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Clinical Approach to Dermatologic Disease in Exotic Animals

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KEYWORDS

• Exotic animal dermatology • Reptile dermatology • Avian dermatology
• Fish dermatology • Small mammal dermatology

KEY POINTS

- Skin disease is an extremely common presenting complaint to the exotic animal practitioner.
- Skin disease cases may be challenging because dermatologic diseases are often multifactorial and many have underlying husbandry or environmental deficiencies that must be identified.
- A thorough diagnostic evaluation is critical for successful management of exotic animal cutaneous disease.

INTRODUCTION

Skin disease is an extremely common presenting complaint to the exotic animal practitioner. A systematic diagnostic approach is necessary in these cases to achieve the appropriate diagnosis and formulate an effective treatment plan. In all exotic species, husbandry plays a central role in the pathogenesis of cutaneous disease, so a thorough evaluation of the husbandry is critical for successful management. There are vast differences in the structure and function of the skin in exotic species; an understanding of these unique properties is important when treating skin disease in exotic pets. This article focuses on the clinical approach to skin disease in exotic pets including structure and function of the skin, appropriate diagnostic testing, and differential diagnoses for commonly encountered cutaneous diseases.

REPTILES

Cutaneous disease is common in reptiles, is often multifactorial, and is most often secondary to husbandry and environmental deficiencies. A recent retrospective

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study of dermatologic lesions in reptiles found that from 29% to 64% (dependent on institution and reptile group) of the cases had underlying husbandry-related deficiencies.[1]

Skin Structure and Function

Reptile skin is modified into scales and composed of a three-layered epidermis and a dermis that typically is aglandular.[2–4] The three layers of the epidermis are (1) stratum corneum (six to eight cell layers, heavily keratinized); (2) stratum intermedium; and (3) stratum germinativum (deepest).[2–4] Two types of keratins compose the stratum corneum.[4] The softer more flexible α-keratins are elastic and pliable and form the suture/hinges and spaces between scales.[4] The β-keratins (unique to birds and reptiles) compose the hard horny scale.[4] The skin is protected by scales produced by the stratum germinativum; scales are separated by scale pockets.[2] The keratinized layers of chelonians are modified into scutes.[5] The scales or scutes of chelonians and some lizards (plated and girdled lizards, skinks, and crocodilians) are underlain by dermal bony plates referred to as osteoderms or osteoscutes.[2–5] In tortoises, the stratum corneum produces the shell, which consists of the carapace (dorsal) and plastron (ventral); the keratinized scutes cover osteoderms that fuse with the vertebrae and sternebrae.[2–4] Chromatophores (pigment cells) are found in the dermis and melanocytes are present within the stratum germinativum.[3] Reptiles shed their skin at regular intervals in a process called ecdysis. The skin of lizards and chelonians shed in several smaller pieces, whereas snakes typically shed their entire skin as one piece.[4] Chelonians and crocodilians shed their epidermis continuously, whereas lizards and snakes shed their epidermis periodically.[5]

Dermatologic Examination and Diagnostic Testing

A detailed clinical history is important in all cases of reptile skin disease; important husbandry-related questions include those pertaining to diet, substrate and housing, lighting, heating, humidity, and temperature.

Common findings during clinical examination of reptiles with dermatologic disease include abrasions, erosions, ulcers, wounds, swellings, pustules, blisters/vesicles/bullae, crusts, dysecdysis, petechial and ecchymoses, discoloration, macroparasites, and edema. In some cases, cutaneous changes can be secondary to systemic disease; petechia and ecchymoses are commonly seen with septicemia and ventral edema may be seen with renal or liver disease.[3] In one study, 47% of all reptiles with confirmed or suspected cases of sepsis had petechiae, with the highest association seen in chelonians (82%).[1]

Commonly used dermatologic diagnostic tests in reptiles include the following[2–5]:

1. Skin cytology and impression smears
2. Acetate tape impression
   - Press clear tape against skin and evaluate microscopically
   - Useful to diagnose mites
3. Skin scrapings
   - Typically use number 15 scalpel blade to collect epidermal samples
4. Microscopic evaluation of shed skin fragments
   - Findings may include mites
5. Skin biopsies for dermatopathology
6. Skin cultures
   - Bacterial, fungal
7. Fine-needle aspirate

- Most useful for swellings and growths

8. Clinicopathologic evaluation including complete blood count (CBC) and biochemistry analysis
9. Radiographs are useful when assessing damaged osteoderms and for the presence of bony changes associated with secondary nutritional hyperparathyroidism or other internal disease

Common Differential Diagnoses for Cutaneous Diseases

See **Table 1** for a review of common differential diagnoses for dermatologic diseases in reptiles, including bacterial dermatitis, shell rot, bacterial ulcerative dermatitis, snake mite, and secondary nutritional hyperparathyroidism (**Figs. 1–5**).

AMPHIBIANS

The thin, relatively unprotected skin of amphibians combined with the significant diversity of amphibian habitats and their biphasic life cycles render them particularly susceptible to a wide range of infectious and noninfectious cutaneous diseases.

Skin Structure and Function

Amphibians belong to three distinct Orders: Anura (frogs); Caudata (salamanders); and Gymnophiona (caecilians). The skin of amphibians is clinically the most important organ system of amphibians and varies depending on the life stage (premetamorphosis or postmetamorphosis); habitat (generally divided into aquatic or terrestrial); and the species.[6] The skin functions in osmoregulation, gas respiration, and water absorption.[6,7] Amphibian epidermis is typically thin; keratinized; and consists of the stratum corneum, stratum granulosum, stratum spinosum, and the stratum basale.[7–11] Modifications of amphibian skin include the presence of dermal scales (caecilians); folds and grooves for increased surface area (salamanders); partial ossification of the cranial skin and adherence to the skull (bufonids); a specialized highly vascularized ventral dermal organ for water absorption ("drinking patch" in anurans); and the presence of dermal bones (some anurans).[10,12] The stratum corneum is typically shed in one piece at regular intervals and consumed (dermatophagy) unless the animal is ill.[6,11,13] The skin of anurans is loosely adhered to the body and can become edematous in disease states.[11] Two key features separate adult caecilians and anurans from their larval form: the epidermis is keratinized in adults and the dermis contains a variety of dermal glands.[7,9,11] Mucus, produced by mucous glands and epithelial cells, aids in respiration, prevents evaporative water loss, contains antibacterial and antifungal properties, can be defensive noxious or contain toxic chemicals, may act as pheromones, and can aid in reproduction.[12,14–17]

Dermatologic Examination and Diagnostic Testing

A thorough history and dermatologic examination are important when evaluating any case of amphibian skin disease. Husbandry-related factors often underlie the development of many skin diseases in amphibians. Important questions to consider include recent introductions into the collection; diet; and tank setup including filtration, aeration, water quality, and temperature. During examination, it is important to always handle amphibians with rinsed gloves to avoid damaging their skin and prevent cutaneous absorption of potentially toxic glandular secretions.[18–20] Many amphibian skin diseases can have a similar appearance with cutaneous hyperemia and discoloration, dermal papules and nodules, ulceration, hemorrhages, edema, and excess mucus being the most common findings.[21]

Table 1
Differential diagnoses for cutaneous diseases in reptiles

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis
Bacterial			
Bacterial dermatitis[a–f] (see **Fig. 1**)	Often secondary to environmental/husbandry deficiencies or trauma Gram-negative environmental bacteria often act as opportunistic pathogens in these cases Various isolates including *Aeromonas*; *Pseudomonas*; *Citrobacter*; *Escherichia coli*; *Klebsiella*; *Proteus*; *Salmonella*; *Serratia*; *Flavobacterium*; *Staphylococcus*; *Streptococcus*; *Morganella*; *Neisseria*; *Dermatophilus congolensis*; *Mycobacterium*; and anaerobes, such as *Bacteroides*, *Fusobacterium*, and *Clostridium*	Moist, exudative, and erythematous, but may also appear as blisters, crusts, and ulcerations of the integument	Clinical signs, impression cytology, and culture/sensitivity
Shell rot[a,c,e] (see **Fig. 2**)	Most common isolates include *Beneckea chitinovora*, *Citrobacter* spp, and *Aeromonas*	Most common bacterial infection in chelonians, ulcers of the shell, often rimmed by areas of hyperpigmentation; loose scutes may be present and lesions can progress to osteomyelitis	Clinical signs, impression cytology, and culture/sensitivity
Septic cutaneous ulcerative disease[a,d]	Disease syndrome in aquatic turtles maintained in poor-quality water *Citrobacter freundii* is most commonly implicated but other gram-negative bacteria may be isolated	Craterifom ulcers on the shell and skin with septicemia and systemic signs	Clinical signs, impression cytology, and culture/sensitivity
Blister disease[a–f] (see **Fig. 3**)	Often associated with moist, dirty substrate or inappropriately humid environments *Aeromonas* and *Pseudomonas* are the most common clinical isolates	Lesions typically start on the ventrum as vesicles and pustules that progress to ulceration, necrosis, and abscessation; secondary septicemia is possible; most commonly seen in snakes	Clinical signs, impression cytology, and culture/sensitivity

Abscesses[a–f]	Common isolates include *Pseudomonas* spp, *Proteus* spp, *Aeromonas* spp, *Serratia* spp, *Providencia* spp, *E coli*, *Citrobacter*, *Proteus*, *Salmonella*, *Streptococcus*, *Corynebacterium pyogenes*, and *Neisseria*	Localized soft to firm, usually nonpainful swellings that have well-defined capsules; because reptile leukocytes lack the isoenzymes to liquefy pus, a thick caseous exudate is often present	Clinical signs, fine-needle aspirate, culture/sensitivity, histopathology
Ectoparasites			
Chiggers[a–f]	Family Trombiculidae	Ingest lymph and dissolved host tissue; zoonotic, skin irritation, pruritus, irregular shedding cycles; mites are most commonly found under scales and around nostrils, eyes, and gular fold (snakes)	Direct observation, microscopic identification
Mites[a–f] (see **Fig. 4**)	Family Macronyssidae; including *Ophionyssus natricis* (commonly seen in snakes) and *Ophinonyssus acertinus* (common in lizards)	Feed on blood; skin irritation, pruritus, irregular shedding cycles, and anemia in severe infestations mites are most commonly found under scales and around nostrils, eyes, and gular fold (snakes)	Direct observation, microscopic identification
Leeches[b]	Various species	Skin irritation at site of attachment, anemia with severe infestation	Direct observation
Fungal			
Fungal dermatitis[a–f]	Often secondary to environmental/husbandry deficiencies and immunosuppression Reported isolates are often opportunistic pathogens including *Aspergillus*, *Basidobolus*, *Geotrichium*, *Mucor*, *Saprolegnia* and *Candida*, *Fusarium*, *Trichosporon*, *Trichoderma*, *Penicillium*, *Paecilomyces*, *Oospora*, and *Trichophyton*	Superficial infections present as moist, exudative erythematous ulcers or blisters, with crusts or hyperkeratotic lesions Deeper infections often present as nodules/swellings, systemic signs may be present with deeper/systemic infections	Impression smears, fungal culture, histopathology

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Table 1
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Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis
Yellow fungus disease[e,f]	*Chrysosporium* anamorph of *Nannizziopsis vriesii*	Seen most commonly in lizards (especially the bearded dragon, *Pogona vitticeps*) Deep, granulomatous dermatomycosis that is contagious and progressive, severe yellowish hyperkeratotic skin lesions, often fatal	Fungal culture, histopathology, PCR
Cheilitis in spiny tail lizards (*Uromastyx* sp)[f]	*Devriesea agamarum*	Cheilitis	Fungal culture, histopathology
Viral			
Green turtle fibropapillomas[d,f]	Herpesvirus	Papillomatous growths affected soft tissues	Histopathology
Neoplasia			
Cutaneous neoplasia[a,b]	Reported types include squamous cell carcinoma, fibrosarcoma, myxomatous tumors, lipoma/liposarcoma, melanoma, chromatophoromas	Cutaneous growths	Histopathology
Husbandry-related/multifactorial/miscellaneous			
Dysecdysis[c] (see **Fig. 3**)	Dysecdysis is almost always a result of deficiencies in husbandry and inappropriate environmental conditions including temperature and humidity	More commonly seen in snakes and some lizards than in chelonians; in lizards and turtles, most commonly affects the digits; in snakes, can be localized or generalized; localized dysecdysis commonly affects the spectacles and retention of this scale can result in other ocular abnormalities, such as subspectacular bullae and abscesses	

