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Morphology of the femoral glands of the lizard *Iguana iguana* (linnaeus, 1758) (reptilia, iguanidae)

Morfologia das glândulas femorais do lagarto Iguana iguana *(Linnaeus, 1758) (reptilia, iguanidae)*

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A B S T R A C T

Femoral glands are specializations of the epidermis existing in certain lizards, and often used in the group's taxonomy and systematic classification. Its aim is to expand knowledge of these glands, especially in terms of their morphology. Adult male *Iguana iguana* individuals were collected in the Pantanal region, Brazil, between November 1998 and July 1999, and the glands analyzed by light microscopy and scanning electron microscopy. The femoral gland of the *I. iguana* consists of three regions: a basal secretory, a secretion channel and pore. It is tubular, ramified and holocrine. They do not seem to present variations in their morphology over the course of the year.

key words: Lizard. *Iguana iguana*. Femoral glands. Morphology. Pantanal region. Brazil.

R E S U M O

Glândulas femorais são especializações da epiderme presentes em alguns lagartos, e muito utilizadas para taxonomia e sistemática do grupo. Este trabalho apresenta detalhes complementares sobre essas glândulas, especialmente quanto à sua descrição morfológica. Indivíduos machos adultos de Iguana iguana *foram coletados na região do Pantanal, Brasil, no período de novembro de 1998 a julho de 1999. As glândulas foram retiradas e analisadas em microscopia de luz e microscopia eletrônica de varredura. As glândulas femorais de* I. iguana *são constituídas por três regiões: basal secretora, canal de secreção e poro. São glândulas do tipo tubular ramificada holócrina. Parecem não apresentar variações na sua morfologia durante o ano.*

Palavras-chave: *Lagarto.* Iguana iguana. *Glândula femoral. Morfologia. Pantanal. Brasil.*

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INTRODUCTION

Femoral glands are located in the ventral face of the hind legs of many lizards. They are important in the taxonomy of diverse lizard groups. They originate from invaginations of the epidermis (Maderson *et al.*, 1972) and have been studied under different aspects, including their biochemistry, the influence of their secretions in individual and group behavior, however, their morphological characteristics are little explored (Chiu & Maderson, 1975; Athavale *et al*., 1977; Van Wyk, 1990; Vinyard, 1992). In male lizards, these glands release, among others substances, pheromones used in territory demarcation and attracting females during the reproductive period (Weldon *et al*., 1990; Alberts, 1991; Alberts *et al.*, 1992a; Alberts, 1993; Vinyard, 1992; Cooper *et al*., 1999; Martin & Lopez, 2000).

Cole (1966) characterized some regions of the femoral glands in the *Crotaphytus collaris* lizard. Maderson (1972) described the epidermal glands in *Sphaerodactyline* and *Eublepharine* gekkonid lizards. Chiu & Maderson (1975) had repeated the data previously described for Maderson epidermal glands in two species of gekkonine lizards, with regard to the difference related to testicular activity. Athavale *et al*. (1977) also explored the histo-morphology of femoral glands in the agamid lizard, *Uromastix hardwickii*. However, in all these works not all the details had been shown and only light microscopy was used.

In this work, we contribute with new morphological data concerning the femoral gland of the *Iguana iguana* lizard, presenting details of histology and scanning electronic microscopy.

MATERIAL AND METHODS

Six adult males were collected in the Pantanal (14º22'S - 53º61'W), Brazil, in November 1998 and July 1999. After being anesthetized by inhaling ethyl ether, they had the femoral glands removed. The glands were fixed in 10% formalin and were soaked in paraffin for the purpose of histology, and stained by Hematoxilin and Eosin and Masson Tricromic. The analysis was done with a light photomicroscope (Olympus, BX60). Some glands were embedded in a 0.5M-3M sucrose solution and cryofractured in liquid nitrogen, were then dehydrated in acetone, critical point dried and sputter-coated with gold. They were observed with a scanning electron microscope (Jeol JSM 5800LV).

