Subcellular Processes in Plants and Animal Cells

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Ultrastructural studies of mucilage secretion in stipular colleters of Ixora heterodoxa (Rubiaceae)

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Colleters are multicellular secretory structures found on the adaxial surface of young reproductive and/or vegetative organs in many angiosperm families [1]. These structures produce a mucilaginous or resinous substance, and function to protect the shoot meristem and leaf primordia against desiccation and pathogens [2,3].

In Rubiaceae, colleters are grouped into standard, dendroid and brush-like types on the basis of their morphology and structure [1]. Although colleters are reasonably common in this family, studies of their subcellular structure and function are lacking. We examined the cell features and secretion mechanism of the stipular colleters of *Ixora heterodoxa*, an evergreen species of Rubiaceae.

Vegetative apices from five specimens were collected during the plant regrowth period in a semideciduous forest located in Botucatu city (S 22º 47' 30" to 22º 50' and W 48º 26' 15"), São Paulo state, Brazil. The samples were processed by the usual methods for histology, histochemistry and ultrastructure.

In *Ixora heterodoxa* the shoot apex is protected by persistent stipules. The pale-yellow colleters are located on the adaxial surface of the stipules, and produce a mucilaginous secretion in the sprouting period. The colleters are of the standard type, consisting of a multicellular stalk and a head composed of a central core of axially elongated parenchyma cells surrounded by a layer of palisade epithelial cells. All the epithelial cells react positively to pectin, acid polysaccharides and protein.

The cuticle has two distinct regions: the cuticle proper, and the cuticular layer, which has an electron-dense network in the amorphous matrix. The epithelial cells of colleters in the secretory phase have large nuclei, abundant cytoplasm with free ribosomes, numerous mitochondria with well-developed cristae (Figure 1A), rough and smooth endoplasmic reticulum, plastids, and many Golgi bodies with numerous cisterns and associated vesicles (Figure 1B). The large plastids are polymorphic and contain electron-dense bodies with variable shapes (Figure 1A). The vesicles are filled with fibrillar material and osmiophilic granules.

The vesicles fuse together to form vacuoles, or fuse with the plasma membrane to form the periplasmic spaces (Figure 1C). The secretion (seen as dense fibrillar material mixed with osmiophilic granules) can be observed in the prominent periplasmic space in the distal portion of the epithelial cell, in the large intercellular spaces formed by the dissolution of the middle lamella along the anticlinal cell walls, and inside pockets in the outer periclinal walls (Figure 1C).

The ultrastructure of colleters in *I. heterodoxa* is similar to colleters of other species of Rubiaceae that produce mucilage [3, 4, 5]. The large number of Golgi stacks close to the large vesicles indicates that these organelles are intensely active in mucilage secretion and transport [6]. The degradation of the epithelial cell walls, combined with pressure from the accumulated material in the periplasmic space, can facilitate the passage of the secretion through the cell wall [7]. Pockets in the outer periclinal cell wall may also facilitate the passage of the secretion, which reaches the subcuticular space and finally the external environment [8]. The presence of microchannels in the cuticular layer allows the exudates to be externalized through the intact cuticle.

