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CLINICAL CASES IN AVIAN & EXOTIC ANIMAL
HEMATOLOGY & CYTOLOGY



CLINICAL CASES IN AVIAN & EXOTIC ANIMAL HEMATOLOGY & CYTOLOGY

Clinical Cases in Avian & Exotic Animal Hematology & Cytology demonstrates how to use hemic cytology and cytodagnosis as part of the assessment of an exotic animal patient, taking the reader through nearly 100 actual clinical cases. Building on the knowledge gained in Terry Campbell's *Avian & Exotic Animal Hematology & Cytology*, the clinical case presentation of this book applies this knowledge, putting theory into practice. With a focus on cytological interpretation, the hands-on, practical approach facilitates learning, teaching, and comprehension.

Organized according to animal type and diagnostic focus, each case begins by presenting the signalment, history, physical exam findings, and other diagnostic information. In addition to the cases, clinical data, such as serum or plasma chemistry profiles, imaging, and histology, are also presented. The book then moves on to interpretive discussion, concluding with a summary describing how to use the techniques in clinical practice.

Illustrated throughout, *Clinical Cases in Avian & Exotic Animal Hematology & Cytology* is a helpful guide for exotics veterinarians, zoo and aquarium veterinarians, and veterinary hematologists.

FEATURES:

- Provides real-life examples for using cytology and hematology to diagnose exotic patients
- Provides nearly 100 clinical cases to demonstrate the principles covered in *Avian & Exotic Animal Hematology & Cytology*
- Provides a practical application of the basic theories and principles
- Helps students and practitioners in learning, teaching, and comprehending the cytological interpretation
- Uniquely formatted cases present the full case, from signalment and history to interpretative discussion and a summary
- Illustrated with many clinical photographs illustrating the concepts mentioned within the book

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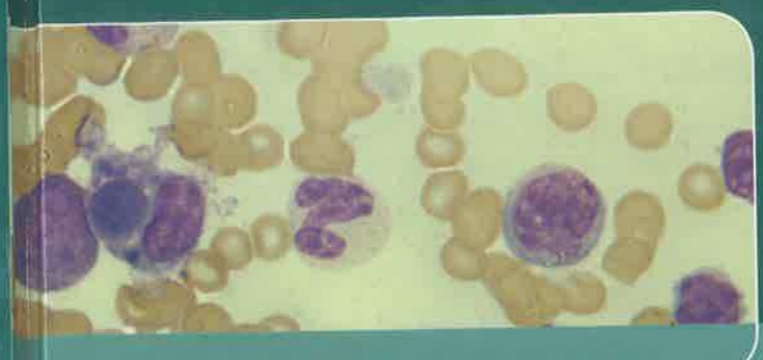
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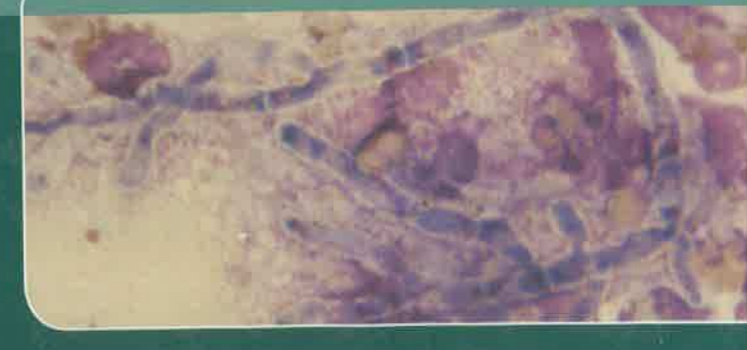
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TERRY W. CAMPBELL & KRISTAN R. GRANT



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**Clinical Cases in Avian and Exotic Animal
Hematology and Cytology**



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TERRY W. CAMPBELL
and
KRYSTAN R. GRANT

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Lewbart GA. 2005. Fish. In *Exotic Animal Formulary*, 3rd ed., edited by Carpenter J. St. Louis, MO: Elsevier Saunders, p. 24.

Magi GE, Iannaccone M, Gili C, Rossi C. 2009. Cardiac cholesterol granuloma in a piper gurnard, *Trigla lyra* (L.). *Journal of Fish Disease* 32:473–475.

Marcos R, Santos M, Oliveira J, Vieira MJ, Vierira AL, Rocha E. 2006. Cytochemical detection of calcium in a case of calcinosis circumscripta in a dog. *Veterinary Clinical Pathology* 35:239–242.

