JAVMA

AVMA

Diagnosis and treatment of *Candida glabrata* proventriculitis in an eclectus parrot (*Eclectus roratus*)

Kyra J. Berg, DVM[1]; David Sanchez-Migallon Guzman, LV, MS[2]*; Joanne Paul-Murphy, DVM[2]; Michelle G. Hawkins, VMD[2]; Barbara A. Byrne, DVM, PhD[3]

[1]William T. Pritchard Veterinary Medical Teaching Hospital, School of Veterinary Medicine, University of California-Davis, Davis, CA
[2]Department of Medicine and Epidemiology, School of Veterinary Medicine, University of California-Davis, Davis, CA
[3]Department of Pathology, Microbiology and Immunology, School of Veterinary Medicine, University of California-Davis, Davis, CA

*Corresponding author: Dr. Sanchez-Migallon Guzman (guzman@ucdavis.edu)

https://doi.org/10.2460/javma.20.12.0670

CASE DESCRIPTION
An 8-year-old sexually intact female eclectus parrot (*Eclectus roratus*) with a 4-day history of hyporexia and lethargy and a 1-day history of tenesmus was examined.

CLINICAL FINDINGS
Severe leukocytosis characterized by severe heterophilia and moderate monocytosis was present. Marked dilation of the proventriculus and ventriculus and ascites were identified by means of radiography, coelomic ultrasonography, and contrast-enhanced CT, with no clinically relevant motility noted on ultrasonography. Results of coelomic fluid analysis were consistent with pyogranulomatous effusion. Endoscopy of the upper gastrointestinal tract following proventricular and ventricular lavage showed a thick caseous plaque occupying 30% of the caudal proventricular mucosa. Abundant yeast organisms were evident during cytologic examination of a proventricular and ventricular wash sample, and fecal culture yielded *Candida glabrata*.

TREATMENT AND OUTCOME
The bird was treated with SC fluids, assisted feedings, nystatin, fluconazole, amoxicillin–clavulanic acid, enrofloxacin, gastroprotectants, maropitant, and analgesics and slowly improved during hospitalization. A marked decrease in proventricular dilation was evident on serial radiographs obtained over a 12-month period. One year after diagnosis, the bird was presented with a 1-week history of hyporexia and lethargy, and fecal culture grew *C glabrata*. Antifungal treatment was resumed for 3 months. The bird had no clinical signs of infection 16 months after this recurrence, and subsequent fecal cultures were negative for fungal growth.

CLINICAL RELEVANCE
Findings illustrate the importance of upper gastrointestinal endoscopy in diagnosing proventricular and ventricular dilation in birds and emphasize the need for long-term antifungal treatment and monitoring in birds with fungal infections.

An 8-year-old sexually intact female eclectus parrot (*Eclectus roratus*) was presented for emergency evaluation because of a 4-day history of hyporexia and lethargy and a 1-day history of tenesmus. The bird had a history of undergoing episodes of hypocalcemia and dystocia, with the most recent episode having occurred 2 years earlier, and a history of obesity. On physical examination, the bird was bright, alert, and responsive. It weighed 0.45 kg and had a body condition score of 8/9. Mildly increased air sac sounds were noted on auscultation, and the vent was mildly everted and inflamed. A soft, convex, and distended coelom was noted by palpation, but no obvious masses were noted. The remainder of the physical examination was unremarkable. The bird was housed in a cage in a heated room and could freely roam the house when the owners were home. A white, hard plastic board was behind the cage to prevent the bird from chewing on the wall. The daily diet consisted of various fruits and vegetables (1 whole kiwi, 8 to 10 blueberries, 8 to 10 blackberries, apple slices, and brussels sprouts), almonds if nuts were provided, a half tablespoon of seeds, and 2 parrot food pellets (Nutri-berries; Lafeber).

On the day of presentation (day 1), a blood sample was collected from the right jugular vein under manual restraint. Hematologic findings included severe leukocytosis, severe heterophilia, moderate monocytosis, and hyperfibrinogenemia **(Table 1)**. Plasma biochemical abnormalities consisted of mildly high creatine kinase enzyme activity, mild hypophosphatemia, mild hypokalemia, and mild hypoalbuminemia. Plasma lead concentration measured with a point-of-care analyzer (Lead Care II; Magellan Diagnostics Inc) was below the lower limit of detection. The bird was hospitalized and provided supportive care including lactated Ringer so-

Table 1—Hematologic and plasma biochemical abnormalities in an 8-year-old sexually intact female eclectus parrot (*Eclectus roratus*) with presumptive severe proventricular candidiasis secondary to *Candida glabrata*.

Variable	Day 1	Day 3	Day 22	Day 155	Reference range[1,2]
WBCs (X 10^3 cells/µL)	56.44	17.89	16.67	11.33	9–15
Heterophils (X 10^3 cells/µL)	49.11	14.13	9.50	7.14	5.75–8.75
Monocytes (X 10^3 cells/µL)	3.39	2.15	2.83	0.79	0–0.125
Fibrinogen (mg/dL)	400	400	300	200	100–280
Creatine kinase (U/L)	377	5,100	282	282	118–345
Aspartate transaminase (U/L)	168	1,187	208	195	148–378
Phosphorus (mg/dL)	2.4	3.2	2.2	2.4	2.9–4.3
Potassium (mEq/L)	2.5	3.3	3.2	2.9	3.5–4.3
Total protein (g/dL)	3.8	3.0	3.5	3.9	3.0–5.0
Albumin (g/dL)	1.1	0.8	1.2	1.4	1.23–2.26