Secondary nutritional hyperparathyroidism (see **Fig. 5**)	Multifactorial: severe imbalance of the Ca:P ration in the diet, no access to a full spectrum (ultraviolet B) light source, and a lack of activated vitamin D_3; other inappropriate husbandry-related factors	Seen more commonly in lizards and chelonians abnormal bones and shells and chronic abscesses especially around jaw	History, clinical signs, radiographs, serum phosphorus, ionized calcium levels
Trauma	Injuries from prey-induced trauma, with rodents being responsible for most cases; trauma from other household pets is also not uncommon	Damaged skin, ulcers, erosions	History and clinical signs
Burns	Burns most commonly result from malfunctioning, malpositioned, or inappropriate heating elements or inactivity of the animal	More frequent in lizards and snakes; discolored, ulcerated and sloughed areas of skin	History and clinical signs, histopathology
Hypovitaminosis A[a–d]	Dietary deficiency of vitamin A results in squamous metaplasia and epidermal hyperkeratosis	Abnormal shedding Most commonly affects lizards and chelonians Lizards: dysecdysis, impaction/abscessation of cutaneous glands Chelonians: dysecdysis, chemosis/ blepharedema and aural abscessation. most common cutaneous changes include hyperkeratosis, dysecdysis, scute loss, and thickened/lichenified skin	History and clinical signs

[a] Hoppmann E, Barron HW. Dermatology in reptiles. J Exot Pet Med 2007;16(4):210–24.
[b] Goodman G. Dermatology of reptiles. In: Patterson S, editor. Skin diseases of exotic pets. Ames (IA): Blackwell; 2006. p. 73–118.
[c] Johnston MS. Scales and sheds: the ins and outs of reptile skin disease. In: Proceedings North American Veterinary Dermatology Forum. Denver (CO): 2008. p. 62–6.
[d] Mitchell M, Colombini S. Reptiles. In: Foster A, Foil C, editors. BSAVA manual of small animal dermatology. Gloucester (England): BSAVA; 2003. p. 269–75.
[e] Hat JM. Dermatologic problems in reptiles. In: Proceedings of the World Small Animal Veterinary Association World Congress. Geneva (Switzerland): 2010.
[f] Mader D. Reptile dermatology. In: Proceedings of the Atlantic Coast Veterinary Conference. Atlantic City (NJ): 2011.

Fig. 1. Bacterial dermatitis on the dorsolateral neck of a green iguana (*Iguana iguana*).

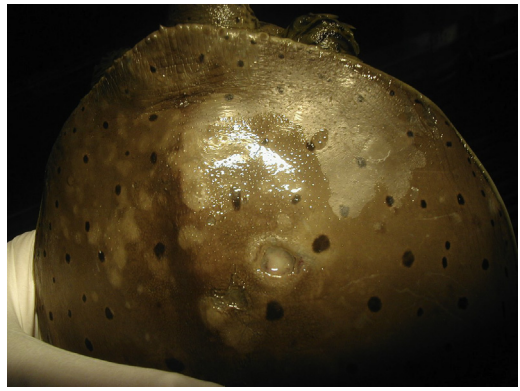

Fig. 2. Shell rot in a softshell turtle (*Apalone* sp). Note crateriform ulcers on the carapace.

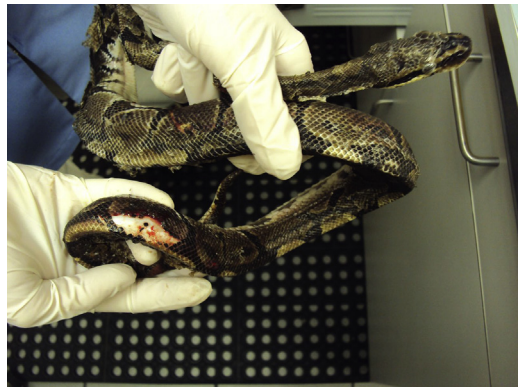

Fig. 3. Ball python (*Python regius*) with bacterial ulcerative dermatitis (blister disease) and dysecdysis. Note ulcerative skin lesions, retained skin, and spectacles.

Fig. 4. Snake mite (*Ophionyssus natricis*).

Commonly used dermatologic diagnostic tests in amphibians include the following:

1. Skin scraping[8,10,13]
   - Using a coverslip, blunt scalpel blade, or edge of a glass slide, gently scrape over the surface of the skin
   - Samples taken from lesions may be more diagnostic
   - Place the sample on a slide
   - If needed, wet the slide with physiologic saline for a wet mount preparation
   - Examine immediately using lowest power objective first
   - Shed skin can also be examined as a wet mount preparation
   - Samples can also be dried and stained for later examination
2. Impression or swab smears, fine-needle aspirates[6,8,13]
   - Typically these samples are air dried and stained
   - Less traumatic than skin scrapings
3. Bacterial culture[10,13,22,23]

Fig. 5. Abnormal shell in a leopard tortoise with secondary nutritional hyperparathyroidism.

- Gentle irrigation of the lesion with sterile physiologic saline or getting a deep sample can reduce contamination of normal surface microflora and environmental bacteria
- Dermal glandular secretions and normal microflora may inhibit bacterial growth because of antibacterial properties
- Swabs can be moistened with sterile saline or transport media to minimize skin damage and maximize recovery of bacteria
- Optimal temperature for sample growth is 35°C/95°F
- Most isolates are gram-negative bacteria but gram-positive and mycobacterial infections also occur

4. Fungal cultures[24,25]
   - Tissue sections can be placed directly onto fungal culture media
   - Sabouraud dextrose agar media is a good choice for most fungal isolates
   - Culture at room temperature
5. Polymerase chain reaction (PCR) of skin swabs[26–29]
   - Consult laboratory for availability; verification of positive results; type of PCR (conventional, Taqman, real-time, and so forth); use of negative and positive controls; sample collection and swab type; and shipping details
   - Avoid cross-contamination
   - Available test for identifying of subclinical carriers of *Batrachochytrium dendrobatidis*
     - Test of choice for screening new animals, detection of subclinical infections, and confirmation of positive cytologic examinations
     - False-negatives can occur with low-level subclinical infections
     - Skin swabs are preferred sample
     - Three swabs taken at various times over 14 days increases chance of identification
     - Tadpole samples are taken from mouthparts (keratinized area)
     - Can be expensive
   - Ranavirus PCR
     - Frozen tissue, biopsy of skin lesion
   - Chlamydophilosis PCR
   - Flavobacteriosis PCR
   - Mycobacteriosis PCR
     - Reliability of results for amphibians is unknown
6. Histopathology

Common Differential Diagnoses for Cutaneous Diseases

See **Table 2** for a review of common differential diagnoses for dermatologic diseases in amphibians.

FISH

Cutaneous disease is an extremely common presenting complaint to the fish veterinarian. Many owners notice abnormalities in the integumentary system as the first sign of disease in their pet fish. In addition, the skin is an extremely common target for many infectious diseases of ornamental fish. The skin of fish provides a protective barrier against infection, osmotic pressure, and injury. Disruptions of the skin can result in osmotic disturbance, disruption of internal homeostasis, morbidity, and mortality.

Table 2
Differential diagnoses for cutaneous diseases in amphibians

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Parasitic				
Protozoal	*Trichodina* sp, *Epistylis*-like ciliates, *Piscinoodinum*, *Ichthyosporidium*, *Dermocystidium*, *Tetrahymena*, *Vorticella*, *Ichthyobodo*	Increased mucus, discoloration, cloudy skin patches, ulcers, secondary skin infection, pruritus	Skin cytology, skin scrapings, histopathology	Trichodinids are typically associated with poor water quality, low numbers may be commensal/ nonpathogenic
Nematodes	*Pseudocapillaroides xenopi*; capillarid nematodes that live in tunnels in epidermis of *Xenopus laevis*	Weight loss, lethargy, skin roughness and ulceration particularly over the dorsum, secondary bacterial and fungal infections	Skin scrapings, histopathology	
Trematodes	*Clinostomum*, *Cathaemasia*	Cutaneous, yellow nodules	Identification of encysted parasite	Typically not pathogenic
	Neascus sp	Nodular cysts on lateral line (*Xenopus* sp)	Identification of encysted parasite	Typically nonpathogenic, but heavy infestation can be fatal
	Riberia ondatrae	Limb deformities (usually hind limbs but can affect all)	Histopathology	Damage occurs because of disruption of limb formation in larval stage, usually frogs farmed or housed outdoors with exposure to snails (intermediate hosts)
Arthropods	*Argulus* sp	Secondary infections, ulcers	Direct observation	Infest aquatic life stages
	Lernaea sp	Secondary infections, ulcers	Direct observation	Infest aquatic life stages
Leeches	Various species	Secondary infections, open wounds	Direct observation	Can transmit *Ichthyophonus* sp–like organism

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Table 2
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Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Trombiculid mites	Various species	Red-orange vesicular lesions, cutaneous cysts	Microscopic identification	Larval stage only; adults live in the environment also known as "chiggers"
Ticks	Various species	Focal irritation, hemorrhage	Direct observation	
Fly larvae (myiasis)	Sarcophagidae, Calliphoridae, Chloropidae species larvae	Ulcers, secondary infections, erythema, deep wounds	Direct observation, histopathology	
Bacterial				
Red leg syndrome (bacterial dermatosepticemia)	Bacterial septicemia in amphibians often presents as reddening of skin on ventrum and hindlegs; can be secondary to environmental stressors; most commonly gram-negative pathogens (*Aeromonas hydrophila*, other) but gram-positive reported	Erythematous hemorrhagic skin, usually ventrally and on extremities, nodules/abscesses, edema, erosions, ulcers, skin sloughing	Clinical signs, culture, histopathology	
Flavobacteriosis ("edema syndrome")	*Flavobacterium* spp	Generalized edema, hydrocoelom, cutaneous hemorrhages	Bacterial culture, PCR	
Mycobacteriosis	*Mycobacterium* spp	Cutaneous nodules	Stained impression smears, histopathology, culture and identification, PCR	
Chlamydophilosis	*Chlamydophila* sp	Reported in *Xenopus laevis* Cutaneous petechia and ulceration with edema	Culture, histopathology	

Viral	Ranavirus (an iridovirus)	Edema, red leg syndrome, pale, raised foci, erythema and swelling near gills and hind limbs, cutaneous erosions and ulcers, secondary bacterial infection; thick mucus, cutaneous white polyps and hemorrhage (salamanders); tadpole edema virus infection in larval stages of anurans	Clinical signs, histopathology, PCR, virus isolation, transmission electron microscopy	
Fungal				
Chytrid	*Batrochochytrium dendrobatis* (chytrid)	Systemic signs (lethargy, anorexia); skin sloughing; color changes; ventral edema and petechiae; mortalities related to osmoregulatory stresses	Cytologic examination of skin scrape, shed skin, PCR, histopathology	Colonizes keratinized skin only, the only keratinized area in larval stages are mouthparts so subclinical infections can occur (can break with clinical disease after metamorphosis); more than 400 amphibian species susceptible; higher incidence in winter months in wild populations
Pigmented fungi	Many species including *Phialophora*, *Fonsecaea*, *Hormodendrum*, *Cladosporium*; fungi found in soil, enter through skin lesions, stress predisposes to infection	Papular and ulcerative skin lesions, nodules, systemic signs	Histopathology, culture	

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Table 2
(*continued*)

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Water molds	*Saprolegnia*, *Aphanomyces*; opportunistic, usually secondary to trauma, immunosuppression, severe physical stress, poor water quality	Focal lesions typically, white to tan cottony growth over ulcers or erosions	Stained impression smears, wet mount impression smears or skin scrape, culture, histopathology	
Noninfectious diseases				
Nutritional				
Metabolic bone disease		Subcutaneous edema, scoliosis, mandibular deformity, postural abnormalities, fractures, tetany, bloating, prolapse	History, clinical signs, radiographs	
Husbandry-related				
Gas bubble disease	Water supersaturated with oxygen	Gas bubbles in skin especially toe webbing, eyes; erythema and hemorrhage of the skin, mortality	Direct observation of gas bubbles in tissues	
Acidic or alkaline environment	Increased or decreased pH (water, soil)	Excess mucus production, skin irritation and ulceration, erythema, respiratory and systemic symptoms	Check pH of environment	
Elevated water hardness	Increased water hardness	Skin lesions seen in some species of caecilians	Test water hardness	

Ammonia toxicity	Elevated ammonia	Increased mucus production, color changes, erythema, skin sloughing, dyspnea, neurologic signs, secondary infections	Test ammonia levels	Less toxic at lower pH, caution when changing water to prevent overall pH increases (favors more toxic unionized ammonia)
Lead toxicity	Lead (plumbing fixtures, décor)	Epidermal sloughing, postural abnormalities, muscular twitching, lethargy, death	Lead levels in tissues	
Rostral abrasions	Shipping, jumping in startled animals, iatrogenic handling, cagemate aggression, live prey items, inappropriate cage	Abrasion of the rostrum, color changes, secondary infections, atrophy of rostrum	History, observation	Usually secondary to nervous, easily startled animals. Buffer panels/coating rough surfaces inside enclosure may help reduce incidence
Neoplasia	Many including squamous cell carcinoma, adenomas, papillomas, chondromas	Masses (focal or diffuse), color changes, secondary infections	Histopathology	