RESULTS

Femoral pores are observed in the ventral face of the hind legs of both sexes of lizard *I. iguana* with a number that varies from 18 to 24 in posterior members. In males, these pores are big and clear (Figure 1A), whereas in females they only appear as small dots (Figure 1B). When removed from the skin, the glands are similar to a "mushroom" when close to the scales of the skin. The widened portion of the gland is located internally and is called the basal region. The external surface of this basal region is convex and the opposing face is concave. Starting a concave and continuous phase with the cylindrical duct that opens in the pore of the femoral gland. The basal region is clear and the canals of the cylindrical portion are dark (Figure 1C).

The entire gland is enclosed in a fine capsule, made up of dense connective tissue in the basal region, rich in vessels and nerves, in addition to melanocytes (Figures 1C, 2A, 2B). This capsule emits septa for the interior of the gland, which divide the secretory portion into lobules (Figures 2A, 2C, 3A, 3B). In the lateral pore regions, there is a penetration of greatly keratinized epidermis (Figures 4A, 4B). Squamous stratified epithelium can be observed coating the secretory channel as irregular septa of sustentation in the interior of this basal (Figures 4A, 5A, 5B).

In the basal region, secretory cells are organized in elongated lobes (Figures 2A, 3A, 3B), which are filled by globoid cells with acidophilic cytoplasm and a large, central nucleus (Figures 2B). Initially, small granules are observed in the interior of the cells. These granules increase, occupying the whole cytoplasm, more easily observed in the transition region of the secretory channel (Figures 3B, 6A, 6B). In the secretory channel, the cells seem to degenerate and the organization of the lobules is lost (Figures 6B, 4A, 5A) and the secretion is fully released into the secretory pore (Figures 7A, 5A, 5B). In the pore region, the secretory cells have a similar appearance to crystals (Figure 7A), and with scanning electron microscopy it was possible to observe that in these cells, there were diverse small vesicles (Figure 7B). Therefore, the gland is ramified, tubular and holocrine.

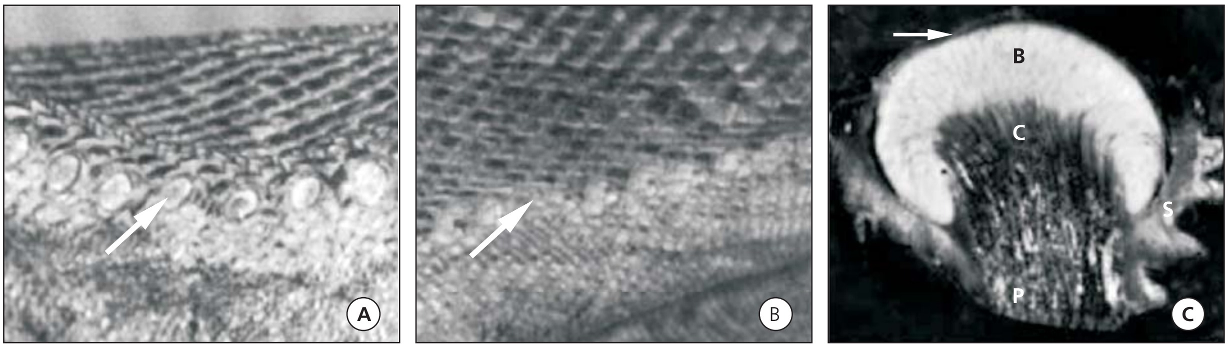

Figure 1. **A**. Macroscopic aspect of the femoral pores (arrow) in the male. Original size. **B**. Macroscopic aspect of the femoral pores (arrow) in the female. To observe that in the male the pores are bigger. Original size. **C**. Longitudinal section. General aspect. The internal and superior region is constituted by: the base (B), involved by a connective tissue envelope (arrow), this region has continuity with the secretory channel (c) and opens for the exterior in a pore (P). All the inferior region of the gland is supported by the skin (S). To observe the ramified and tubular aspect of the gland. X10.

