THE PHYSIOLOGICAL BASIS OF TROPHALLAXIS (ABSTRACT)

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A constant exchange of food between the adults is common in all social insects. Some social insects, however, also display food exchange between the adults and the larvae. This is true for all species of social wasps and for a few species of ants.

The phenomenon of food exchange between the various colony members has been called "trophallaxis" by Wheeler (1928) and the term is now used by most students of social insects to imply mainly the transfer of alimentary contents, in liquid or solid state, either mutually or unilaterally. Among wasps, it has been proven that in the course of food exchange between the adults and the larvae, the adults offer the larvae bits of meat and receive, in return, droplets of saliva which are extremely rich in sugars.

Incubation of wasp haemolymph with fat-body, midgut, venom sac extract or glucagon causes a rise in initial glucose content to a level approximately that commonly found in wasp larval saliva which is passed during the process of trophallaxis from the larvae to the adults. Since the incubation of honeybee haemolymph together with honeybee midgut (or with wasp midgut) or that of ant haemolymph with midgut yields similar results, it is clear that the ability of haemolymph to form glucose rapidly is not restricted to insects that display trophallaxis, like vespinae, but occurs generally among social and non-social insects (Wyatt, 1967). Possibly the "capacity" of haemolymph to produce high levels of glucose has been instrumental in the development of food exchange relationships, such as occur typically among social wasps and to a lesser extent among ants. What is the origin of the glucose in the larval saliva or of that formed in the haemolymph incubated with various hyperglycaemic factors? In the experiments with C^{14} labelled protein (in vivo) and with C^{14} labelled glutamic acid (in vitro), it has been proven that gluconeogenesis does occur, i.e. there is a net effect of incorporation of C^{14} from non-carbohydrate precursors into glucose.

What could be the teleological basis for the formation of so much glucose *in vivo*? I believe that the phenomenon is dependent on detoxication reactions whereby phenols and their derivatives such as the precursors of melanin are converted into the corresponding β-D-glucosides. Such reactions occur normally in the insect fat-body (Hins and Smith, 1963). It seems that the acceleration of glucose formation by midgut and other tissues may serve the latter purpose, that is to say if more glucose is available there is a greater potential for conjugation of the phenol compounds which implies enhanced potential of detoxication.

In summary, larval and pupal haemolymph of wasps, ants and bees, are capable of spontaneous, *in vitro*, formation of glucose.

In vivo and by the use of hormonal and enzymatic mechanisms, these insects are also capable of regulating the glucose level in their bodies, in a manner resembling that in vertebrates. This capacity, however, finds its fullest expression primarily in the larvae of social wasps, which, in the course of trophallaxis, produce and secrete a saliva rich in sugars. Larval secretion of saliva of high glucose content, the signalling system of the hungry larvae, and the particular structure of the wasp comb which enables the transmission of such larval-signal vibrations, all contribute to the proper maintenance of the food exchange between adults and larvae which so typifies colonies of social wasps.

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