HISTOMORPHOLOGY OF THE SKIN OF THE GECKO *CYRTODACTYLUS SCABER* (GEKKONIDAE, REPTILIA)

By

M. B. H. MOHAMMED*
Zoology Department, Faculty of Science, University of Qatar
Doha, Qatar

Key words : Skin, histology, gecko.

ABSTRACT

The histological structures from different dorsal and ventral regions of the skin of the gecko *Cyrtodactylus scaber* are described. Qualitative differences in the skin structures are recorded. The correlation between the integumental structures and functional specializations are reported. Hinge epidermis, like the scale epidermis, undergoes cyclic changes in its organization and 4 consecutive stages are itemized during one complete cycle. The oberhautchen bears the repeating pattern of ornamentation. The clear layer can be identified by its tendency to curl and crack during preparation. Only males possess pre-anal glands, which have a tubuloacinar structure.

INTRODUCTION

The integument anatomy possesses a complex organization and differs markedly among reptiles. Several studies described the histology, the structure and the physiological importance of the squamate integument (Lillywhite and Maderson, 1982; Dhouailly and Maderson, 1984; Levrat-Calviac and Zylberberg, 1986), and particularly the pre-anal glands (Taylor and Leonard, 1956; Chiu and Maderson, 1975; Chauhan, 1986). The epidermal shedding cycle has been also described in many lizards and snakes. (Dhouailly and Maderson, 1984; Mittal and Singh, 1987). However, information concerning the histology and structure of gecko skin is limited. In the present work, the skin histological structure, the adult shedding cycle and the structure of the pre-anal glands are described in gecko *Cyrtodactylus scaber*.

---

*Present Address: Zoology Department, Faculty of Science, Mansoura University, Mansoura, Egypt.

MATERIALS AND METHODS

Cyrtodactylus scaber (Ruppell 1827) were collected during May 1988 from different localities in the State of Qatar. Pieces of skin were dissected form different parts of the body of male and female adult geckos. Samples were fixed in Bouin's fluid, dehydrated in ethanol, cleared in methyl benzoate and toluene, and embedded in paraplast. Sections were cut either peripendicular or parallel to the skin surface, and either along transverse or the longitudinal axis of the body.

The skin bearing the pre-anal glands was removed and spread over a piece of filter paper and fixed in Sausa fixative for 6 hours at room temperature. The tissue was then treated with an alcohol-iodine mixture (Hin-Ching-Liu and Maneely, 1969), dehydrated in ethanol, embedded in paraffin, and sectioned at 7 um. Sections were stained with haematoxylin and eosin, azan or alcian blue/chlorantine fast red.

RESULTS

The skin is covered with a series of elavated thick epidermal scales separated by thin inter-scale hinge regions. The histo-logical appearance of the epidermis differs in these 2 regions (Figs. 1-4). Besides, the size and shape of the dorsal and ventral scales differ conspicuously. Dorsal scales are small, polygonal, bud-shaped and overlap only slightly or not at all (Fig. 1). Ventral scales, on the other hand, are larger and wider than dorsal ones (Fig. 2). Toes scales are large, longer than wide and overlapping. In these scales, the free surface remains flat with a smooth or somewhat wrinkled and serrated or sculptured epidermis. The outer epidermal scale comprises a very thin keratinized periderm, the oberhautchen consists of large squamous cells with small round nuclei. There are 3-4 layers of parakeratotic stratum corneum cells. The intermedium is a one-cell-thick and consists of undifferentiated cuboidal cells. The stratum germinativum consists of small cuboidal rather than cylindrical cells. The epidermis in the inter-scale hinge region is folded and the stratum corneum is poorly differentiated. The whole epidermis is much thinner than in the outer scale, comprising only 5-6 layers of cells, and the stratum germinativum is of small cuboidal cells. In the hinge regions, ingrowing buds are observed with distinct barb ridges (Figs. 4 and 5). In some regions, they possess deep pits, which are crowded with thin lamellated keratinized layers (Fig. 6).

