Kritska'a, T. I. (1961): The role of the raccoonlike dog (*Nyctereutes procyonoides*) in the biocenose of the Manych Steppe. Zool. Zhurn. **40**, 788–790. (In Russ., English summary).
**Morozov, V. F. (1948): Ergebnisse der Einbürgerung des Marderhundes in den Gebieten Leningrad und Nowgorod. Arbeiten des Unions-Forschungsinstituts für Erwerbsjagd 8.
Morozov, V. F. (1953): Akklimatizaci'a ussurijskogo enota (*Nyctereutes procyonoides* Gray) kak primer uspešnykh zverej evripejskoj territorii SSSR. Zool Zhurn. **32**, 524–533.
Naaber, J. (1971): Kährikkoer. Eesti Loodus **14**, 449–455.
Nowak, E.; Pielowski, Z. (1964): Die Verbreitung des Marderhundes in Polen im Zusammenhang mit seiner Einbürgerung und Ausbreitung in Europa. Acta theriol. **9**, 81–110.
Nyholm, E. (1972): Mäyrä. In: Suomen Nisäkkäät. II. Ed. by L. Siivonen. Keuruu: Otava. pp. 264–275.
Prusaite, J. (1960): Usūrino šuns (*Nyctereutes procyonoides* Gray) plitimas ir mityba Lietuvoje. Lietuvos Tsr. Mokslu Akademijos Darbai, Serija C. **2**, 125–140.
Rukovskij, N. N. (1950): Materialy po pitni'u enotovidnoj sobaki v Astrakhanskoj oblasti. B'ulleten'M. O-va Isp. Prirody, Otd. Biologii, T. **55** (5), 33–34.
**Samusenko, É. G.; Goloduško, B. Z. (1961): Die Ernährung des Marderhundes in Belorussland. Sammelband Fauna und Ökologie der Landwirbeltiere Belorusslands.
Siivonen, L. (1972): Supikoira. In: Suomen Nisäkkäät. II. Ed. by L. Siivonen. Keuruu: Otava. pp. 140–148.
— (1977): Pohjolan nisäkkäät (Mammals of Northern Europe). Keuruu: Otava.
Skoog, P. (1970): The food of the Swedish badger, *Meles meles* L. Viltrevy **7**, 1–120.
Sorokin, M. G. (1956): Biologische und morphologische Veränderungen des im Gebiet Kalinin eingebürgerten Marderhundes. Wissenschaftliche Schriften des Kaliner Pädagogischen Instituts **20.
Yamaguchi, Y. (1976): A short note on the Japanese racoon dogs (*Nyctereutes procyonoides viverrinus*) with stomach contents. Bull. Kanagawa Pref. Mus. Natur. Sci. 9, 73–76. (In Japan., English summary).
*Cited in Bannikov, A. G.
**Cited in Heptner, V. G., et al.

Authors' addresses: Pirkko Viro, Department of Zoology, University of Oulu, SF-90100 Oulu 10; Heimo Mikkola, Department of Zoology, University of Kuopio, P. O. B. 138, SF-70101 Kuopio 10

Sebaceous glands of the anal sacs of Genetta tigrina (Schreber, 1778)

By F. I. B. Kayanja and H. Schliemann

Department of Veterinary Anatomy and Histology, Makerere University, Kampala, Zoologisches Institut und Zoologisches Museum, Universität Hamburg

Receipt of Ms. 27. 3. 1980

Abstract

Studied the sebacous glands of the anal sac wall of *Genetta tigrina* by means of light and electron microscopy. The anal sac wall of *Genetta* contains two elaborate complexes of sebaceous glands. The glandular epithelium consists of peripheral cells lying against the basal lamina, intermediate and mature cells. The intermediate cells are the most active cells according to their ultrastructure. The cytoplasm contains mitochondria with a mixture of tubuli and cristae, filaments, lipid droplets, elaborate smooth endoplasmic reticulum, and rigidly patterned crystalloids. The latter are associated with the granular endoplasmic reticulum. The ultrastructure of these cells suggests a steroidogenic role.

U.S. Copyright Clearance Center Code Statement: 0044-3468/81/4601-0026 $ 2.50/0
Z. Säugetierkunde 46 (1981) 26–35

ISSN 0044–3468/InterCode: ZSAEA 7

Introduction

Chemical signals play an important role in mammalian social communication. Although several sources of pheromones in mammals exist, skin glands are most essential as sources of odours.

The glandular organs of the mammalian integument have been dealt with by SCHAFFER (1940) in his still unique synopsis. ORTMANN (1960) has written a comprehensive article on the skin glands of the anal region of mammals. According to these authors, viverrids are endowed with typical glandular organs in the genito-anal region, i. e. the perineal organs and the anal sacs (see also POCOCK 1915a, 1915b, 1916). Doubtlessly, these glandular organs are used for scent marking, as has been reported by DÜCKER (1965) for several species, and by GORMAN et al. (1973) for *Herpestes auropunctatus*. However, the behavioural significance of the scent remains inadequately understood, and obviously observations of free-ranging viverrids are still lacking.