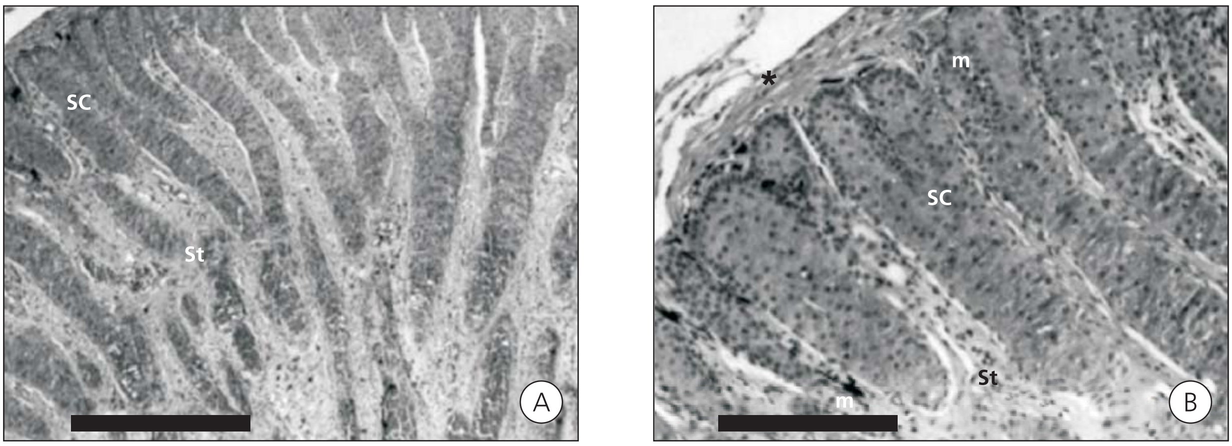

Figure 2. Light microscopy. Longitudinal section of the secretory basal region. **A**. To observe the lobes disposal, where it is possible to distinguish two cellular types: the secretory cells (sc), which are round; and the sustentation cells (st). X30. **B**. Detail of the secretory basal region. To observe the capsule (*) that coats this region. Secretory cells (sc) polyhedral, with central and big nucleus and initially homogeneous cytoplasm. Sustentation cells (st), with flattened nucleus and great amount of cytoplasm that emits prolongations. Melanocytes (M). X100.

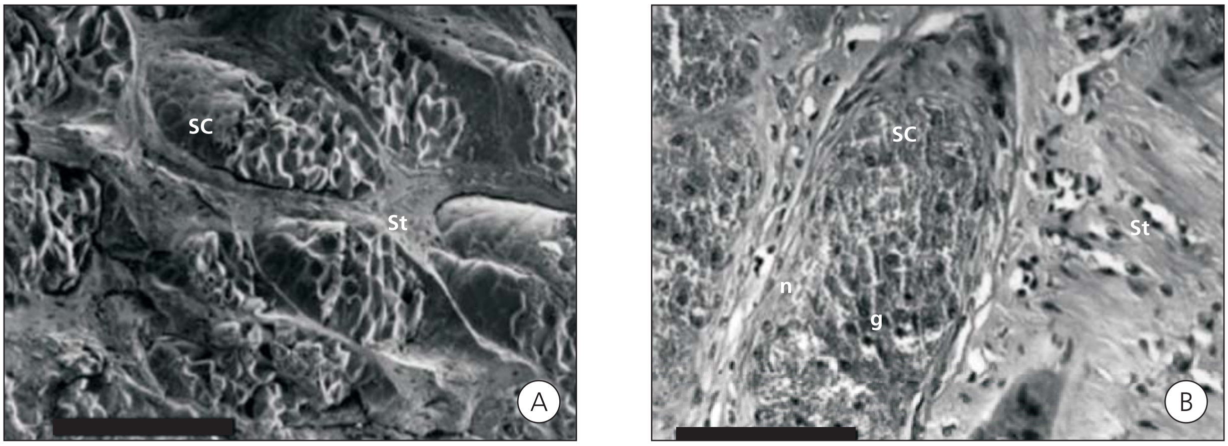

Figure 3. **A**. Scanning electron microscopy of the secretory basal region. X1000. **B**. Differentiation region of the secretory cells (sc), where the cytoplasm of secretion granules (g) degenerates the nucleus (n). Sustentation cells (st) more prolongated. X200.

