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SCIENTIFIC ARTICLE

Avian and Reptilian Cytodiagnosis

Terry Campbell, D.V.M., Ph.D.

Cytology is a valuable in-house diagnostic tool for the evaluation of avian and reptilian patients. The basic principles of veterinary diagnostic cytology used to evaluate domestic mammals also apply to these animals. Cytology often provides a rapid definitive or strong presumptive diagnosis that allows for quick specific therapy.

The choice of the sample collection procedure depends on the preference of the cytologist, the species of animal being tested, and the location of the tissue or fluid being examined. The basic sample collection techniques (i.e., wash samples, fine-needle aspiration biopsy, and contact or impression smears) and sample processing procedures of mammals apply to birds and reptiles. Various staining procedures can be used. For routine procedures, many veterinary cytologists prefer the Romanowsky method, including Wright's and quick Wright's stains.

The same approach to interpretation of the cellular response is made regardless of the source of the sample. The cytologist examines the stained slide containing the sample and determines what types of cells predominate. The 4 primary diagnoses made from cytologic examination are inflammation, malignant neoplasia, tissue hyperplasia (or benign neoplasia), and normal cellularity.

Inflammation

A diagnosis of inflammation is made if inflammatory cells predominate. The inflammatory cells of birds and reptiles include heterophils, lymphocytes, plasma cells, monocytes, and macrophages. Eosinophils are also included; however, eosinophilic inflammations in birds or reptiles are rare and difficult to detect.

Inflammatory lesions can be divided into heterophilic, mixed-cell, and macrophagic inflammations.[1] Heterophilic inflammation is characterized by a predominance of heterophils in which these cells make up more than 70% of the inflammatory cells in the lesion. Heterophil granules in cytologic specimens tend to lose their normal rod-shaped appearance and often appear more rounded. Degenerate heterophils from birds and reptiles have similar characteristics to degenerate neutrophils of mammals—swelling, karyorrhexis, karyolysis, nuclear hyalinization, and cytoplasmic basophilia and vacuolization. Degenerate heterophils imply toxicity in the microenvironment similar to what one would associate with microbial toxins. The etiologic agent may be present in the cytologic sample. For example, septic inflammatory lesions may demonstrate bacteria being phagocytized by heterophils. Heterophilic inflammation in birds and reptiles usually indicates an acute phase of the inflammatory response.

Mixed-cell inflammation is present when more than 50% of the inflammatory cells are heterophils with increased numbers of mononuclear leukocytes, such as monocytes, lymphocytes, macrophages, and plasma cells. Mixed-cell inflammation is the most common type of inflammation seen in reptiles and birds because macrophages often migrate quickly (within a few hours) into the lesion; this differs from the mammalian response.[2]

The necrotic center of heterophilic inflammation produces necrotoxins that are chemotactic to macrophages, and a granuloma quickly develops. Therefore, granuloma formation in birds and reptiles may be a response to necrotic tissue rather than a reaction to an infectious agent. Heterophils in this type of inflammation are typically nondegenerate. Giant cell formation is a common occurrence in avian and reptilian inflammatory lesions because the necrotic tissue stimulates a foreign body-like response. Therefore, unlike mammalian giant cell formation, the presence of giant

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Avian and Reptilian Cytodiagnosis

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cells in avian and reptilian inflammatory lesions does not necessarily suggest chronicity.[2] Lymphocytes and plasma cells may also be associated with heterophilic granulomas, whereas the presence of epithelioid cells (macrophages that contain no cytoplasmic vacuoles or phagocytized material) and connective tissue cells (i.e., fibroblasts) suggest chronic granulomas. Heterophilic and mixed-cell inflammation of birds and reptiles are associated with a variety of infectious (bacterial and fungal) and noninfectious (trauma and foreign body) etiologies.

Macrophagic inflammation may have a different pathogenesis than heterophilic and mixed-cell inflammation in birds and reptiles. This kind of inflammation is represented by a predominance of macrophages (more than 50% of the inflammatory cells) in the cytologic specimen. Macrophagic inflammation may be associated with etiologies such as foreign bodies, cutaneous xanthomatosis, and fungal, mycobacterial, and chlamydial infections. Large vacuolated macrophages often coalesce into multinucleated giant cells, especially if large amounts of foreign bodies and fungi are present. Macrophages and giant cells do not necessarily imply chronicity.