The anal sacs are paired glandular organs which open in the anus and which are present not only in viverrids but also in other carnivores. Their structure and histology have been described in many species (CUYLER 1924; SCHAFFER 1940; MONTAGNA and PARKS 1948; KAINER 1954; ORTMANN 960; HASHIMOTO et al. 1963; GREER and CALHOUN 1966; GORMAN et al. 1974; ALBONE and EGLINGTON 1974; ALBONE and GRÖNNEBERG 1977). The walls of the sac, which is surrounded by a layer of striated musculature, are made up of fibrous connective tissue in which are embedded sebaceous gland complexes and coiled tubular glands in the domestic cat (KRÖLLING 1927; GREER and CALHOUN 1966). The lion and tiger have glands which basically resemble those of the domestic cat. In the dog, the anal sac wall contains predominantly coiled tubular apocrine glands alone, sebaceous glands being confined to the wall of the duct (ALBONE and GRÖNNEBERG 1977). These authors also described the anal sacs of *Vulpes vulpes* as similar to those of the dog (ALBONE and EGLINGTON 1974; ALBONE and GRÖNNEBERG 1977). According to SCHAFFER (1940), in H*erpestes ichneumon* the anal sac wall contains sebaceous glands and apocrine tubular glands as well. This has also been found by GORMAN et al. (1974) for *Herpestes auropunctatus* and by ORTMANN (1960) for *Genetta* and *Ichneumia*.

ALBONE and GRÖNNEBERG (1977) noted a relationship between the type of secretions and the histological organization of the anal sacs. They found that the anal sac secretions of the lion were richer in lipid and contained more complex, less uniform mixtures of lower molecular weight lipids than the anal sac secretion of the red fox. GORMAN et al. (1974) and ALBONE et al. (1971) have drawn attention to the fact that the odourous secretions of *Herpestes* and *Vulpes* are rich in volatile fatty acids, so constituting an important part of the scent. These carboxylic acids, among others, are products of microbial activity. The sebum of the sebaceous glands and the secretion of the apocrine glands serve as the substratum for producing the volatile fatty acids by bacteria.

This paper addresses itself to the problem of the histology and ultrastructure of the sebaceous gland complexes of the anal sacs of *Genetta* about which nothing is known. On the microscopic anatomy of the anal sacs, the histology and ultrastructure of the apocrine sweat glands will be reported elsewhere.

Materials and methods

Two female genets, *Genetta tigrina* (Schreber, 1778), were trapped from the countryside around Kampala. They were kept in cages for one week during which time they remained in good health and were fed on a meat diet. The animals were killed with chloroform and tissues were initially fixed in FG-trinitro fixative (ITO and KARNOVSKY 1968), post-fixed in osmium tetroxide, and after dehydration, embedded in Epon-Araldite. Tissues for investigation were taken only from the anal sac wall. In addition, the anal sac of a male specimen of *Genetta tigrina* from the vicinity of Nairobi was used for light microscopy. These slides were stained with Pasinis trichrome stain.

Results

Histology

The predominant light microscopic features of the anal sac wall of *Genetta tigrina* – besides the tubular glands surrounding the anal sac cavity underneath the epithelium and a connective tissue layer – were the two complexes of sebaceous glands (Fig. 1). Lobes in different stages of maturity are present, as well as new acini, which are in direct contact with ducts which lead into the anal sac lumen. The mature lobes with secretion are most conspicuous. The acini are separated from each other by thin layers of a well-vascularised connective tissue comparatively rich in collagenous fibers.

