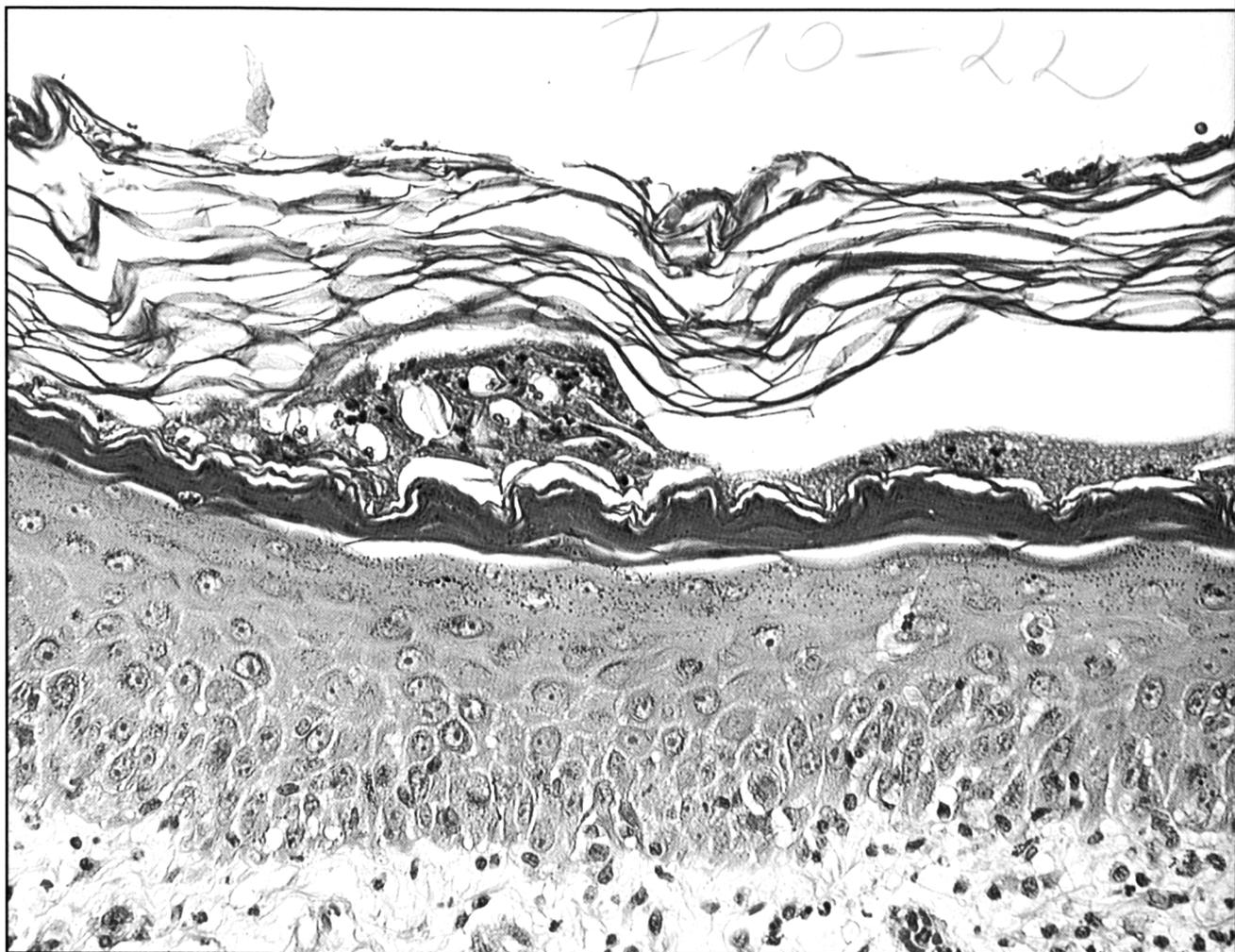


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Veterinary Dermatology
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Veterinary Dermatology



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- Pemphigus foliaceus in a horse
- Microanatomy of the canine claw
- Potentiated sulfonamides in the treatment of canine pyoderma
- Feline cutaneous melanocytic neoplasms
- A canned lamb and rice diet for cats
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Cover illustration: Section from superficial spreading pyoderma illustrating intracorneal bacteria (Dunstan's Blue Line). From Ihrke and Gross, page 35.