Day 1 refers to the day of initial presentation and the first day of hospitalization. Day 3 refers to the third day of hospitalization, when crackles were auscultated. Days 22 and 155 refer to days when owners reported normal behavior and activity in the bird. The reference range for fibrinogen concentration is specific for African grey parrots (*Psittacus erithacus*).[1,2]

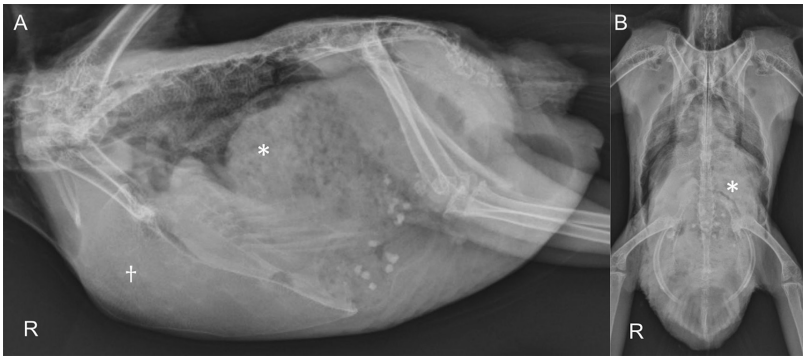

Figure 1—Right lateral (A) and ventrodorsal (B) radiographic views of an 8-year-old sexually intact female eclectus parrot (*Eclectus roratus*) that was presented for evaluation of nonspecific clinical signs of illness. The ratio of the diameter of the proventriculus (asterisk) to the height of the keel (cross) was 1.84, indicating a severely enlarged proventriculus.

lution (50 mL/kg, SC, q 12 h), calcium gluconate (75 mg/kg, SC, q 24 h for 2 days), meloxicam (1.5 mg/kg, PO, q 12 h), amoxicillin–clavulanic acid (125 mg/kg, PO, q 12 h), and gavage feeding with an intensive care diet (Emeraid IC Omnivore; Emeraid LLC; 10 mL, PO, q 8 h). The bird's body condition score remained static throughout hospitalization.

On day 2, the bird was sedated with midazolam (0.5 mg/kg, IM) and butorphanol (1.5 mg/kg, IM). Orthogonal whole-body radiographs were obtained, and marked dilation of the proventriculus with a proventriculus-to-keel ratio of 1.84 was identified **(Figure 1)**. Coelomic ultrasonography confirmed dilation of the proventriculus and ventriculus with heterogeneous echogenic material, some of which had associated hard shadowing; a partial mechanical obstruction was suggested. The proventriculus width was 2.5 cm on ultrasonographic images. No clinically relevant motility was noted in the proventriculus or ventriculus, but normal motility of the small intestine was appreciated. There was a moderate volume of mildly echogenic free coelomic fluid, and fine-needle aspiration of the free fluid was performed. Results of cytologic examination of the coelomic fluid were consistent with a pyogranulomatous exudate; no infectious agents or overtly neoplastic cells were observed. Aerobic and anaerobic culture of the coelomic fluid grew very small numbers of *Enterococcus faecalis* susceptible to amoxicillin–clavulanic acid, ampicillin, chloramphenicol, doxycycline, and tetracycline.

Following ultrasonography, the bird was anesthetized and intubated, and anesthesia was maintained with isoflurane and oxygen via mechanical ventilation. An IV catheter was placed in the left ulnar vein to facilitate administration of lactated Ringer solution (10 mL/kg/h, IV). Anesthetic depth was assessed by monitoring heart rate, respiratory rate, cloacal temperature, oxygen saturation (as determined by pulse oximetry), and an ECG. Thermal support was provided throughout the procedure. Gastroscopy with a 2.7-mm X 18-cm, 30° telescope (Hopkins Rigid Telescope; Karl Storz Veterinary Endoscopy America Inc) and a 3.5-mm protective sheath was performed via the oral approach, and white fluffy material was seen adhered to mucosa of the crop, esophagus, and proventriculus. The crop, esophagus, and proventriculus were lavaged with warm sterile saline (0.9% NaCl) solution; large numbers of budding yeast organisms were evident on cytologic examination of a proventricular fluid sample **(Figure 2)**. Owing to the oral approach that was used, the large amount of fluid in the proventriculus, and the requirement to limit anesthesia time for this critical patient, complete visualization of the proventriculus, isthmus, and ventriculus was not possible, and foreign object obstruction could not be ruled out on the basis of endoscopic finding. Anesthesia was reversed with flumazenil (0.05 mg/kg, IM), and recovery from anesthesia was unremarkable. After the bird recovered from anesthesia, supportive care with lac-

tated Ringer solution, amoxicillin–clavulanic acid, and gavage feeding was continued, but administration of meloxicam and calcium gluconate was discontinued. Additional treatments included enrofloxacin (10 mg/kg, SC, q 12 h), sucralfate (25 mg/kg, PO, q 12 h), and fluconazole (6 mg/kg, PO, q 12 h).