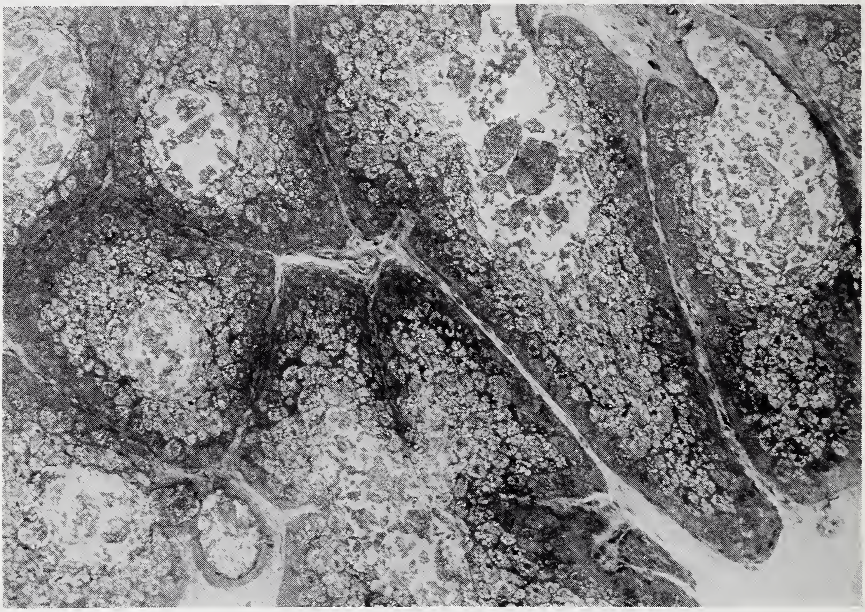

Fig. 1. A section through the anal sac wall of *Genetta tigrina* showing the sebaceous glands. (Toluidine blue X 150)

The peripheral cells lying against the basal lamina have elongated nuclei containing notable amounts of heterochromatin (Fig. 2). Their compact cytoplasm stains deeply. Beyond the peripheral cells are intermediate cells. The latter contain the least amount of heterochromatin in the usually spherical nuclei carrying distinct nucleoli. In the cytoplasm, many small vacuoles are found. The mature glandular cells lie nearest the lumen. Their nuclei often have an irregular outline and their cytoplasm contains large vacuoles.

The sebaceous gland ducts are lined by a stratified squamous epithelium which comprises up to four cell layers.

Ultrastructure

A basal lamina separates the acinar cells from the connective tissue between the acini (Fig. 3). The peripheral cells lying next to the basal lamina have nuclei with large clumped deposits of heterochromatin. Within the cytoplasm are large amounts of free ribosomes, occasional glycogen granules and coated vesicles near the plasma membrane. Filaments are also present in the cytoplasm as well as mitochondria and lipid droplets. The lipid droplets contain an elec-

Fig. 2. A section through the periphery of two adjacent acini. The peripheral cells (arrows) have nuclei with much heterochromatin. The intermediate cell nuclei contain less heterochromatin (I). The mature luminal cells show extreme vacuolation. (Toluidine blue X 900)

tron-lucent product, which is not extracted during the processing of the tissues. These membrane-bound lipid droplets are of the type normally found in many cell types. The endoplasmic reticulum is generally poorly developed in the peripheral cells. The basal plasma membrane of the peripheral cells is sometimes thrown into microvillous formations, which are tucked up between the cell and the basal lamina.

As the intermediate cells develope, the amount of heterochromatin in their nuclei is reduced so that the fully formed intermediate cells contain large amounts of euchromatin in their nuclei. The cytoplasm contains many mitochondria with a dark matrix and a mixture of tubular and lamellar cristae. The endoplasmic reticulum is elaborate in the intermediate cells. Whorls of cisternae and tubules of smooth endoplasmic reticulum are present in the cytoplasm as well as lipid droplets (Figs. 4 and 5). Free ribosomes, isolated tubules of granular endoplasmic reticulum and filaments are also present in the cytoplasm. A patterned crystalloid is present in the cytoplasm of the intermediate cells. It is developing even in the earliest differentiated intermediate cells (Fig. 4). The crystalloid contains ribosomes and membranes (Figs. 4, 5, 6). In areas where the crystalloid will probably form, the ribosomes, which are abundant in the cytoplasm, take on neat parallel and linear patterns in association with tubular and cisternal membranes of the endoplasmic reticulum. The fully formed crystalloid has linear parallel arrays of ribosomes and tubules cut in cross-section in one plane (Fig. 6). There is a repeating sequence of closer lines followed by wider lines (Fig. 6). In other planes the arrangement of ribosomes forms a zig-zag pattern with the membranes of the endoplasmic reticulum (Fig. 5). The crystalloid is often closely associated with filaments. The intimate relationship of ribosomes and membranes sometimes gives the impression that the granules are on the inside of the tubules (Fig. 6). Cytoplasmic organelles, especially mitochondria, may be trapped inside the crystalloid.

The Golgi complex is well developed with several elements in the intermediate cells. Clo-