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Microanatomy of the Canine Claw

RALF S. MUELLER*, ANJA STERNER-KOCK‡ & ANTHONY A. STANNARD§

*Veterinary Medical Teaching Hospital, ‡Department of Pathology and §Department of Medicine,
University of California, Davis, CA 95616 U.S.A.

(Received 19 June 1993; accepted 23 June 1993)

Abstract—The histologic appearance of the canine claw was evaluated in twenty dogs of various breeds. Sagittal and horizontal cross sections of the claw were obtained, fixed, decalcified and stained with hematoxylin and eosin. Sections were evaluated and are described herein. Among notable findings were few to numerous intranuclear vacuoles found predominantly in the cells of the stratum spinosum, especially in the dorsal and ventral matrix. These vacuoles displaced the chromatin to the periphery. There was epidermal ridge formation in the angle of the dorsal fold. In several specimens there were clefts at the dermoepidermal junction present most commonly in the dorsal matrix. The previously reported lack of a granular layer in the epithelium forming the claw was confirmed.

Key Words: Canine claw; Claw matrix; Intranuclear vacuoles; Subepidermal clefting; Histologic anatomy.

INTRODUCTION

Although the microscopic appearance of the skin of the dog has been described in detail (1–10), information about the claws is not readily available. Because pathologists regularly receive biopsies for histologic evaluation of the canine claw, a detailed histologic description of the normal canine claw is indicated.

MATERIALS AND METHODS

Twenty dogs without historical or gross evidence of skin disease or claw abnormalities were selected from the dogs presented to the pathology service at the School of Veterinary Medicine, University of California, Davis, CA, for post mortem examination. Breeds examined included an akita, an Irish setter, three labrador retrievers, a samoyed, a kuvasz and 13 mixed breeds. Their age varied from 6 months to 14 years and in seven dogs, the exact age was not known. Cardiac hypertrophy, degenerative joint disease, hemangiosarcoma, hepatic necrosis, malignant ependyoma, medullary carcinoma, meningiosarcoma, metastatic osteosarcoma (two dogs), myositis, ossifying pachymeningitis, panniculitis, pyelonephritis and spondylosis led to death or euthanasia in 14 dogs. In the remaining six, diagnostic pathologic abnormalities could not be detected.

The distal phalanx of the second front digit and the dew claw (the latter was present in only 13 dogs)

were removed and fixed in 10% neutral buffered formalin. The tissue was then decalcified for 8–14 days prior to sectioning. The digits were cut in half sagittally and one sagittal section was obtained. Cross sections of one half were taken in the horizontal plane from dorsal to ventral 1–2 mm apart. The samples were embedded in paraffin, sectioned at 6 µm and stained with hematoxylin and eosin. Additionally, the sections of four claws were stained with periodic acid Schiff stain. Each section was divided into four different areas (dorsal fold consisting of dorsal epidermis and matrix, ventral fold consisting of ventral epidermis and matrix, dermoepidermal junction and dermis) and evaluated for abnormalities such as cytoplasmic or intranuclear vacuoles, cell shape and shape and location of cell nuclei. Two additional digits were fixed in 10% neutral buffered formalin and sectioned without decalcification.

RESULTS

The dorsal aspect of the digit was comprised of haired skin. The epidermis consisted of a single layer of basal cells, 1–2 layers of stratum spinosum cells, 1–2 layers of stratum granulosum cells and an overlying horny layer of basket weave keratin lamellae. Epidermal appendages were apparently present in normal quantity and distribution. The subjacent dermis was composed of variably dense, collagenous connective tissue with occasional intermingled elastin fibers.

The inner surface of the claw fold lacked epidermal appendages. The dorsal epidermis (see Fig. 1) consisted of 4–12 cell layers. The stratum basale was comprised in most dogs of tall columnar cells with oval, deeply basophilic nuclei. In some dogs the basal cells were cuboidal to flattened (Table 1).

This work should be attributed to the Dermatology Service of the Veterinary Medical Teaching Hospital, University of California. Correspondence and reprint requests: Dr Anja Sterner; Department of Pathology; School of Veterinary Medicine; University of California; Davis, CA 95616; U.S.A. Tel. (916) 752-6066.