Data from Refs.[7,22,26–29,38,39]

Skin Structure and Function

The skin can be divided histologically into the cuticle, epidermis, dermis, and subcutis. The cuticle (outermost layer) is approximately 1 μm thick and contains mucus, sloughed cells, and cellular debris. It has antimicrobial properties mediated by antibodies (IgM), free fatty acids, and lysozymes.[30,31] This layer is commonly referred to as the "slime coat" by aquarium hobbyists because of its high concentration of mucus. This layer is usually lost during routine processing for histopathology. Together with the cuticle, the epidermis produces a waterproof barrier. The epidermis is a nonkeratinizing (most species) stratified squamous epithelium that contains 3 to 20 cell layers.[30,31] It contains many mucus-producing goblet cells and, in some species, club cells that secrete an "alarm substance" when the skin is damaged. Unlike mammals, epidermal cells are not keratinized and are capable of mitotic division in all layers; however, division most commonly occurs in cells adjacent to the basement membrane where the epidermis junctions with the dermis.[30,31] The upper dermis contains collagen and reticulin and forms a supportive network; the deeper dermis contains more compact collagen and provides the main structural strength to the skin.[30,31] Scales are flexible bony plates that develop in scale pockets in the dermis; they are not shed regularly.[30,31] As scales emerge they are covered by a layer of epidermis, and often overlap one another, providing structural support and protection. Two main types (ctenoid and cycloid scales) are described that differ in surface sculpture.[30,31] Ultrastructurally, scales contain collagen fibers interspersed with an organic matrix in which hydroxyapatite crystals are deposited.[30,31] Some fish are scaleless and histologically have a thicker epidermis. Chromatophores (pigment cells) are present in the dermis and include melanophores; xanthophores (yellow); erythrophores (orange-red); leucophores (white); and iridophores (reflective/iridescent/silver). The pigments consist mainly of carotenoids. The subcutis contains connective tissue and fat and is highly vascular; bacterial disease can spread rapidly along this layer.[30,31]

Dermatologic Examination and Diagnostic Testing

The diagnostic approach to a fish with dermatologic disease should include a complete history, direct observation of the fish in its aquarium or pond, dermatologic examination, complete water quality, skin scrapings, and a gill biopsy.

As with other species, historical evaluation is extremely important. Because infectious disease is very common in pet fish, questions pertaining to quarantine protocol, most recent fish introduction, and number of fish affected are extremely important. Husbandry-related questions (water changes, filtration, tank or pond setup, water quality testing, and so forth) are extremely important because many diseases in fish are related to poor husbandry and water quality. The owner should be questioned regarding prior treatments because many fish hobbyists attempt numerous over-the-counter remedies before consulting with a veterinarian.

Direct observation is best performed in the home aquarium or pond. Isolation is often an early indication of disease in schooling fish. Other signs that can be seen during direct observation include piping (gasping for air at the surface) and flashing (a sign of pruritus in which the fish rubs against objects in the aquarium or pond). The skin and fins can also be evaluated for abnormalities.

During the dermatologic examination, the skin, fins, and scales should be evaluated thoroughly. Some fish require sedation for this procedure. Latex gloves should be worn to protect the cuticle. Abnormalities that are commonly seen on the dermatologic examination include skin discolorations; erythema; frayed and irregular fins; erosions

and ulcerations; petechial and ecchymoses; edema and raised scales; macroparasites (anchor worm, fish lice); papules and nodules; excess mucus production; scale loss; and white-to-gray irregular patches.[30]

Commonly used dermatologic diagnostic tests in fish include the following:

1. Water quality evaluation
   a. Poor water quality is the most common cause of morbidity and mortality in pet fish
   b. Poor water quality is the most common underlying cause of immunosuppression and opportunistic infections in pet fish
   c. Parameters that should be monitored include temperature, pH, ammonia, salinity, nitrite, nitrate, dissolved oxygen, and alkalinity[3]
2. Skin scrapings and gill biopsy
   a. Skin scrapings
      i. If there are lesions on the skin, a coverslip should be dragged across lesional skin in a head-to-tail direction, collecting mucus on the coverslip. The coverslip is then placed onto a slide with a drop of tank water. Some fish require sedation for this procedure. Sedation may reduce the number of ectoparasites found on skin scrapings.
      ii. When there are no obvious lesions on the skin, sites commonly sampled include just caudal to the pectoral fin, operculum, and the ventrum. Samples should be taken from two to three different sites; when possible, several fish should be sampled.
   b. Gill biopsy
      i. Gill is epithelial tissue and many ectoparasites affect the gills and skin. Occasionally, ectoparasites are found only on the gills.
      ii. Typically requires sedation
      iii. The operculum is lifted and a small snip of distal gill lamellae is taken (usually with iris scissors) and placed onto a slide with a drop of tank or pond water to examine.
   c. Skin scrapings and gill biopsies are examined under the microscope; superior results are obtained with the condenser down. Most parasites can be seen on $\times 4$ or $\times 10$ magnification. However, with some smaller parasites, such as *Ichythobodo*, and bacteria, such as *Flavobacterium columnare*, $\times 40$ magnification is required.
3. Bacterial culture and sensitivity
   a. Tissue biopsy for culture sampling is preferred over superficial swabbing of ulcerative lesions
4. Histopathology
5. Clinical pathology (complete blood count, biochemistry panel)
6. Viral testing
   a. Koi herpes virus serology and PCR
7. Necropsy

Common Differential Diagnoses for Cutaneous Diseases

See **Table 3** for a review of common differential diagnoses for dermatologic diseases in fish, including *Gyrodactylus* and ulcerative bacterial dermatitis (**Figs. 6** and **7**).

AVIAN

Cutaneous disease is extremely common in pet birds; assessing the skin can be difficult given the variation in species presenting to the avian practitioner. Avian

Table 3
Differential diagnoses for cutaneous diseases in fish

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis
Ectoparasties			
Ciliated protozoans			
"Ich," white-spot disease[a]	*Ichthyophthirius multifiliis* (freshwater), *Cryptocaryon irritans* (marine)	Punctate white nodules (up to 1 mm in size) on the skin/fins caused by the encysted trophont feeding stage, increased mucus, flashing, respiratory symptoms	Skin scrapings, gill biopsy
	Chilodonella (freshwater), *Brookynella* (marine)[a]	Erythema, scale loss, white-to-gray irregular patches, hemorrhages, discolorations, flashing, excessive mucus production, respiratory symptoms	Skin scrapings, gill biopsy
Guppy killer disease[a]	*Tetrahymena* (freshwater), *Uronema* (marine)	Erythema, scale loss, white-to-gray irregular patches, hemorrhages, discolorations, flashing, excessive mucus production, respiratory symptoms; common in guppies (*Poecilia reticulata*)	Skin scrapings, gill biopsy
Sessile ciliates[a]	*Epistylis, Ambiphyra* (*Scyphidia*), *Apiosoma* (*Glossatella*)	Erythema, scale loss, white-to-gray irregular patches, hemorrhages, discolorations, flashing, excessive mucus production, respiratory symptoms	Skin scrapings, gill biopsy
Flagellated protozoans			
	Ichthyobodo (*Costia*)[a]	Erythema, scale loss, white-to-gray irregular patches, hemorrhages, discolorations, flashing, excessive mucus production, respiratory symptoms	Skin scrapings, gill biopsy
Freshwater and marine velvet[a]	*Piscinoodinium* (*Oodinium*) (freshwater), *Amyloodinium* (marine)	Amber or gold dust–like sheen to the skin, excess mucus, respiratory symptoms	Skin scrapings, gill biopsy

Flukes[a] (see **Fig. 6**)	*Dactylogyrus*, *Gyrodactylus*	Erythema, scale loss, white-to-gray irregular patches, hemorrhages, discolorations, flashing, excessive mucus production, respiratory symptoms	Skin scrapings, gill biopsy
Capsalids[a]	*Benedenia*, *Neobenedenia*	Erythema, scale loss, white-to-gray irregular patches, hemorrhages, discolorations, flashing, excessive mucus production, respiratory symptoms	Skin scrapings, gill biopsy
Macroparasites (crustaceans)			
Anchor worm[a]	*Laernea*	Parasite visible on examination; long, and narrow parasite with anchor at one end and egg sacks at opposite end; erythema and ulceration at site of attachment	Direct observation, microscopic identification
Fish lice[a]	*Argulus*	Parasite visible on examination, erythema, excess mucus production, flashing	Direct observation, microscopic identification
Bacterial			
Columnaris disease[a,b]	*Flavobacterium columnare*	Cottony white proliferative lesions on the skin/fins; most commonly affects live bearers	Clinical signs, skin scrapings, bacterial culture
Koi ulcer disease[a,b] (see **Fig. 7**)	Multifactorial, often underlying husbandry issues and environmental stressors, secondary bacterial infection	Koi (*Cyprinus carpio*) with ulcerative skin lesions, often rimmed by annular hemorrhage	Clinical signs, bacterial culture
Mycobacteriosis[a,b]	*Mycobacterium* spp	Clinical signs include ulcerative skin lesions, reduced appetite, emaciation, lethargy, exophthalmia, swollen abdomen, and fin/tail rot. Mycobacteriosis is zoonotic and can cause "fish tank granuloma" in people	Clinical signs, identification of bacteria on acid-fast stains of histopathology, culture, PCR

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Table 3
(*continued*)

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis
Bacterial septicemia[a,b] (see Fig. 6)	*Aeromonas* and various other gram-negative isolates	Lethargy, anorexia, abnormal swimming patterns/spinning, hemorrhagic lesions on the skin, abdominal distension/ascites, abnormal position in the water column, exophthalmia, external ulcerative lesions, gill necrosis and mortality	Clinical signs, culture
Viral			
Lymphocystis[c]	*Lymphocystivirus*	Iridovirus that infects dermal fibroblasts causing them to swell up to 10,000 times results in whitish nodules, typically on the fins Common species of fish affected include freshwater glass fish, marine angelfish and clownfish	Wet mounts/skin scrapings with classic swollen dermal fibroblasts that appear like a cluster of grapes, histopathology
Carp pox[c]	Cyprinid herpesvirus 1	Affects koi (*Cyprinus carpio*), causing epidermal hyperplasia; results in papillomatous "candle-wax" appearing lesions that typically occur on the fins and skin in cooler water temperature (<68°F) during the winter and spring Progression to squamous cell carcinoma reported	Clinical signs, histopathology
Goldfish Herpesvirus[c]	Cyprinid herpesvirus 2	Affects goldfish (*Carassius auratus*), causing mortalities, lethargy, anorexia, and patchy pale areas of gill necrosis and skin lesions including cutaneous ulceration, sloughing of scales, increased mucus production, secondary bacterial/parasitic infections, and petechia/ecchymoses	Clinical signs, histopathology, PCR

Koi herpes virus[c]	Cyprinid herpesvirus 3	Massive mortality (80%–100%) in koi (*Cyprinus carpio*) Common cutaneous signs include cutaneous ulceration, sloughing of scales, decreased mucus production, secondary bacterial/parasitic infections, and petechia/ecchymoses All affected fish have gill necrosis and typically show respiratory signs, in addition to lethargy, weight loss, enophthalmos, and occasionally a notched appearance to the head between the eyes and nares	Clinical signs, histopathology, PCR, virus isolation
Neoplasia			
Cutaneous neoplasia	Various types including fibromas; fibrosarcoma; pigment cell tumors (melanoma, erythrophoroma) and tumors of neural origin (neurofibroma, neurofibrosarcoma, schwannoma, peripheral nerve sheath tumor); squamous cell carcinoma	Nodular growths	Histopathology
Husbandry-related			
Poor water quality	Various causes including overstocking, overfeeding, inadequate filtration or aeration, infrequent water changes	Skin changes including increased mucus production, erythema, erosions/ulceration, injected fins, flashing; behavioral changes, lethargy, anorexia, poor growth, secondary opportunistic infections, respiratory signs, gill hyperplasia, neurologic abnormalities and mortalities	Water quality evaluation (temperature, pH, ammonia, salinity, nitrite, nitrate, dissolved oxygen, and alkalinity)

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Table 3
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Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis
Gas supersaturation, gas bubble disease	Supersaturation of water caused by faulty equipment, sudden elevations in temperature, Venturi effect	Gas emboli formed in circulation and tissues; gas bubbles may be seen in eyes, on fins, gills, and under skin; behavioral abnormalities, positive buoyancy (small fish), death	Clinical signs, linear gas bubbles can be seen on fin clippings and gill biopsies
Idiopathic			
Head and lateral line erosion[d]	Multifactorial: proposed causes include hexamitid parasites; activated carbon/carbon dust; heavy metals, such as copper; stray electrical voltage; ozone; ultraviolet radiation products; poor nutrition; nutrient deficiencies of vitamins A and C and minerals; internal disease; and various other stressors	Freshwater cichlids (*Symphysodon* spp, *Astronotus ocellatus*, other South American cichlids) are commonly affected. Marine fish that are commonly affected include surgeonfishes and tangs (family Acanthuridae) and marine angelfish (family Pomacanthidae). Examination reveals often symmetric, depigmented erosions and ulcerations that coalesce to produce large crateriform lesions and pits on the head; may extend down the lateral line/flanks	Clinical signs, histopathology

[a] Roberts HR, Palmeiro BS, Weber SW. Bacterial and parasitic diseases of fish. Vet Clin North Am Exot Anim Pract 2009;12(3):609–38.
[b] Palmeiro BS. Bacterial diseases. In: Roberts HR, editor. Fundamentals of ornamental fish health. Ames (IA): Wiley-Blackwell; 2010. p. 125–36.
[c] Palmeiro BS, Weber SW. Viral pathogens of fish. In: Roberts HR, editor. Fundamentals of ornamental fish health. Ames (IA): Wiley-Blackwell; 2010. p. 112–24.
[d] Wildgoose W, Palmeiro BS. Specific syndromes and diseases. In: Roberts HR, editor. Fundamentals of ornamental fish health. Ames (IA): Wiley-Blackwell; 2010. p. 214–23.