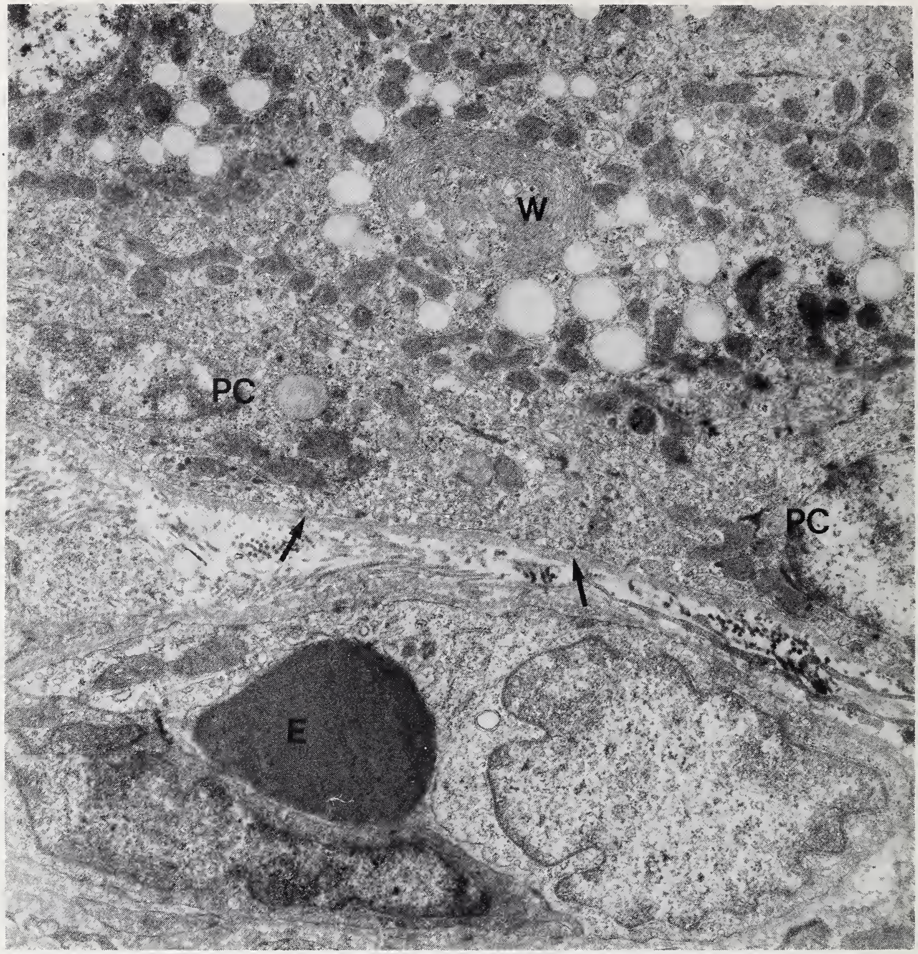

Fig. 3. The periphery of an acinus. (E) is an erythrocyte in the lumen of a blood capillary in the inter acinar connective tissue. Note the basal lamina (arrow), and the peripheral cell (PC). The intermediate cells contain whorled cisternae of smooth endoplasmic reticulum (W), many mitochondria, and extracted lipid droplets. (X 11,000)

sely associated vesicles may form curved linear series along one face of the Golgi element. Membrane-bound lipid droplets form a prominent feature of the intermediate cell cytoplasm. Most droplets appear empty, the contents having been extracted during processing, but a few still contain peripheral residual lipid in association with an extracted interior. Membrane-bound bodies, containing a fine granular material of intermediate electron density, are present in the intermediate cell cytoplasm. They occur in the vicinity of smooth endoplasmic reticulum and resemble the "inclusion bodies" described by Sisson and Fahrenbach (1967) (Fig. 7).

The plasma membranes of adjacent cells are occasionally encountered. Coated vesicles are often present in the vicinity of the plasma membrane.

The mature sebaceous gland cells contain nuclei with an irregularly infolded nuclear membrane. The nuclei may contain more heterochromatin than those of the intermediate cells. The cytoplasm of the mature cells is filled mainly with large empty spaces, the contents