Eosinophilic inflammation appears to be rare in birds and reptiles. This may be because of the difficulty in differentiating eosinophils from heterophils in cytologic samples using routine cytologic stains or to the fact that eosinophils of these lower vertebrates behave differently than mammalian eosinophils. If present, eosinophilic inflammation suggests a hypersensitivity to a certain antigen, such as a parasite or allergen.

Tissue Hyperplasia

Once the cytologist has determined that the cellular response is representative of neither an inflammatory response nor of normal cellularity, a decision can be made between a diagnosis of tissue hyperplasia (also known as *benign neoplasia*) and malignant neoplasia. Tissue hyperplasia is a proliferative process in tissue that is usually responding to cellular injury or chronic stimulation (i.e., glandular tissue). The cellular morphology of tissue hyperplasia is usually indistinguishable from that of benign neoplasia. The cells exhibit cytoplasmic basophilia and have pale vesicular nuclei and a slightly higher mitotic index than normal cells. The cells typically appear uniform, unlike those from malignant neoplasias that tend to be highly pleomorphic.

Malignant Neoplasia

The cytomorphologic criteria for malignant neoplasia involve information concerning the general features of cells sampled from the lesion. These features refer to the cellularity and overall appearance of the cell population in the sample. Malignant neoplasms often provide highly cellular samples because the cells have lost their normal cell-to-cell interactions and tissue alteration creates greater cellular exfoliation. Malignant neoplasms often provide cellular samples that contain a polymorphic population of cells that appear to have a common origin; however, a uniform population of cells that are foreign to the location from which they were taken may also suggest malignancy in the form of a metastatic lesion. The nuclear features are the most significant cytologic criteria for malignant neoplasia. Cells from malignant neoplasms tend to have variations in nuclear size and nucleus–cytoplasm ratios. They also exhibit variable nuclear shapes, abnormal and multiple nucleoli, irregular chromatin, multinucleation, and high mitotic activity. Cytoplasmic features of malignant neoplasia include increased basophilia, abnormal vacuolation or inclusions, and variable staining and cytoplasmic margins. The structural features of malignant cells can aid in the classification of neoplasms. Malignant

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PRACTICE TIP

Terry Campbell, D.V.M., Ph.D.

Wound Management in Aquatic Turtles

Wounds on the head, carapace, and plastron of aquatic and semi-aquatic turtles are managed in a manner similar to wounds in other animals. After débridement and cleaning of the wound, wet-to-dry bandaging is used for further débridement. The gauze is held in place using tape, which is secured to the hard surface of the turtle's head, carapace, or plastron using cyanoacrylate adhesive applied to the margins of the tape. After the infection has resolved and a granulation bed has been established, the wound can be protected with a semi-occlusive dressing made of a thin, flexible, transparent polyurethane membrane (Tegaderm, 3M Health Care, St. Paul, MN). This membrane is applied to the dry surface and the margins are sealed with a cyanoacrylate adhesive. This dressing does not easily break down in the aquatic environment and can remain in place for several weeks to protect the wound during healing. The transparent membrane allows for direct inspection of the wound.

ROUNDTABLE

Treating Avian Aspergillosis

Q. In what species of birds does aspergillosis usually appear?

Dr. Morrisey: *Aspergillosis is common in psittacines, especially African grey parrots, macaws, and Amazon parrots, as well as raptors, penguins, and waterfowl. Any bird can get aspergillosis; immunosuppressed or highly stressed animals are especially susceptible.*

Dr. Worell: *Poultry, penguins, waterfowl, many species of raptors, and shorebirds are often affected. Pet birds commonly diagnosed with aspergillosis include African grey parrots, pionus parrots, and amazons.*

Q. What are common clinical signs of aspergillosis?

Dr. Morrisey: *Clinical signs typically related to the respiratory tract include dyspnea, tachypnea, respiratory wheezing, increased respiratory effort, and changes in vocalization. Nonspecific signs such as anorexia, quietness, and lethargy are also common. Aspergillosis may also affect other body systems such as the central nervous system and cause signs including ataxia, weakness, and seizures.*

Dr. Worell: *Aspergillosis may present as a chronic debilitating disease, acute disease, or, frequently, as an acute manifestation of a chronic underlying condition. Signs vary in affected birds but include weight loss and dyspnea or other respiratory signs. If the spinal cord is involved, paresis of the legs may be seen. Ascites, vocalization changes, and lethargy may also occur.*