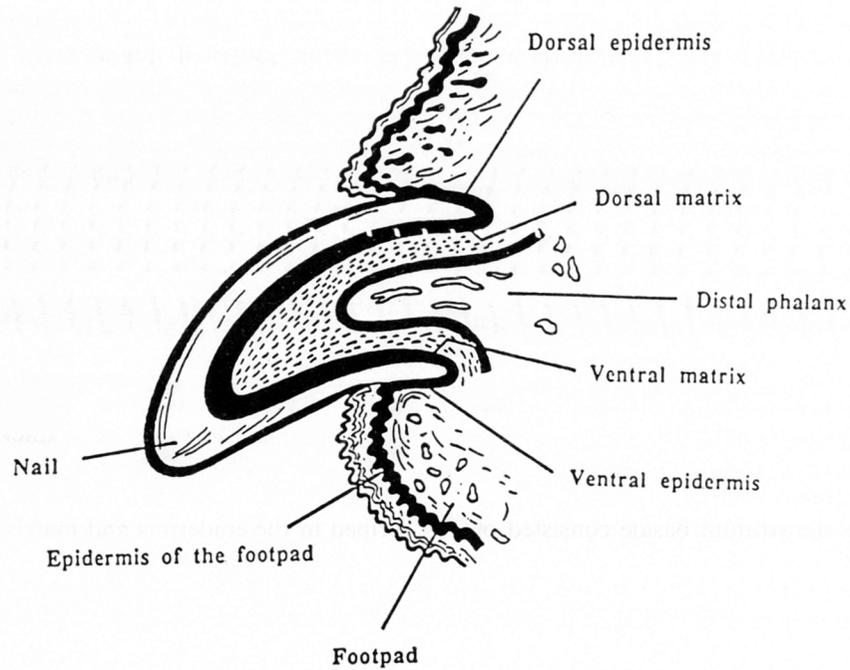


Figure 1. Schematic anatomy of the canine claw.

TABLE 1. Microanatomical features of the claw epidermis and matrix and their frequency of occurrence in the examined 20 dogs

	Epidermis of the dorsal fold	Dorsal matrix	Ventral matrix	Epidermis of the ventral fold
Basal cells				
flattened	2*	1	1	1
cuboidal	4	13	13	7
tall columnar	14	6	6	12
Basal cell nuclei				
round	4	13	6	8
oval	16	7	14	12
vacuolization present	3	9	10	3
Spinous cells				
flattened	1			
cuboidal	16	18	17	17
columnar	3	2	3	3
Spinous cell nuclei				
round	16	18	17	17
oval	4	2	3	3
Vacuolization present	7	11	20	12
Stratum granulosum				
absent	19	19	18	18
present	1	1	2	2
Clefting at DE junction	3	8	3	

*Number of dogs.

The nucleoli were variably distinct and centrally located. The basal layer in three dogs had large, clear, intranuclear vacuoles with peripheral, deeply basophilic chromatin (Fig. 2). The spinous cells were polyhedral in most dogs. In some dogs they were columnar or highly flattened. Their nuclei were round in the majority of dogs. The intranuclear

vacuolization described in the basal cell layer typically occurred more frequently in the spinous cells, but the quantity of the vacuoles varied (Fig. 3). The chromatin was peripherally located and crescent shaped in four dogs; in three dogs the chromatin was seen in the centre of the vacuoles. A stratum granulosum was generally absent with the exception of one

dog where it was present as a continuous layer. The dorsal epidermal aspect was in close association with the claw horn. The subjacent dermis was composed of dense, fibrous, collagenous tissue containing variably sized islands of basophilic ground substance and more differentiated foci of hyaline cartilage with gradual enchondral ossification of the ungular process (Fig. 4). In the angle of the dorsal fold, prominent, blunt to elongated, irregular epidermal ridges were noted in all dogs (Fig. 5). The horn was comprised peripherally of eosinophilic, fibrillar keratin with a gradual transition to a clear central core of fibrillar, refractile keratin with occasional linear streaks of increased eosinophilia assumed to represent less mature keratin (Fig. 6).