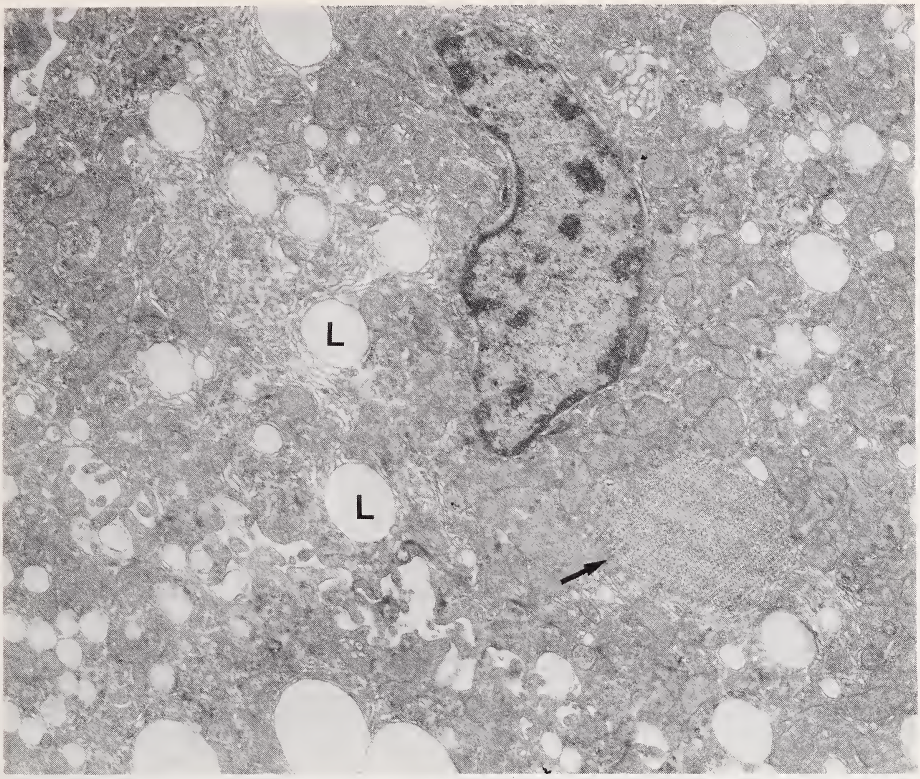

Fig. 4. The early intermediate cell. Note the many mitochondria, the smooth endoplasmic reticulum associated with extracted lipid droplets (L), and the crystalloid (arrow). (X 11,000)

of which are extracted during processing of the tissue. The cytoplasm forms thin strands between the large empty spaces. Crystalloids are present where adequate amounts of cytoplasm are present to contain them.

Discussion

Albone and Grönneberg (1977) and Albone and Eglington (1974) commented on the histological similarity between the anal sacs of the red fox and the dog, on the one hand, and those of the domestic cat, tiger and lion, on the other. They correlated this structure with some similarity in the type of secretion, and indicated that the anal sac secretion of felids is richer in lipid than that of canids. The elaborate development of sebaceous gland complexes described in *Genetta* corresponds in a certain way with the findings of Albone and Grönneberg (1977). These authors suggested that there is better development of the sebaceous glands in felids. According to our results this is true also for *Genetta* (see also Ortmann 1960), and it applies even more to *Herpestes* (Gorman et al. 1974), where many sebaceous glands besides apocrine sweat glands are found in the anal sac wall.

The units of the sebaceous gland complexes of the anal sac wall are easily identified because of their resemblance to the sebaceous glands of the skin (Ebling 1970). The peripheral cells are not yet activated for secretion according to their ultrastructure. Initiation of secretory activity is most probably what transforms peripheral cells into intermediate cells. The latter are the most active cells in this glandular epithelium. The elaborate development of the

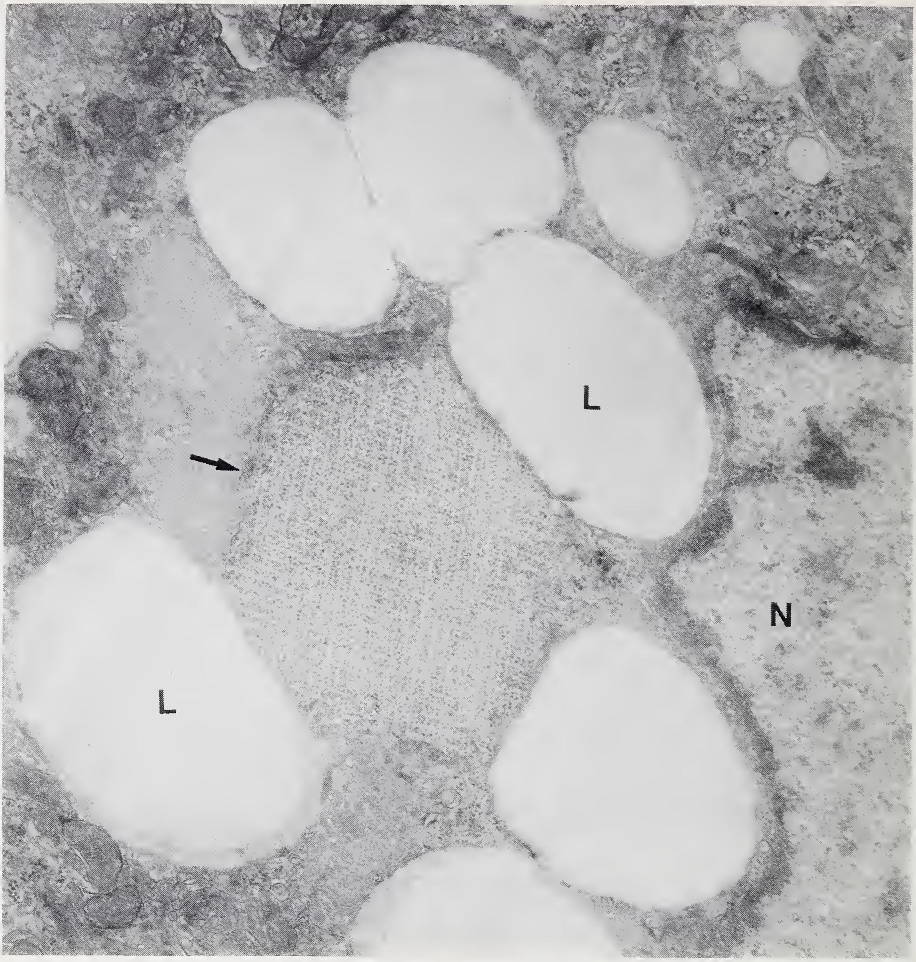

Fig. 5. The intermediate cell. Note the nucleus (N), lipid droplets (L), filaments, and the crystalloid (arrow) in the centre of the picture. (X 24,000)

smooth endoplastic reticulum, the presence of lipid droplets, and the mitochondria having tubular cristae are all indications that these cells are involved in steroidogenesis.

