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PERRISODACTYLIDS

CHAPTER 80

Skin Diseases of Black Rhinoceroses

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The captive population of black rhinoceroses (*Diceros bicornis*) has had persistent health problems that have impeded population growth,[9] and the most prevalent health problem has been skin disease. In the United States, nearly 50% of adult black rhinoceroses have had at least one episode of skin or oral/nasal mucosal lesions that resulted in significant morbidity and, less commonly, mortality. Although some skin conditions appear as primary disease, most episodes appear to be secondary to other major health problems, such as hepatic failure, hemolytic anemia, enteritis, pneumonia, and generalized debility. Many episodes have also been linked to stressful environmental conditions, such as transportation, introduction of new animals, or sudden cold temperatures. The relationship between skin disease and other conditions suggests that rhinoceros skin is acutely sensitive to the physiologic status of the animal and that events disrupting normal homeostasis may initiate structural and functional changes in the epidermis that result in increased fragility and poor healing. The distinctive dermatologic syndrome that accounts for the majority of lesions in captive black rhinoceroses, superficial necrolytic dermatopathy, is consistent with this concept. In contrast, skin disease in wild black rhinoceroses has been almost exclusively associated with *Stephanofilaria dinniki* infestations.

NORMAL SKIN HISTOLOGY

Black rhinoceros skin has features that most closely resemble those of human skin except for the deep collagenous dermis. Rhinoceros epidermis has prominent rete ridges and a distinct papillary dermis (Fig. 80–1). The epidermis is composed of approximately 5 to 10 layers of keratinocytes covered by several layers of cornified epithelial cells. The papillary dermis is notably less dense than the dermis below the rete ridges (reticular dermis), which is very thick (up to 2 cm) and composed of dense, interwoven collagen bundles. The skin has sparse hair with only rare, small pilosebaceous units. Evenly dispersed in the superficial reticular dermis are large, round clusters of eccrine sweat glands and prominent arterioles. These histologic characteristics suggest that black rhinoceros skin lacks the protective benefits of hair and the moisturizing effects of sebum but can rapidly disperse heat through eccrine gland secretion and abundant superficial vasculature. The epithelium of the oral and nasal mucosa is similar

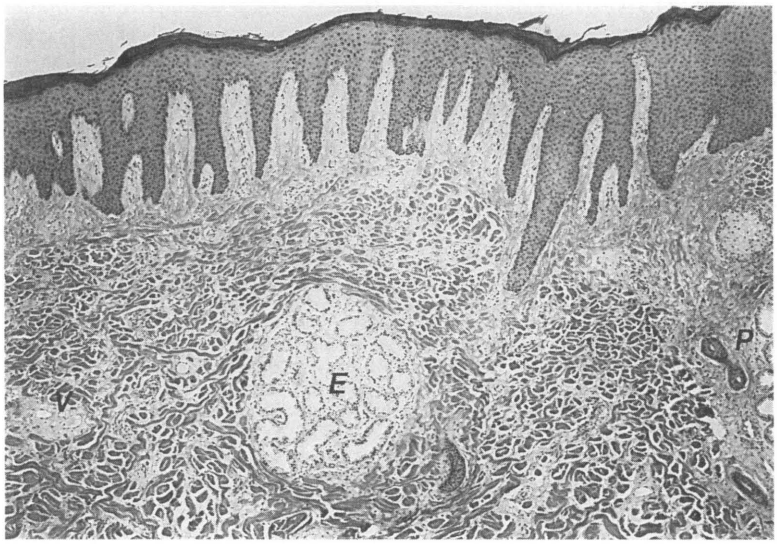

FIGURE 80–1. Histologic appearance of normal black rhinoceros skin. The reticular dermis is markedly collagenous and contains eccrine sweat glands (E) and scant pilosebaceous units (P). The epidermis is thin and has rete ridges. Hematoxylin and eosin stain; original magnification, ×400.

to the skin except that the superficial cells do not undergo cornification.