The epidermis of the dorsal matrix had 3–15 cell layers. In most dogs the stratum basale consisted of cuboidal cells with round nuclei that gradually changed to tall columnar cells with oval nuclei toward the angle of the dorsal fold. In some dogs, the stratum basale was tall columnar only (Table 1). In one dog the basal cells were flattened. Intranuclear vacuolization of the stratum basale was seen in nine dogs. The chromatin in these vacuolated nuclei was round and centrally located in six and marginated in three dogs. In the stratum spinosum the cells had a cuboidal form with round nuclei in most dogs. Intranuclear vacuoles were seen in 11 dogs (Fig. 7). The number of vacuoles increased in the stratum spinosum, however, the location and form of the vacuoles and chromatin in these cells were the same as described in the basal cell layer. In eight dogs, variable degrees of clefting at the dermoepidermal junction below the basal cells was present (Figs 8, 9). The subepidermal vascular plexus was prominent. The dermis subjacent to the dorsal matrix was much less dense than that associated with the dorsal fold. It consisted of loosely arranged, fibrous collagenous tissue mixed with lacy, basophilic precipitates and was intimately associated with the underlying spongiosa of the ungular process.

The ventral matrix was comprised of 3–12 cell layers. The stratum basale was low cuboidal with oval nuclei in most dogs and columnar with round nuclei in some. Intranuclear vacuoles were seen in 10 dogs (Table 1). In the affected cells, the chromatin was peripherally displaced. The cells of the stratum spinosum were polyhedral; the nuclei of these cells were predominantly round. In each section, few to numerous vacuoles were present; the chromatin was deeply basophilic and marginated. A continuous stratum granulosum throughout the ventral matrix was present in two dogs. Focal clefting below the basal cells was seen occasionally. At the angle of the ventral fold, epidermal ridges were present in only two cases and were not as pronounced as in the dorsal fold (Fig. 10).

The epidermis of the ventral fold consisted of 4–12 cell layers. The basal cells were tall columnar in most dogs (Fig. 11). In only three dogs, vacuoles

were seen in this layer (Table 1). The stratum spinosum consisted predominantly of polyhedral cells with round nuclei. In three dogs, the cells were tall columnar with oval nuclei. Few to numerous vacuoles were present in 12 dogs, in most cases displacing the chromatin marginally, although in two dogs a coarse chromatin clump was located in the centre of the vacuoles. A granular layer was noted throughout the epidermis in the two dogs with this layer present in the ventral matrix. The sections of all other dogs lacked this layer.

The epidermis of the footpad consisted of a single layer of basal cells, 1–3 layers of spinous cells, 1–2 layers of granular cells and a thick overlying horny layer of basket-weave keratin forming the foot pad. Intranuclear vacuoles similar to the vacuoles described in the epidermis and matrix of the claw were seen in the stratum basale and the stratum granulosum of the foot pad as well (Fig. 12).

The epidermis of the lateral claw fold was comprised of 5–7 cell layers. Cells of the stratum basale were columnar with oval nuclei in most dogs (Fig. 13), although two dogs had cuboidal basal cells and in two others the basal cells were flattened. The spinous cells were cuboidal with round nuclei. In eight dogs intranuclear vacuoles were prominent.

The lateral claw matrix consisted of eight layers on average, although there was a substantial variation of 4–18 layers. The basal cells were cuboidal in most cases. Columnar basal cells were seen in four dogs, four other dogs showed flattened basal cells. The spinous cells were cuboidal with round nuclei for the most part. Intranuclear vacuoles were seen in the basal layer in 12 and in the spinous layer in 16 dogs. Both the epidermis of the lateral claw fold as well as the lateral matrix lacked a granular layer.

Microanatomical findings of the examined dew claws and distal phalanges of the second digit were identical. The only difference between the decalcified samples and the samples fixed in formalin alone was a substantially increased clefting throughout the non-decalcified tissue thought to be due to increased shearing forces at sectioning.

DISCUSSION

Although detailed descriptions of the canine claw are not available, certain microscopic anatomical features of this structure have been described previously. The inner surface of the claw fold has been reported to lack hair and glandular structures (4, 5). This is in agreement with the findings of this study.