On day 3, crackles attributable to the endoscopic procedure were auscultated in the caudal abdominal air sacs, and evidence of regurgitation was present in the cage. Feces were scant and without odor. The bird weighed the same (0.45 kg). Hematologic findings at that time included improving leukocytosis, heterophilia, and monocytosis, but unchanged hyperfibrinogenemia (Table 1). Plasma biochemical findings included a low-normal total protein concentration, progressive hypoalbuminemia, a moderate increase in aspartate transaminase enzyme activity, a mild to moderate increase in creatine kinase enzyme activity, and resolution of the hypokalemia and hypophosphatemia. Nebulization with amikacin (1 mg/mL for 10 minutes, q 8 h, for 2 days) and oxygen support were provided for 2 days to increase local antibacterial concentrations in the respiratory tract, after which time the bird was no longer oxygen dependent and both treatments were discontinued. Over the next 4 days, supportive care with lactated Ringer solution, amoxicillin–clavulanic acid, gavage feeding, enrofloxacin, sucralfate, and fluconazole was continued. Additional treatments added at this time included nystatin (400,000 U/kg, PO, q 12 h), ranitidine (1 mg/kg, SC, q 24 h), and maropitant (1 mg/kg, SC, q 24 h). The nystatin was administered because of its local antifungal effects.

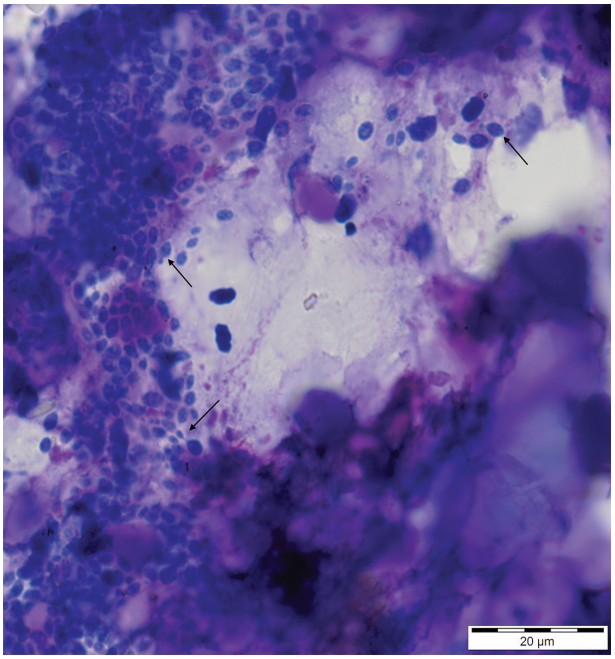

Figure 2—Photomicrograph of a cytologic preparation of a proventricular wash sample. Notice the large number of yeast organisms, some of which were budding (arrows). Wright Giemsa stain; bar = 20 µm.

The finding of a large amount of fluid in a severely distended proventriculus raised concerns regarding possible proventricular and ventricular outflow obstruction. Therefore, after continued stabilization of the bird's condition, advanced diagnostic testing was pursued on day 8. At this time, the bird weighed 0.43 kg, representing a 3.3% decrease from the time of presentation. The bird was sedated with midazolam (1 mg/kg, IM) and butorphanol (1.5 mg/kg, IM). Anesthesia was induced, maintained, and monitored and thermal support was provided as previously described. An intraosseous catheter was placed in the left ulna to facilitate administration of lactated Ringer solution (10 mL/kg/h, intraosseous). Computed tomography with nonionic iopamidol (Isovue-370; Bracco Diagnostics; 0.5 mL, intraosseous) revealed persistent marked proventricular and ventricular dilation with concurrent variable small intestinal and cloacal dilation and a moderate accumulation of free coelomic fluid **(Figure 3)**. No gastrointestinal wall thickening, focal contrast enhancement, or mechanical or functional gastrointestinal obstruction was identified.

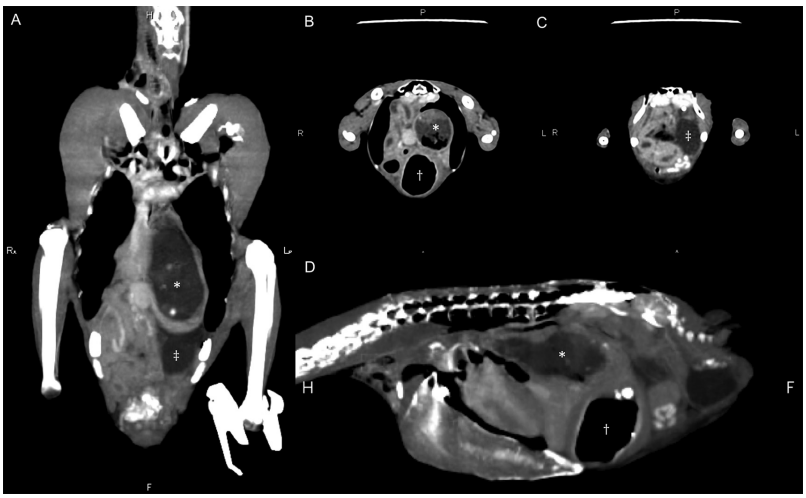

Figure 3—Coronal (A), transverse (B and C), and sagittal (D) multiplanar reconstructed CT images. The proventriculus (asterisk) is severely dilated with fluid, the ventriculus (cross) is severely dilated with gas, and free fluid is present in the coelom (arrow).