Sisson and Fahrenbach (1967) described the fine structure of a crystalloid formed by differentiation of the agranular endoplasmic reticulum in the interstitial cells of the antebrachial organ of the ring-tailed lemur (*Lemur catta*). These authors suggested that the crystalloid was probably the chief organelle of steroid synthesis. The Reinke crystalloid of human Leydig cells is not composed of agranular endoplasmic reticulum (Fawcett and Burgos 1960; Yamada 1962). Similarly the crystalloid we have described in *Genetta* is different from that described by Sisson and Fahrenbach (1967) in that it appears to be associated with the granular endoplasmic reticulum. The part this organelle plays in the secretory activity of the cells remains to be elucidated. Its ultrastructure has widened the spectrum of crystalloids which occur in steroidogenic cells.

The "inclusion bodies" described in this paper resemble those noted by Christensen and Fawcett (1966) in Leydig cells of mice and those seen by Sisson and Fahrenbach

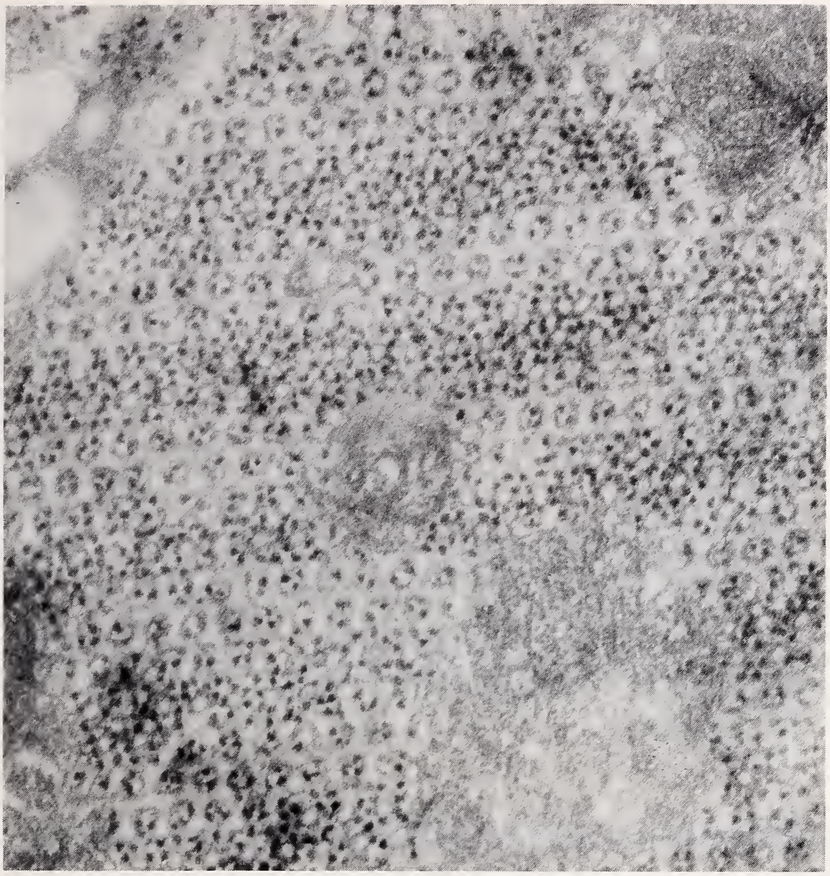

Fig. 6. Portion of a late intermediate cell showing the crystalloid. Note the tubule-ribosome relationship and trapped organelles. (X 78,000)

(1967) in the interstitial cells of the primate cutaneous organ. The latter authors suggested that these may be storage organelles.

Acknowledgements

We are deeply indebted to Mr. MUHAMED NDAWULA and Mr. LIVINGSTONE JEMBA for help in obtaining the animals. We thank Dr. W. B. NEAVES for providing facilities for electron microscopic investigations and Miss CATHERINE GIDDINGS for excellent technical assistance. We are grateful to the Ford Foundation for providing funds to enable Dr. KAYANJA to travel to the Department of Cell Biology of the Southwestern Medical School at Dallas where much of the work was done during Dr. KAYANJA's sabbatical.