The epidermis of the dorsal fold was only slightly thicker than the epidermis of the ventral fold. This is in contrast with previous reports that there was a significant difference in thickness between the dorsal fold and the other parts of the canine claw (2).

Previous investigators have stated that a granular layer is seen in the ventral epidermis of the canine

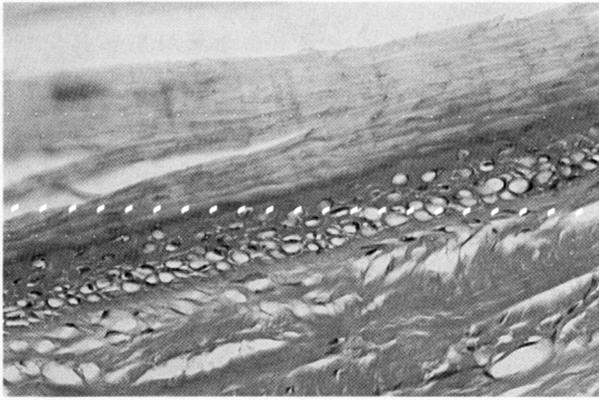


Figure 2. Basal layer of dorsal epidermis with large intranuclear vacuoles (H&E, $\times 912$).

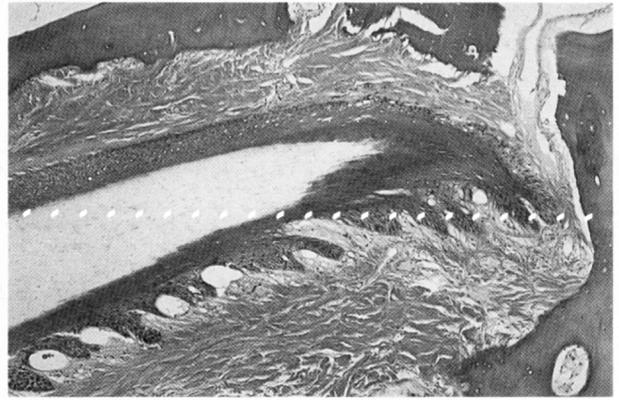


Figure 5. Epidermal ridges in the angle of the dorsal fold (H&E, $\times 228$).

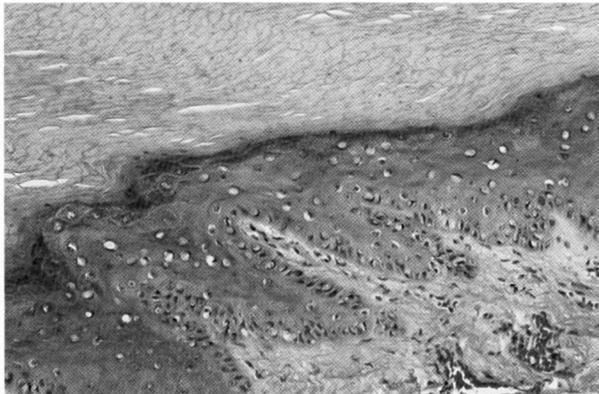


Figure 3. Intranuclear vacuolization typically occurred more frequently in spinosal than basal cells of the dorsal epidermis (H&E, $\times 456$).

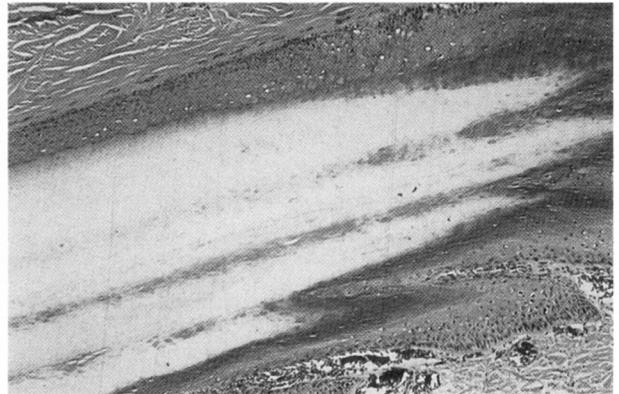


Figure 6. Claw horn comprised of fibrillar keratin (H&E, $\times 456$).