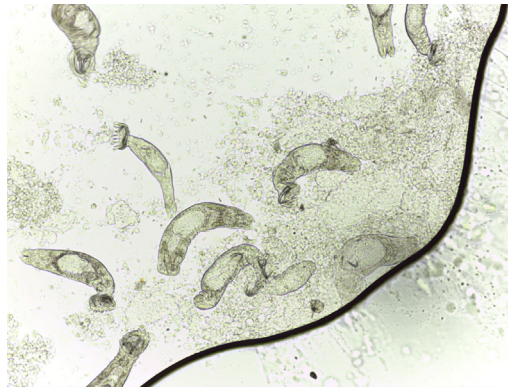

Fig. 6. *Gyrodactylus* sp (fluke) on a skin scraping from a goldfish (*Carassius auratus*).

dermatology cases can be complex and are often multifactorial; nutritional deficiencies, poor management, lack of exercise, and environmental stimulation and behavioral disorders frequently contribute to clinical disease.[32]

Skin Structure and Function

Avian skin is composed of an epidermis and dermis; the skin is thicker in nonfeathered areas. The layers of the epidermis include the stratum germinativum and the stratum corneum.[33] The stratum germinativum (bottom most layer) produces cells that mature to form the keratinized stratum corneum and can be divided into three distinct layers: (1) the stratum basale, (2) the stratum intermedium, and (3) the stratum transitivum. The cells show signs of keratinization in the stratum transitivum.[33] Feathers are formed from feather follicles in the dermis. The dermis is thicker than the epidermis and contains structurally supportive collagen, blood vessels, fat, nerves and neuroreceptors, feather follicles, and associated smooth muscle.[32,33] Avian skin is aglandular with the

Fig. 7. Ulcerative bacterial dermatitis in a koi (*Cyprinus carpio*). Note deep ulcerative lesion with exposed muscle and peripheral annular rim of hemorrhage. This koi also has secondary septicemia and hemorrhages on the skin and fins.

exception of the uropygial (or preen) glands; the pericloacal glands (secrete mucus); and the sebaceous glands of the ear canal.[32,33] The uropygial gland is a holocrine gland found at the base of the tail that secretes a liposebaceous material important in protecting and waterproofing feathers; it is spread through the feathers in a process called preening that is also necessary for interlocking of feather barbules.[32,33]

Feathers are arranged into tracts known as pterylae that are separated by featherless areas of skin called apteria.[32–34] **Table 4** illustrates the common feather types and their properties. The calamus is the part of the feather that attaches to the follicle.[32–34] The main shaft of the feather is called the rachis; where the rachis meets the calamus is a pulp cap referred to as the superior umbilicus.[32–34] There may be a smaller feather attached to the superior umbilicus that is referred to as the after feather.[32–34] Projections from the rachis are referred to as barbs, which bear projections called barbules.[32–34] Most barbules contain hooks called barbicels that hold the barbs and barbules together.[32–34] Molting occurs when the growth of a new feather in the follicle forces out the older feather; all feathers of adult birds are replaced regularly during molting. Most species of pet birds molt once to twice yearly.[32,33]

Dermatologic Examination and Diagnostic Testing

A thorough history and dermatologic examination are important when evaluating any case of avian skin disease. Dermatologic examination in birds should include evaluation of feathers, skin, beak and cere, ears, legs and claws, preen gland, and cloaca.

Table 4
Feather types

Feather Type	Feather Properties
Natal down	Initial feather covering usually present at time of hatching
Juvenile feathers	Smaller and narrower than adult feathers, replace natal down feathers
Feather sheath	Cover feathers as they grow from feather follicle. Typically ruptures and releases barbs
Contour feathers	Predominant adult feather; main type present on wings and body
Remiges	Flight feathers of wings; divided into primary remiges (attach to metacarpus) and secondary remiges (attach to ulna) Typically there are 10 primary feathers and up to 14 secondary feathers per wing
Rectrices	Flight feathers on tail
Coverts	Feathers that cover the bases of remiges and rectrices
Down	Fine feathers that lack barbules on the barbs
Filoplume	Close to the follicle of each contour feather, fine hairlike feathers
Bristle	Few or no barbs and very stiff rachis; found at base of beak and around eyes
Powder down	Specialized down feathers that disintegrate to produce fine granules of keratin that waterproof feathers
Semiplume	Large rachis with fluffy vane; present under contour feathers, important in insulation
After feathers (hypopenae)	Smaller feather attached to the superior umbilicus

Data from Refs.[32–34]

Table 5
Differential diagnoses for cutaneous diseases in pet birds

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis
Parasitic			
Scaly leg/beak mite[a,b]	*Cnemidocoptes* spp	Hyperkeratosis and crusting (often honey combed) of the cere/beak, face, legs and feet; common in Budgerigars	Skin scraping
Red mite[a,b]	*Dermanyssus gallinae*	Some cases asymptomatic, papular eruption, anemia, overpreening	Can be difficult because mite lives off host
Ornithonyssus spp[a,b]	*Ornithonyssus* spp	Feathers matted with gray-black discoloration, skin thickened and scaly, anemia	Skin scraping
Feather mites[a,b]	Various species	Usually asymptomatic, large numbers may cause discoloration of the feathers and self-trauma	Direct microscopy of feather
Quill mites[a,b]	Various species of family Syringophilidae (quill mites), Laminosioptidae and Fainocoptinae (quill wall mites)	Usually asymptomatic, large numbers may cause brittle feathers, hyperkeratosis of quill sheath, pruritus	Direct microscopy of feather or feather preparation with KOH
Giardiasis[a,b]	*Giardia* spp	Feather plucking over the torso in cockatiels (*Nymphicus hollandicus*)	Fecal examination
Bacterial			
Bumblefoot bacterial/ulcerative pododermatitis[a,b]	Various bacterial isolates including *Staphylococcus* and *Escherichia coli*; hypovitaminosis A; poor perch design (all of same diameter)	Commonly seen in overweight cage birds including buderigars, canaries, and cockatiels; lesions including swelling, hyperkeratosis, and swelling on plantar surface of foot	History, clinical signs, impression smears, and culture/sensitivity
Mycobacterial granuloma[b]	Skin lesions most commonly caused by *Mycobacterium tuberculosis*, less commonly *M avium*	Most common in Amazons, blue and gold (*Ara ararauna*) and green wing (*Ara chloropterus*) macaws; localized lesions often around the head or face; zoonotic risk	Histopathology, microbiology, PCR

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Table 5
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Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis
Fungal			
Aspergillosis[a,b]	*Aspergillus* spp (*fumigatus* most common)	May occur secondary to skin trauma, greenish blue or dark gray ulcerated patches on skin	Clinical signs and fungal culture
Candidiasis[a,b]	*Candida albicans*	In canaries may cause intense head/neck pruritus, also associated with feather picking	Clinical signs, skin cytology and fungal culture
Malassezia[c]	*Malassezia* spp	No difference in *Malassezia* levels were found between feather picking and normal psittacines	Skin cytology
Viral			
Psittacine beak and feather disease[a,b]	Psittacine circovirus	Chronic form causes feather dystrophy/abnormalities (clubbing and blunting); feather loss; shiny beak; deformed beak and nails; and immunosuppression Acute infections may occur in chicks, with systemic symptoms followed by profound changes in the developing feathers and death (similar to polyoma virus)	Clinical signs, PCR of blood sample of feather pulp
Polyoma virus[a,b]	Avian polyoma virus	In budgerigars, may cause French moult, which presents as abdominal distention, subcutaneous hemorrhages, lack of down/contour feathers and deformed feathers; other species often subclinical with rare feather abnormalities; subcutaneous and follicle hemorrhages may be seen	Cloacal swab for PCR
Papillomas[a,b]	Considered to be viral induced; herpesvirus or papillomavirus	Papilloma-like hyperplastic/hyperkeratotic lesions most common around palpebrae, commissure of beak or feet (finches), cloaca or choana of psittacines	Clinical signs, histopathology

Poxvirus[b]	Species-specific poxviruses	Dry form causes nodular lesions on nonfeathered areas around face, cere and feet; wet form affects similar areas plus mouth, pharynx, and viscera; canary pox highly infectious with 20%–100% mortality and three forms (cutaneous, diphtheritic, or septicemic)	Histopathology
Nutritional			
Hypovitaminosis A[a,b]	Most commonly seen in parrots on unsupplemented all seed diets deficient in vitamin A	Skin hyperkeratosis/scaling (worse on feet); white plaques in oral mucosa; rhinitis; blepharitis; sublingual salivary gland abscessation caused by squamous metaplasia	History of inappropriate diet and clinical signs
Neoplasia			
Skin neoplasia[a,b]	Uropygial adenocarcinoma, lipoma, fibrosarcoma, lymphosarcoma, squamous cell carcinoma, melanoma, hemangiosarcoma	Nodular lesions	Histopathology
Idiopathic/multifactorial/miscellaneous			
Feather picking[a,b,d] (see **Fig. 8**)	Many behavioral and nonbehavioral causes Nonbehavioral causes include ectoparasites; endoparasites (*Giardia*); heavy metal toxicity; hypothyroidism; infectious folliculitis (viral, fungal, bacterial); malnutrition; neoplasia; and other systemic diseases	Self-induced feather loss, often sparing the head	Rule out nonbehavioral causes of feather plucking before diagnosing as behavioral
Chronic ulcerative dermatitis[a,b]	Unknown; possibly associated with stressful environment	Small Psittaciformes, such as lovebirds, cockatiels, and parakeets ulcerative skin lesions over wing web or patagium and under wing	Ruling out other potential causes
Xanthomatosis[a,b]	Unknown; possibly caused by high-fat diet, trauma, or disorder of lipid metabolism	Nodular lesions caused by accumulation of lipid-containing macrophages Common in smaller Psittaciformes and present as discrete yellow-brown dermal swellings; most common on wing tips	Histopathology

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Table 5
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Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis
Allergic skin disease[a,b,d]	Cutaneous hypersensitivity; IgY seems to be involved in allergic reactions	Presence of true allergic dermatitis is controversial in birds; clinical signs include signs of pruritus (possibly seasonal) including feather plucking and skin mutilation	Rule out other causes of pruritic skin disease, intradermal allergy testing, skin biopsies
Feather follicle cysts[a,b]	Probable hereditary basis, may occur secondary to traumatic damage to feather follicle and nutritional deficiencies	Common in small caged birds, such as budgerigars and canaries; cyst/swelling develops because of inability of growing feather to break through skin, may have caseous exudate or become infected	Ruling out other causes; histopathology
Constricted toe syndrome[a,b]	Fibrous band of tissue constricts one or more digits, possibly caused by decreased humidity	Most common in African greys (*Psittacus erithacus*), macaws, eclectus (*Eclectus roratus*); swollen toes distal to area of fibrosis	Clinical signs
Articular gout[a,b]	Accumulation of urates in the synovial capsules and tendon sheaths of the joints, most commonly secondary to renal pathology	Most common in psittacines; white gritty swellings around the intertarsal or metatarsal joints	Cytologic demonstration of uric acid crystals, elevated serum uric acid
Hypothyroidism[a,b]		Rare disease of parrots, may be overdiagnosed, causes decreased molting, feather discoloration, hyperkeratosis, alopecia, obesity	Thyroid-stimulating hormone stimulation

[a] Girling S. Skin diseases and treatment of caged birds. In: Patterson S, editor. Skin diseases of exotic pets. Ames (IA): Blackwell; 2006. p. 22–47.
[b] Forbes NA. Birds. In: Foster A, Foil C, editors. BSAVA manual of small animal dermatology. Gloucester (England): BSAVA; 2003. p. 256–67.
[c] Preziosi DE, Morris DO, Johnston MS, et al. Distribution of *Malassezia* organisms on the skin of unaffected psittacine birds and psittacine birds with feather-destructive behavior. J Am Vet Med Assoc 2006;2:216–21.
[d] Nett CS, Tully T. Anatomy, clinical presentation and diagnostic approach to the feather picking pet bird. Comp Cont Educ Pract 2003;25(3):206–19.

