TURTLE EPIDERMIS: ELECTRON MICROSCOPIC OBSERVATIONS ON A GRANULAR COMPONENT OF MALPIGHIAN CELLS*†

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The structure of epidermis from snakes and lizards (order Squamata) has recently received considerable attention (Ernst and Ruibal 1966; Bryant, Breathnach, and Bellairs 1967; Roth and Jones 1967; Flaxman *et al.* 1968; Maderson 1968). Epidermis from these reptiles is characterized by periodic shedding of the horny layer. Little attention has been given, however, to the epidermis of turtles (order Chelonia), which is not renewed periodically but is replaced continuously (Spearman 1966). The process of epidermal keratinization appears to be less complex in the turtle than in snakes and lizards in which epidermis often is stratified by more than one generation of epithelial cells.

Light microscopic examination of the soft integument covering the leg and neck regions of the turtle indicates that the epidermis bears some morphological similarity to the epidermis of mammals, although lacking keratohyalin granules which are a distinguishing characteristic of mammalian epidermis. The purpose of this paper is to comment upon some of the ultrastructural characteristics of turtle epidermis as an example of a reptilian epidermis that is not periodically shed.

Materials and Methods

Skin from the neck and leg regions of four *Pseudemys* sp. (carapace length 3–4 cm) was fixed in osmium tetroxide buffered with collidine, phosphate, or veronal acetate; dehydrated in ethanol; and embedded in Araldite or Maraglas. Thin sections were stained by aqueous uranyl acetate and lead citrate and were examined with RCA EMU-3F or Hitachi HU-11C electron microscopes. Thick epoxy sections and paraffin sections were studied by light microscopy.

Observations and Discussion

Basal cells in turtle epidermis resemble similarly located cells in the epidermis of other vertebrates. The cells are cuboidal in shape and their centrally placed nuclei are surrounded by an unindented envelope (Fig. 1). Many filaments course through the cytoplasm of basal cells and mitochondria with dense granules are enmeshed by the filaments. Golgi membranes and cisternae of the rough-surfaced endoplasmic reticulum are seldom encountered.

Distal to the basal cells are several layers of flattened cells (Fig. 1). The most prominent components of these cells are fibrils and granules (Figs. 2 and 3). The fibrils consist of bundles of fine filaments. Most fibrils appear at the cell periphery,

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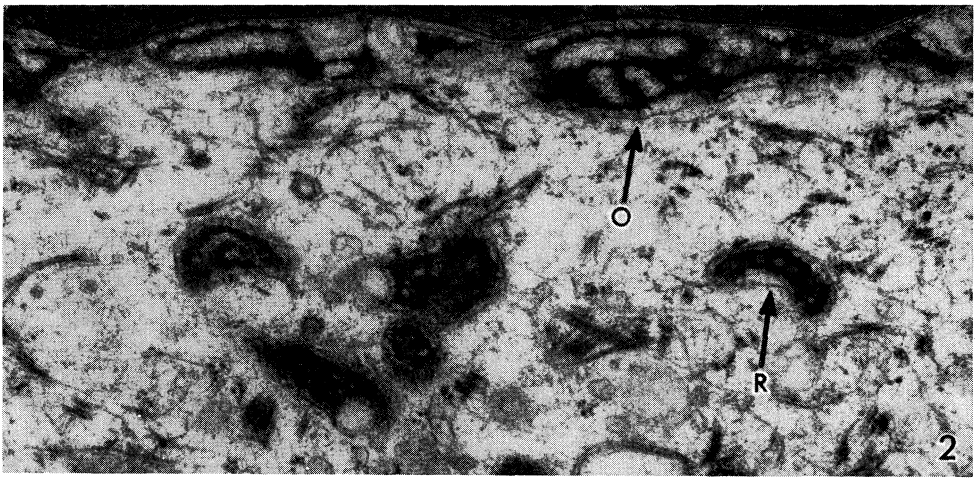
Fig. 1.—Thin section of turtle skin showing the epidermis and part of the dermis. At the lower left are dermal pigment cells and some cornified cells are seen in the upper right part of the field. Basal cells are cuboidal; at higher levels the cells are flattened. Note dense granules appearing in increasing numbers toward the surface of the epidermis. The level of the epidermis which was studied at higher magnification is indicated (↔). ×5600.