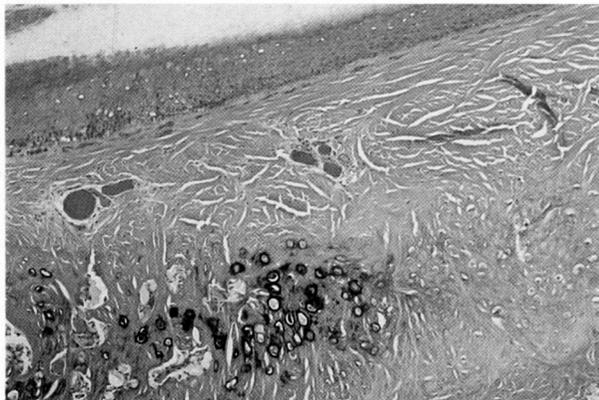


Figure 4. Foci of hyaline cartilage in the dermis of the dorsal fold (H&E, $\times 456$).

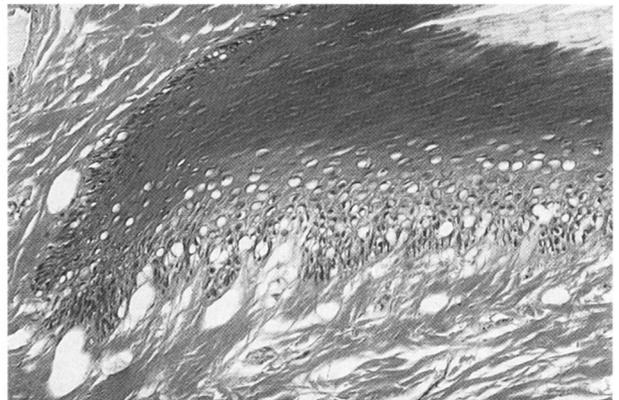


Figure 7. Vacuolization of the spinosal cells in the dorsal matrix (H&E, $\times 456$).

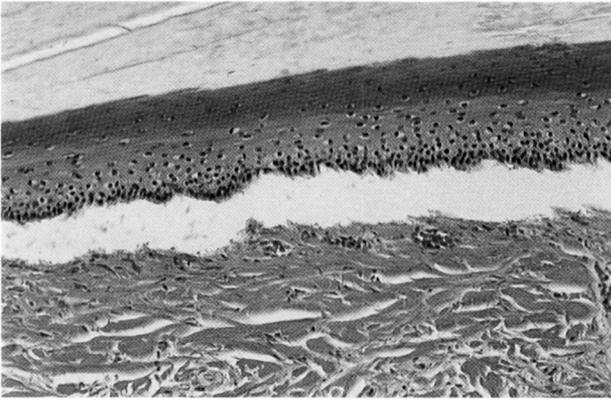


Figure 8. Clefting at the DE junction of the dorsal matrix (H&E, $\times 456$).

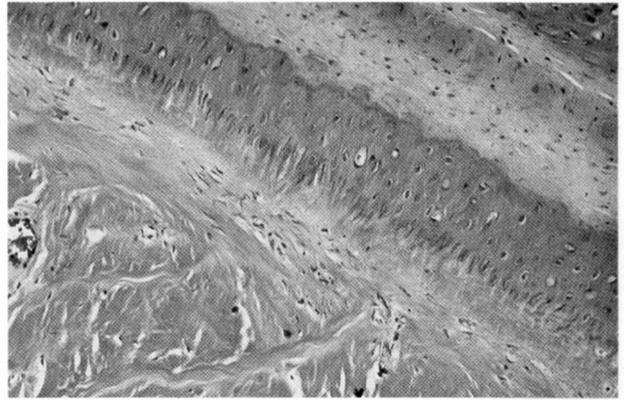


Figure 11. Columnar basal cells of the ventral epidermis (H&E, $\times 456$).

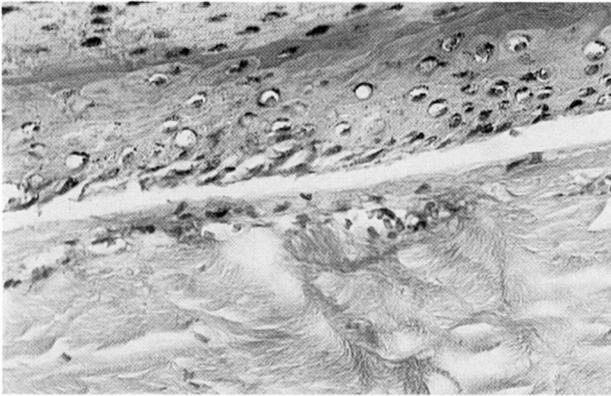


Figure 9. Clefting at the DE junction of the dorsal matrix (H&E, $\times 912$).