In the dermis, the upper fibrous layer is very thin while the lower one is voluminous. Collagen fibril bundles run from the basal part into the deep dense dermis (Fig. 1-8). Many melanocytes are aligned along the adjoining basement
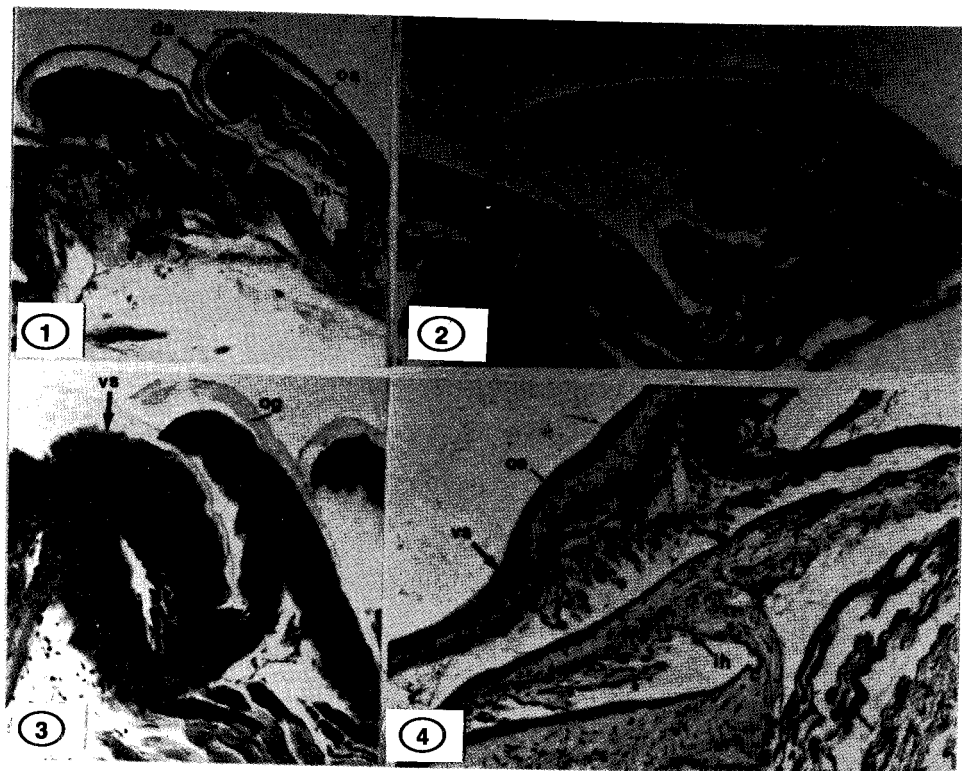
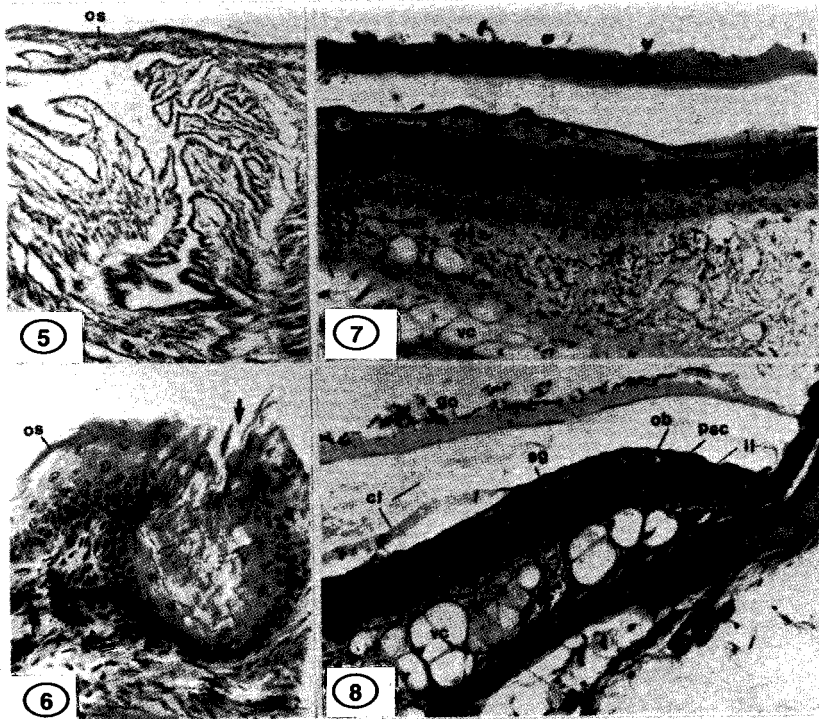Fig. 1: Transverse section in the dorsal skin. (x200)

Fig. 2: Transverse section in the ventral skin. (x250).

