legume that requires honey bees (*Apis mellifera* L.) or other insects for pollination. During peak flowering periods in spring and early summer, cool weather and excessive rainfall restrict the time during which honey bees may forage on the clover. If a clover floret is not pollinated shortly after it opens, the floret will usually be seedless.

A study to determine if honey bees differ in their ability to pollinate white clover, and to identify bee characteristics that might contribute to more efficient pollination, was conducted by the LSU Agricultural Experiment Station in cooperation with the USDA Bee Breeding and Stock Center Laboratory in Baton Rouge.

Twenty-four honey bee colonies were used in the study. Each colony was composed of workers from a single mating of a drone and queen. The worker bees, therefore, were highly related (r = 0.75). All queens and drones were reared from different colonies. Each colony contained the appropriate queen, approximately 2 pounds of workers, and equal amounts of brood and stored food. Each colony was placed in a screened cage 9 feet by 12 feet in a field of Louisiana S-1 white clover.

Before placing the colonies in the cages, 50 immature clover flower heads in each cage were individually tagged and covered with glassine bags. An area of 1 square meter was marked in each plot for future observation. New plots were used for each of three replications.

Foraging Behavior

After the flower heads had been covered for approximately 5 days, the bags were removed and the bees were allowed to work the heads for 30 minutes. The flower heads were re-covered after 30 minutes.

The foraging behavior of the bees was observed for the following characteristics: (1) 15 bees were graded for percent coverage of a flower head during a foraging visit; (2) the 15 bees were also scored on a scale of 1 to 5 for intensity of body movement during the visitation; (3) visitation times on individual flower heads were recorded; (4) a second group of 15 bees was monitored to determine the number of flower heads visited during 2 minutes, and (5) the number of bees that visited the marked-off area in 30 seconds was recorded.

After the behavioral portion of the experiment was completed, tagged flower heads were grown to maturity, harvested, and seed from each head counted. Also, 10 bees from each colony were collected and the following morphological characteristics were evaluated: (1) length of the fringe of hairs on the posterior margin of the metathoracic tibia; (2) length of hairs on the margin of the metathoracic basitarsus; (3) width of the metathoracic basitarsus; (4) length of the metathoracic basitarsus; (5) length of the tongue from the distal end of the glossa to the proximal end of the prementun, and (6)

Selected clover blossoms were "bagged" before the experiments, then uncovered for 30 minutes to observe foraging behavior of the bees.

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number of hairs per square millimeter on the most dorsal area of the scutellum on the mesotergum.

The data collected were analyzed using standard analysis of variance procedures. Correlation coefficients were calculated among all characteristics.

Differences Noted

Significant differences occurred among colonies for most bee characteristics measured (Table 1). There was a significant difference among colonies in the number of seed set per flower head, which is an indication of how effectively bees of each colony distributed pollen.

The observed variations among colonies for all characteristics indicated that those characteristics can be changed by selective breeding. Since all measurements were made under similar environmental conditions, large portions of the observed variations are probably genetic in origin. The distributions observed also suggest that the characteristics are influenced by polygenetic systems, or by genetic systems very sensitive to environmental conditions.

Strong correlations were not observed between any bee characteristic and seed set (Table 2). However, three characteristics—flower heads visited in 2 minutes, number of bees entering a 1 square meter area in 30 seconds, and the intensity of motion when bees were on flower heads—were weakly but significantly correlated with seed set. Other characteristics—hair lengths on tibiae, hair lengths on basitarsi, basitarsus lengths, and tongue lengths—were also weakly correlated with seed set.

Although correlation coefficients among other characteristics were generally small to nonexistent, a few were significant. Hair lengths on basitarsi and tibiae were significantly correlated ($r = 0.612$), as were length of basitarsi and both hair length on tibiae ($r = -0.594$) and hair length on basitarsi ($r = -0.760$).

