

Morphology and ultrastructure of a specialized bacterial pouch in the digestive tract of *Tetraponera* ants (Formicidae, Pseudomyrmecinae)

J. Billen^{a,*}, A. Buschinger^b

^aZoological Institute, University of Leuven, Naamsestraat 59, B-3000 Leuven, Belgium

^bZoologisches Institut, Technische Universität Darmstadt, Schnittspahnstrasse 3, D-64287 Darmstadt, Germany

Received 9 October 2000; accepted 21 November 2000

Abstract

The digestive tract in workers of some species of the pseudomyrmecine ant genus *Tetraponera* is characterized by a conspicuous pear-shaped diverticulum at the transition between the midgut and the intestine, that so far has not been found in any other ant species. As this organ is filled with a mass of bacteria, we propose to designate it as a bacterial pouch. Its distal wall is formed by a thin ectodermal epithelium, through which tens of tracheal branches penetrate into the bacterial mass that fills the pouch lumen. The proximal wall, in contrast, is formed by a cylindrical epithelium with a conspicuous microvillar differentiation of the apical cell membrane, but without a cuticular lining. The contact region between both epithelia occurs as a complex fold surrounding the pouch like a belt. The Malpighian tubules open into the pouch through the cylindrical epithelium adjacent to the belt fold. The functional significance of the bacterial pouch remains unknown, although the abundant presence of bacteria may indicate a symbiotic function. The conspicuous tracheolar supply illustrates the metabolic activity in the pouch, while the microvillar differentiation of the cylindrical epithelium may be interpreted in the uptake of metabolites from the pouch lumen. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: *Tetraponera*; Formicidae; Bacterial pouch; Digestive tract; Morphology; Ultrastructure

1. Introduction

The anatomical organization of the insect digestive system in general shows the same elements, albeit with eventual differences in the proportional development of particular parts, that can be related with the insects' dietary characteristics. A very peculiar situation is found in a number of insects that harbour a microcosmos of symbiotic microorganisms inside their digestive tract, mostly for the digestion of cellulose, for which the insect itself lacks the necessary enzymatic infrastructure (Dettner and Peters, 1999). A well-known example is found in the termites, that contain flagellates or bacteria in their hindgut for this purpose (Noirot and Noirot-Timothee, 1969). In many of the Termitidae, the bacteria are found in the so-called mixed segment that occurs at the junction between midgut and intestine, and that is characterized by the lumen being lined on one side by the midgut epithelium, and by the intestinal epithelium on the other (Kovoor, 1968; Noirot and Noirot-Timothee, 1969). Bacteria have equally been described in the digestive tract of overwintering honeybee

workers, where they occur in the lumen of the hindgut (Cruz-Landim, 1972). In the stingless Meliponinae, bacteria can be found in the entire gut system from oesophagus to rectum (Cruz-Landim, 1990).

Also in ants, especially in species belonging to the tribe Cephalotini, a variety of microorganisms has been reported in the digestive system, with bacteria and fungi the most common representants (Hölldobler and Wilson, 1990). The anatomical location of these endosymbionts may vary, but generally they occur in the lumen of the midgut and especially in the posterior part of the ileum (Caetano, 1989; Caetano and Cruz-Landim, 1985, 1987). The structural organization of the organ they are situated in usually is in agreement with the common appearance of the organ concerned, without obvious specializations. Also intracellular endosymbiotic bacteria may be found, such as in specialized bacteriocytes in the midgut of *Camponotus* species (Schröder et al., 1996).

We here report on the presence of a unique, hitherto unknown and structurally complex lateral pouch organ, filled with a bacterial mass, that occurs at the junction between the midgut and the intestine in *Tetraponera attenuata*, *Tetraponera binghami* and *Tetraponera nitida*, whereas it is lacking in some other species of this genus.

* Corresponding author. Tel.: +32-16-32-3975; fax: +32-16-32-4575.
E-mail address: johan.billen@bio.kuleuven.ac.be (J. Billen).