RESPONSES OF RHINOCEROS SKIN TO INJURY

Skin pustules and ulcers develop in black rhinoceroses under many circumstances, and only histopathologic study can distinguish the primary dermatologic problem. For this reason, this chapter emphasizes the histologic character of skin lesions.

Black rhinoceros skin has common responses to a variety of injuries. The skin undergoes marked epidermal hyperplasia, increasing in depth up to 30 or more layers, and rete ridges become complex and branching. Stratification of keratinocytes often becomes disorganized, and multinucleated keratinocytes appear. Altered epidermal keratinization is also common and results in dyskeratosis, parakeratosis, and hyperkeratosis. If cytokeratin immunohistochemistry or electron microscopy is not used, dyskeratotic epithelial cells may contain distinct eosinophilic keratin aggregates that can be mistaken for viral inclusions.

The papillary dermis responds to many injuries with marked neovascularization, edema, hemorrhage, and an increase in basophilic fibrillar ground substance. Hemorrhage also is common in the superficial reticular dermis, and red blood cell (RBC) exocytosis through the epithelium (which has been described as "sweating blood") results in subcorneal pooling of blood or hemorrhagic crusts. In most types of injury, dermal fibroplasia is prominent and disorganized, appearing similar to neoplasia. Neutrophils and eosinophils are the predominant inflammatory cells in most rhinoceros skin diseases, and melanophages are common in chronic inflammatory conditions because pigmentary incontinence occurs.

Ulcers, erosions, and fissures develop under many circumstances, possibly because rhinoceros skin has a relatively thin, unprotected epidermis overlying a rigid, collagenous dermis. Ulcers typically heal slowly, and the epidermis at ulcer margins can be very hyperplastic, forming large, fungating, neoplasm-like masses (pseudocarcinomatous hyperplasia). Dense granulation tissue beds form under most chronic ulcers and are often accompanied by collagen degeneration and mineralization.

SPECIFIC DERMATOLOGIC SYNDROMES

Superficial Necrolytic Dermatopathy of Black Rhinoceroses

Synonyms for this condition are mucosal and cutaneous ulcerative syndrome, hepatocutaneous syndrome, vesicular and ulcerative dermatopathy, and ulcerative skin disease. It is the most prevalent skin disease in captive black rhinoceroses and is characterized by abnormal epidermal growth, degeneration, and superficial necrosis, subsequently leading to the formation of vesicles and chronic ulcers.[11] More than 40 rhinoceroses in 21 zoological parks have been affected by this syndrome. Clinically, lesions first appear as epidermal plaques, vesicles, or pustules that subsequently erode or ulcerate. In many cases, ulcers are the first noted clinical sign and are often mistaken for abrasions when located over pressure points. The lesions are usually bilateral and relatively symmetric, located predominantly on pressure points, ear margins, coronary bands, the tip of the tail, or the lateral body surfaces. Oral or nasal mucosal lesions also occur alone or concurrently with skin lesions. Most oral lesions are on the palate or the lateral margins of the tongue or lips in contact with teeth.

The clinical course is typically one of a waxing and waning of lesions. Most rhinoceroses with lesions are anorectic and have a depressed attitude and weight loss.

Generalized weakness and unexplained lameness also accompany these lesions. Rhinoceroses with extensive skin involvement become moribund. In many rhinoceroses, serum albumin, cholesterol, and hematocrits are lower than those in unaffected wild or captive black rhinoceroses, which may reflect the direct loss of albumin and blood through the skin.

The lesions have distinctive histopathologic characteristics. Early lesions are characterized by epidermal hyperplasia, intraepithelial edema, hydropic degeneration of keratinocytes, and parakeratosis (Fig. 80–2). Vesicles or pustules form in the epidermis at sites of degeneration and edema, resulting in superficial epidermal necrosis. Ulcers subsequently occur after minimal trauma, and the ulcers expand peripherally and heal poorly. A dermal inflammatory reaction does not occur until the ulcerative stage, and it is confined to areas with exposed dermis. Secondary superficial bacterial infections are common.