Repeated lavage and endoscopy of the upper gastrointestinal tract revealed a white plaque occupying approximately 30% of the caudal aspect of the proventricular mucosa **(Figure 4)**. Although the plaque was extensive, it did not extend into the crop or esophagus. An approximately 2 X 2-mm esophageal ulcer was present, which was attributed to the previous endoscopic procedure. Proventricular and ventricular lavage with warm sterile saline solution yielded seeds and approximately 6 to 8 hard white plastic pieces that were 2 to 3 mm in diameter. Recovery from anesthesia was uneventful, and supportive care was continued as previously described. Cytologic examination of a proventricular wash sam-

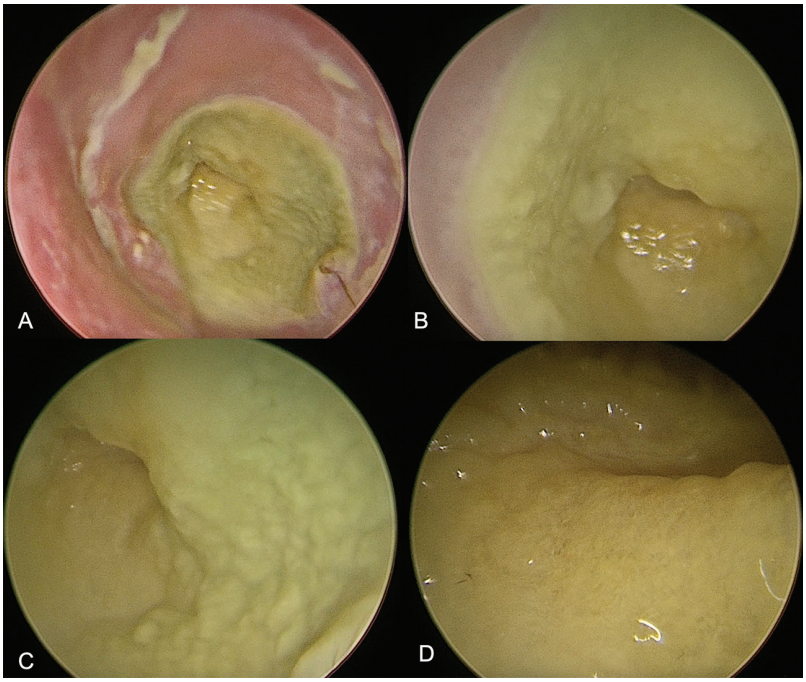

Figure 4—Intraluminal endoscopic image of the proventriculus. Notice the large plaque occupying approximately 30% of the proventriculus (A), with raised components of the plaque characteristic of candidiasis (B through D). Proventricular lavage revealed large numbers of budding yeast organisms.

ple was not repeated, but cytologic examination and fungal culture of a fecal sample were performed. Moderate numbers of budding yeast organisms were evident on cytologic examination of the fecal sample. Fungal culture grew very small numbers of a fungal organism that was identified as *Candida glabrata* on the basis of Gram staining, a hyphal formation test, a urea test, and a yeast identification strip (API 20C AUX; bioMerieux). Minimum concentrations (Fungus Testing Laboratory; University of Texas) of nystatin and fluconazole that inhibited growth of the isolate were 2 and 32 µg/mL, respectively. Given the clinical signs, endoscopic findings, persistence of yeast in both proventricular-ventricular wash samples, results of fecal cytology, and isolation of *C glabrata* from feces, a diagnosis of severe fungal proventriculitis was made.

On day 11, the bird began to eat small amounts of seed and fruit on its own and was considered adequately hydrated. Ranitidine, lactated Ringer solution, enrofloxacin, and maropitant were discontinued. The bird's weight was unchanged from day 8, and the bird was discharged on day 13 with prescriptions for amoxicillin–clavulanic acid (125 mg/kg, PO, q 12 h for 21 days), sucralfate (25 mg/kg, PO, q 12 h for 21 days; to be administered 1 hour before or 2 to 3 hours after all other medications), fluconazole (6 mg/kg, PO, q 12 h for 21 days), and nystatin (400,000 U/kg, PO, q 12 h for 21 days). The owners were told to monitor the bird's weight twice daily; convert to a diet consisting mainly of pelleted feed; remove all chewable plastics, including the wall covering; and return the bird for a recheck examination in 1 week.

On day 22, the bird was returned for a recheck examination. The owners reported good compliance with the medication regimen, improving appetite, and improving activity levels. The bird weighed 0.45 kg and had a body condition score of 8/9. Hematologic findings at that time included nearly resolved leukocytosis, nearly resolved heterophilia, mildly progressive monocytosis, and normal fibrinogen concentration. Plasma biochemical findings included normal total protein and albumin concentrations and normal aspartate transaminase and creatine kinase activities (Table 1). The bird was discharged the same day with owner recommendations to continue medications until instructed otherwise by a veterinarian, convert to a diet consisting mainly of pelleted feed, and maintain monthly recheck examinations.

On day 36, the owners discontinued amoxicillin–clavulanic acid and sucralfate but continued administration of fluconazole and nystatin. Two months after initial presentation (day 57), the bird was presented for emergent evaluation of a 1-day history of lethargy and inappetence. The owners had discontinued all medications without veterinary advice at least 4 days earlier. The bird weighed 0.47 kg and had a body condition score of 8/9; no other physical examination abnormalities were noted. The bird was hospitalized overnight for SC administration of lactated Ringer solution and gavage feeding as previously described. Results of hematologic and plasma biochemical analyses were unremarkable. Cytologic examination of a fecal sample did not show any yeast organisms, and standard orthogonal whole-body radiographs revealed a proventriculus-to-keel ratio of 0.92, improved coelomic serosal detail, and resolved ascites. The bird was discharged with instructions to resume fluconazole and nystatin and to return the bird for a recheck examination in 1 month.