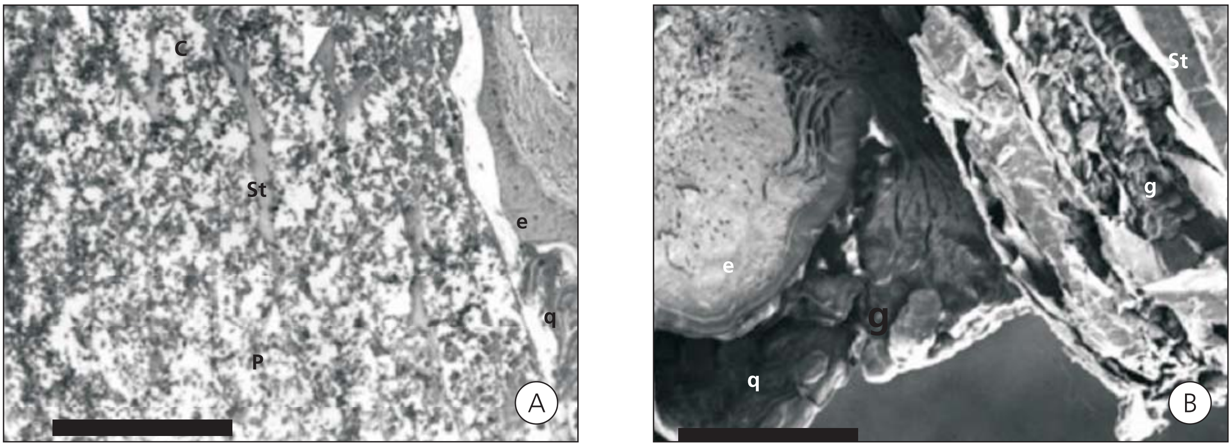

Figure 4. **A**. Light microscopy. Longitudinal section of the secretory channel (c) and pore (P). To observe that the secretory cells lose their characteristics due to the cytoplasm elimination with the secretion (arrow head). Long prolongations of the sustentation cells (st). Laterally invagination of the epidermis (e) and great amount of keratin (q). X100. **B**. Scanning electron microscopy. Region of invagination of the skin and opening of the pore. Secretion granules (g), sustentation cells (st), epidermis (e) and skin very keratinized (q). X400.

