CHAPTER 5

DIPLOPODA — DIGESTIVE SYSTEM

BY

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The digestive tract of millipedes is a straight tube, differentiated into three large regions: foregut, midgut, and hindgut (Fig. 5.1). Except for the midgut, of mesodermal origin, the other two regions, of ectodermal origin, are internally lined by cuticle (Hopkin & Read, 1992). A pair of salivary glands, or a single one, runs along the foregut and is responsible for the production of a secretion that in addition to lubricating the food, may contain digestive enzymes. From the pylorus, the first portion of the hindgut, a pair of Malphighian tubules arise which play a role in the osmoregulation and excretion of nitrogen residues and inorganic material (Hopkin & Read, 1992; Fantazzini et al., 1998; Moreira-de-Sousa & Fontanetti, 2012).

Histological and, to a very limited extent, ultrastrucural studies have been performed in the last fifty years on representatives of most millipede orders, i.e. Polyxenida: *Polyxenus lagurus* (Schlüter & Seifert, 1985); Glomerida: *Glomeris marginata* (Schlüter, 1980b; Martin & Kirkham, 1989); Polydesmida: *Euryurus erythropygus* (Miley, 1930), *Oxidus gracilis* (Seifert & Rosenberg, 1977), *Polydesmus angustus* (Schlüter, 1980a, b), *Anoplodesmus tanjoricus* (Deshmukh & Deshmukh, 2011); Chordeumatida: *Mycogona germanica* (Köhler et al., 1991), *Mastigona mutabilis* (Meyer & Eisenbeis, 1985); Julida: *Ptyojulus impressus* (Hefner, 1929), *Cylindroiulus londinensis* (Hubert, 1978a, b, 1979a, b, 1981, 1988), *Tachypodoiulus niger* (Schlüter, 1980a); Spirobolida: *Narceus americanus* (Miley, 1930), *N. gordanus* and *Floridobolus penneri* (Bowen, 1968), *Rhinocricus padbergi* (Fantazzini et al., 1998, 2002; Camargo-Mathias et al., 2004, 2011; Miyoshi et al., 2005); Spirostreptida: *Plusioporus setiger*, *Urostreptus atrobrunneus* and *Orthoporus* sp. (Nunes & Crawford, 1977; Schlüter, 1979, 1982, 1983; Crawford et al., 1983; Fontanetti & Camargo-Mathias, 1997; Fontanetti et al., 2001; Miyoshi et al., 2005; Moreira-de-Sousa & Fontanetti, 2012).
FOREGUT

The foregut runs from the mouth to the esophageal valve. Morphological descriptions of this region are available for *R. padbergi* (Fantazzini et al., 1998), *Plusioporus setiger* (Fontanetti & Camargo-Mathias, 1997), *Urostreptus atrobrunneus* (Moreira-de-Sousa & Fontanetti, 2012), *P. impressus* (Hefner, 1929), *E. erythropygus* (Miley, 1930) and *A. tanjoricus* (Deshmukh & Deshmukh, 2011).

Characteristic for this region are epidermal invaginations whose cells secrete a cuticle with many folds facing the lumen (Fig. 5.1A). The wall of this region is comprised of epithelium, basal membrane, and muscles. Salivary glands surround the entire structure (Figs. 5.1A, 5.2A).

In *R. padbergi*, the foregut is the shortest portion of the alimentary canal, representing approximately one sixth of the total length. The epithelium is formed by columnar cells with nuclei mainly in the cell’s central region. A cuticular intima and a thin peritrophic membrane are observed (Fantazzini et al., 1998).

The foregut epithelium of *Anoplodesmus tanjoricus* is composed of columnar cells with oval nuclei in the basal region. In the middle region of this portion, the epithelium exhibits six plicae that occupy most of the lumen, while in the posterior region, the plicae are crunched. The basal membrane is continuous in the plicae, unlike the muscles (Deshmukh & Deshmukh, 2011). Miley (1930) observed the presence of six plicae in the posterior portion of the *E. erythropygus* foregut, while near the mouth the epithelium consisted of a thin layer of small and irregular cells.

In *P. setiger*, the foregut is also the shortest portion of the digestive tract, representing approximately 14% of the total length. Histologically, it is similar to the foregut of *R. padbergi*, but the epithelium is formed by columnar cells in the anterior portion and cuboidal cells in the posterior portion. Approaching the midgut, the cells become columnar again and in the transition region (esophageal valve), they are extremely elongated (Fontanetti & Camargo-Mathias, 1997).

The foregut epithelium of *U. atrobrunneus* (Fig. 5.2B), *P. impressus* and *P. setiger* is composed of cells of different heights depending on the region. In the former species, the cells of the anterior portion are shorter, with central nuclei, while in the middle and posterior portions the cells are taller with nuclei in the basal region. A peritrophic membrane is observed (Moreira-de-Sousa & Fontanetti, 2012). In *P. impressus*, the cells near the mouth are columnar; in the region before the esophageal valve, the cells are cuboidal, but become columnar again approaching the esophageal valve. The esophageal valve exhibits extremely elongated cells (Hefner, 1929).

The transition from the foregut to the midgut is marked by the esophageal valve and the gradual disappearance of the cuticular intima (Fig. 5.2C, D).

MIDGUT

Histologically, the midgut is composed of epithelium, basal membrane, muscle layer, hepatic cells, and an external membrane that lines these structures (Figs. 5.1B, 5.3A). The