Zusammenfassung

Die Talgdrüsen der Analbeutel von Genetta tigrina (Schreber, 1778)

Die Wandung der Analbeutel von *Genetta* enthält zwei Komplexe von Talgdrüsen. Das Drüsenepithel besteht aus peripheren Zellen an der Basalmembran, intermediären und reifen Zellen. Die intermediären Zellen müssen nach ihrer Ultrastruktur als die aktivsten angesehen werden. Ihr Zytoplasma enthält Mitochondrien mit Cristae und Tubuli, Filamente, Lipidtröpfchen, ein ausgedehntes glattes endoplasmatisches Retikulum, sowie durch regelmäßige Anordnung der Baubestandteile ausgezeichnete Kristalloide. Letztere sind mit dem granulären endoplasmatischen Retikulum verbunden. Die Ultrastruktur dieser Zellen weist auf ihre Rolle als steroidbildende Elemente hin.

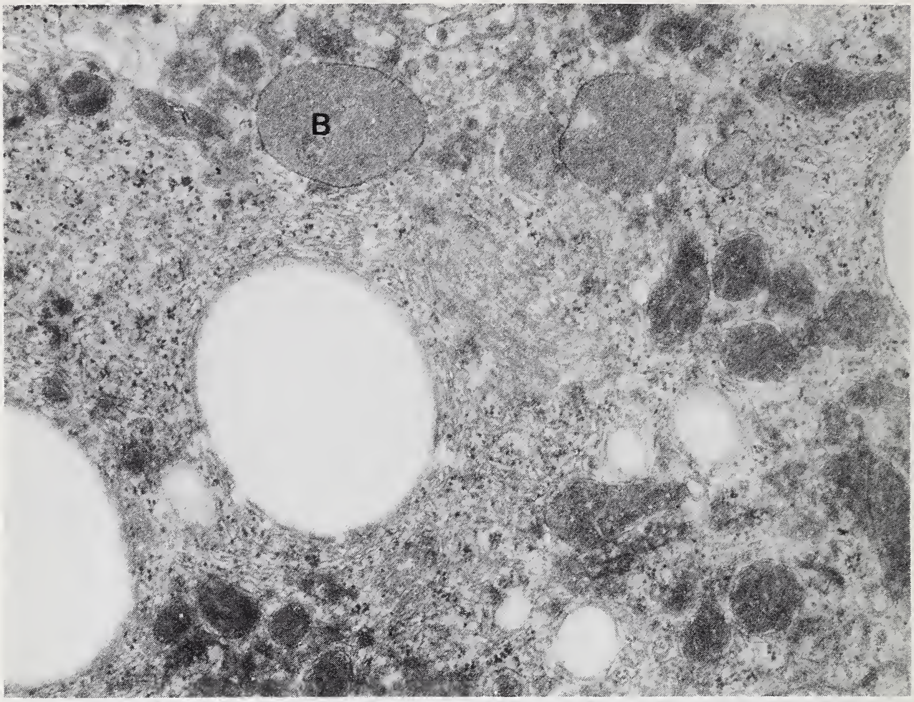

Fig. 7. Portion of an intermediate cell showing lipid droplets, endoplasmic reticulum and membrane bound bodies (B). (X 28,000)

References

ALBONE, E. S.; EGLINGTON, G. (1974): The anal sac secretion of the red fox (*Vulpes vulpes*) its chemistry and microbiology. A comparison with the anal sac secretion of the lion (*Panthera leo*). Life Sci. **14**, 387–400.

ALBONE, E. S.; GOSDEN, P. E.; WARE, G. C. (1976): Bacteria as a source of Chemical Signals in Mammals. In: Chemical Signals in Vertebrates. Ed. by D. MÜLLER-SCHWARZE and M. M. MOZELL. New York and London: Plenum Press. 35–44.

ALBONE, E. S.; GRÖNNEBERG, T. O. (1977): Lipids of the anal sac secretions of the red fox (*Vulpes vulpes*) and the lion (*Panthera leo*). J. Lipid Res. **18**, 474–479.

CHRISTENSEN, A. K.; FAWCETT, D. W. (1966): The fine structure of testicular interstitial cells in mice. Am. J. Anat. **118**, 551–572.

CUYLER, W. K. (1924): Observations on the habits of the striped skunk (*Mephitis mesomelas varians*). J. Mammalogy **5**, 180–189.

DÜCKER, G. (1965): Das Verhalten der Viverriden. In: Handbuch der Zoologie. Ed. by. J.-G. HELMCKE, H. v. LENGERKEN, D. STARCK, H. WERMUTH. Berlin: De Gruyter. Vol. **8**, 1–48.

EBLING, F. J. G. (1970): Sebaceous glands. In: An introduction to the biology of the skin. Ed. by R. H. CHAMPION, T. GILLMAN, A. J. ROOK, R. T. SIMS. Philadelphia, PA.: F. A. Davis Comp.