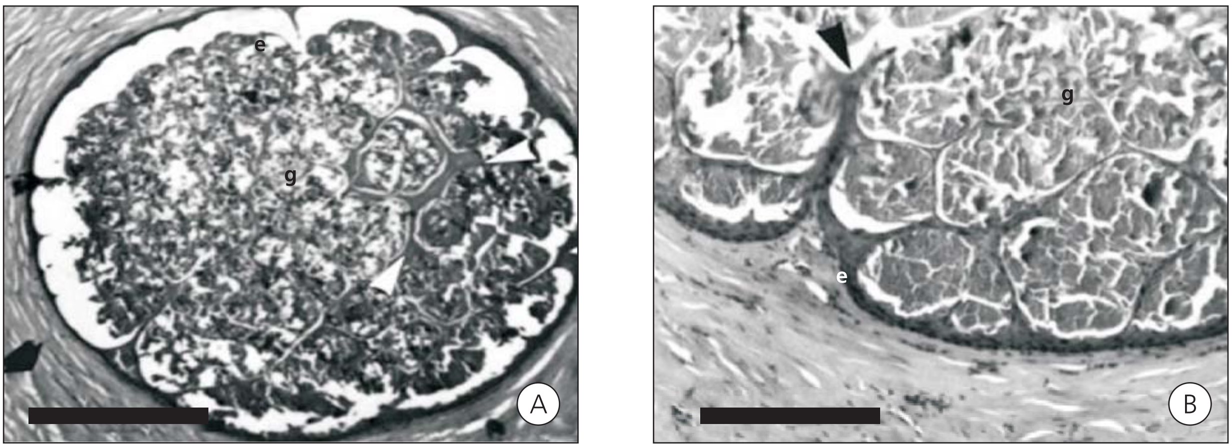

Figure 5. **A**. Light microscopy. Transversal section of the opening of the pore. Involved by dense connective tissue, rich in collagen fibers (arrow). Envelope that coats the gland (e). Secretion granules (g). Prolongations of the sustentation cells (st). X100. **B**. Light microscopy. Detail of the capsule, squamous stratified epithelium (e). Secretion granules (g) and the sustentation cells (arrow head). X200.

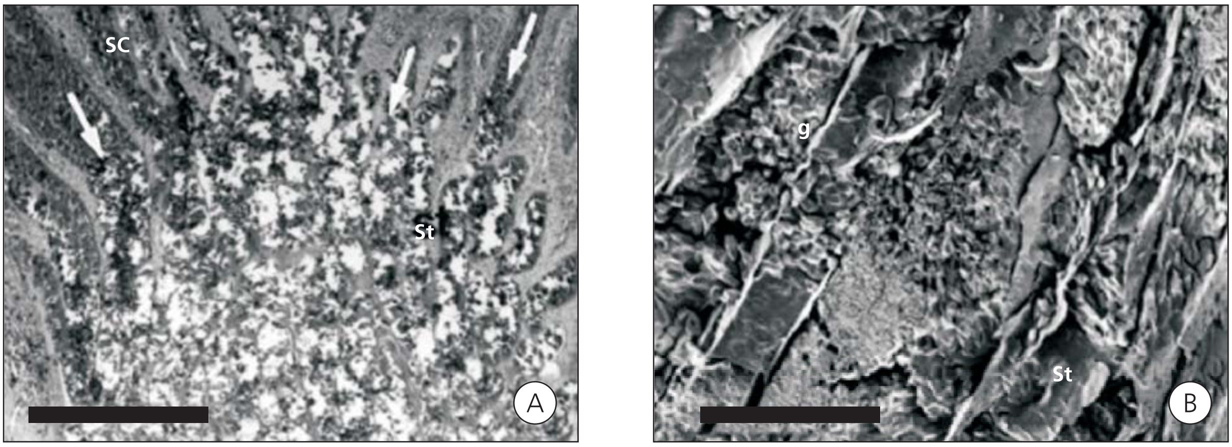

Figure 6. **A**. Light microscopy of the transition region from the secretory basal region to the secretory channel. Secretory cells (sc), where the cytoplasm is eliminated with the secretion (arrows). Supported by the long prolongations of the sustentation cells (st). X100. **B**. Scanning electron microscopy of the secretory channel, with secretion granules (g), and fine cytoplasmic prolongations of the sustentation cells (st). X400.