Mulley RC. 1979. Haematology and blood chemistry of the black duck (*Anas superciliosa*). *Journal of Wildlife Diseases* 15:437–441.

Mulley RC. 1980. Haematology of the wood duck (*Chenoneta jubata*). *Journal of Wildlife Diseases* 16:271–273.

Mylniczzenko N. 2009. Amphibians. In *Manual of Exotic Pet Practice*, edited by Mitchell MA, Tully TN. St. Louis, MO: Saunders Elsevier, pp. 73–111.

Nevarez J. 2009. Lizards. In *Manual of Exotic Pet Practice*, edited by Mitchell MA, Tully TN. St. Louis, MO: Saunders Elsevier, pp. 164–206.

Noga EJ. 2000. *Fish Disease Diagnosis and Treatment*. Ames, IA: Blackwell Publishing.

Olson KR. 1999. Rectal gland and volume homeostasis. In *Sharks, Skates, and Rays the Biology of Elasmobranch Fishes*, edited by Hamlett WC. Baltimore, MD: The Johns Hopkins University Press, pp. 329–352.

Pessier AP, Nichols DK, Longcore JE, Fuller MS. 1999. Cutaneous chytridiomycosis in poison dart frogs (*Dendrobates* spp) and white's tree frogs (*Litoria caerulea*). *Journal of Veterinary Diagnostic Investigation* 11:194–199.

Pollack C, Carpenter JW, Antinoff, N. 2005. Birds. In *Exotic Animal Formulary*, 3rd ed., edited by Carpenter J. St. Louis, MO: Elsevier Saunders, p. 268.

Quesenberry KE, Donnelly TM, Hillyer EV. 2006. Biology, husbandry, and clinical techniques of guinea pigs and chinchillas. In *Ferrets, Rabbits, and Rodents Clinical Medicine and Surgery*, 2nd ed., edited by Quesenberry KE, Carpenter JW. Philadelphia, PA: WB Saunders.

Saunders DC. 1958. The occurrence of *Haemogregarina bigemina*, Laverna and Mesnil, and *H. dasyatus* N. sp. in marine fish from Bimini, Bahams, B.W.I. *Transactions of the American Microscopical Society* 77(4):404–412.

Schmidt RE, Reavill DR, Phalen DN. 2003. *Pathology of Pet and Aviary Birds*. Ames, IA: Wiley-Blackwell.

Schultze AE. 2000. Interpretation of canine leukocyte responses. In *Schalm's Veterinary Hematology*, 5th ed., edited by Feldman BF, Zinkl JG, Jain NC. Philadelphia, PA: Lippincott Williams & Wilkins, pp. 366–381.

Sedacca CD, Campbell TW, Bright JM, Webb BT, Aboelail TA. 2009. Chronic cor pulmonale secondary to pulmonary atherosclerosis in an African Grey parrot. *Journal of the American Veterinary Medical Association* 234:1055–1059.

Straub J, Pees M, Krautwald-Junghans M-E. 2002. Measurement of the cardiac silhouette in psittacines. *Journal of the American Veterinary Medical Association* 221:76–79.

Sykes JM, Garner MM, Greer LL, Lung NP, Coke RL, Ridgley F, Bush M, Montali RJ, Okimoto B, Schmidt R, Allen JL, Rideout BA, Pesavento PA, Ramsay EC. 2007. Oral eosinophilic granulomas in tigers (*Panthera tigris*)—a collection of 16 cases. *Journal of Zoo and Wildlife Medicine* 38(2):300–308.

Thrall MA. 2004. Erythrocyte morphology. In *Veterinary Hematology and Clinical Chemistry*, edited by Thrall MA. Philadelphia, PA: Lippincott Williams & Wilkins, pp. 69–82.

Walker D. 1999. Peripheral blood smears. In *Diagnostic Cytology and Hematology of the Dog and Cat*, edited by Cowell RL, Tyler RD, Meinkoth JH. St. Louis, MO: Mosby, Inc., pp. 254–283.

Wildgoose WH. 1998. Twelve-month study of ulcer disease in a pond of koi carp (*Cyprinus carpio*). *Fish Veterinary Journal* 2:13–28.

Williams BH, Weiss CA. 2004. Neoplasia. In *Ferrets, Rabbits and Rodents*, 2nd ed., edited by Quesenberry KE, Carpenter JW. Philadelphia, PA: WB Saunders, pp. 91–106.

Zinkl JG. Avian hematology. 1986. In *Shalm's Veterinary Hematology*, 4th ed., edited by Jain NC. Philadelphia, PA: Lea & Febiger, pp. 256–273.

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