The owners were contacted 2 months later (day 125). The fluconazole and nystatin had been discontinued by the owners 1 month earlier, but the bird was reported to have normal activity, appetite, and behavior at home. One month later (day 155), the bird was presented for a recheck examination. Standard orthogonal whole-body radiographs revealed static width of the proventriculus and a static proventriculus-to-keel ratio; results of hematologic and plasma biochemical analyses were unremarkable (Table 1). Cytologic examination of a fecal sample did not reveal any yeast organisms, and fecal fungal culture did not yield any growth. No medications were prescribed or recommended at this time.

The bird was presented for a wellness examination 1 year after initial presentation (day 365). No abnormalities were reported by the owner, and physical

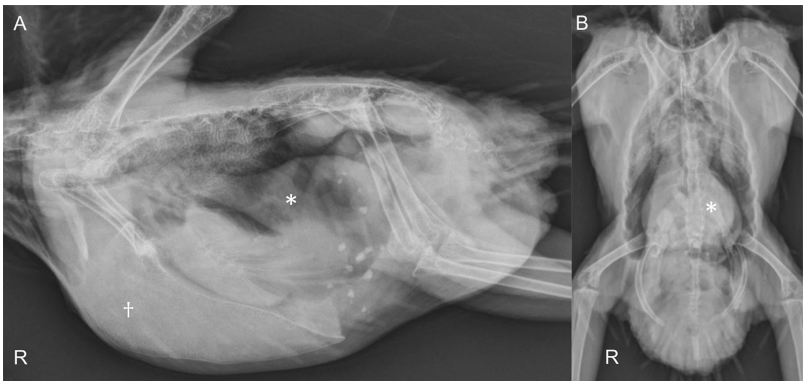

Figure 5—Right lateral (A) and ventrodorsal (B) radiographic images obtained approximately 13 months after the initial diagnosis. The proventriculus (asterisk)-to-keel (cross) ratio was 0.92.

examination was unremarkable excluding an increased body weight of 0.55 kg (22% increase from initial presentation) and increased body condition score of 9/9. Conversion to a pellet-based diet and close monitoring for intended weight loss were again recommended. On day 386, the bird was presented for emergent evaluation of a 1-week history of hyporexia and lethargy. Standard orthogonal whole-body radiographs revealed static width of the proventriculus and a static proventriculus-to-keel ratio **(Figure 5)**. Results of hematologic and plasma biochemical analyses were unremarkable. No abnormalities were identified on cytologic examination of crop and fecal samples. Fecal fungal culture grew very small numbers of *C glabrata*; minimum inhibitory concentrations of nystatin and fluconazole were 4 and 16 µg/mL, respectively. Treatment with nystatin and fluconazole was resumed as previously prescribed. Two months later (day 446), the owners reported the bird to have resumed normal activity, behavior, and appetite; the owners had elected to discontinue the antifungal treatments without veterinary consultation 1 month earlier. Twenty-one months after initial presentation (day 617), 3 fecal samples submitted over a 3-week period for cytologic examination showed rare budding yeast, no yeast, and no yeast, respectively. Portions of the same 3 fecal samples were also submitted for fungal culture, and no yeast species were grown. Twenty-nine months after initial presentation (day 884) and 16 months after the suspected recurrence, the owners report that the bird appeared clinically normal.

Discussion

Findings for the bird described in the present report highlight the importance of upper gastrointestinal endoscopy in diagnosing proventricular and ventricular dilation in birds and emphasize the need for long-term antifungal treatment and monitoring in birds with fungal infections. Furthermore, this case demonstrated that severe proventricular candidiasis can cause radiographic, ultrasonographic, and CT evidence of severe proventricular dilation and should be considered in the differential diagnosis of proventricular dilation.

Candidiasis in birds may be due to *Candida albicans* or a non–*C albicans* species. Non–*C albicans* species may be a normal component to the avian microbiota,[3–6] but can also be primary pathogens.[7,8] Candidiasis may occur secondary to stress, immunosuppression, long-term antimicrobial administration, nutritional deficiencies, overcrowding, poor hygiene, dysbiosis, and other disease processes that disrupt the mucosa of the gastrointestinal tract.[3,7] Candidiasis in birds frequently results in necrosis, ulceration, and pseudomembrane formation in the upper gastrointestinal tract,[9] with occasional proventricular involvement when coinfections or severe comorbidities are present.[10] The bird described in the present report did not appear to have an underlying immunosuppressive event that may have triggered the proventricular candidiasis. Also, the owners reported no change in the bird's at-home environment, and the last visit to a veterinarian had occurred 6 months prior to the initial presentation. The bird was reported to be clinically abnormal at home 4 days prior to examination at the hospital; therefore, although hospital-induced stress may have exacerbated the disease process, it was highly unlikely to have been the inciting cause. It was also unlikely that dietary vitamin A deficiency played a role, because, according to the diet description given by the owners, seeds were a small component of the bird's diet. In-hospital antimicrobial administration was not considered a contributor to the bird's severe proventricular candidiasis given the severity of the infection and the fact that antimicrobial treatment was initiated only 2 days prior to the first endoscopic procedure. The plastic pieces originating from the board placed behind the cage to protect the wall that were removed from the proventriculus during the second endoscopic procedure could have contributed to the development of candidiasis through physical irritation as well as disruption of proventricular-ventricular pH, flora, or motility.

Hematologic and biochemical assessment may aid in determining the severity of disease in birds. The changes in plasma biochemical analyses in the bird of the present report were associated with inappetence and IM injections; the hypoalbuminemia may have reflected an acute negative phase response.[11] The bird's hematologic changes further supported the severity of the proventricular candidiasis and provided a novel differential diagnosis for such severe hematologic changes.