Common findings during clinical examination of birds with skin disease include feather abnormalities (broken or absent feathers, dystrophic and discolored feathers); scaling; crusting; ulceration; redness; and nodules and masses.

Commonly used dermatologic diagnostic tests in pet birds include the following:

1. Feather pulp cytology[32,33]
   - Feather pulp cytology is collected from a freshly plucked feather and used to assess for the presence of folliculitis. The calamus can be removed from the feather and contents smeared onto a microscope slide. Possible findings include bacteria, inflammatory cells, viral inclusion bodies, and dermatophytes.
2. Gross and microscopic examination of feathers[32,33]
   - Evaluate for overall condition, ectoparasites, fret marks and stress bars, evidence of self-trauma
3. Feather preparation with potassium hydroxide[33]
   - To improve mite identification, the calamus of the feather can be placed into a 10% potassium hydroxide solution, gently heated, and then centrifuged, followed by microscopic examination of the sediment
4. Acetate tape impressions
   - Used to detect ectoparasites, yeast, and bacterial infections. Feather dander and keratinaceous debris is very abundant on these samples and in some cases can be difficult to differentiate from bacteria and yeast.
5. Impression smear
   - For moist, exudative, or crusted lesions, direct slide impressions are often used
   - For drier lesions, direct impressions can be attempted but acetate tape impressions may be preferred. Alternatively, a moistened swab can be used to collect a sample and contents rolled onto a slide.
6. Skin scrapings
7. Culture and sensitivity (bacterial, fungal)
   - Calamus and feather plucking, sterile tissue biopsy, or superficial swabs
8. Biopsy
   - Avian skin is much thinner than dogs and cats. In some cases, it is easier to biopsy the skin with a scalpel compared with a punch biopsy. If a punch biopsy is

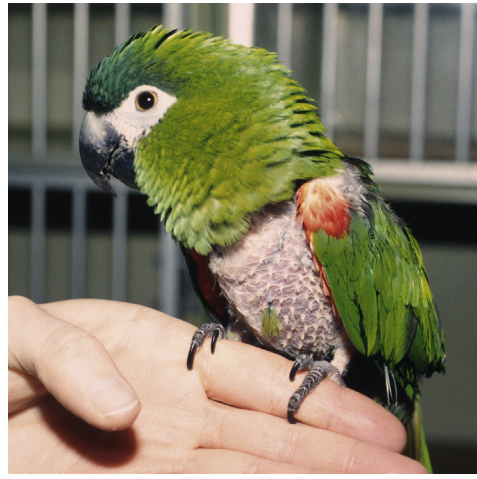

Fig. 8. Feather picking in a Hahns Macaw.

Table 6
Differential diagnoses for cutaneous diseases in rabbits

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis
Ectoparasites			
Ear mites[a–d]	*Psoroptes cuniculi*	Pruritic otitis, pinnal crusting, head shaking, canal erythema, thick ceruminous debris in canals, otitis externa and secondary otitis media; lesions rarely reported on face, neck, trunk extremities, and perineum; life cycle 3 wk and adults can live in environment for up to 3 wk	Otoscopic examination, microscopy of aural debris
Scabies[c]	*Notoedres cati var cuniculi*, *Sarcoptes scabei var cuniculi*	Crusting, pruritic dermatitis, most often affecting the head	Skin scrapings, trichogram, acetate tape impression
Cheyletiellosis[a–d] (see **Fig. 9**)	*Cheyletiella* spp (*parasitivorax* most common)	Scaling, walking dandruff, pruritus, alopecia, some cases asymptomatic, lacks host specificity and is zoonotic; life cycle 3 wk and can live off host for up to 10 d	Skin scrapings, trichogram, acetate tape impression
Fur-clasping mite[a–d]	*Listrophorus* (*Leporacarus*) *gibbus*	Often asymptomatic, scaling, alopecia; coinfestation with *Cheyletiella* common	Skin scrapings, trichogram, acetate tape impression
Demodicosis			
	Demodex cuniculi[b,c]	Most often aclinical, alopecia	Skin scrapings, trichograms
Fleas[a]	Numerous species including *Spilopsyllus cuniculi* (rabbit stick-tight flea), *Ctenocephalides felis* (cat flea), *Cediopsylla simplex* (Eastern rabbit flea), *Odontopsyllus multispinous* (giant Eastern rabbit flea), *Echidnophaga gallinacea* (stick-tight flea)	Often asymptomatic, may have pruritus or poor coat; *S cuniculi*: flea life cycle tied to reproductive cycle, transmits myxomatosis; *C felis* most commonly found on pet rabbits	Removal and microscopic identification
Lice[a]	*Haemodipsus ventricosus*	Anemia, pruritus	Trichograms, scrapings, microscopic identification
Ticks[a,c]	Numerous species including *Haemaphysalis leporis-palustris*		Removal and microscopic identification

Myiasis[a,c,d]	Various fly species including *Wohlfahrtia vigil*, *Lucilia*, and *Calliphora* spp	Fly strike common in outdoor environments in warm summer months, typically seen in rabbit with soiled perineum, inguinal/perineal skin most commonly affected	Removal and microscopic identification
Cuterebra[a–d]	*Cuterebra* spp larvae	Subcutaneous nodular swelling with small breathing hole; neurologic and respiratory signs rare; rabbits housed outdoors most commonly affected in summer months	Surgical removal, identification
Fungal			
Dermatophytosis[a–d]	*Trichophyton mentagrophytes* (most common), *Microsporsum gypseum*, *Microsporum canis*	Crusting, scaling alopecic lesions most common on the face and feet	Trichogram, fungal culture
Viral			
Myxomatosis[a–d]	Myxoma virus (poxvirus)	Swelling of eyelids, genitals, and pinna; fever; lethargy; anorexia; nodular swellings of the face and ears; death typically within 14 d; more mild form of the disease with widespread cutaneous nodules reported in vaccinated rabbits Insect vectors, such as mosquitoes and rabbit flea; vaccines developed, availability depending on country	Histopathology, virus isolation
Shope papilloma virus[a–d]	Shope papilloma virus (papovavirus)	Multifocal hyperkeratotic papillomas typically around ears and eyelids; can become neoplastic (squamous cell carcinoma) and metastasize to axillary lymph node or resolve over several months; insect vector	Histopathology, virus isolation
Shope fibroma virus[a]	Shope fibroma virus (poxvirus)	Fibroma lesion; single or multiple flat subcutaneous nodules especially on genitals, perineum, ventral abdomen, legs, nose, pinna, eyelid; up to 7 cm in diameter, tumors typically regress over a period of months	Histopathology, virus isolation

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Table 6
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Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis
Bacterial			
Rabbit syphilis, venereal spirochaetosis[a–d]	*Treponema paraluiscuniculi*	Venereal transmission and by direct contact Lesions (redness, edema, vesicles, ulcers, hemorrhagic crusts) often limited to mucocutaneous junctions of nares, philtrum, vulva, perineum, eyes Can be subclinical	Dark field microscopic visualization of organism or silver stains on histopathology, serology
Subcutaneous abscesses[c,d]	Dental disease, bite wounds, other injuries; isolates include various anaerobic bacteria, *Pasturella multocida* (may be less common than previously reported), *Staphylococcus* spp, *Streptococcus* spp	Rabbit heterophils cannot liquefy pus so abscesses are caseous with thick capsule; facial abscesses most commonly caused by dental disease	Clinical signs, fine-needle aspirate/cytology, culture/sensitivity, imaging for dental-associated abscesses
Moist dermatitis "blue fur disease"[a,c,d]	Severe chronic dental disease and excess salivation (slobbers), Overweight animals with large dewlap; constant wetting prediposes to colonization with *Pseudomonas* spp	Moist erythematous dermatitis of chin, neck, and dewlap, blue-green discoloration to fur (from pyocyanin pigment produced by *Pseudomonas*)	Clinical signs, impression cytology, culture/sensitivity
Neoplasia			
Neoplasia[e]	Reported types (in decreasing frequency) trichoblastoma, collagenous hamartoma, shope fibroma, lipoma, squamous cell carcinoma, myxosarcoma, peripheral nerve sheath tumor, malignant melanoma, fibrosarcoma, carcinoma, squamous papilloma, liposarcoma, leiomyosarcoma, trichoepithelioma, apocrine carcinoma, shope papilloma	Cutaneous growths	Histopathology
Husbandry-related/multifactorial/miscellaneous			
Urine scalding	Urinary tract disease (hypercalciuria, urinary calculi, urinary tract infection), wet bedding, obesity, inactivity, neuromuscular disease, and so forth	Moist erythematous dermatitis perineal region, plantar hind limbs	Clinical signs

Frostbite[a]	Cold environmental temperatures	Necrosis of pinnal margins	Clinical signs; histopathology
Ulcerative pododermatitis[a,d]	Loss of thick fur on plantar/palmar limbs leads to pressure induced necrosis of skin Overweight, inactive rabbits, wet/soiled bedding, grid wire floors, hereditary factors with Rex rabbits being commonly affected because of lack of protective guard hairs; secondary infection with *Staphylococcus aureus* common	Alopecia, erythematous, painful ulcerative dermatitis of the metatarsal (less commonly metacarpal) regions; can progress to osteomyelitis	Clinical signs, impression cytology, culture/sensitivity
Barbering[a–d]	Dominant animals in collection; occasionally self-barbering during estrus or with low-fiber diet	Broken hairs, alopecia	History, clinical signs, trichograms showing broken hairs
Sebaceous adenitis[f]	Unknown; immune-mediated attack on sebaceous glands	Nonpruritic scaling and alopecia, follicular casting	Histopathology
Telogen defluxion[a–d]	Systemic stress/illness or after parturition	Widespread hairloss 4–6 wk after systemic stress, nonpruritic, hair easily epilated, patchy alopecia	History, clinical signs, histopathology
Cutaneous asthenia	Heritable collagen defect	Hyperextensible skin, thin atrophic scars, wounds	Electron microscopy, histopathology may be supportive
Thymoma-associated exfoliative dermatitis[g]	Thymoma	Generalized scaling, alopecia	Histopathology, thoracic radiographs

[a] Meredith A. Dermatology of mammals. In: Patterson S, editor. Skin diseases of exotic pets. Ames (IA): Blackwell; 2006. p. 175–312.
[b] Scarff D. Rabbits and rodents. In: Foster A, Foil C, editors. BSAVA manual of small animal dermatology. Gloucester (England): BSAVA; 2003. p. 242–51.
[c] Jenkins JR. Skin disorders of the rabbit. Vet Clin North Am Exotic Anim Pract 2001;4:543–63.
[d] Johnston MS. Small, cute, fluffy and itchy: clinical approach to rabbit and rodent skin diseases. In: Proceedings North American Veterinary Dermatology Forum. Denver (CO): 2008. p. 74–8.
[e] von Bomhard W, Goldschmidt MH, Shofer FS, et al. Cutaneous neoplasms in pet rabbits: a retrospective study. Vet Pathol 2007; 44(5):579–88.
[f] White SD, Linder KE, Schultheiss P, et al. Sebaceous adenitis in four domestic rabbits (Oryctalagus cuniculus). Vet Dermatol 2000;11:53–60.
[g] Florizoone K. Thymoma-associated exfoliative dermatitis in a rabbit. Vet Dermatol 2005;16(4):281–4.