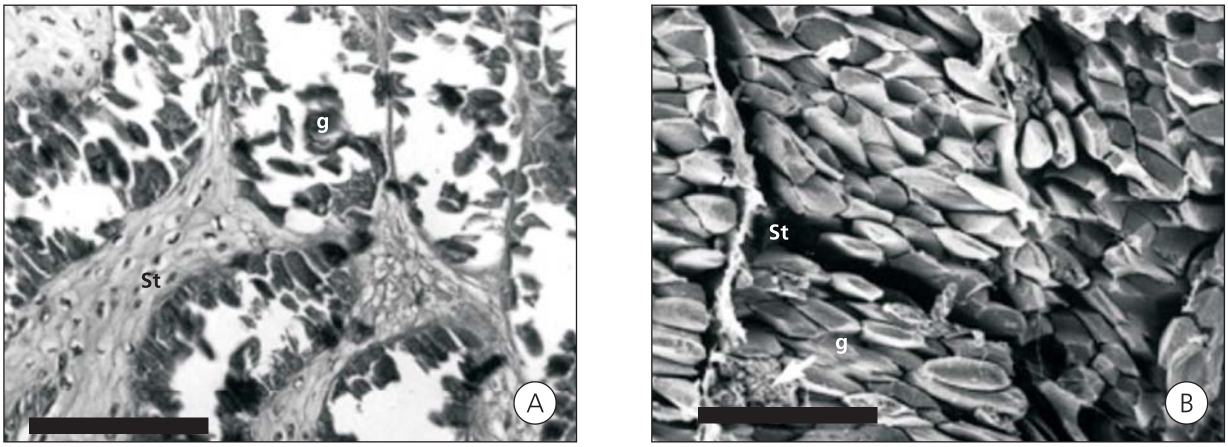

Figure 7. **A**. Light microscopy. Final region of the secretory channel. To observe the secretion in crystal form (g). Sustentation cells (st) with the cytoplasm reduced in comparison to the region of the base. X400. **B**. Scanning electron microscopy of the excretory pore. To observe the fine cytoplasmic prolongations of the sustentation cells (st) and secretion in crystal form with granules (g) in the interior. X1200.

DISCUSSION

Femoral glands are secretory structures located on the ventral surface of the hind legs of many lizards, with the same position in *I. iguana*. Several studies have shown pheromone production in different species, which is often attributed to pre-cloacae and femoral glands (Cooper & Vitt, 1984; Alberts, 1993; Martín & López, 2000). Weldon *et al*. (1990) had verified through biochemistry studies that there are diverse types of lipids in the secretion of these glands. The green iguanas are thought to deposit femoral gland exudates, possibly to mark territory, by running their thighs against branches as described by other authors. A number of studies indicate that femoral gland activity is modulated by androgenic hormones (Chiu & Maderson, 1975; van Wyk, 1990; Alberts, 1993). The presence of a welldeveloped olfactory epithelium and vomeronasal organ indicates that green iguanas probably detect volatile and non-volatile chemicals (Alberts *et al*., 1992a). These glands are most active during the breeding season and are usually better developed in males than in females. I did not follow the activity of these glands for long periods, but I believe that variations can occur, not the form but the type of secretion. The majority of the lizards territorialize and demarcate their territories, achieved through the release of secretions from the femoral glands (Cooper *et al*., 1999), which was possible to observe with the behavior of the lizard *I. iguana*, which was always lying on twigs with its thighs in close contact with of the trees.

In most iguanids with femoral pores, including *I. iguana*, each pore is situated in a large scale. It contains a hard secretion plug, consisting of several closely packed rods of secretion (Cole, 1966). In our study, it was observed that glands fill with light in the duct modified through epithelial cells, where crystal-like secretions form. True femoral glands are described as invaginations of the *stratum germinativum* of the epidermis that resemble closely the holocrine sebaceous glands of mammals (Maderson, 1972; Athavale *et al*., 1977).

Cooger (1978) and Van Wyk (1990) have shown there is a probable relationship between the reproductive cycle and the secretion production by the femoral glands. The male *I. iguana* in the Pantanal region presents a discontinuous reproductive cycle, with maximum peak of spermatogenesis for three months of the year (Ferreira *et al*., 2002), but do not observe any variation in the morphology of the femoral glands. Alberts *et al*. (1992b) believe that the variation in the secretion production for the femoral glands in *I. iguana* is seasonal and follows the reproductive cycle, and moreover that this variation is perceived in the different types of lipids and hormones present in secretions.

In conclusion according to the details of the femoral glands of *I. iguana* observed, there is a great similarity with the glands of other lizards that had been already morphologically studied. The gland is branched, holocrine and tubular. The glands of the *I. iguana* had been collected and no variation was observed in the morphology that could be related to the variation in the reproductive cycle.

ACKNOWLEDGEMENTS

We thank Mahmoud Mehanna for important suggestions in this paper. The research was supported by the FAPEMAT (file # 0769/2006). The animals were collected with the authorization of the MMA/IBAMA (file # 02014.0077/01-10).