Making a diagnosis of gastrointestinal candidiasis in birds may be challenging given the organism's ubiquitous and opportunistic nature, but a diagnosis can be obtained through cytologic or histologic examination and fungal culture. The presence of pseudohyphae and budding yeast-like organisms in conjunction with clinical signs are supportive of *Candida*

overgrowth, and seeing high numbers of organisms on cytologic examination is considered diagnostic.[8] The bird of the present report underwent extensive diagnostic testing, the results of which were clearly consistent with and supportive of *C glabrata* proventriculitis. Given the diagnostic findings and the lack of results suggestive of other causes, the authors were confident of the diagnosis at the time, which became more certain with the long-term treatment, follow-up, and response. If this eclectus parrot had had another disease, such as avian ganglioneuritis, the clinical signs would have likely persisted or the bird would have died.

In avian species, standard survey radiography can aid in identifying proventricular and ventricular disease, and measurements of the organs of various bird species have been reported.[12–16] The proventriculus-to-keel ratio has been shown to be a sensitive indicator of proventricular disease in parrots, with a ratio > 0.52 associated with clinical proventricular disease.[14,17] In the bird of the present report, the radiographic proventriculus-to-keel ratio at initial presentation was 1.84. Ultimately, this bird stabilized at a proventriculus-to-keel ratio of 0.92, which was still much higher than the ratio reported for healthy noneclectus psittacines (< 0.5).[14,17] It has been suggested that eclectus parrots have a relatively large proventriculus in comparison with other parrot species,[16,18] but a literature review demonstrated a paucity of evidence to confirm this or provide an eclectus-specific proventriculus-to-keel ratio. Nevertheless, serial radiography revealed continued reduction of the proventriculus-to-keel ratio, suggesting that this may be a noninvasive, readily-available diagnostic modality to monitor improvement of proventricular candidiasis.

Ultrasonography can be used to characterize gastrointestinal abnormalities as well as differentiate between complete and partial obstruction in avian species,[19] and ultrasonographic descriptions of coelomic organs in healthy avian species, including psittacines, have been reported.[20,21] In the bird of the present report, the proventriculus was observed to be dilated during the ultrasonographic examination, and a lack of proventricular motility was noted. These findings were strongly suggestive of a proventricular disease process. Computed tomography provides fine anatomic resolution that is not possible with radiography because of tissue superimposition or difficult to achieve with ultrasonography owing to the presence of feathers and air sacs and allows visualization of structures that could remain obscure with other imaging modalities.[22–24] Several studies[22,24,25] have described specific CT anatomic features of several avian taxa, including psittacines. In the bird of the present report, CT determined the extent of the disease and ruled out obvious foreign object obstruction, infiltrative disease, reproductive disorders, and neoplasia. Use of a previously described atlas of the psittacine coelomic cavity[24] provided an objective assessment of proventricular and ventricular dilation in the bird of the present report. Computed tomography also allowed us to rule out the need for exploratory proventriculotomy and confirmed the recommendation for gastrointestinal endoscopy. Prior to this case report, *Candida* infection was not a documented differential diagnosis for severe proventricular dilation as determined by radiography, ultrasonography, or CT.

In contrast to a proventriculotomy, endoscopy can be a safe and minimally invasive technique for the diagnosis and treatment of proventricular and ventricular diseases in birds.[13,26] An oral approach for gastroscopy with proventricular and ventricular biopsy has been described in pigeons.[26] In the present case, endoscopy allowed direct visualization and documentation of the characteristic white plaque lesions caused by *Candida* spp.[8,27] Biopsy of the crop and esophagus were not performed endoscopically during the first procedure owing to the instability of the patient. During the second endoscopic procedure, the crop and esophageal plaques were no longer apparent. The presence of a few seeds during the second endoscopic procedure might have been a result of the bird ingesting seeds offered twice daily while hospitalized, with this food consumption having gone unnoticed. Although endoscopy is a well-established technique in avian medicine, endoscopic images of parrots with proventricular candidiasis have not, to our knowledge, been published before.

Proventricular biopsy via coeliotomy or endoscopy was considered in this case. Surgery of the proventriculus via coeliotomy is considered high risk in birds, especially in critical cases with ascites as was the case for the bird in the present report, because it can adversely impact ventilation and disrupt the integrity of the air sacs, leading to aspiration of fluid by the lungs. In addition, the lack of omentum in birds creates a higher risk of peritonitis as a result of leakage during gastrointestinal surgery.[28–30] Endoscopic proventricular biopsy was also considered a high-risk procedure for the bird in the present report owing to possible perforation of the severely dilated proventriculus and concerns regarding the integrity of the proventricular wall. Although proventricular biopsy could have provided further evidence to support the diagnosis, it was not believed to be necessary in this case.

Treatment of candidiasis involves supportive care in the form of supplemental fluids and feedings, gastroprotectants, analgesics, and antifungal administration. Most systemic fungal infections require weeks to months of treatment; however, owner and patient compliance may wane during prolonged treatment. Adverse antifungal effects may also occur. Specifically, the relative toxicity of azoles depends on the specificity for binding to the fungal cytochrome P450 enzyme, and avian species–specific sensitivities and pharmacokinetics have been previously documented.[31] In the bird of the present report, antifungal medications did not appear to have caused any adverse effects, such as nausea-like behaviors, regurgitation, inappetence, diarrhea, or increases in hepatic enzyme activities.