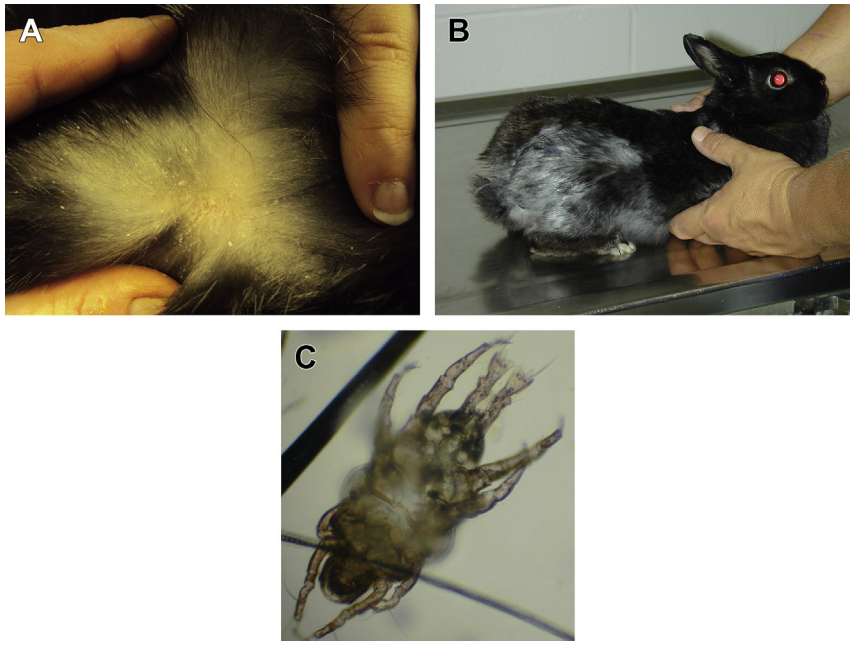

Fig. 9. (*A, B*) Note moderate scaling and self-induced alopecia. (*C*) *Cheyletiella parasitivorax*.

to be performed, a technique has been described where acetate tape is placed over the biopsy site to maintain the structure of the skin.[35]

9. Clinical pathology evaluation including complete blood count and biochemistry panel and heavy metal testing[32,33]
   - Systemic diseases can cause cutaneous changes including feather picking
   - Testing for lead and zinc levels may be needed in some cases
10. Crop washes[33]
    - Can identify *Trichomonas* or *Candida*, which can present in birds that feather pluck over the crop area
11. Fecal examination
    - Certain intestinal parasites may result in feather plucking[32,33]
12. Intradermal allergy testing
    - Codeine phosphate at 1:100,000 wt/vol preferred over histamine as a positive control in birds[36]
    - Further research is needed to evaluate appropriate protocols for intradermal allergy testing in pet birds and establish correct allergen dilutions and thresholds
13. Viral testing including PCR for polyoma virus and psittacine beak and feather disease[32,33]

Common Differential Diagnoses for Cutaneous Diseases

See **Table 5** for a review of common differential diagnoses for dermatologic diseases in pet birds, including feather picking (**Fig. 8**).

Table 7
Differential diagnoses for cutaneous diseases in guinea pigs

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Infectious				
Bacterial				
Cervical lymphadenitis	Bacterial infection of cervical lymph nodes, coarse feed causes oral trauma	Fluctuant to firm swelling in cervical lymph nodes	History of consumption of coarse feed causing oral trauma, typical clinical signs, culture	Node may rupture, *Streptococcus zooepidemicus* most commonly isolated, stress increases predisposition
Staphylococcal pyoderma	*Staphylococcus aureus*, *Staphylococcus epidermidis*, other; secondary to bites or wounds, self-trauma	Alopecia, erythema, crusts, abscessation, ulcers, folliculitis	Clinical signs, cytology, culture/sensitivity	
Otitis media/interna	Multiple bacterial etiologies	Head tilt, head shaking, circling, purulent discharge, ataxia	Clinical signs, diagnostic imaging of bulla, culture exudate	
Abscesses	Bite wounds, environmental trauma	Fluctuant to firm subcutaneous swelling, drainage	Clinical signs, culture	

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Table 7
(*continued*)

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Ectoparasites				
Lice (see **Fig. 10**)	*Trixacarus caviae*	Pruritus, alopecia, crusts/scales, erythema, excoriations, secondary pyoderma, Pruritus can be intense, resembling seizures	Skin scraping, acetate tape impression, trichogram	Zoonotic but self limiting
	Glirocola porcelli, *Gyropus ovalis*	Often subclinical, rough coat, scale, alopecia, pruritus in heavy infestations	Skin scraping, acetate tape impression, trichogram, direct visualization	Biting lice; environmental cleaning essential part of treatment
	Chirodiscoides caviae	Subclinical, pruritus, self-induced alopecia	Skin scraping, acetate tape impression, trichogram	
	Demodex caviae	Alopecia, erythema, crusts, affected animals immunosuppressed	Skin scraping	
Fungal				
Dermatophytosis	*Trichophyton mentagrophytes*	Scaling alopecia on face, legs, ears; occasional pruritus; crusts; papules; pustules; secondary bacterial pyoderma	Trichogram, fungal culture, biopsy	
Noninfectious/husbandry-related/miscellaneous				
Hypovitaminosis C	Vitamin C deficiency	Poor wound healing, depression, rough hair coat, pinnal scaling, swollen joints, abnormal gait, petechiae of mucous membranes, lameness, secondary infections		Guinea pigs cannot synthesize vitamin C, condition can be seen in cavies fed rabbit pellets or other ascorbic acid–deficient diet

Cystic ovarian disease (see **Fig. 11**)	Cause unknown; estrogenic substances in hay have been implicated	Bilateral, symmetric alopecia (back, flanks, ventrum), nonpruritic	Clinical signs in a female cavy, palpation, diagnostic imaging	
Pregnancy-associated alopecia		Sow with nonpruritic bilateral flank alopecia during late pregnancy	History, ruling out other causes	
Pododermatitis	Poor cage hygiene, wire cage flooring, obesity, sedentary cavy, hypovitaminosis C; *Staphylococcus aureus* most commonly isolated	Mild swelling of plantar surface of foot progressing to ulcerations and osteomyelitis	Clinical signs, culture lesions, history	Multimodal approach to treatment is required Prognosis is poor after deep ulceration present
Cheilitis	Oral trauma; feeding acidic and abrasive food stuffs, hypovitaminosis C; *Staphylococcus* commonly isolated; possible pox virus etiology	Perioral ulceration erythema and crusting	History, clinical signs, impression cytology culture	
Scent gland impaction	Scent glands on rump become impacted	Malodorous dermatitis, matted hairs, secondary infection	History, clinical signs	
Barbering	Barbering in group of animals or self-barbering	Incomplete/traumatic alopecia, chewed whiskers	History, trichogram showing broken hair shafts	
Neoplasia	Trichofolliculoma most common cutaneous neoplasm, others include sebaceous adenoma, lipoma, fibromas, fibrosarcomas, schwannoma, vascular anomaly	Nodules, masses and lumps; trichofolliculomas often have central pore through which keratinaceous debris is discharged	Biopsy, fine-needle aspirate/ cytology	

Data from Refs.[37,40,41]

Fig. 10. *Gyropus ovalis* from a guinea pig.

SMALL MAMMALS

The skin is a common site of disease in small mammals and a very common presenting complaint to the exotic animal practitioner. Parasites, bacterial infections, and husbandry- and environmental-related conditions are most commonly seen.

Skin Structure and Function

The basic structure and function of exotic small mammal skin is very similar to that of the dog and cat. Relevant differences are discussed. The skin is divided into a four-layered avascular epidermis (stratum corneum, stratum granulosum, stratum spinosum, stratum basale) and the underlying, structurally supportive, collagenous, and vascular dermis. The subcutis is below the dermis and consists of connective tissue and fat. In rodents, brown fat is located between the scapulae, in the ventral neck, and in the axillary and inguinal regions; it is more prominent in smaller rodents, rabbits, and ferrets and less so in guinea pigs and chinchillas.[37]

Fig. 11. Cystic ovarian disease resulting in symmetric noninflammatory flank alopecia.

Table 8
Differential diagnoses for cutaneous diseases in gerbils and hamsters

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Infectious causes				
Bacterial				
Bacterial pyoderma	Secondary to trauma, ectoparasites, or accumulated hardenian gland secretions in nasal dermatitis (gerbils) or dental disease (hamsters) *Staphylococcus* spp most commonly isolated	Erythema, crusting, alopecia	Impression smears, cytology, culture	
Viral				
Hamster polyomavirus (papovavirus)	HaPV	Associated with cutaneous epithelioma/ trichoepithelioma; verrucous mass near eyes, mouth, and perianal region in young hamsters; transmitted by urine	Histopathology	

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Table 8
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Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Parasitic		Pruritus, scales, crusts, secondary infections	Skin scraping, impression smear, biopsy	
	Demodex aurati (hamsters) (see **Fig. 12**)	Alopecia, scaling, erythema	Skin scraping	Cigar-shaped, inhabits hair follicles; evaluate for underlying immunosuppressive disease
	Demodex criceti (hamsters) (see **Fig. 12**)	Alopecia, scaling, erythema	Skin scraping	Short- and fat-bodied, superficial, inhabits keratin; evaluation for underlying immunosuppressive disease
	Notoedres notoedres (hamster), *N cati* (hamster)	Yellow crusts, pinnae, tail, paws, muzzle	Skin scraping	
	Demodex meroni (gerbils)	Alopecia, scaling, ulceration, secondary bacterial infection; most commonly affects face, thorax, abdomen, and limbs	Trichogram, skin scrapings	
	Acarus farris (fur mite, gerbils)	Alopecia, scaling, thickening of skin over tail, head, hind end	Trichogram, skin scrapings	
	Trixacarus caviae (hamster)	Pruritus, alopecia	Skin scraping	Transmissible to other animals including humans
Fungal				
Dermatophytosis	*Trichophyton mentagrophytes*, *Microsporum canis*, *M gypseum*	Pruritus, alopecia, crusts, scales, erythema, dry skin, secondary bacterial infections	Fungal culture, trichogram	Asymptomatic carriers possible, environmental cleaning essential, can be zoonotic and also spread to other susceptible species

Noninfectious				
Hyperadrenocorticism (hamster)	Primary-neoplasia of adrenal gland, secondary-pituitary tumor, iatrogenic	Symmetric alopecia, hyperpigmentation, thin skin, comedones, polyuria/ polydipsia, polyphagia, pot-bellied, secondary demodicosis	Clinical signs, adrenal ultrasound Dynamic function tests like ACTH stimulation test or dexamethasone suppression test, urine cortisol creatinine ratio not well described and difficult because of required blood and urine volumes	Can resemble demodicosis and cutaneous lymphoma Hyperadrenocorticism with secondary demodicosis is common
Hair coat roughness (hamster, gerbils)	Aging, fighting, high humidity (gerbils, >50%), overall bad health, stress	Rough appearing, greasy coat	History, clinical signs, ruling out other causes	
Facial dermatitis, nasal dermatitis, "sore nose" (gerbils)	Gerbils stressed by overcrowding and high humidity, hypersecretion of gland results in accumulation of porphyrin pigment around nares; may lead to self-trauma and secondary staphylococcus infection	Alopecia, erythema and crusting around the nares, can progress to face, paws, and ventral abdomen, alopecia, secondary moist dermatitis	Clinical signs, impression smears, bacterial culture porphyrins fluoresce under ultraviolet light	
Bald nose	Rubbing on wire cage or feeders or burrowing	Traumatic alopecia on dorsum of nose and muzzle	Clinical signs, history, trichogram	
Barbering	Dominant individual chews hair off of other animals	Traumatic alopecia on dorsal head and tail base	Clinical signs, history, trichogram	
Tail slip (gerbils)	Improper handling of tail	Skin lost from tail exposing muscle and bone	History and clinical signs	

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Table 8
(*continued*)

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Neoplasia				
Hamsters	Epitheliotrophic lymphoma	Alopecia, erythema, scaling, pruritus, secondary infections, ulceration, crusts, plaques, or nodules	Histopathology	Rule outs include demodicosis or hyperadrenocorticism; demodicosis can be secondary to epithelioptrophic lymphoma
	Melanoma, melanocytoma, epithelioma, trichoepithelioma, squamous cell carcinoma, fibrosaroma, basal cell carcinoma, papilloma		Fine-needle aspirate, histopathology	
Gerbils	Melanoma, melanocytoma, neoplasia of ventral scent gland (scent gland carcinoma), squamous cell carcinoma, basal cell carcinoma		Fine-needle aspirate, histopathology	

Data from Refs.[37,42,43]

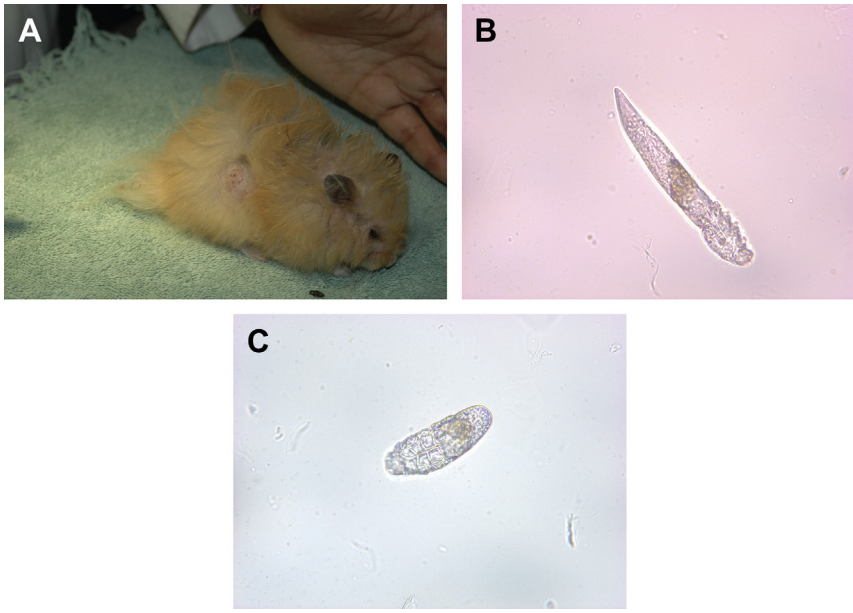

Fig. 12. (*A*) Demodicosis resulting in alopecia and mild crusting in a long-haired golden hamster (*Mesocricetus auratus*). (*B*) *Demodex aurati*: note long cigar shape. (*C*) *Demodex criceti*: note short stubby appearance.