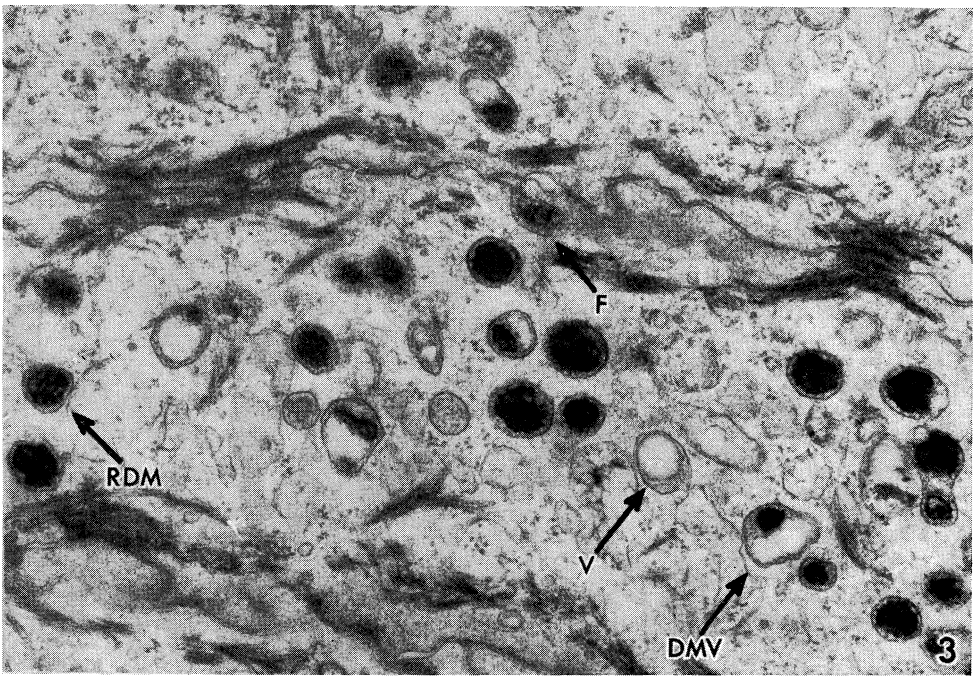


Fig. 2.—Junction between the malpighian and horny layers. Several granules are seen in the malpighian cells and there is a suggestion that some granules are reticulated (*R*). An opaque material (*O*) is seen in the intercellular space between distal malpighian cells and proximal cornified cells. ×35,000.

Fig. 3.—Variable structure of the granules and fusion of a granule with the plasma membrane (*F*) are shown. Some granules contain vesicles (*V*), others a dense mass and vesicle (*DMV*), and several others a reticulated dense mass (*RDM*). ×35,000.

only rarely do fibrils extend into the centre of the cell which is occupied by numerous granular structures (Fig. 3). The granules are bounded by a membrane and range in diameter from about 150 to 200 nm. They are not to be confused with the much larger melanin granules which also occur in the epidermis. The morphology of the granular structures varies considerably: some contain vesicles and appear relatively electron-lucent, others contain a dense mass as well as vesicles, and still others are filled by a dense mass which appears reticulated (Fig. 3).

More superficially in the epidermis, just proximal to the stratum corneum, are larger granules which also are bounded by a membrane (Fig. 2). Their reticulated appearance and overall density suggest that they are related to the smaller granules located deeper in the epidermis.

There is an indication that some of the granular structures coalesce with the distal plasma membrane (Figs. 2 and 3) in a manner suggestive of membrane coating of granules in mammalian epidermis (Matoltsy and Parakkal 1967). The intercellular space between epithelial cells is dilated at various points (Fig. 2) and the dilatations are filled by an opaque material that resembles the dense component of the granules.

Granular structures have been described in reptilian and avian epidermis which bear some similarity to the granules noted in turtle epidermis. Bryant, Breathnach, and Bellairs (1967) have shown multivesicular body-like vacuoles in epidermal cells from a lizard and indicate that the vacuoles are lysosomal derivatives. In studies of the development of chick skin, Mottet and Jensen (1968) and Parakkal and Matoltsy (1968) have described granules in the periderm which resemble some of the granules observed in turtle epidermis.

The granular organelles in malpighian cells of turtle epidermis probably are related to the process of keratinization, although an understanding of their precise role in differentiation of the epidermal cell awaits more detailed fine structural and histochemical studies.

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