

nutrients have been observed to get clogged in the midgut and thus cause a distention of the 1st ventriculus. Sometimes the latter may even rupture.

Table showing the distribution of digestive enzymes of the leafhoppers

Name of insect	Organ	Amylase	Maltase	Invertase	Alkaline Proteinase	Polypeptidase	Lipase	Chlorophyllase
<i>E. kerri</i> . . .	Salivary glands	×	—	×	—	—	—	—
	Midgut	×	×	×	×	×	×	×
<i>E. devastans</i> .	Salivary glands	×	—	×	—	—	—	—
	Midgut	×	×	×	×	×	—	×
<i>T. spectra</i> . .	Salivary glands	—	—	×	—	—	—	—
	Midgut	—	×	×	—	×	—	—
<i>P. porrectus</i> .	Salivary glands	—	—	×	—	—	—	—
	Midgut	—	×	×	—	×	—	—

Note: (i) '×' denotes the presence and '—' the absence of enzymes.
(ii) The hind gut did not show the presence of these enzymes.

These observations suggest that the specificity of jassids to a particular plant-tissue is related to the distribution of enzymes in their digestive tract and, hence, to their capacity to utilize various nutrients.

Thanks are due to Dr. M. L. BHATIA for encouragement in my work.

K. N. SAXENA

Department of Zoology, University of Delhi, February 15, 1954.

Zusammenfassung

Die Zikaden *Empoasca kerri* und *E. devastans* saugen in erster Linie den Saft des Mesophyllgewebes, während *Tettigella spectra* und *Parabolocratrus porrectus* sich hauptsächlich vom Phloemgewebe ernähren. Bei den mesophyllfressenden Formen sind folgende Fermente vorhanden: Amylase, Maltase, Invertase, alkalische Proteinase, Polypeptidasen, Chlorophyllase und allein bei *E. kerri* Lipase. Die Phloemfresser besitzen nur Maltase, Invertase und Polypeptidase.

On the Ovary Development in Queenless Worker Bees (*Apis mellifica* L.)

Introduction. If the queen of a colony of honeybees gets lost, a new one is reared from a fertilized egg or a young female larva. If, however, in a queenless colony, no eggs or young larvae are available, a development occurs in the ovaries of a great number of worker bees resulting in the production of haploid eggs from which only drones emerge. As long as a queen is present in a colony, the ovaries of the worker bees remain small and undeveloped with no differentiation in the ovarioles. Thus the presence of the queen prevents the development of the worker bee ovary. The nature of the factors responsible for the inhibition of the worker bee ovary in a queen-right colony is still unknown, and so far experi-

mental data concerning this problem are scanty and contradictory¹.

In an attempt to obtain more information on this problem, experiments were performed with small groups of bees kept under laboratory conditions.

Material and methods. Very young worker bees, emerging from a comb with sealed brood in an incubator, were used as experimental material. Within 24 h after emergence, groups of about 50 bees were transferred into LIEBEFELDER experimental cages. The caged bees were kept at 30°C throughout the experiment and supplied with food and water *ad libitum*. The food consisted of sugar candy containing bee gathered pollen in a concentration of 15 % of the dry sugar. (For further details of this method of keeping bees see².) After about 3 weeks, the bees were killed with chloroform and dissected under 70 % alcohol. The development of the ovaries was studied under a binocular microscope using the classification of developmental stages as given by HESS³. According to this method, the degree of development is qualified by the figures 1–5, representing a development of respectively none, first signs, distinct, high and highest. Based on the situation in a normal bee colony, the stages 1 and 2 were considered as undeveloped and only the stages 3, 4, and 5 as developed.

Results. In preliminary experiments, it was observed that the degree of development of the ovaries of young worker bees caged without a queen is highly dependent on the amount of pollen consumed. In order to eliminate as far as possible the variable factor of pollen intake, which might influence the results, the bees were forced to consume the pollen by incorporation in sugar candy. A pollen concentration of 15 % was sufficient to obtain a development of more than 50 % of the ovaries within a period of 21 days. At higher pollen concentrations many bees died, apparently as a result of accumulation of indigestible material in the gut. In subsequent experiments a pollen concentration of 15 % was therefore used.

Under the conditions of our experiments, the presence of a queen resulted in a complete inhibition of ovary development of the worker bees during the first three weeks, whereas, in the controls without a queen, the number of developed ovaries after three weeks varied between 50 and 100 %. A virgin queen prevented the ovary development as well as a mated one. More surprising was the observation that the inhibiting influence is not only exerted by a living queen but also by the presence of a dead one. In general the effect of dead queens decreased with increasing time after the queen had been killed, but in some experiments even after 12 months a distinct inhibition was obtained.