Q. What diagnostic tests are helpful in diagnosing aspergillosis?

Dr. Morrisey: *There isn't one specific test that is effective, therefore I use a combination of tests. The CBC typically shows an elevated WBC with an increase in monocytes and lymphocytes. The protein electrophoresis shows elevated beta and gamma fractions. An antigen/antibody test is available through the University of Miami and can be helpful in chronic cases and may be of use in monitoring progression of the disease. Radiographs may reveal thickened or hyperinflated air sacs and pulmonary lesions. Endoscopy with biopsy of the air sacs and lung for cytology and culture is often the most helpful. The trachea should also be examined endoscopically to look for granulomas or tracheitis.*

Dr. Worell: *The disease is challenging to diagnose. I find a complete blood panel (especially the WBC), protein electrophoresis, radiographs, an ELISA test, and the antigen/antibody tests*

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WHAT'S YOUR DIAGNOSIS ???

*An 8-month-old neutered male rabbit (*Oryctolagus cuniculus*) was evaluated for partial anorexia. The owner said the rabbit had not been eating well for 5 days. She began force-feeding the rabbit carrot baby food several times daily 2 days before the visit because it exhibited complete anorexia. Examination showed a temperature of 100.8˚F. The rabbit was alert and responsive, and no obstruction was palpated in the abdomen. The incisors were not overgrown. Diagnostic tests were postponed, and the owner began force-feeding, 3 to 4 times daily, 5 to 10 mL of a mixture (1 part each) of rabbit pellets, Pedialyte, fresh pineapple juice, and carrot baby food. Two days later the rabbit was reevaluated because he was still not eating on his own and was passing few fecal pellets. A CBC and serum biochemical profile were performed, and radiographs were taken.*

Questions

1. What is your differential diagnosis?
2. What is a common abnormality that is caused by anorexia in rabbits?
3. How would you proceed?

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What's Your Diagnosis ???

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Answers

1. Radiographic test results reveal a large amount of gas throughout the GI tract (ileus), suggestive of an anatomic or physiologic obstruction.
2. Hepatic lipidosis can be caused by anorexia. Because the rabbit was being force-fed, hepatic lipidosis was not seen in this case and results of the CBC and biochemical profile were within normal limits.
3. The owner was given the options of exploratory surgery or treatment with a GI promotility medication. The owner elected to continue force-feeding and have the rabbit reevaluated in the morning. Before discharge, the rabbit was treated with lactated Ringer's solution (80 mL SC), 0.5 mL of B-complex vitamins, flunixin meglumine (1.1 mg/kg SC), enrofloxacin (10 mg/kg SC q12hr), and a tap water enema. The following morning, the owner thought the rabbit was slightly more active although still not eating on his own. Follow-up radiographs appeared similar to those made the night before.

Once again, surgery or treatment with a promotility medication were offered. The owner elected promotility medication. Cisapride (0.5-1.0 mg/kg PO q12hr) was dispensed along with oral enrofloxacin (10 mg/kg q12hr). The owner continued to force-feed the animal. The rabbit began eating on its own over the next few days and made a complete recovery.

This case was particularly challenging. Despite correct therapy with force-feeding, the rabbit did not improve. Radiographs suggested either a true obstruction, or a physiologic ileus. GI surgery is associated with high mortality; rabbits often survive the surgery only to die within a few days postoperatively. Cisapride or metoclopramide therapy can be useful to stimulate GI motility. However, if a true obstruction is present, their use is contraindicated. The lack of palpable obstruction, the lack of a radiopaque area suggestive of obstruction on the radiograph, and the apparent slight improvement in the rabbit's attitude suggested physiologic ileus rather than true obstructive disease. Although the radiographic patterns usually indicate a "surgical abdomen" in most pets, they make for a therapeutic dilemma when treating rabbits.

Treating Avian Aspergillosis

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(University of Miami) most helpful. I prefer to use all of the tests when I suspect aspergillosis. If radiographic lesions are seen, endoscopic biopsy might allow for a culture test. Response to treatment is also useful if the clients decline certain tests.