The disease appears in rhinoceroses of all ages (range of 1 to 39 years) and under different management strategies, with different diets, and under different environmental conditions. The disease occurs as a primary condition or (more commonly) in association with other medical conditions, such as toxic hepatopathy, hemolytic anemia, gastrointestinal diseases, and respiratory infections. The primary disease is often associated with stress events such as sudden cold temperatures, transportation, introduction of new animals, or parturition.

This ulcerative dermatopathy has clinical and histologic features of a rare degenerative skin disease in other species, known as superficial necrolytic dermatitis (hepatocutaneous syndrome) of dogs[2, 10] and necrolytic migratory erythema of humans.[5, 6] These conditions are usually caused by hyperglucagonemia or other metabolic derangements leading to hypoaminoacidemias. The specific cause of this condition in black rhinoceroses has not been identified, although glucagon and amino acid levels have not yet been measured. The high prevalence of this syndrome exclusively in the captive population suggests a dietary deficiency or a metabolic change resulting from captivity.

Because the cause is unknown, treatment has been empiric. No treatment has consistently succeeded in reversing these lesions, and many lesions resolved without treatment. Secondary bacterial infections can be effectively controlled with topical or systemic antibiotics, topical antiseptics, moisturizing salves, and hydrotherapy. Affected rhinoceroses should be examined for underlying diseases, and management practices should be evaluated for dietary adequacy and potential stress factors. Biologic samples (from biopsies of lesions and from plasma and serum) from current cases and recording of environmental and management factors during emerging cases will contribute significantly toward establishing the cause of this condition.

Epidermal Exfoliation

Rhinoceroses sometimes exfoliate large sheets of superficial epidermis from their flanks and lateral thorax, exposing an underlying grey, shiny epidermis. Histologically, the exfoliated material is composed of multiple layers of degenerating superficial epidermis with hyperkeratosis and parakeratosis. The similarity of the epidermal changes with those of the superficial necrolytic dermatopathy and the occurrence of these two syndromes in the same rhinoceroses at different times suggests that this exfoliative syndrome is a clinical variant of superficial necrolytic dermatopathy. The syndrome has resolved without complications after topical moisturizing and antiseptic treatments.

Superficial Pustular Dermatitis

Superficial pustules and serocellular crusts commonly occur in black rhinoceros skin. Although most pustules are secondary to superficial necrolytic dermatopathy, intraepithelial pustules occur in rare cases without epithelial degeneration. Primary superficial pustular derma-

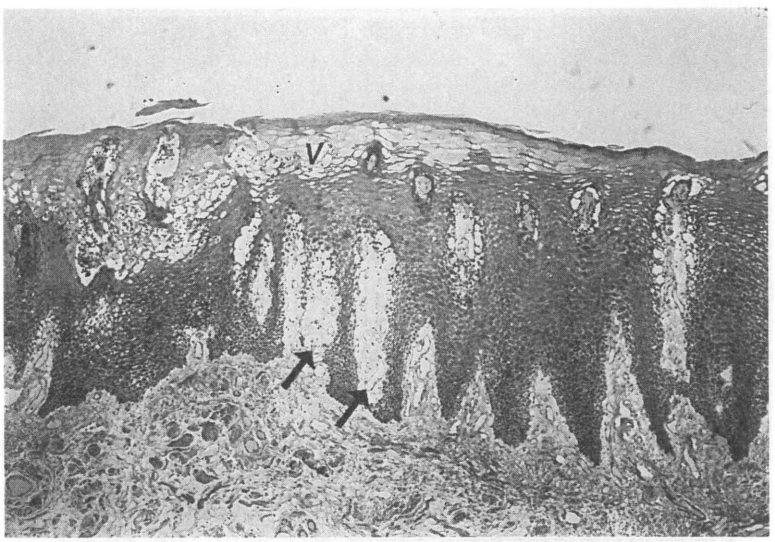

FIGURE 80–2. Black rhinoceros skin with superficial necrolytic dermatopathy. The epidermis is hyperplastic and degenerating, and intercellular edema leads to formation of an early vesicle (V). Parakeratosis also is present. The dermis has vascular dilation and proliferation (*arrows*) but lacks inflammation. Hematoxylin and eosin stain; original magnification, ×400.