In further experiments it turned out that especially certain parts of a dead queen attract the worker bees and exert a distinct influence. If only the head of a queen was present an almost complete suppression of ovary development was obtained. The influence of an

¹ G. HESS, Über den Einfluss der Weislosigkeit und des Fruchtbarkeitsvitamins E auf die Ovarien der Bienenarbeiterin, Beih. Schweiz. Bienenz. 1, 33 (1942). — A. MÜSSBICHLER, Die Bedeutung äusserer Einflüsse und der Corpora allata bei der Afterweiselenstehung von *Apis mellifica*, Z. vgl. Physiol. 34, 207 (1952). — J. PAIN, L'alimentation et le développement des ovaires chez l'ouvrière d'abeille, Arch. int. Physiol. 59, 203 (1951); La «substance de fécondité» dans le développement des ovaires des ouvrières d'abeilles (*Apis mellifica* L.). Critique des travaux de MÜSSBICHLER, Insectes Sociaux 1, 59 (1954).
² A. P. DE GROOT, Protein and Amino Acid Requirements of the Honeybee (*Apis mellifica* L.), Physiol. Comp. Oecol. 3, 197 (1953).
³ G. HESS, Über den Einfluss der Weislosigkeit und des Fruchtbarkeitsvitamins E auf die Ovarien der Bienenarbeiterin, Beih. Schweiz. Bienenz. 1, 33 (1942).

Table

	Number of ovaries in stage 1–5					Percent developed
	1	2	3	4	5	
Queenless 1	5	10	13	10	7	67
Queenless 2	4	3	22	6	4	82
Dead fecundated queen (freshly killed)	44			2		4
Dead virgin queen (10 days)	36					0
Dead fecundated queen (10 months)	44			2		4
Dead virgin queen (12 months)	23	6	4	3	1	22
Dead fecundated queen head	43	1				0
thorax	8	7	15	10	1	63
abdomen	41	1	2	4		13

Inhibition of ovary development by dead queens or separated queen head, thorax and abdomen.

isolated queen abdomen was somewhat less, whereas the thorax exerted no distinct influence. The results of only one of the experiments showing a clear effect of dead queens or parts of it are given in the table.

In order to investigate the significance of direct (mechanical) and indirect contact between queen and worker bees for the inhibition of ovary development, three experimental cages with 50 bees in each were fastened against each other. The middle cage containing a queen was separated from the one by a single layer of gauze which prevented the passage of the bees, and from the other by two such layers of gauze at a distance of about 20 mm. Any direct contact of the queenless bees in the latter cage with the queen was impossible. In these experiments, development of the ovaries only occurred in the bees separated from the queen by the double gauze wall. Thus the bees, which were not allowed a direct contact with the queen or the queen attendants by means of tongue or antennae, developed the ovaries while the others did not.

In another experiment, two cages with 50 bees in each and one containing a queen were separated partly by a zinc plate, partly by gauze. The cage with the queen was divided into two compartments by means of a queen excluder. The queen was placed in the compartment separated from the queenless bees by the zinc plate. In this way the queenless bees were unable to touch the queen. Indirect contact was possible by means of the bees which could pass the queen excluder. In this experiment the ovaries of the queenless bees were not inhibited, which points to the necessity of a direct contact between each worker bee and the queen for the inhibition of the ovaries.

Comparable results were obtained in experiments with dead queens. If a dead queen was surrounded by gauze in such a way that the worker bees were unable to touch it, the ovaries developed to the same extent as without a queen, whereas in the controls with a dead queen not surrounded by gauze ovary development was suppressed.

From these experiments, we are inclined to conclude that it is neither the odour of the queen, nor the active transfer of certain substances from the worker bees to the queen or conversely, which accounts for the results obtained. A logical explanation seems to be the presence of a substance on the surface of the queen which after consumption by the worker bees inhibits the development of the ovaries.

To test this hypothesis, dead queens were extracted with ethanol in a Soxhlet apparatus. In the presence of an extracted queen, about the same development of the ovaries was obtained as shown by control bees without a queen, while a queen which was extracted but afterwards impregnated with the extraction fluid inhibited the ovaries almost completely. About the same results were obtained if the queens were extracted with acetone instead of ethanol.

These observations support the above-mentioned hypothesis. Further experiments are needed, however, to allow a more definite conclusion.

A. P. DE GROOT and STIEN VOOGD

Laboratory of Comparative Physiology, University of Utrecht, March 8, 1954.

Zusammenfassung

Gruppen von 50 Jungbienen wurden in kleinen Versuchskäfigen im Thermostaten bei 30°C gehalten und mit Zuckerteig + 15% Pollen gefüttert. Bei Anwesenheit einer Königin entwickelten sich ihre Ovarien nicht. Ohne Königin waren jedoch die Ovarien bei Tötung nach 3 Wochen deutlich entwickelt. Die hemmende Wirkung geht nicht nur von der lebenden Königin aus; auch bei Anwesenheit einer toten Königin unterbleibt die Ovarienentwicklung. Es genügte sogar bloss deren Kopf oder Abdomen; der Thorax hingegen war nicht deutlich wirksam. Für das Zustandekommen der hemmenden Wirkung ist direkter Kontakt jeder einzelnen Arbeiterin mit der Königin bzw. deren erwähnten Körperteilen erforderlich. Mit Alkohol oder Azeton extrahierte Königinnen waren unwirksam; nach Imprägnierung mit der Extraktflüssigkeit wirkten sie wieder hemmend.

Aus den Versuchen scheint somit hervorzugehen, dass die Entwicklung der Arbeiterinnen-Ovarien normalerweise deshalb unterbleibt, weil jede einzelne Arbeiterin in direktem Kontakt vom Körper der Königin eine Substanz aufnimmt, welche die Ovarienentwicklung hemmt.

**Augenrückbildung und Lichtsinn
bei *Anoptichthys jordani* Hubbs und Innes**

Blinde Höhlenfische sind aus verschiedenen Familien und aus ganz verschiedenen Regionen bekannt: so *Stygi-*