Q. What is the recommended treatment (drugs and dosages, length of treatment, etc.)?

Dr. Morrisey: *I typically use a combination of topical administration (for tracheal lesions) or nebulization of amphotericin B and with systemic antifungals such as itraconazole (10 mg/kg PO q24hr), ketoconazole (25 mg/kg PO bid) or fluconazole (20 mg/kg PO bid). The nebulization is continued for several weeks, and the oral drugs are used for a minimum of 6 months. Itraconazole has been reported to cause anorexia and even death in African grey parrots and should not be given to this species.*

Dr. Worell: *Surgical debulking of granulomatous lesions and antifungal medications are useful. The fungicidal drug amphotericin B may be given intratracheally (1 mg/kg q8-12hr), intravenously (1.5 mg/kg q8-12hr for 3-5 days), or in a nebulizing solution (1 mg/g in water). These various methods can be used individually or at the same time. Two fungistatic drugs, itraconazole (10-20 mg/kg PO q12hr) and fluconazole (10-20 mg/kg PO q12hr), can also be used. Itraconazole has greater activity against aspergillosis and is preferred. Caution is advised when using this drug in African greys, because anorexia, lethargy, and occasionally death have been reported. (You might wish to decrease the dose or use fluconazole in greys.) Length of treatment varies but generally extends longer than 6 months.*

Q. How do you monitor the effectiveness of treatment? How do you know when the bird is "cured"?

Dr. Morrisey: *The effectiveness of treatment can be monitored by following the clinical signs and any abnormal results of diagnostic tests (blood work or radiographs). The use of the antigen/antibody tests may prove useful for this in the future, but there is not enough information to date. Treatment is continued for a minimum of 6 months and then 2 to 4 months after the clinical or diagnostic tests have become normal.*

Dr. Worell: *This is challenging. Return to normal function (weight gain, etc.) and improvement in laboratory tests are important. Determining the exact endpoint can be difficult, because even birds that show improvement may still be infected. I generally recommend treatment for 1 month longer than the point at which the bird is deemed "improved" by clinical signs or diagnostic testing.*

FROM THE LITERATURE

Lymphoma in a Ferret

Shawn Messonnier, D.V.M.

An 1-kg, 8-year-old spayed female ferret *(Mustela putorius furo)* was referred for generalized progressive pruritus of 4 month's duration. The dermatitis failed to respond to ivermectin, antibiotics, and corticosteroids. Cutaneous epitheliotrophic lymphoma was diagnosed on biopsy. Treatment with prednisolone resulted in moderate reduction in pruritus with worsening of the dermatitis and alopecia. Blood testing and urinalysis also revealed renal disease and bacterial cystitis. Treatment for the lymphoma included isotretinoin, and the cystitis was treated with amoxicillin and clavulanate potassium. The skin improved markedly by 60 days; however, the renal disease had progressed to renal failure and the ferret was euthanized.

Rosenbaum MR, Affolter VK, Usborne AL, et al: Cutaneous epitheliotrophic lymphoma in a ferret. *J Am Vet Med Assoc* 209:1441-1444, 1996.

Editor's Note: Lymphoma is a common neoplasia of the pet ferret, although the skin form is rare. The disease discussed here is similar to mycosis fungoides in people. This case demonstrates the value of a good workup in determining the cause of a nonresponsive dermatosis. For help with treatment, consultation with an oncologist can be quite valuable.

HOW I ...

Treat Prey Bites in Snakes

Shawn Messonnier, D.V.M.

A popular method of feeding snakes is to offer live prey. Although this is usually acceptable, occasionally the prey item might actually attack the snake, causing damage that can range from mild to severe. At times, death can occur as a result of the wound.

Prey attacks on snakes most commonly occur in 2 scenarios. Either the snake is not hungry, does not strike the prey, and the prey attacks the snake; or the snake may strike the prey but not properly hold it, in which case the snake is attacked as the prey tries to defend itself.

The most common type of bites that occur in my practice are directed toward the head and first quarter of the snake. Treatment depends on the severity of the wound. Mild wounds can be débrided and sutured under anesthesia. I typically anesthetize the snake with isoflurane and suture with absorbable material in an everting pattern. Sutures are removed in 6 weeks. Antibiotics are given as needed.

More severe bites or non-healing chronic wounds require more aggressive therapy, débridement, and prolonged antibacterial therapies. Aerobic and anaerobic cultures are done. Damage to the tongue can be severe, and removal or amputation of the affected part may be necessary.