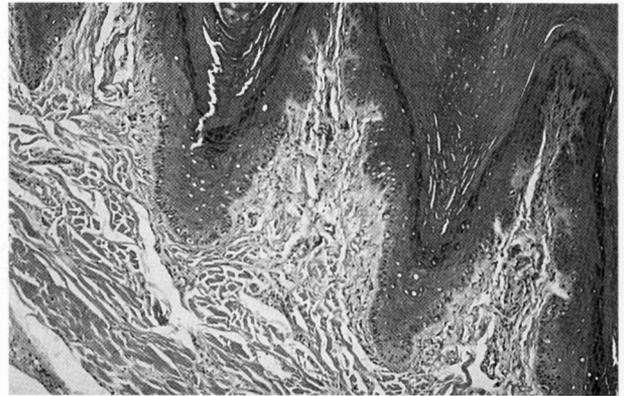


Figure 12. Vacuolization in the epidermis of the footpad (H&E, $\times 912$).

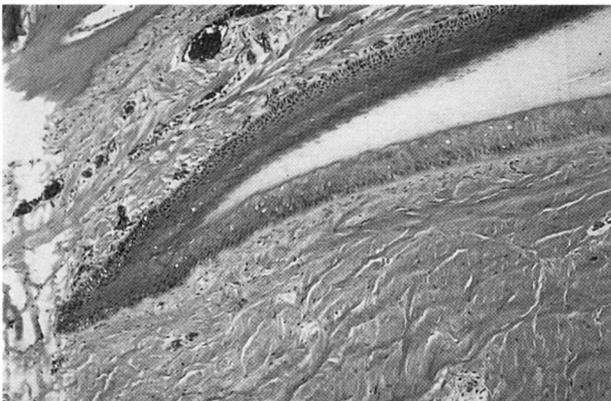


Figure 10. Ventral nail fold without epidermal ridges (H&E, $\times 228$).

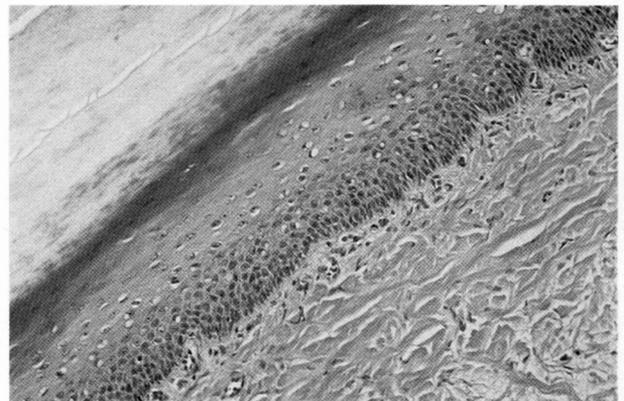


Figure 13. Epidermis of the lateral claw fold (H&E, $\times 456$).

claw (2). In this study, only two dogs showed a stratum granulosum in the ventral matrix and epidermis. In all other dogs, the stratum granulosum was first seen within the epidermis of the foot pad.

Intranuclear vacuoles were seen in the stratum basale and the stratum spinosum of the claw matrix in varying numbers. They were most common in the ventral matrix. In general, these vacuoles were seen in higher numbers in the stratum spinosum than the stratum basale. The intravacuolar chromatin was either margined or centrally located and round. This vacuolization was seen in the epidermis of the footpad as well. The significance of these vacuoles is not known. They are not a consequence of decalcification as samples fixed only in 10% neutral buffered formalin revealed similar changes. The vacuolization is assumed to be a consistent artefact. It should be differentiated from interface dermatoses and ballooning degeneration observed in pox or papilloma virus infections. In interface dermatoses the vacuolization is intracytoplasmic and not intranuclear. In contrast to the normal claw, inflammatory cells should be present at the dermoepidermal junction. Viral infections are characterized by ballooning degeneration of the cytoplasm and other changes such as acanthosis and inflammation.