REFERENCES

Alberts, A.C. (1991). Phylogenetic and Adaptive Variation in Lizard Femoral Gland Secretions. *Copeia*, 1(1):69-79.

Alberts, A.C.; Pratt, N.C. & Phillips, J.A. (1992a). Seasonal productivity of lizard femoral glands: relationship to social dominance. *Physiology & Behavior*, 51(1):729-33.

Alberts, A.C.; Sharp, T.R.; Werner, D.I. & Weldon, P.J. (1992b). Seasonal variation of lipids in femoral gland secretions of male green iguanas (*Iguana iguana*). *Journal of Chemical and Ecology*, 18(5):703-12.

Alberts, A.C. (1993). Chemical and behavioral studies of femoral gland secretions in iguanid lizards. *Brain Behavior and Evolution*, 41(1):255-60.

Athavale, N.V.; Asnani, M.V.; Pilo, B. & Shani, R.V. (1977). Histo-morphology of the femoral glands in the agamid lizard, *Uromastix hardwickii* (Gray). *Journal of Animal Morphology and Physiology*, 24(1):51-5.

Chiu, K.W. & Maderson, P.F.A. (1975). The microscopic anatomy of epidermal glands in two species of Gekkonine lizards, with some observations on testicular activity. *Journal of Morphology*, 147(1):23-40.

Cole, C.J. (1966). Femoral glands of the lizard, *Crotaphytus collaris*. *Journal of Morphology*, 118(1):119-36.

Cooger, H.G. (1978). Reproductive cycles, fatty body cycles and social behavior in the male dragon *Amphibolurus fordi* (Lacertilia: Agamidae). *Australian Journal of Zoology*, 26(1):653-72.

Cooper Jr., W.E. & Vitt, L.J. (1984). Conspecific odor detection by the male broad-headed skink, Eumeces laticeps: effects of sex and site of odor source and of male reproductive condition. *Journal of Experimental Zoology,* 230(2):199-209.

Cooper, W.E.; Van Wyk, J.K. & Mouton, P.L.N. (1999). Discrimination between self-produced pheromones and those produced by individuals of the same sex in the lizard *Cordylus cordylus*. *Journal of Chemical and Ecology*, 25(1):197-208.

Ferreira, A.; Laura, I.A. & Dolder, H. (2002) Reproductive cycle of the male lizard *Iguana iguana* (Reptilia: Sauria: Iguanidae). *Brazilian Journal of Morphological Sciences*, 19(2):23-8.

Maderson, P.F.A. (1972). The structure and evolution of holocrine epidermal glands in *Sphaerodactyline* and *Eublepharine* Gekkonid lizards. *Copeia*, 1(3):559-71.

Maderson, P.F.A.; Flaxman, B.A.; Roth, S.I. & Sazbo, G. (1972). Ultrastructural contributions to the identification of cell types in the lizard epidermal generation. *Journal of Morphology*, 136(2):191-210.

Martín, J. & López, P. (2000). Chemoreception, symmetry and mate choice in lizards. *Proceedings of the Royal Society of London Series B. Biological Sciences*, 267(1):1265-9.

Van Wyk, J.H. (1990). Seasonal testicular activity and morphometric variation in the femoral glands of the lizard *Cordylus polyzonus polyzonus* (Sauria: Cordylidae). *Journal of Herpetology*, 24(4):405-9.

Vinyard, D. (1992). Zur morphologie und biochemie der präanal - und femoralorgane von *Gekko* und *Iguana*. *Mitteilungen aus dem Hambburgischen Zoologischen Museum und Institut,* 89(1):295-317.

Weldon, P.J.; Dunn Jr, B.S.; McDaniel, C.A. & Werner, D.I. (1990). Lipids in the femoral gland secretions of the green iguana (*Iguana iguana*). *Comptes Biochemistry Physiology,* 95(3):541-3.

Received on: 6/6/2007
Final version represented on: 11/9/2007
Approved on: 18/10/2007