Empiric antifungal treatment in birds with fungal proventricular disease has had varying degrees of success, ranging from failure to control the infection

and death of the patient to complete resolution of clinical signs.[3,5,12,32] Even with susceptibility testing, selecting an appropriate antifungal to treat *C glabrata* can be challenging. In both humans and birds, *C glabrata* has shown increased antifungal resistance, compared with *C albicans*.[5,33–36] Furthermore, differences between in vitro versus in vivo efficacy of fluconazole and nystatin against *C glabrata* have been reported,[33] and there have been conflicting reports of resistance, intermediate dose-dependent susceptibility, and susceptibility of *C glabrata* to these 2 antifungal medications.[34–38] In the bird of the present report, empiric treatment with nystatin and fluconazole was initiated because of the severity of clinical signs, which necessitated immediate treatment, and cytologic results that indicated yeast overgrowth.

Antifungal susceptibility testing is available at select laboratories but is time-consuming and expensive, compared with bacterial susceptibility testing.[5] In addition, results of antifungal susceptibility testing must be interpreted cautiously given the unique drug-pathogen-patient complex of each disease process. Susceptibility testing results for the bird of the present report were interpreted to suggest that nystatin would be effective against the cultured *C glabrata*, but that fluconazole would not be. However, given differences between in vitro versus in vivo susceptibility and the improvement in clinical signs, fluconazole was continued in this bird. Furthermore, a recent case series[5] includes 3 birds with gastrointestinal *C glabrata* infections in which clinical signs resolved after administration of fluconazole alone or in combination with nystatin.

The duration of antifungal administration is likely case dependent because of unique host-pathogen relationships and may depend on serial diagnostic test results. In the present case, repeated CT or endoscopy to evaluate the proventriculus was declined by the owners. When repeating advanced diagnostic testing is not possible, consistent client communication with routine follow-up examinations and noninvasive diagnostic testing such as fecal cytology and fecal fungal culture are recommended. There are no published guidelines for determining when infection is considered resolved in birds with fungal gastrointestinal disease. For the bird in the present report, antifungals were administered for several months each time and for > 1 year cumulatively. Both veterinarians and owners should be aware of the challenges associated with treating proventricular candidiasis, especially given concerns regarding owner and patient compliance.

In summary, an eclectus parrot was presented for evaluation of nonspecific clinical signs of illness, and severe proventricular candidiasis secondary to *C glabrata* was ultimately diagnosed. Radiographic, ultrasonographic, and CT findings were consistent with severe proventricular dilation, which until now had only been associated anecdotally with this disease and should be considered as a differential diagnosis in the future. Upper gastrointestinal endoscopy was essential to directly visualize the characteristic gross lesions of candidiasis. Measurement of the radiographic proventriculus-to-keel ratio, fecal cytology, and fecal fungal culture were valuable noninvasive diagnostic tests. Non–*C albicans* species, especially *C glabrata*, are increasingly reported to have antifungal resistance in both birds and humans, presenting clinical challenges. Antifungal treatment after the initial diagnosis and subsequent recurrence resulted in resolution of the disease, highlighting the need for long-term treatment and monitoring in cases of severe infection.

Acknowledgments

No third-party funding or support was received in connection with this study or the writing or publication of the manuscript. The authors declare that there were no conflicts of interest. We would like to thank Dr. Flavio de Alonso for providing the image for Figure 2.

References

1. Fudge A, Speer BL. Appendix 2—normal clinical pathologic data. In: Speer BL, ed. *Current Therapy in Avian Medicine and Surgery*. Elsevier; 2016:825–855.
2. Hawkey C, Hart MG. An analysis of the incidence of hyperfibrinogenaemia in birds with bacterial infections. *Avian Pathol*. 1988;17(2):427–432.
3. Pennycott TW, Duncan G, Venugopal K. Marek's disease, candidiasis and megabacteriosis in a flock of chickens (*Gallus domesticus*) and Japanese quail (*Coturnix japonica*). *Vet Rec*. 2003;153(10):293–297.
4. Quist EM, Belcher C, Levine G, Heatley JJ, Kiupel M, Giri D. Disseminated histoplasmosis with concurrent oral candidiasis in an eclectus parrot (*Eclectus roratus*). *Avian Pathol*. 2011;40(2):207–211.
5. Donnelly KA, Wellehan JFX Jr, Quesenberry K. Gastrointestinal disease associated with non-*albicans Candida* species in six birds. *J Avian Med Surg*. 2019;33(4):413–418.
6. Brilhante RSN, Castelo-Branco DSCM, Soares GDP, et al. Characterization of the gastrointestinal yeast microbiota of cockatiels (*Nymphicus hollandicus*): a potential hazard to human health. *J Med Microbiol*. 2010(pt 6);59:718–723.
7. Hubbard GB, Schmidt RE, Eisenbrandt DL, Witt WM, Fletcher KC. Fungal infections of ventriculi in captive birds. *J Wildl Dis*. 1985;21(1):25–28.
8. Reavill DR, Dorrestein G. Psittacines, Coliiformes, Musophagiformes, Cuculiformes. In: Terio KA, McAloose D, St Leger J, eds. *Pathology of Wildlife and Zoo Animals*. Academic Press; 2018:775–798.
9. Nouri M, Kamyabi Z. Occurrence of ventricular candidiasis in a lovebird (*Agapornis fischeri*). *Iran J Vet Sci Technol*. 2010;2(1):51–56.
10. Muir M, Raidal SR. Necrotizing ventriculitis due to combined infection with *Rhizopus microspores* var. *chinensis* and *Candida krusei* in an eclectus parrot (*Eclectus roratus*). *Aust Vet J*. 2012;90(7):277–280.
11. Delk KW, Wack RF, Burgdorf-Moisuk A, Kass PH, Cray C. Acute phase protein and electrophoresis protein fracture values for captive American flamingos (*Phoenicopterus ruber*). *J Zoo Wildl Med*. 2015;46(4):929–933.
12. De Voe R, Degernes L, Karli K. Dysplastic koilin causing proventricular obstruction in an eclectus parrot (*Eclectus roratus*). *J Avian Med Surg*. 2003;17(1):27–32.
13. Cotton III RJ, Divers SJ. Endoscopic removal of gastrointestinal foreign bodies in two African grey parrots (*Psittacus erithacus*) and a hyacinth macaw *(Anodorhynchus hyacinthinus). J Avian Med Surg*. 2017;31(4):335–343.
14. Dennison SE, Adams WM, Johnson PJ, Yandell BS, Paul-Murphy JR. Prognostic accuracy of the proventriculus: keel ratio for short-term survival in psittacines with proventricular disease. *Vet Radiol Ultrasound*. 2009;50(5):483–486.
15. Rettmer H, Deb A, Watson R, Hatt J-M, Hammer S. Radio-