Hairs can be divided into primary (guard) hairs; secondary (undercoat) hairs; and tactile hairs.[37] The number of hairs per follicle varies with the species, breed, age, and other external factors; chinchillas have as many as 60 hairs per follicle, producing the characteristic dense soft coat.[37] The keratinized hair consists of the innermost medulla, pigmented cortex, and outermost cuticle. Primary hairs are associated with sebaceous glands, apocrine sweat glands, and an arrector pili muscle. Rodents and ferrets have no epitrichial (apocrine) sweat glands.[37] Secondary hairs are typically only accompanied by sebaceous glands.[37] The rat and mouse tail is very sparsely haired. In interfollicular regions, there is surface parakeratosis and no stratum granulosum, whereas follicular ostia contain the typical orthokeratosis and stratum granulosum; these changes give the tail its characteristic scaly appearance.[37]

The footpads are areas of specialized thickened epidermis with underlying shock-absorbing fat deposits. Atrichial (eccrine) sweat glands are located only in the footpad. Rabbits lack foot pads, but instead have coarse fur on their distal limbs. Sebaceous scent glands are a common feature in many small mammal species and are important in scent marking and communication. Hamsters have large darkly pigmented glands on their flanks, more prominent in males.[37] Gerbils have large oval-shaped yellowish hairless scent glands on the ventrum.[37] Guinea pigs have a large gland over the rump that can secrete an oily substance, especially in boars.[37] Rabbits have sebaceous scent glands on the chin (mental gland) that is used for territorial marking, anal glands, and androgen-dependent inguinal scent glands.[37] Ferrets have active sebaceous glands throughout their skin that results in their typical musky odor and greasy coat; they also have two prominent perianal scent glands.[37]

Table 9
Differential diagnoses for cutaneous diseases in mice and rats

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Infectious causes				
Bacterial				
Pyoderma	*Staphylococcus aureus*, *Streptococcus*, other Can be secondary to ectoparasites, trauma, or salivary gland infection	Pruritus, hairloss, abscessation	Impression smears, culture	
Viral				
Sialodacryoadenitis (rats; rat coronavirus)	*Coronavirus*	Sneezing, oculonasal discharge, swelling near eyes, cervical edema, cervical lymphadenopathy, corneal ulceration/hyphema, secondary infections	Clinical signs, serology, histopathology	
Ectoparasites				
Fur mite (mice, rats)	*Radfordia* spp (fur mite, mice and rats)	Alopecia, pruritus, ulceration, scaling, secondary bacterial dermatitis; asymptomatic	Skin scraping, acetate tape impression, trichograms	

Fur mite (mice, rats) (see **Fig. 13**)	*Myobia musculi*	Alopecia, pruritus, ulceration, scaling, secondary bacterial dermatitis; asymptomatic	Skin scraping, acetate tape impression, trichograms	
	Psorergates muricola (mice)	Small white nodules, especially on the pinnae	Skin scraping, acetate tape impression, trichograms	Burrowing mite, found in stratum corneum
	Demodex musculi (mice), *Demodex ratticola* (rats)	Rare, follicular mite, localized alopecia, secondary infection		
Rat mange mite	*Notoedres muris* (rat)	Most common on pinnae and nose, hyperkeratotic, papules, yellow crusts	Skin scraping, acetate tape impression	
	Myocoptes musculinus	Alopecia, pruritus, ulceration, scaling, secondary bacterial dermatitis; asymptomatic	Skin scraping, acetate tape impression, trichograms	
Lice (see **Fig. 14**)	*Polyplax serrata* (mouse), *Polyplax spinulosa* (rats)	Pruritus, hairloss, restlessness, anemia		Possible vector of tularemia
Pinworms	*Syphacia* sp	Perianal pruritus	Acetate tape impression from perineal region	
Fungal				
Dermatophytosis	*Trichophyton mentagrophytes*, *Microsporum canis*, *M. gypseum*	Alopecia, crusts, scales, erythema, dry skin, secondary bacterial infections; asymptomatic carriers common	Fungal culture, trichogram	Environmental cleaning essential, can be zoonotic and also spread to other susceptible species

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Table 9
(*continued*)

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Noninfectious				
Neoplasia	Mammary gland fibroadenoma (rats); adenocarcinoma; fibrosarcoma (mice); squamous cell carcinoma (mice, rats); fibroma; papillomas; basal cell carcinomas	Clinical signs and typical location, fine-needle aspirate/cytology, biopsy	Histopathology	Mammary masses in rats can get very large
Husbandry-related				
Barbering (mice)	Hair and whiskers of subordinates are chewed by dominant mouse	Incomplete/traumatic alopecia, chewed whiskers, dominant mouse has intact whiskers	History, clinical signs	Typical in group housing, especially males Reducing numbers may help
Ring tail (mice, rats)	Low environmental humidity	Annular constriction at base of tail, secondary edema and necrosis develop	History, clinical signs	Usually young mice/rats, not common in pet rats

Data from Refs.[37,42–44]

Fig. 13. *Myobia musculi* from a mouse.

Dermatologic Examination and Diagnostic Testing

As with other exotic species, a thorough questioning and evaluation of the husbandry is critical for successful diagnosis and treatment of small mammal dermatoses. Important questions include those pertaining to the environment and husbandry (type of housing, indoor or outdoor, substrate or bedding, diet, and so forth), and more targeted questions pertaining to skin disease. In small mammals, it is important to know whether the condition is pruritic and whether any other animals are affected.

A thorough dermatologic examination is necessary in all patients with skin disease. Common lesions include hairloss, erythema, scaling, crusting, excoriations, erosions, and ulcers. Restraint to obtain quality diagnostic samples from small mammal skin can be challenging in some cases, so anesthesia or sedation may be needed.

Commonly used dermatologic diagnostic tests in small mammals include the following:

1. Impression smear
    - For moist, exudative, or crusted lesions, direct slide impressions are often used

Fig. 14. *Polyplax spinulosa* from a rat.

Table 10
Differential diagnoses for cutaneous diseases in ferrets

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Infectious				
Viral	Canine distemper virus (paramyxovirus)	Brown crusted lesions on chin, nose, inguinal, and perianal region Hyperkeratosis and swelling of footpads; pyrexia, nasal, and ocular discharge, coughing, anorexia, neurologic signs and death	Clinical signs, fluorescent antibody of conjunctival smears, peripheral blood smear, serum antibody titers, histopathology	Vaccine available
Bacterial				
Bacterial pyoderma	Secondary to trauma, bite wounds, rough playing, ectoparasites; most commonly caused by *Staphylococcus* or *Streptococcus*	Superficial to deep pyoderma, abscesses, cellulitis	Cytology, culture	
Fungal				
Dermatophytosis	*Trichophyton mentagrophytes*, *Microsporum canis*; uncommon, may be secondary to underlying immunosuppression	Circular alopecia, erythema, scaling, secondary pyoderma	Trichogram, fungal culture	

Parasitic			
Ectoparasites	Fleas (*Ctenocephalides felis*)	Pruritus, scaling, crusting, alopecia, excoriations	Observation, clinical signs, flea "dirt" or live fleas on flea combing
	Ear mites (*Otodectes cynotis*)	Otic pruritus, excess dark brown ceruminous debris, head shaking, ectopic sites include feet and tail tip	Otoscopic examination, microscopy of aural debris
	Sarcoptic mange mite (*Sarcoptes scabei*)	General form: focal to diffuse alopecia, pruritus, scaling; Localized form: only toes/feet affected inflammation, swelling, crusts, and pruritus of paws; nails may become deformed and slough	Skin scraping, mites may be difficult to find
Noninfectious			
Endocrine			
Hyperadrenocorticism (see **Fig. 15**)	Adrenocortical hyperplasia, adenoma or adenocarcinoma; neutering may play role in pathogenesis	Bilateral, symmetric alopecia, pruritus, vulvar enlargement, comedones, prostatic hyperplasia, stranguria, and urinary obstruction in males	Clinical signs, abdominal palpation, elevations of one or more levels of circulating sex hormones, ultrasonography, pancytopenia may be present
Hyperestrogenism	Unmated females not stimulated to ovulate may result in prolonged estrus	Swollen vulva, alopecia, bone marrow suppression, anemia	Clinical signs, history, CBC
Hypersensitivity	Atopic dermatitis, food allergy	Pruritus	Rule out more common causes of pruritus, intradermal allergy testing, food trial

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Table 10
(*continued*)

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis	Comments
Neoplasia				
Mast cell tumors		Small, round, slightly raised, dermal mass, Occasional yellow crusty surface or pruritic	Fine-needle aspirate, histopathology	Usually benign Can occur anywhere but common head, neck, shoulders, or trunk
Apocrine scent tumors	Adenocarcinoma, adenoma	Located in areas of high concentration of scent glands; head, neck, prepuce, vulva, perineum	Fine-needle aspirate, histopathology	Can exhibit rapid growth and be locally aggressive and metastatic
Basal cell tumor		Discrete, solitary, often pedunculated or ulcerated	Fine-needle aspirate, histopathology	
Cutaneous lymphoma		Nodules, ulcerated masses, swelling, pruritus, alopecia, erythema, scaling; most commonly affects feet and extremities	Cytology, histopathology	
Sebaceous adenomas/ epitheliomas		Mass may be ulcerated, have necrotic centers	Fine-needle aspirate, histopathology	
Environmental				
Seasonal alopecia	Seasonal molting	Bilaterally symmetric alopecia of tail, inguinal region, and perineum during breeding season	Clinical signs, history, season, ruling out other etiologies	
Telogen defluxion	2–3 mo after stressful event	Thinning of coat	History, ruling out other causes	
Nutritional				
Biotin deficiency	Raw eggs in diet	Bilaterally, symmetric alopecia	Dietary history, clinical signs	Compound in egg whites, avidin, binds dietary biotin

Data from Refs.[37,45–50]

- For drier lesions, direct impressions can be attempted but acetate tape impressions may be preferred. Alternatively, a moistened swab can be used to collect a sample and contents rolled onto a slide.

2. Skin scrapings
   a. Very useful for detection of ectoparasites
   b. Given the thin skin of many exotic patients, some practitioners prefer to use scraping spatulas to perform skin scrapings
3. Bacterial culture and sensitivity
4. Fungal culture
5. Wood lamp
   a. Limited usefulness in small mammals given that *Trichophyton mentagrophytes* is the most common dermatophyte isolate in clinical cases
6. Trichogram
   a. Useful to evaluate hair structure
   b. Evaluation for broken or fractured hair ends that would help determine whether hair loss is traumatic. Evaluate for ectoparasites.
   c. Evaluation for evidence of dermatophytosis (fungal hyphae/ectothrix spores)
7. Acetate tape impression
   a. Useful for collection of surface-dwelling mites, such as *Cheyletiella* and *Myobia*
8. Skin biopsies for histopathology
9. Clinical pathology testing including complete blood count and biochemistry panel
10. Testing for adrenal disease in ferrets

Common Differential Diagnoses for Cutaneous Diseases

See **Table 6** for a review of common differential diagnoses for dermatologic diseases in rabbits, including *Cheyletiella parasitivorax* (**Fig. 9**). See **Table 7** for a review of common differential diagnoses for dermatologic diseases in guinea pigs, including *Gyropus ovalis* and noninflammatory flank alopecia (**Figs. 10** and **11**). See **Table 8** for a review of common differential diagnoses for dermatologic diseases in gerbils and hamsters, including demodicosis, (*Demodex aurati* and *Demodex criceti*, [**Fig. 12**]). See **Table 9** for a review of common differential diagnoses for dermatologic diseases in mice and rats, including *Myobia musculi* and *Polyplax spinulosa* (**Figs. 13** and **14**). See **Table 10** for a review of common differential diagnoses for dermatologic diseases

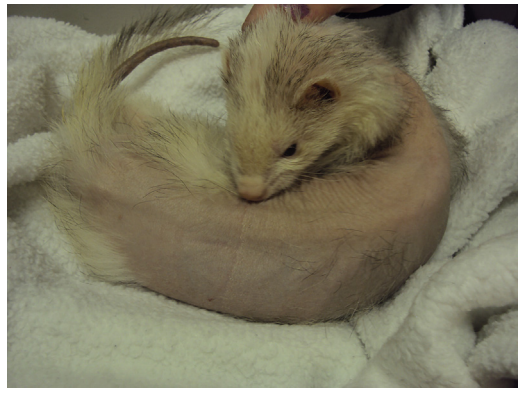

Fig. 15. Alopecia in a ferret with hyperadrenocorticism.