titis is characterized by accumulations of neutrophils and small numbers of eosinophils in the epidermis, usually directly beneath the stratum corneum, resulting in small (1- to 2-mm) pustules (Fig. 80–3). Less commonly, transepidermal coagulative necrosis occurs in association with superficial neutrophil accumulations and colonies of bacterial cocci (*Staphylococcus* species). Dermal inflammatory reactions accompany these lesions. These lesions are similar to staphylococcal pyoderma in other species.[1] Most cases have resolved with appropriate topical or systemic antibiotic therapy.

Collagenolytic and Eosinophilic Diseases

NODULAR COLLAGEN DEGENERATION

Dermal collagen degeneration with dystrophic mineralization occurs alone or adjacent to chronic ulcers from other causes. The primary disease manifests as rapidly developing irregular plaques in the oral or nasal cavities or in the dermis. Histologically, the dermis contains discrete areas of collagen degeneration, usually with dystrophic mineralization and surrounded by aggregations of macrophages and inflammatory giant cells (Fig. 80–4). The overlying epidermis is unaffected. The cause of these lesions has not been determined, although similar lesions are seen in domestic dogs with hyperglucocorticoidism and in domestic horses with nodular collagenolytic granuloma, which are suspected to be caused by arthropod induced injury.[17] Collagen degeneration and mineralization also are a feature of eosinophilic granulomas in black rhinoceroses (see next section). Lesions of collagen degeneration have been successfully treated by excision, and untreated lesions have been described as eventually exuding chalky material.

EOSINOPHILIC DERMATITIS AND GRANULOMAS

Eosinophils are a common minor component of the dermal inflammatory response of black rhinoceroses, but in some cases eosinophilic infiltrates predominate. Eosinophilic dermatitis is usually accompanied by eosinophilic granulomas and ulcers, most of which are associated with collagenolysis and mineralization. Most eosinophilic granulomas and ulcers occur in the oral and nasal cavities and are similar to indolent ulcers in domestic cats.[1] No parasitic or fungal agents are associated with these lesions in captive rhinoceroses, whereas in wild black rhinoceroses, eosinophilic granulomas commonly develop during bouts of stephanofilariasis.[7]

Allergic and Arthus-Like Reactions

Some rhinoceroses have manifested acute skin lesions in response to vaccinations or systemic antibiotics. One animal had small vesicles or pustules over the entire body, whereas other rhinoceroses appeared to exude blood through the skin. The pathologic basis for the hemorrhagic responses has not been determined, although vascular injury is most likely. An Arthus-like reaction (dermal vascular necrosis, thrombosis, and epithelial necrosis) has occurred in association with ulcers in other rhinoceroses, although these animals had not recently undergone systemic treatments or vaccination. However, these Arthus-like lesions also occur with frostbite, which may indicate that they are not immune mediated.

Viral Skin Diseases

A poxvirus was isolated from a rhinoceros with vesicles and pustules in a European zoo,[3, 12, 13] but no poxviral lesions have been reported in other captive and wild populations. Pox-like intracytoplasmic inclusions have been noted in the keratinocytes of captive rhinoceroses in the United States with superficial necrolytic dermatopathy, but these inclusions were determined by electron microscopy and immunohistochemistry to be composed of keratin intermediate filament aggregates. An