Fig. 3: Transverse section in the toe ventral skin. (x200).

Fig. 4: Transverse section in the female abdominal ventral skin in the position of carrying ova. (x250).

membrane of the epidermis, and send long cellular processes filled with melanin granules into the epidermis. In some places, the dermis appears rich in blood capillaries and vacuolated cells (Figs. 7 and 8).

The outer and hinge epidermis undergo cyclic changes in their organization and are differentiated into outer and inner epidermal generations. Renewal-phase epidermis maturation may not occur synchronously across the entire scale surface; some regions may appear mature while adjacent areas do not. The outer epiddermis has 4 consecutive stages during one complete shedding cycle (Fig. 9). In

Fig. 5: Transverse section in the dorsal skin. The hinge region has distinct barb ridges. (x200)

Fig. 6: Transverse section through a skin pit. The skin pit is crowded with thin lamellated keratinized layers. The pore (arrow) of the pit. (x200).

Fig. 7: Transverse section of the dorsal skin prior to shedding (x200).

Fig. 8: Transverse section through the epidermis just prior to shedding. The dermis has vacuolated cells. The clear layer remains bounded to the oberhautchen over some areas. (x200).

stage 1, the epidermis is represented by an outer epidermal generation consisting of 5 layers. The oberhautchen is a thin compact layer with no nuclei or cell boundaries. It frequently becomes separated from the underlying layer as a histo-logical artifact. Beta cells are distinguished from oberhatchen by their strong eosinophilic character. The mesos layer is devoid of nuclei and cell boundaries. Alpha cells are irregular and have rounded or oval nuclei. The stratum germinativum consists of cuboidal or flattened cells with flattened nuclei. This layer rests on a thin-cellular basement membrane. In stage 2, the epidermis has 2-5 layers of undifferentiated epidermal cells which underly the outer epidermal generation layer. In stage 3, the undifferentiated cells are associated with newly differentiated

inner epidermal generation layers. These layers are presumptive oberhautchen, presumptive mesos, and 3-4 undifferentiated cellular layers. The presumptive oberhautchen is closely associated with the overlying inner surface of the clear layer. The oberhautchen is represented by a single layer of swollen cells with central rounded nuclei that are moderately basophilic. The presumptive mesos layer consists of 5-6 layers of flattened cells with rounded or flattened moderately basophilic nuclei. Cell boundaries are thick and are strongly basophilic while the cytoplasm is weakly basophilic. Starting from stage 4, the presumptive oberhautchen is mature and represented by a thin compact, slightly chromophilic layer. The compact presumptive mesos layer cells contain darkly-stained nuclei, often enclosed within a vacuole. The outer epidermal generation is invariably detached from the inner epidermal generation. The clear layer remains bound to the oberhautchen over some areas of scales.
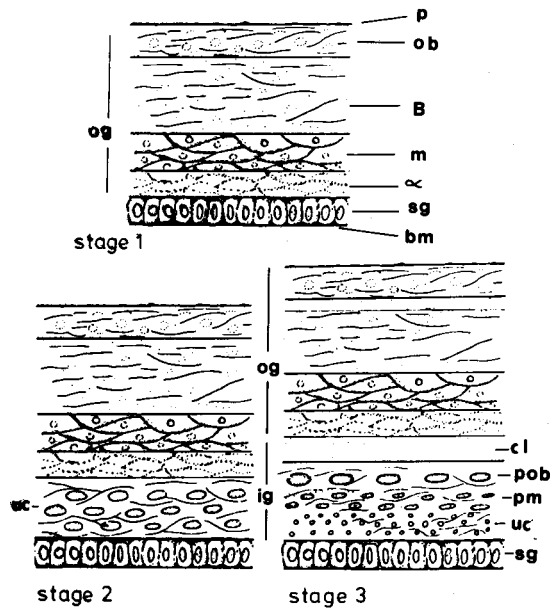

Fig. 9: Schematic representation of the stages
of epidermal shedding cycle.