Table 11
Differential diagnoses for cutaneous diseases in chinchillas

Disease/Condition	Causes	Clinical Signs/Properties	Diagnosis
Bacterial			
Abscesses[a]	Bite wounds, dental disease; *Staphylococcus* and *Streptococcus* are common isolates	Soft fluctuant swelling	Fine-needle aspirate, culture/sensitivity, imaging
Moist dermatitis[a]	Staphylococcal infection caused by excessive salivation from dental disease	Moist erythematous dermatitis, ventral chin and neck	Clinical signs, culture/sensitivity
Fungal			
Dermatophytosis[a]	*Trichophyton mentagrophytes* most common, *Microsporum canis* and *Microsporum gypseum* less common	Alopecia; scaling; crusting and erythema around eyes, nose, mouth, legs, and feet	Trichogram, fungal culture
Husbandry-related			
Dietary deficiencies of fatty acids, zinc, and panthothenic acid[a]	Unbalanced diet	Patchy alopecia, scaly skin	History, clinical signs, and response to supplementation
Yellow ears, yellow fat[a]	Diet deficient in choline, methionine, or vitamin E; impaired metabolism of plant pigments leads to concentration of yellow-orange pigment in skin and fat	Yellowish discoloration of skin worse on the ventral abdomen and perineal, painful swellings on ventral abdomen	Clinical signs and history
Cotton fur syndrome[a]	High protein diet (crude protein >28%)	Wavy, weak hair that appears like cotton	Dietary analysis for protein levels and clinical signs
Fur chewing[a]	Barbering, may be related to overcrowding or other stressor	Traumatic alopecia	Trichogram
Matted fur[a]	Lack of dust baths, high relative humidity	Matted fur	Clinical signs and history
Miscellaneous			
Fur-slip[a]	Rough handling, frightened, trauma, fighting causes rapid shedding of patch of fur; natural defense mechanism	Well-circumscribed alopecia	History, clinical signs, and ruling out other differentials, especially dermatophytosis

[a] Meredith A. Dermatology of mammals. In: Patterson S, editor. Skin diseases of exotic pets. Ames (IA): Blackwell; 2006. p. 175–312.

in ferrets, including alopecia (**Fig. 15**). See **Table 11** for a review of common differential diagnoses for dermatologic diseases in chinchillas.

SUMMARY

Skin disease is an extremely common presenting complaint to the exotic animal practitioner. These cases may be challenging because dermatologic diseases are often multifactorial and many have underlying husbandry or environmental deficiencies that must be identified. A thorough diagnostic evaluation is critical for successful management of exotic animal cutaneous disease.

REFERENCES

1. White SD, Bourdeau P, Bruet V, et al. Reptiles with dermatological lesions: a retrospective study of 301 cases at two university veterinary teaching hospitals (1992-2008). Vet Dermatol 2011;22(2):150–61.
2. Hoppmann E, Barron HW. Dermatology in reptiles. J Exot Pet Med 2007;16(4):210–24.
3. Goodman G. Dermatology of reptiles. In: Patterson S, editor. Skin diseases of exotic pets. Blackwell: Ames (IA); 2006. p. 73–118.
4. Johnston MS. Scales and sheds: the ins and outs of reptile skin disease. In: Proceedings North American Veterinary Dermatology Forum. Denver (CO): 2008. p. 62–6.
5. Mitchell M, Colombini S. Reptiles. In: Foster A, Foil C, editors. BSAVA manual of small animal dermatology. Gloucester (England): BSAVA; 2003. p. 269–75.
6. Gentz EJ. Medicine and surgery of amphibians. ILAR J 2007;48(3):255–9.
7. Wright KM. Pathology of amphibia. In: Wright KM, Whitaker BR, editors. Amphibian medicine and captive husbandry. Malabar (FL): Krieger; 2001. p. 401–85.
8. Pessier AP. Cytologic diagnosis of disease in amphibians. Vet Clin North Am Exot Anim Pract 2007;10:187–206.
9. Campbell CR, Voyles J, Cook DL, et al. Frog skin epithelium: electrolyte transport and chytridiomycosis. Int J Biochem Cell Biol 2012;44:431–4.
10. Clayton LA, Gore SR. Amphibian emergency medicine. Vet Clin North Am Exot Anim Pract 2007;10:587–620.
11. Wright KM. Anatomy for the clinician. In: Wright KM, Whitaker BR, editors. Amphibian medicine and captive husbandry. Malabar (FL): Krieger; 2001. p. 15–30.
12. Wright KM. Applied physiology. In: Wright KM, Whitaker BR, editors. Amphibian medicine and captive husbandry. Malabar (FL): Krieger; 2001. p. 31–4.
13. Wright KM. Clinical techniques. In: Wright KM, Whitaker BR, editors. Amphibian medicine and captive husbandry. Malabar (FL): Krieger; 2001. p. 89–110.
14. Conlon JM, Mechkarska M, King JD. Host-defense peptides in skin secretions of African clawed frogs (Xenopodinae, Pipidae). Gen Comp Endocrinol 2012;176:513–8.
15. McKenzie VJ, Bowers RM, Fierer N, et al. Co-habiting amphibian species harbor unique skin bacterial communities in wild populations. ISME J 2012;6:588–96.
16. Prates I, Antoniazzi MM, Sciani JM, et al. Skin glands, poison and mimicry in dendrobatid and leptodactylid amphibians. J Morphol 2012;273:279–90.
17. Raspotnig G, Norton RA, Heethoff M. Oribatid mites and skin alkaloids in poison frogs. Biol Lett 2011;7(4):555–6.

18. Bennett TD. Frogs and toads. In: Meredith A, Johnson-Delaney C, editors. BSAVA manual of exotic pets. Gloucester (United Kingdom): British Small Animal Veterinary Association; 2010. p. 316–30.
19. de la Navarre BJ. Common procedures in reptiles and amphibians. Vet Clin North Am Exot Anim Pract 2006;9:237–67.
20. Wright KM. Restraint techniques and euthanasia. In: Wright KM, Whitaker BR, editors. Amphibian medicine and captive husbandry. Malabar (FL): Krieger; 2001. p. 111–22.
21. Pessier AP. An overview of amphibian skin disease. Semin Avian Exot Pet 2002; 11(3):162–74.
22. Klaphake E. Bacterial and parasitic diseases of amphibians. Vet Clin North Am Exot Anim Pract 2009;12:597–608.
23. McCampbell S. Clinical microbiology of amphibians for the exotic practice. In: Wright KM, Whitaker BR, editors. Amphibian medicine and captive husbandry. Malabar (FL): Krieger; 2001. p. 123–8.
24. Taylor S. Mycoses. In: Wright KM, Whitaker BR, editors. Amphibian medicine and captive husbandry. Malabar (FL): Krieger; 2001. p. 188–92.
25. Wright KM. Bacterial diseases. In: Wright KM, Whitaker BR, editors. Amphibian medicine and captive husbandry. Malabar (FL): Krieger; 2001. p. 160–79.
26. Johnson AJ, Wellehan JF. Amphibian virology. Vet Clin North Am Exot Anim Pract 2005;8:53–65.
27. Pessier AP, Mendelson JR III. Quarantine. In: Proceedings from Workshop on Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs. San Diego (CA): 2009. p. 69–101.
28. Pessier AP, Mendelson JR III. Diagnostic testing. In: Proceedings from Workshop on Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs. San Diego (CA): 2009. p. 102–58.
29. Searle CM, Gervasi SS, Hua J, et al. Differential host susceptibility to *Batrachochytrium dendrobatidis*, an emerging amphibian pathogen. Conserv Biol 2011; 25(5):965–74.
30. Palmeiro BS. Skin to fins: diving into pet fish dermatology. In: Proceedings North American Veterinary Dermatology Forum. Denver (CO): 2008. p. 55–9.
31. Wildgoose WH. Skin diseases. In: Wildgoose WH, editor. BSAVA manual of ornamental fish. 2nd edition. Gloucester (England): BSAVA; 2001. p. 269–75.
32. Forbes NA. Birds. In: Foster A, Foil C, editors. BSAVA manual of small animal dermatology. Gloucester (England): BSAVA; 2003. p. 256–67.
33. Fraser M. Dermatology of birds. In: Patterson S, editor. Skin diseases of exotic pets. Ames (IA): Blackwell; 2006. p. 3–14.
34. Nett CS, Tully T. Anatomy, clinical presentation and diagnostic approach to the feather picking pet bird. Comp Cont Educ Pract 2003;25(3):206–19.
35. Nett CS, Hodgin EC, Foil CS, et al. A modified biopsy technique to improve histopathological evaluation of avian skin. Vet Dermatol 2003;14:147–51.
36. Columbini S, Foil C, Hosgood G, et al. Intradermal skin testing in Hispaniolan parrots (Amazonia ventralis). Vet Dermatol 2000;11:271–6.
37. Meredith A. Dermatology of mammals. In: Patterson S, editor. Skin diseases of exotic pets. Ames (IA): Blackwell; 2006. p. 175–312.
38. Williams D. Reptiles. In: Foster A, Foil C, editors. BSAVA manual of small animal dermatology. Gloucester (England): BSAVA; 2003. p. 281–7.
39. Wright KM. Trauma. In: Wright KM, Whitaker BR, editors. Amphibian medicine and captive husbandry. Malabar (FL): Krieger; 2001. p. 233–8.

40. Johnson-Delaney C. Guinea pigs, chinchillas, degus and duprasi. In: Meredith A, Johnson-Delaney C, editors. BSAVA manual of exotic pets. Gloucester (United Kingdom): British Small Animal Veterinary Association; 2010. p. 28–62.
41. O'Rourke DP. Disease problems of guinea pigs. In: Quesenberry KE, Carpenter JW, editors. Ferrets, rabbits, and rodents: clinical medicine and surgery. 2nd edition. St Louis (MO): Saunders; 2003. p. 245–54.
42. Donnelly TM. Disease problems of small rodents. In: Quesenberry KE, Carpenter JW, editors. Ferrets, rabbits, and rodents: clinical medicine and surgery. 2nd edition. St Louis (MO): Saunders; 2003. p. 299–315.
43. Sayers I, Smith SA. Mice, rats, hamsters, and gerbils. In: Meredith A, Johnson-Delaney C, editors. BSAVA manual of exotic pets. Gloucester (United Kingdom): British Small Animal Veterinary Association; 2010. p. 1–27.
44. Garner M. Cytologic diagnosis of diseases of rabbits, guinea pigs, and rodents. Vet Clin North Am Exot Anim Pract 2007;10:25–49.
45. Antinoff N, Hahn K. Ferret oncology: disease, diagnostics, and therapeutics. Vet Clin North Am Exot Anim Pract 2004;7:579–625.
46. Orcutt C. Dermatologic diseases. In: Quesenberry KE, Carpenter JW, editors. Ferrets, rabbits, and rodents: clinical medicine and surgery. 2nd edition. St Louis (MO): Saunders; 2003. p. 107–14.
47. Pollock C. Emergency medicine of the ferret. Vet Clin North Am Exot Anim Pract 2004;10:463–500.
48. Quesenberry KE, Rosenthal KE. Endocrine diseases. In: Quesenberry KE, Carpenter JW, editors. Ferrets, rabbits, and rodents: clinical medicine and surgery. 2nd edition. St Louis (MO): Saunders; 2003. p. 79–90.
49. Schoemaker NJ. Ferrets, skunks, and otters. In: Meredith A, Johnson-Delaney C, editors. BSAVA manual of exotic pets. Gloucester (United Kingdom): British Small Animal Veterinary Association; 2010. p. 127–38.
50. Williams BH. Neoplasia. In: Quesenberry KE, Carpenter JW, editors. Ferrets, rabbits, and rodents: clinical medicine and surgery. 2nd edition. St Louis (MO): Saunders; 2003. p. 91–106.