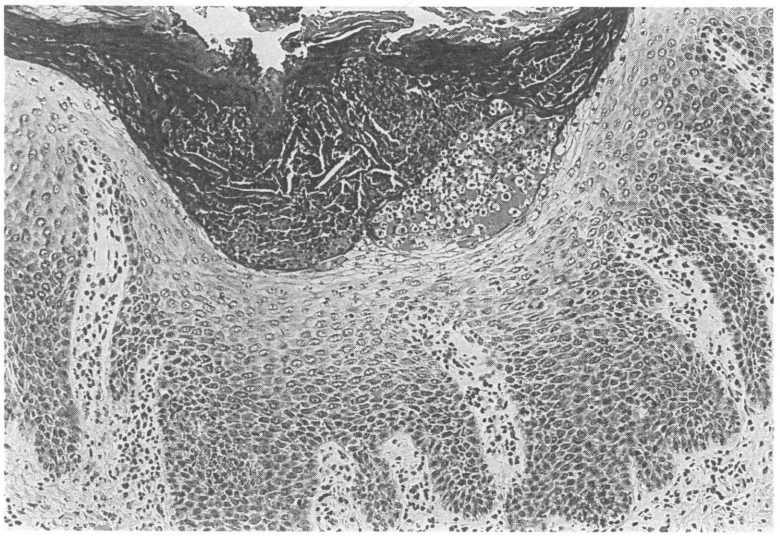

FIGURE 80–3. Black rhinoceros skin with superficial pustular dermatitis. A subcorneal pustule is present in a hyperplastic epidermis. Hematoxylin and eosin stain; original magnification, ×1000.

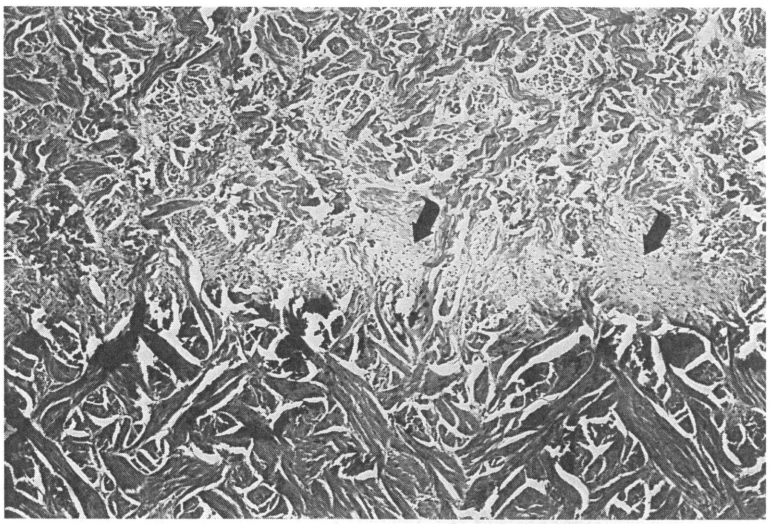

FIGURE 80–4. Black rhinoceros skin with nodular collagen degeneration. Discrete areas of degenerate and mineralized collagen in the reticular dermis are surrounded by macrophages and giant cells (*arrows*). Hematoxylin and eosin stain; original magnification, ×400.

epitheliotropic herpesvirus also has been reported in a black rhinoceros in Germany with ulcers,[8] but no herpes virus has been detected in any U.S. or wild rhinoceroses to date.

Stephanofilariasis in Wild Black Rhinoceroses

None of the aforementioned syndromes have been identified in free-ranging black rhinoceroses. However, skin ulcers associated with dermal *S. dinniki* infestations are common in southern and eastern African black rhinoceroses.[4, 7, 9, 14–16] Ulcers occur primarily on the ventral aspect of the neck and on the lateral aspect of the thorax, particularly behind the shoulder and on the back, abdomen, and forelimbs. The lesions are seasonal (occurring primarily during the summer and resolving in winter) and are markedly erythematous and pruritic,[15] in contrast to the ulcers caused by superficial necrolytic dermatopathy. Chronic ulcers from stephanofilariasis develop thick beds of granulation tissue and have marked dermal inflammatory infiltrates of eosinophils, histiocytes, inflammatory giant cells, and lymphocytes.[7, 15, 16] Stephanofilarial microfilaria and mature filarial nematodes can be identified in most lesions. Stephanofilarial dermatitis has not been identified in captive rhinoceroses, except for two cases in wild-caught rhinoceroses.[4] Transmission to other rhinoceroses in nonendemic regions is unlikely because the appropriate insect vectors[14] are not present, and anthelmintic treatments during quarantine should eliminate current infections.

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