THE COMPOSITION OF LARVAL FOOD IN STINGLESS BEES:
EVALUATING NUTRITIONAL BALANCE
BY CHEMOSYSTEMATIC METHODS

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SUMMARY

Nutritional balance of larval food supposedly plays an important role in honey bee caste formation. Whether this is similar in stingless bees was an open question. We analysed the major water-soluble constituents in the larval food of 7 species of meliponids. The data were used to evaluate the hypothesis that a balanced composition of larval food is shaped by selection. Chemosystematic trees were calculated and compared to a published phylogenetic tree based on morphological characters. A considerable degree of congruence between the chemosystematic trees for the general composition of larval food and the phylogenetic tree allowed us to discuss the composition of larval food in highly eusocial bees in relation to functional aspects of larval nutrition.

ZUSAMMENFASSUNG

Zusammensetzung des Larvenfutters bei Stachellosen Bienen:
Bewertung der Ausgewogenheit an Nährstoffen mittels chemosystematischer Methoden

INTRODUCTION

Exactly one hundred years ago analytical chemists began investigating the nutritional base of honey bee caste formation by careful analyses of the composition of larval food (von Planta, 1888). Continued research in this area was spurred by the hypothesis that chemical differences in larval food may be responsible for the alternative induction of the queen/worker developmental pathways. More recently, extensive biotests with semi-synthetic diets were designed to analyse the trophogenic base of honey bee caste formation. While Rembold et al. (1974) succeeded in partially purifying a labile determinative fraction in royal jelly, experimental rearing studies led Dixon and Shuel (1963) and Weaver (1974) to conclude that the developmental switch in honey bee caste formation could not depend on a distinct “determinator” substance, but rather on a balanced composition of nutrients in royal jelly. Unfortunately, when larvae are artificially reared on fractionated and reconstituted royal jelly, or on larval food supplemented with chemically defined nutrients, it is difficult to discriminate effects of specific nutrients from those of an altered nutritional balance. Even recent progress in royal jelly analysis (Takenaka and Takahashi, 1980, 1983) and the development of new in vitro rearing techniques (Rembold and Lackner, 1981; Wittmann and Engels, 1987) did not settle this controversy. The “balanced composition hypothesis”, however, has gained widespread acceptance, nowadays. In this hypothesis nutritional balance is a rather wide open concept, comprising not only the complete nutrient composition, but also factors influencing feeding rates, as for instance physico-chemical properties and phagostimulatory compounds. The multitude of possible combinations that have to be tested in the process of shaping and optimizing diets makes it extremely difficult to experimentally test this hypothesis as a result of socio-evolution.

Taking a comparative approach, we analysed the larval food in 7 species of stingless bees (Meliponinae). In all stingless bee, the brood cells are fully provisioned with larval food just before oviposition, and are closed shortly afterwards (Sakagami, 1982). In most of the trigonine genera, enlarged queen cells are built on the margins of the combs. These royal cells receive much more provisions. In the genus Melipona, enlarged queen cells have never been found. Kerr (1950) proposed a genetic predisposition for caste development in this genus, with the nurse bees exerting a modifying influence (Kerr et al., 1966). In contrast, caste induction in the Trigonini seems to be a purely quantitative problem depending upon the amount of food available to the larva. In a number of African trigonine species, Darchen and Delage-Darchen (1970, 1971) successfully reared queens on excessive food quantities. Camargo (1972) later demonstrated the same phenomenon for the Brazilian species Scaptotrigona postica. Darchen and