FAWCETT, D. W.; BURGOS, M. H. (1960): Studies on the fine structure of the mammalian testis. II. The human interstitial tissue. Am. J. Anat. **107**, 245–269.

GORMAN, M. L.; NEDWAHL, D. B.; SMITH, R. M. (1974): An analysis of the contents of anal scent pokkets of *Herpestes auropunctatus* (Carnivora: Viverridae). J. Zool., Lond., **172**, 389–399.

GREER, M. B.; CALHOUN, M. L. (1966): Anal sacs of the cat, *Felis domesticus*. Am. J. Vet. Res. **27**, 773–781.

HASHIMOTO, Y.; EGUCHI, Y.; ARAKAWA, A. (1963): Histological observations on the anal sac and its glands on a tiger. Japan J. Vet. Sci. **25**, 29–31.

ITO, S.; KARNOVSKY, M. J. (1968): Formaldehyde-glutaraldehyde fixatives containing trinitro compounds. J. Cell Biol. **39**, 168a.

KAINER, R. A. (1954): The gross anatomy of the digestive system of the mink. II. The midgut and the hindgut. Am. J. Vet. Res. **15**, 91–97.

Krölling, O. (1927): Entwicklung, Bau und biologische Bedeutung der Analbeuteldrüsen bei der Hauskatze. Z. Anat. Entwickl. **82**, 22–69.
Montagna, W.; Parks, H. F. (1948): A histochemical study of the glands of the anal sac of the dog. Anat. Rec. **100**, 297–315.
Ortmann, (1960): Die Analregion der Säugetiere. In: Handbuch der Zoologie. Ed. by J.-G. Helmcke, H. v. Lengerken, D. Starck, H. Wermuth. Berlin: De Gruyter. Vol. **8**, 1–68.
Pocock, R. J. (1915): On the Feet and Glands and other External Characters of the Paradoxurine Genera *Paradoxurus, Arctictis, Arctogalidia* and *Nandinia*. Proc. Zool. Soc. Lond. 387–412.
— (1915): On the Feet and Glands and other External Characters of the Viverrinae, with the description of a new Genus. Proc. Zool. Soc. Lond. 131–149.
— (1916): On the external characters of the mongoose (Mungotidae). Proc. Zool. Soc. Lond. 349–374.
Schaffer, J. (1940): Die Hautdrüsenorgane der Säugetiere. Berlin und Wien: Urban & Schwarzenberg.
Sisson, J. K.: Fahrenbach, W. H. (1967): Fine structure of the steroidogenic cells of a primate cutaneous organ. Am. J. Anat. **121**, 337–368.
Yamada, E. (1962): Some observations on the fine structure of the interstitial cell in the human testis. In: Fifth International Congress for Electron Microscopy. Ed. by S. S. Breese. New York: Academic Press. Vol. 2.

Authors' addresses: Prof. Dr. F. I. B. Kayanja, Department of Veterinary Anatomy and Histology, Makerere University, Box 7062, Kampala, Uganda; Prof. Dr. H. Schliemann, Zoologisches Institut und Zoologisches Museum, Universität Hamburg, Martin-Luther-King-Platz 3, D-2000 Hamburg 13

Einige Beobachtungen zum Paarungs- und Lautgebungsverhalten von Irbissen (Uncia uncia) im Zoologischen Garten[1]

Von I. Rieger und G. Peters

Aus dem Zoologischen Garten Zürich und dem Max-Planck-Institut für Verhaltensphysiologie, Arbeitsgruppe Wuppertal

Eingang des Ms. 24. 1. 1980

Abstract

Observations on the mating and vocal behaviour of snow leopards (Uncia uncia) in zoological gardens

Studied the mating and vocal behaviour of snow leopards (*Uncia uncia*) in captivity. Copulations were monitored by 12h continuous tape recording when direct observation was not possible. This method was adequate because male snow leopards produce a typical high intensity call at the end of each copulation. Copulations occur in bouts interspersed by phases of variable duration with little or no copulatory activity.

The vocal repertoire of snow leopards during mating behaviour was analyzed spectrographically.

Einleitung

Das Paarungsverhalten der Feliden ist bei allen bisher untersuchten Arten dieser Familie in seinem Ablauf ziemlich einheitlich (Leyhausen 1979). Die Paarungen ziehen sich über mehrere Tage hin; die Tiere kopulieren viele Male. Bisweilen läßt sich ein ♀ auch während einer Hitzeperiode von mehreren ♂♂ begatten.

[1] Über einen Teil der Ergebnisse wurde auf der 53. Hauptversammlung der Deutschen Gesellschaft für Säugetierkunde in Zürich, 24.–28. 9. 1979, berichtet.

U.S. Copyright Clearance Center Code Statement: 0044-3468/81/4601-0035 $ 2.50/0
Z. Säugetierkunde 46 (1981) 35–48

ISSN 0044–3468/InterCode: ZSAEA 7