Prevention is best accomplished by instructing owners to feed their snakes thawed frozen, stunned, or freshly killed prey from the moment the snake is purchased. If the snake refuses to eat anything other than live prey, advise as follows: Feed the prey item and observe the snake for 10 to 15 minutes to ensure the prey is killed and eaten. If the snake does not kill the prey, remove the prey and feed another time. Live prey should NEVER be left with an unobserved snake!

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neoplasms can be classified cytologically as epithelial (carcinomas), mesenchymal (sarcomas), or discrete-cell (round-cell) neoplasms.

Effusions

An abnormal accumulation of fluids in the body cavities can be classified as a transudative, modified transudative, exudative, hemorrhagic, malignant, or chylous effusion. Although they are important in mammals, chylous effusions have not been reported in birds and reptiles.

Transudates result from abnormal accumulation of normal body fluid. They are characterized by low levels of cellularity, specific gravity, and total protein, as well as the presence of a mixture of mesothelial cells and leukocytes (primarily monocytes and macrophages). Transudates may be range from colorless to a pale straw color and can be slightly turbid. Modified transudates resemble transudates with a higher cellularity and protein content. They occur as a result of long-standing transudative effusion.

Exudative effusions result from inflammatory processes and are characterized by high levels of cellularity, specific gravity, and protein content. Exudates vary in color and turbidity, are often viscous, may have a foul odor, and frequently clot during collection. The cellular characteristics of exudates depend on the cause but are inflammatory in appearance.

Hemorrhagic effusions are characterized by the presence of erythrocytes and macrophages demonstrating a variable amount of erythrophagocytosis. Malignant effusions may have features of modified transudates, exudates or hemorrhagic effusions with the presence of malignant cells.

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2. Montali RJ: Comparative pathology of inflammation in the higher vertebrates [reptiles, birds, mammals]. *J Comp Path* 99:1-26, 1988.

Client Teaching Guide

Bird

CARE SHEET

Amy B. Worell, D.V.M., Dipl. A.B.V.P.-Avian Specialist

Toucans

✔ **Place of Origin:** Mexico, Central and South America

✔ **Life Span in Captivity:** Ranges from 15 to 20 years

✔ **Predominant Subspecies in Captivity** — **Range of Body Weights**

•Toco toucan	450 to 650 g
•Keel-billed or sulfur-breasted toucan	300 to 450 g
•Red-billed toucan	450 to 650 g

✔ **Total Number of Species:** Approximately 33 to 43 species, depending on which birds are considered subspecies.

✔ **Characteristics of Toucans:** Although toucans do not talk, they do make a variety of sounds. Toucans are active birds that jump from branch to branch or perch to perch, so they need adequate space in their enclosure. Hand-fed toucans make good pets and are quite entertaining to watch. Young toucans being hand-fed enjoy playing with toys, and all toucans seem to "play" with their food in that they swallow the food and regurgitate it into the tip of their beak. Toucans have loose, messy droppings.

✔ **Common Medical Problems:** The most common medical problem affecting toucans is hemochromatosis, or iron storage disease. Affected birds may appear clinically healthy and then suddenly be found dead. The condition is definitively diagnosed by a liver biopsy.

✔ **Occasionally Encountered Medical Problems:** Diabetes mellitus occurs in some keel-bills and tocos. Chronic respiratory infections may occur involving the lower respiratory tract; these infections are not fatal but also not resolvable.

✔ **Incubation Period of Eggs:** 16 Days

✔ **Age Commonly Weaned:** The large toucans wean between 55 and 60 days; the smaller toucans wean between 45 and 50 days.

CASE REPORT

Quill Loss in a Hedgehog

Cathy A. Johnson-Delaney, D.V.M.

A 2-year old male African pygmy hedgehog (*Atelerix albiventris*) was brought in because of quill loss with bleeding and flaking. The hedgehog was kept in a heated aquarium with wood chip bedding and was fed a commercial cat food. At presentation, the hedgehog weighed 848 g and was considered obese. The skin of the mantle was flaking, and scales and crusts were present. Light stroking of the quills caused them to come loose with mild hemorrhage. The hedgehog was pruritic, and there was evidence of scratching with scabs and loss of quills. Differential diagnosis included ectoparasites, dermatophytosis, and secondary bacterial dermatitis.[1]

A skin scraping along with debris from the base of several quills revealed an abundance of mites, including numbers of adults, larvae, and eggs. Cytology did not show any fungal elements. A diagnosis of severe acariasis was made, with the most likely mite being *Caparinia tripilis*.[2] This psoroptid mite has been found to cause severe infestations in *A. albiventris* in New Zealand. The U.S. pet hedgehog founding stock was in large part imported from New Zealand, although a different *Caparinia* sp. mite has been found on *A. albiventris* in Africa (*Caparinia erinacei*).[2] *Caparinia* sp. do not affect humans.

