Olfaction and Gustation in Coccids (Coccoidea)

Various coccid species fed successfully via artificial membranes on sucrose solution[1,2], but after mixing it with HCl or NH_4Cl, it was rejected by the soft scale *Lecanium acuminatum* Signoret[3], which suggests the probability of existing taste receptors. The occurence of epipharyngeal taste organs was recorded in some hemipterous insects and their stylets were presumed to be guided in plants in response to the taste of liquids in the food canal[4-7]. Chemoreception of coccids is not yet known. The present study deals with the olfaction and gustation in the citrus mealy bug *Planococcus citri* Risso (Pseudococcodea) in relation to its behaviour in nature.

A standard culture of this insect has been maintained on potato sprouts at 30°C. The female stage, whose longevity may extend for 3 months, is used in experiments since this is the feeding stage, whereas the male does not feed as it has no mouth parts and lives 1–3 days. Further details are given in the text.

Experiments and results. a) Olfaction. The antenna of the female is 8-segmented and bears 2 thin walled basiconic sensilla on the apical segment and another one on the subapical segment. Females with amputated apical and subapical antennal segments show no discrimination to odors in an arena[8] half of which was scented with ethyl alcohol and the other half was left neutral, in contrast to normal females which strongly avoided the alcohol scented side of the arena. Amputation of the apical antennal segment alone reduced the olfactory response. This indicates that the olfactory receptors are located on the apical and subapical antennal segments.

b) Gustation. When females were released on potato sprouts previously soaked in water solutions of non-olfactory compounds like HCl or NH_4Cl (1*M*), they settled down to feed on the sap after insertion of the stylets into the sprout. This gave evidence that the insect bears no external chemoreceptors on the tarsi or mouth parts, otherwise it would have tasted compound supposed to be rejected and failed to settle on the sprout or to pierce the stylets for sucking the sap. On the other hand, with potato sprouts treated with an olfactory compound like the insecticide malathion, the insects did not settle for feeding but they migrated far away as an olfactory response to malathion.

Chemoreception internal to the stylet food canal of the insect was investigated by testing its feeding response to water solutions of chemicals coloured with methylene blue (0.01%) and presented through artificial membranes of Parafilm (M)[2]. The compounds tested were presented in aqueous solution at different concentrations; for electrolytes an 0.1 *M* sucrose solution was used as a mediator for positive response. The experimental insects were starved for 24 h and then they were given access to the tested solution for 24 h, after which they were dissected to detect the acceptability of the solution which can be judged from the blue coloured traces in the alimentary tract. Control tests for feeding insects on water coloured with methylene blue showed no signs of rejection.

The insect accepts sucrose, glucose and fructose solutions at 0.1% *M* concentration but they reject sucrose to which electrolytes have been added (Table) at 0.5 *M* concentration. The concentration at which more than 50% of the insects accept this mixture vary for different compounds and the effectiveness for either acids or hydroxides is much higher than for neutral inorganic salts. The concentrations of electrolytes accepted by 50% of the insects or more were found to increase with increase of sucrose concentration. The factor of increase in acids ranges from 2–3 and in neutral salts it ranges from 5–6 with increase in sucrose concentration from 0.1 to 1 *M*. These results indicate that the insects were able to discriminate between chemicals when sucked up through the food canal. It is also suggested that there are at least 2 types of receptors involved in feeding, one for acceptable compounds and the other for unacceptable compounds. Histological investigations with an electron microscope are needed to identify the gustatory receptors in the food canal.

The foregoing studies show that olfactory receptors are located on the antennae. No external contact chemoreceptors are detected on the labium or rostrum. An evidence of chemoreception internal to the stylet food canal is obtained and by means of which the insects are able to discriminate between acceptable and nonacceptable compounds when sucked up through the food canal. From these results and other field observations, it is suggested that the insects in nature are probably transported by wind from one locality to another as their activity is too small to assume that they move on their own. The insects seem to be attracted to the host plant within a short distance through the olfactory receptors. They settle in the suitable microhabitat and the rostrum is extended and the saliva is secreted into the substrate and drawn up the stylet food canal to be brought into contact with the area where gustation occurs. At this point discrimination is manifested and the insects either accept to feed on the plant sap or leave it in search of another host.

Zusammenfassung. Nachweis, dass das 7. und 8. Antennensegment weiblicher Schildläuse der Art *Planococcus citri* Geruchsrezeptoren trägt. Alkohol wird nicht mehr vermieden, wenn die beiden Antennensegmente amputiert werden. Indizien für das Vorhandensein äusserlicher Kontakt-Chemorezeptoren konnten nicht erbracht werden.

Response of *Planococcus citri* to electrolytes in 0.1 *M* sucrose

Compound	% of individuals accepting the compound at molar concentrations					
	0.5	0.1	0.05	0.01	0.001	0.0005
HCl	0	0	0	0	30	82
H_2SO_4	0	0	0	0	14	64
NaOH	0	0	0	30	78	92
KOH	0	0	0	12	66	90
NH_4Cl	0	40	88	98	—	—
Na_2SO_4	0	54	100	—	—	—
$NaNO_3$	0	62	96	100	—	—

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