Small epidermal lamellae have been reported on the inner surface of the claw wall (1, 4). The epidermal ridges observed by the authors in the angle of the dorsal fold may correspond to these lamellae.

In the dorsal matrix, focal clefting was seen at the dermoepidermal junction in eight of 20 cases. In the ventral epidermis, this clefting occurred in only three dogs. Subepidermal clefting is a key feature of congenital or immune-mediated subepidermal bullous diseases and some cases of systemic lupus erythematosus. In immune-mediated disease, inflammatory changes usually are present in addition to the cleft-

ing. Onset of clinical signs at a very young age characterizes congenital bullous diseases that typically affect other areas of the body as well. Since there was no evidence of dermatological disease in all of the examined dogs, it is assumed that the clefts are a shrinkage artefact and not the result of a pathological process.

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Résumé—L'aspect histologique de l'ongle du chien a été étudié chez 20 chiens de races différentes. Des coupes horizontales et sagittales ont été faites, fixées, décalcifiées et colorées à l'hémalin-éosine. Parmi les observations les plus significatives on note de nombreuses vacuoles intranucléaires principalement dans les cellules de la couche épineuse et plus particulièrement au niveau dorsal et ventral de la matrice. Ces vacuoles déplacent la chromatine en périphérie. Il y avait des crêtes épidermiques au niveau du pli dorsal. Dans plusieurs spécimens il existait des disjonctions dermoépidermiques, principalement au niveau de la matrice dorsale. L'absence de couche granuleuse dans l'épithélium formant l'ongle précédemment décrite a été confirmée. [Mueller, R. S., Sterner-Kock, A., Stannard, A. A. Microanatomy of the canine claw (Microanatomie de l'ongle du chien). *Veterinary Dermatology* 1993; 4: 5–11].

Zusammenfassung—Bei zwanzig Hunden verschiedener Rassen wurde der histologische Aufbau der Hundekralle untersucht. Es wurden sagittale und horizontale Schnitte angefertigt, fixiert, entkalkt und mit Hämatoxylin und Eosin gefärbt. Die Schnitte wurden ausgewertet und beschrieben. Beachtenswerte Befunde sind wenige bis zahlreiche intranukleäre Vakuolen, die vorwiegend in den Zellen des Stratum spinosum, speziell in denen der dorsalen und ventralen Matrix, gefunden wurden. Die Vakuolen drängten das Chromatin an die Peripherie. Im Winkel der dorsalen Falte war eine epidermale Kamm- oder Lamellenbildung zu beobachten. Bei einigen Proben waren Spalten in der dermoepidermalen Verbindung vorhanden, am häufigsten in der dorsalen Matrix. Das schon früher bekannte Fehlen einer granulären Schicht im Epithel, das die Krallen bildet, wurde bestätigt. [Mueller, R. S., Sterner-Kock, A., Stannard, A. A. Microanatomy of the canine claw (Mikroanatomie der Hundekralle). *Veterinary Dermatology* 1993; 4: 5–11].

Resumen—En este artículo se estudia la apariencia histológica de la uña canina en veinte perros de diferentes razas. En un principio se obtuvieron secciones sagitales y horizontales, luego se fijaron, decalcificaron, y tiñeron con hematosilina-eosina. Las secciones fueron evaluadas y se describieron a continuación. Entre un considerable número de hallazgos, se demostró la presencia de un número de vacuolas intranucleares predominantemente en las células del estrato espinoso, y especialmente en la matriz dorsal y ventral. Estas vacuolas se encontraban desplazando la cromatina hacia la periferia de la célula. También se observó la presencia de la formación de una cresta epidérmica en el ángulo del pliegue dorsal. En algunos de los especímenes se vieron indentaciones a nivel de la frontera dermo-epidérmica, mas frecuentemente en la matriz dorsal. También se confirmó la ausencia de de capa granular en el epitelio de la uña. [Mueller, R. S., Sterner-Kock, A., Stannard, A. A. Microanatomy of the canine claw. (Microanatomía de la uña canina). *Veterinary Dermatology* 1993; 4: 5–11].