Caparinia mites may burrow into a hedgehog's skin, causing surface skin lesions and crusting. Debilitating infestations with *Caparinia* sp. suggest that severe mange may decrease winter survival and may limit hedgehog populations at high densities.[2] A sarcoptid mange mite, *Notoedres muris* may also be found in mixed infestations with *C. tripilis*. Generally *Notoedres* sp. tunnel into the skin. With any mite infestation, symptoms may include pruritus, hair loss, spine loss, deformation of the ears, and scaly, encrusted skin lesions. Severe infestations in the ear canals may cause otitis and may result in decreased hearing if the dried exudates completely block the ear canals.[1]

Treatment for this particular hedgehog was initiated with ivermectin (Ivomec 1%) at 0.2 mg/kg subcutaneously.[1,3] The owner was instructed to thoroughly clean the hedgehog's tank, remove the wood chip bedding, and replace it with either a recycled paper product or just paper towels that could be changed on a daily basis during treatment. Generally, the administration of ivermectin 2 to 3 times every 10 to 14 days is effective in the elimination of mites. The owner did not bring the hedgehog in for the next treatment.

Three months later, the hedgehog was given up for adoption, with the main complaint being that the skin marginally improved, but the animal now appeared deaf and the children could not play with him. The hedgehog did not respond to loud claps or a bell rung near it. Under isoflurane anesthesia, a thorough examination revealed complete occlusion of both ear canals with crusted exudate. A repeated skin scraping revealed a few mites. A fungal culture was taken, and material was examined for fungal elements. The culture eventually was negative, and no fungal elements were seen on cytology. [Hedgehogs have been diagnosed with *Trichophyton mentagrophytes* var. *erinacei* (*T. erinacei* alternate nomenclature), as well as *Arthrodermia benhamiae* and *Microsporum* sp.[2,3] Most occurrences of ringworm in hedgehogs are only mildly pathogenic, and many infections are subclinical.[1,3]]

The ears were gently cleaned with Cerumite (Evsco Pharmaceuticals, Buena, NJ) on cotton swabs. Ivermectin was administered subcutaneously at 0.4 mg/kg. This dosage was repeated in 2 weeks, at which time the ears were also retreated with Cerumite, although they appeared clean under otoscopic magnification. Two weeks later, a skin scraping tested negative for mites, and no clinical signs of infestation were seen.

It is notable that although the skin appeared normal, at necropsy 1 year later, evidence of deep fungal infection was seen in the skin samples. A skin biopsy may be the best way to determine whether the skin is truly clear of fungal infections.

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3. Hoefer HL: Hedgehogs. *Vet Clin North Am Small Anim Pract* 24:113-120, 1994.

Q&A

Answer by Shawn Messonnier, D.V.M.

What is a unique husbandry requirement for chinchillas to maintain healthy skin and coat?

A. regular brushing

B. supplementary vitamin C

C. regular dust baths

D. a high-protein diet

E. supplementary vitamin D

(C.) An important part of the grooming habits of chinchillas is access to a regular dust bath consisting of a 9:1 ratio of silver sand and Fuller's earth.

Readers: We welcome your questions, practice tips, and case reports. Please submit any materials to Susan Sibiski, Mosby, Inc., 7250 Parkway Drive, Suite 510, Hanover, MD 21076; susan.sibiski@mosby.com; (800) 345-8738; fax (410) 712-4424.

UPCOMING MEETINGS

Western Veterinary Conference, Las Vegas Hilton and Riviera Hotels, Las Vegas, NV; February 14-18. For information call (702) 739-6698; or e-mail <wvc@lvdi.net>.

Student American Veterinary Medical Association Symposium, Pullman, WA; March 18-20. Sponsored by Washington State University College of Veterinary Medicine & Oregon State University College of Veterinary Medicine. For information e-mail <loftis@vetmed.wsu.edu>.

Third World Congress on Alternatives and Animal Use in the Life Sciences, Bologna, Italy; August 29 to September 2. For information call (39) 332-789-889; or e-mail <prp@jrc.it>.

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