Of the behavioral measurements, intensity of movement on flower heads was significantly correlated with percentages of flower heads covered during visits ($r = 0.342$) and with durations of visits ($r = 0.250$). Durations of visits also were correlated with percentages of flower heads covered ($r = 0.700$). The number of flower heads visited was significantly correlated with the number of bees en-

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Table 1.—Means, standard errors, ranges, and results of analyses of variance for 12 measurements of honey bees from 24 colonies caged over white clover plots

Colony characteristics	Mean ± standard error	Range	Probability
Seeds set per flower head	51.4 ± 8.3	31.1-85.1	0.0001
Flowers heads visited in 2 min.	9.2 ± 0.9	7.0-11.0	0.0001
Bees entering m^2 area in 30 sec.	1.99 ± 0.3	0.93-3.77	0.0001
% of flower head covered during visit	38.0 ± 5.6	27.4-51.6	0.0001
Duration of visits, sec.	12.3 ± 2.7	8.0-16.7	0.1033
Intensity of movement during visit	1.9 ± 0.1	1.4-2.7	0.0001
Hair length on tibia, mm	0.6 ± 0.02	0.44-0.81	0.0001
Hair length on basitarsus, mm	0.48 ± 0.02	0.29-0.68	0.0001
Width of basitarsus, mm	1.08 ± 0.02	1.0-1.15	0.0994
Length of basitarsus, mm	1.69 ± 0.04	0.94-2.30	0.0001
Length of tongue, mm	5.77 ± 0.11	4.86-6.38	0.0001
Hair density	84.3 ± 2.8	60.5-106.3	0.0001

Table 2.—Correlation coefficients of 12 measurements of honey bees from 24 colonies caged over white clover plots

Colony characteristics[1]	Colony characteristics[1]										
	FV	BM²	PC	DV	IM	HT	HB	WB	LB	LT	HD
	Correlation coefficients, degrees of freedom										
SS	0.303** 70	0.201* 70	0.050 70	−0.001 70	0.249* 70	0.315 22	0.271 22	0.013 22	−0.261 22	−0.264 22	0.058 22
FV		0.351** 70	−0.114 70	−0.131 70	0.213 70	0.471* 22	0.391 22	0.081 22	−0.272 22	−0.149 22	0.097 22
BM²			0.034 70	0.047 70	0.193 70	0.018 22	0.182 22	−0.045 22	−0.131 22	−0.555 22	−0.040 22
PC				0.700** 1068	0.342** 70	0.133 22	0.248 22	−0.111 22	−0.253 22	−0.050 22	−0.035 22
DV					0.250** 1068	0.255 22	0.055 22	−0.122 22	−0.150 22	0.070 22	0.233 22
IM						0.267 22	0.261 22	−0.086 22	−0.204 22	0.041 22	−0.167 22
HT							0.612** 238	0.057 238	−0.594** 238	−0.179** 238	−0.003 238
HB								0.013 238	−0.760** 238	−0.140* 238	−0.108 22
WB									0.089 238	0.372** 238	−0.064 238
LB										0.241** 238	0.112 238
LT											−0.180** 238

[1]SS = seeds set/flower head; FV = flower heads visited in 2 min.; BM^2 = bees entering m^2 area in 30 sec.; PC = percentage of flower head covered during visit; DV = duration of visits, sec.; IM = intensity of movement during visit; HT = hair length on tibia, mm; HB = hair length on basitarsus, mm; WB = width of basitarsus, mm; LB = length of basitarsus, mm; LT = length of tongue, mm; HD = hair density.

*P<.05. **P<.01.

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tering the 1 square meter area in 30 seconds ($r = 0.351$).

The low correlations between the measured bee characteristics and seed set indicate that no one characteristic can be singled out as a superior candidate for inclusion in a selective breeding program designed to improve pollination ability. Nonetheless, several of these characteristics combined into a selection index may be useful in improving pollination ability through selective breeding. However, studies involving individual bees on single flowers are needed to more thoroughly understand bee-plant interrelationships before a selective breeding program in undertaken.