The pre-anal glands occur in male geckos. There are 6 pre-anal pores each of which occurs near the posterior border of a large scale and all pores are in one row in front of the vent (Fig. 10). The glands are tubulo-acinar, consisting of small, closely packed acini separated by connective tissue septa. These septa are continuous with the dermal collagenous tissue. The connective tissue sheath surrounding the gland is thick around the duct and becomes gradually thinner towards the blind end of the

gland. The epidermal layers lining the duct wall in the neck region, where the duct opens to the outside, consists of a few layers of flattened cells with oval nuclei, covered with a superficial keratinized layer. In the interior part of the duct, its wall is lined by a stratified epithelium (Figs. 11-14).
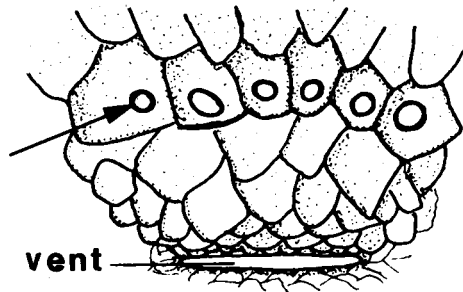

Fig. 10: Diagrammatic ventral view of the position of the pre-anal glands showing the pores (arrow) of the glands
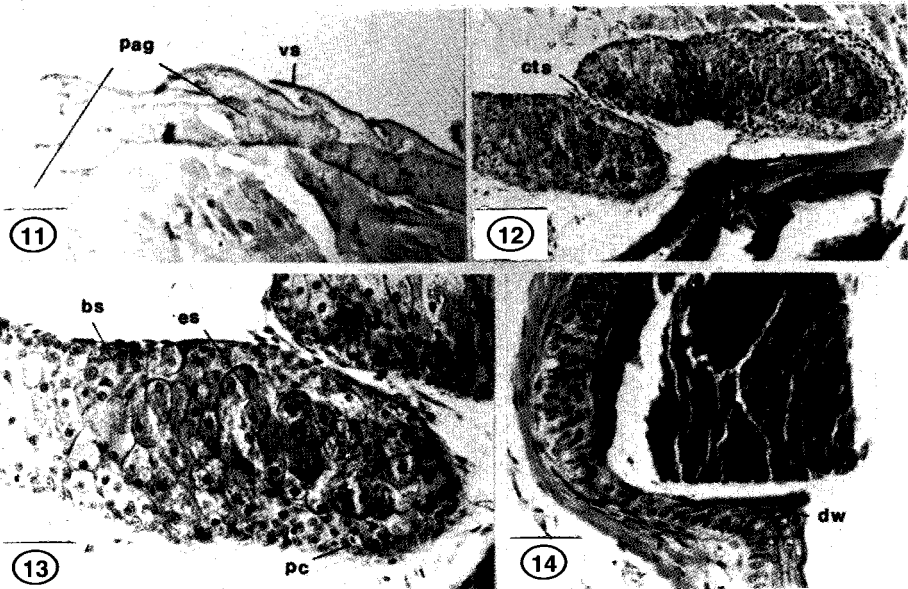

Fig. 11: Mid-sagittal section of a complete pre-anal gland. (x100).

Fig. 12: Blind end of the gland showing germinal cells and inner differentiating cells. (x150).

Fig. 13: The structure of the gland to show the types of cells. (x200).

Fig. 14: Secretory matter of the pre-anal gland containing pyknotic nuclei. (x2500).

The gradual changes in cell structure are reflected by their different staining properties. These staining differences are associated with the degree of differentiation of the germinal and differentiating cells after haematoxylin and eosin staining. The undifferentiated peripheral cells of the acini at the blind end of the gland has a basophilic cytoplasm whereas the differented cells are eosinophilic. Moreover, the peripheral cells are in active mitosis. The acinar cells in the neck region of the gland reveals a greater degree of differentiation, with their shape changing from polyhedral to oval and then to nearly rectangular in a brick-like arrangement.