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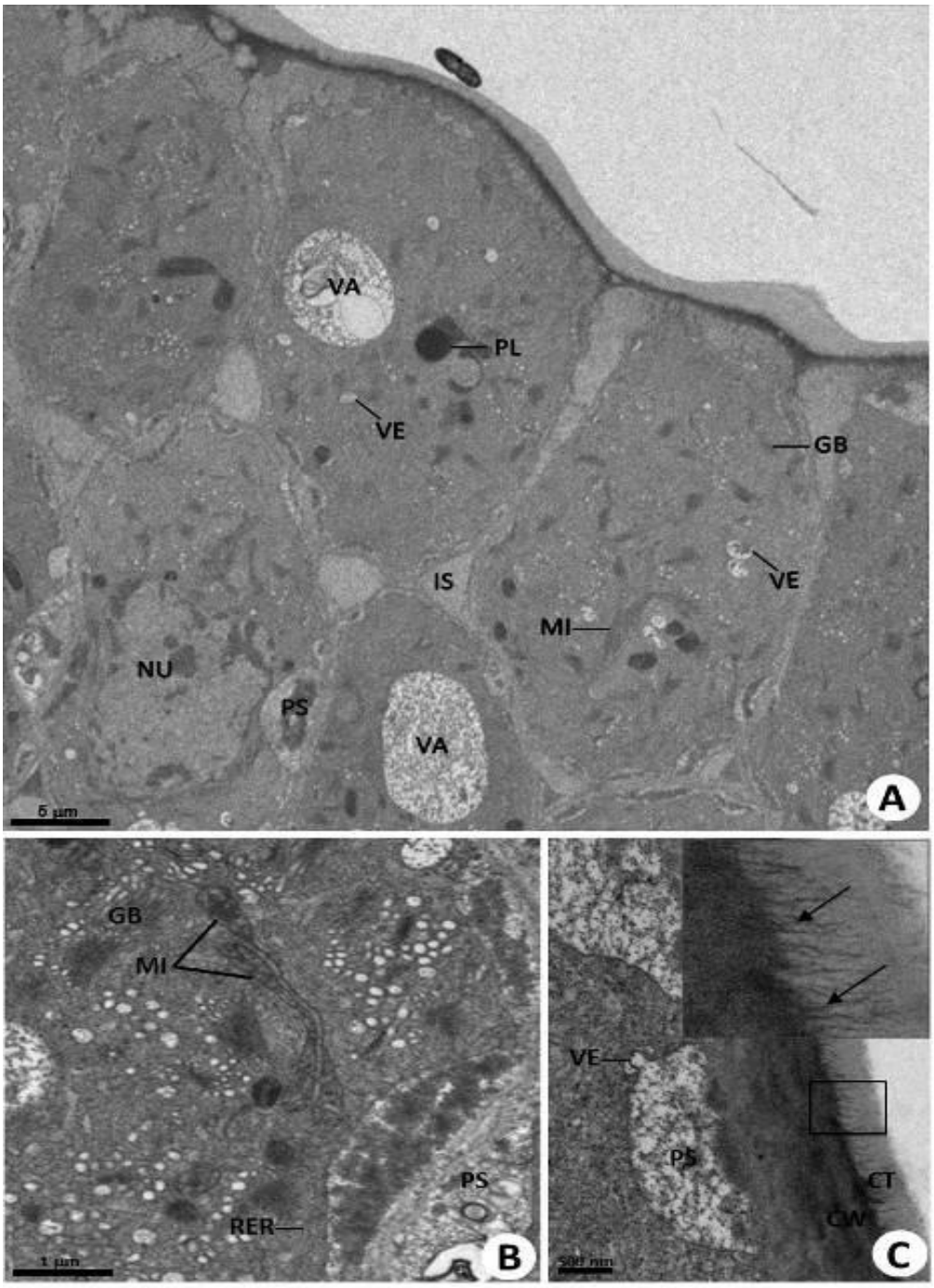

Figure 1. (A–C) Transmission electron micrographs (TEM) of epidermal cells of standard colleters in stipules of *Ixora heterodoxa*. (A) General view of epidermal cell showing abundant cytoplasm containing ribosomes, a voluminous nucleus, Golgi bodies, plastids, mitochondrias and vesicles. Notice the intercellular and periplasmic spaces. (B) Epidermal cell with rough endoplasmic reticulum, numerous Golgi bodies associated with vesicles, mitochondria with well-developed cristae. (C) Fusion of vesicles to the plasmalemma release content to the periplasmic space.(C) Periplasmic space containing fibrillar material. The insert shows fibrillar material mixed with osmiophilic granules in the cuticle (arrows). CT: cuticle; CW: cell wall; GB: Golgi bodies; IS: intercellular space; MI: mitochondria; NU: nucleus; PL: plastid; PS: periplasmic space; RER: rough endoplasmic reticulum; VA: vacuoles; VE: vesicles.