Ultimately, such cells appear to disintegrate and liberate their contents i.e., they are holocrine. Increasing nuclear fragmentation occurs as the secretory contents move towards the pore (Fig. 14).

DISCUSSION

In *Cyrtodactylus scaber,* the histological structure of the epidermis differs in the outer and inter-scale hinge regions. Similar observations were recorded in several other lizards and snakes (Dhouailly and Maderson, 1984; Levrat-Calviac and Zylberberg, 1986; Mohammed, 1987). The *C. scaber* oberhautchen free surface shows distinct patterns which vary in different regions. Leyding (1873) noted that the oberhautchen texture is of possible taxonomic significance. So, this layer was termed microornamentation (Ruibal, 1968); ultradermatoglyphics (Burstein *et al.,* 1974) and microarchitecture (Peterson, 1984). The pattern was considered to be species specific (Fahrenbach and Knutson, 1975; Mohammed, 1987).

In *C. Scaber,* the integument hinge regions have distinct barb ridges or keratinized lamellated layers. In *Cordylus giganteus* (Mertens, 1960), *Uromastyx hardwickii* (Seshadri, 1956) and *Moloch horridus* (Cloudsley-Thompson and Chadwick, 1964) the skin is hygroscopic and absorbs water like a blotting paper. Bentley and Blumer (1962) showed that the agamid *Moloch horridus* soaks water into fine capillary channels that run parallel to the skin surface, passes it into the mouth and swallows it. Thus, the skin pattern in *C. scaber* may be imprevious and is suitable for the desert life, yet the gecko can still can use the skin architectures to collect water from dew or sporadic showere. Mittal and Singh (1987) explained the ventral surface elasticity and stretching as a requirement for free movement in snakes. In *C. scaber,* these properties are also required for ventral skin extension during pregnancy.

In *C. scaber,* variation in the distribution of dermal collagen fibers and they is associated with the grows morphology of the skin. Studies on arrangement of dermal collagen fibers in fish (Hebrank and Hebrank, 1986) and snake (Jayne,

1988) indicated that they might facilitate lateral flexion and distension during swallowing and are useful for predicting the skin stiffness or transmission of locomotor forces. Thus, the distribution of collagen fibers in *C. scaber* may be associated with mechanical properties more or less similar to those in the snake skin. The vacuolated cells in *C. scaber* dermis may be similar to the cells which show positive staining for fat in the gecko *Underwoodisurus millii* (Elkan, 1976). Some desert reptiles are able to store water in fat, which when needed could be metabolized producing water as an end product (Cloudsley-Thompson, 1971).

In *C. scaber,* the outer and hinge regions of the scale have periodic synchronous production, differentiation and subsequent shedding of an entire epidermal cell generation. However, this maturation may not occur synchronously across the entire scale surface. Similar electron microscope studies of many squamates (Maderson, 1965; Lillywhite and Maderson, 1968; Mohammed, 1987; Irish *et al.,* 1988) and in *Sphenodon* (Maderson, 1968). Furthermore, there are 4 stages during the shedding cycle in *C. scaber.* Maderson (1966, 1985) standarized the nomenclature of identifiable epidermal layers, and divided the shedding cycle into several stages. However, the present observations are confirmed by the squamate shedding stages as presented in histological and ultrastructural studies (Maderson *et al.,* 1972).

In *C. scaber,* at shedding, a break appears between the clear layer of the old epidermal generation and the underlying oberhautchen of the new generation, and thus the entire old generation is sloughed. Similar observations are recorded in the gecko *Tarentola mauritanica* (Hiller, 1970), in snakes (Irish *et al.,* 1988) and in several squamates (Landmann *et al.,*1981; Maderson, 1985). The clear layer remains bound to the oberhautchen over certain areas of the scale in *C. scaber.* Presumably, the desmosomes connecting these two layers do not break down completely until later in the renewal phase (Landmann, 1979). Irish *et al.* (1988) suggests that breaks may even occur between the inner and outer plasma membranes within the cells.

The pre-anal glands of *C. scaber* are tubulo-acinar and dorsoventrally flattened. This is in contrast to the glands of *U. hardwickii* which are tubular and not dorsoventrally flattened (Athavale *et al.,* 1977). However, they closely resemble the glands of the geckos *Hemidactylus bowringii* (Chiu and Maderson, 1975) and *H. flaviviridis* (Chauhan, 1986) in their structures, but not in their positions. In *C. scaber,* they are frontal to the vent while in *Hemidactylus* they are located on the ventral femoral side. On the other hand, histological evidence shows clearly that the pre-anal glands of *C. scaber* are holocrine in their mode of secretion as in *Hemidactylus.* It seems probable that they have a socio-sexual function.

Abbreviations

B, beta cells; bm, basement membrane; bs, basophilic cells; cl, clear layer; cts, connective tissue septum; ds, dorsal scales; dw, duct wall of the pre-anal gland; es, eosinophilic cells; ig, inner generation; ih, inner hinge region; il, intermedium layer; m, mesos cells; mc, melanocytes; ob, oberhautchen; og, old generation; os, outer scale; p, periderm; pag, pre-anal glands; pc, proliferated cells; pm, presumptive mesos cells; pob, presumptive oberhautchen; psc, parakeratotic stratum cornium; sc, secretory contents of the pre-anal glands; sg, stratum germinativum; uc, undifferentiated cells; vc, vacuolated cells; vs, ventral scales; $\propto$, alpha cells.

REFERENCES

Athavale, H. V., M. V. Asmani, B. Pilo and **R.V. Shah 1977.** Histomorphology of epidermal glands of an Agamid lizard, *Uromastix hardwickii* (Gray). J. Animal Morphol. and physiol. 25: 51-55.

Bentley, P. J. and **W. F. C. Blumer 1962.** Uptake of water by the lizard, *Moloch Horridus.* Nature 194: 699-700.

Burstein, N., K.R. Larsen and **H.M. Smith 1974.** A preliminary survey of dermatoglyphic variation in the lizard genus *Scleropous.* J. Herpetol. 8: 359-369.

Chauhan, N.B. 1986. Histological and structural observations on pre-anal glands of the gekkonid lizard *Hemidactylus flaviviridis.* J. Anat. 144: 93-98.

Chiu, K.W. and **P.F.A. Maderson 1975.** The microscopic anatomy of epidermal glands in two species of gekkonine lizards, with some observations on testicular activity. J. Morphol. 147: 23-40.

Cloudsley-Thompson, J.L. 1971. The temperature and water relations of reptiles. Merrow, Watford, U K.

Cloudsley-Thompson, J. L. and **M. J. Chadwick 1964.** Life in deserts. Dufour Editions, Philadelphia, Pennsylvania.

Dhouailly, D. and **P.F.A. Maderson 1984.** Ultrastructural observations on the embryonic development of the integument of *Lacerta muralis* (Lacertilia, Reptilia). J. Morphol. 179: 203-228

Elkan, E. 1976. Mucopolysaccharides in reptilian skin. J. of Zool. 25: 73-94.

Fahrenbach, W.H. and **D.D. Knutson 1975.** Surface adaptations of the vertebrate epidermis to friction. J. Invest. Dermatol. 65: 39-44

Hebrank, M.R. and **J.H. Hebrank 1986.** The mechanics of fish skin: Lack of an external tendon role in two teleosts. Biol. Bull mar. Biol. Lab. Woods Hole. 171: 236-246.

Hiller, U. 1970. Morphologische untersuchungen der haftborstenbildug and hauting bei *Tarentola mauritanica* (Rept). Forma Functio. 2: 169-177.

Hin-Ching-Liu and **R.B. Maneely 1969.** Observations on the development and regeneration of tail epidermis. Acta Anatomica. 72: 549-584.

Irish, F.J., E.E. Williams and **E. Seling 1988.** Scanning electron microscopy of changes in epidermal structure occuring during the shedding cycle in squamate reptiles. J. Morphol. 197: 105-126.

Jayne, B.C. 1988. Mechanical behaviour of snake skin. J. Zool. Lond. 214: 125-140.

Landmann, L. 1979. Keratin formation and barrier mechanisms in the epidermis of *Natrix natrix* (Reptilia: Serpentes) : An ultrastructural study. J. Morphol. 162: 93-126.

Landmann, L., C. Stolinski and **B. Martin 1981.** The permeability barrier in the grass snake epidermis during the resting stage of the shedding cycle. Cell Tissue. Res. 215: 369-382.

Levrat-Calviac, V. and **L. Zylberberg 1986.** The structure of the osteodermis in the gecko : *Tarentola mauritanica.* J. Anat. 176: 437-446.

Leyding, F. 1873. Uber die ausseren Bedeckungen der Reptilien and Amphibien. Arch. Mikrosk. Anat. Entwicklungsmech. 9: 753-794.

Lillywhite, H.B. and **P.F.A. Maderson 1968.** Histological changes in the epidermis of the subdigital lamellae of *Anolis corolinensis* during the shedding cycle. J. Morphol. 125: 379-402.

——————— **1982.** Skin structure and permeability. In: C. Gans and F.H. Pough (eds). Biology of the Reptilia. Vol. 12, Physiology C. Lond. Academic Press, pp. 397-442.

Maderson, P.F.A. 1965. The structure and development of the squamate epidermis. In: A.G. Lynne and B.F. Short (eds). Biology of the skin and hair growth. Sydney: Angus and Robertson, pp. 127-153.

Maderson, P.F.A. 1966. Histological changes in the epidermis of the tokay *(Gekko gekko)* during the sloughing cycle. J. Morphol. 119: 39-50.

——————— **1968.** Observations on the epidermis of the tuatara *(Sphenodon punctatus)*. J. Anat. 103: 311-320.

——————— **1985.** Some developmental problems of the reptilian integument. In: C. Gans, F. Billett and P.F.A. Maderson (eds). Biology of the Reptilia, Vol 14, New York: John Wiley and Sons, pp. 523-598.

Maderson, P.F.A., B.A. Flaxman, S.J. Roth and G. Szabo 1972. Ultrastructural contributions to the identifications of cell types in the lizard epidermal generation. J. Morphol. 136: 191-210

Mertens, R. 1960. The world of amphibians and reptiles. Mc Gaw-Hill, New York.

Mittal, A.K. and **J.P.N. Singh 1987.** Hinge epidermis of *Natrix piscator* during its sloughing cycle-structural organization and protein histochemistry. J. Zool. Lond. 213: 685-695.

Mohammed, M.B.H. 1987. Skin development in the lizard embryos, *Chalcides ocellatus* Forscal (Scincidae, Sauria, Reptilia). The Wasmann J. Biol. 45: 49-58.

Peterson, J.A. 1984. The scale microarchitecture of *Sphenodon punctatus*. J. Herpetol. 18: 40-47.

Ruibal, R. 1968. The structure of the surface of lizard scales. Copeia 1968 (4): 698-703.

Seshadri, C. 1956. Urinary excretion in the Indian house lizard, *Hemidactylus flaviviridis* (Ruppell) J. Zool. Soc. India. 8: 63-78.

Taylor, E.H. and **A.B. Leonard 1956.** Concerning the relationship of certain neotropical gekkonid lizard genera with comments on the microscopical structure of their glandular scales. Kensas Univ. Scie. Bull. 38: 1019-1029.

الشكل النسيجي لجلد البرص كيرتود اكتلس سكيبر
(البرصيـــات ، الزواحـــف)

محمـد بهجـت حسـين محمـد

تتناول الدراسة وصفاً للتراكيب النسيجية المختلفة لمناطق ظهرية وأخرى بطنية في جلد البرص **كيرتود اكتلس سكيبر** ، ويضم الوصف الغدد قبل شرجية .

وتشتمل الدراسة وصفاً لمراحل عملية الإنسلاخ التي يمر بها الجلد . وبمناقشة نتائج هذه الدراسة مع بحوث مشابهة على الزواحف المختلفة فإنه يوضح أن التراكيب الجلدية تلعب دوراً رئيسياً في تجميع الماء في الوسط المحيط كما تسمح هذه التراكيب الجلدية وخاصة البطنية منها في أنثى البرص بالتمدد وزيادة مساحة سطح الجلد .