graphic measurement of internal organs of Spix's macaws (*Cyanopsitta spixii*). *J Avian Med Surg*. 2011;25(4):254–258.
16. Geerinckx L, Van der Vekens E, Saunders JH, Lautenschläger I, Van Caelenberg AIL. Literature review of radiographic measurements of internal organs in Psittaciformes. *J Exot Pet Med*. 2018;28:60–68.
17. Dennison SE, Paul-Murphy JR, Adams WM. Radiographic determination of proventricular diameter in psittacine birds. *J Am Vet Med Assoc*. 2008;232(5):709–714.
18. Gancz AY, Clubb S, Shivaprasad HL. Advanced diagnostic approaches and current management of proventricular dilatation disease. *Vet Clin North Am Exot Anim Pract*. 2010;13(3):471–494.
19. Applegate JR Jr, Wettere AV, Christiansen EF, Degernes LA. Management and case outcome of gastric impaction in four raptors: a case series. *J Avian Med Surg*. 2017;31(1):62–69.
20. Krautwald-Junghanns ME, Stahl A, Pees M, Enders F, Bartels T. Sonographic investigations of the gastrointestinal tract of granivorous birds. *Vet Radiol Ultrasound*. 2002;43(6):576–582.
21. Krautwald-Junghanns ME, Moerke-Schindler T, Vorbrüggen S, et al. Radiography and ultrasonography in the backyard poultry and waterfowl patient. *J Avian Med Surg*. 2017;31(3):189–197.
22. Kusmierczyk J, Wall CR, Hoppes S, Budke CM, Spaulding KA. Comparison of computed tomographic images of birds obtained with sedation vs general anesthesia. *J Exot Pet Med*. 2013;22(3):251–257.
23. van Zeeland YRA, Schoemaker NJ, Hsu EW. Advances in diagnostic imaging. In: Speer BL, ed. *Current Therapy in Avian Medicine and Surgery*. Elsevier; 2016:531–549.
24. Veladiano IA, Banzato T, Bellini L, Montani A, Catania S, Zotti A. Normal computed tomographic features and reference values for the coelomic cavity in pet parrots. *BMC Vet Res*. 2016;12(1):182. doi:10.1186/s12917-016-0821-6
25. Lautenschlager S, Bright JA, Rayfield EJ. Digital dissection—using contrast-enhanced computed tomography scanning to elucidate hard- and soft-tissue anatomy in the common buzzard *Buteo buteo*. *J Anat*. 2014;224(4):412–431.
26. Sladakovic I, Ellis AE, Divers SJ. Evaluation of gastroscopy and biopsy of the proventriculus and ventriculus in pigeons (*Columba livia*). *Am J Vet Res*. 2017;78(1):42–49.
27. Bauck L. Mycoses. In: Ritchie BW, Harrison GJ, Harrison LR, eds. *Avian Medicine: Principles and Applications*. HBD International Inc; 1999:997–1007.
28. Guzman DSM. Avian soft tissue surgery. *Vet Clin North Am Exot Anim Pract*. 2016;19(1):133–157.
29. Rubin JA, Runge JJ, Mison M, et al. Surgery. In: Speer BL, ed. *Current Therapy in Avian Medicine and Surgery*. Elsevier; 2016:631–667.
30. Simova-Curd S, Foldenauer U, Guerrero T, Hatt JM, Hoop R. Comparison of ventriculotomy closure with and without a coelomic fat patch in Japanese quail (*Coturnix coturnix japonica*). *J Avian Med Surg*. 2013;27(1):7–13.
31. Antonissen G, Martel A. Antifungal therapy in birds: old drugs in a new jacket. *Vet Clin North Am Exot Anim Pract*. 2018;21(2):355–377.
32. Anderson NL. Candida/Megabacteria proventriculitis in a lesser Sulphur-crested cockatoo (*Cacatua sulphurea sulphurea*). *J Assoc Avian Vet*. 1993;7(4):197–201.
33. Martins HPR, da Silva MC, Paiva LCF, Svidzinski TIE, Consolaro MEL. Efficacy of fluconazole and nystatin in the treatment of vaginal *Candida* species. *Acta Derm Venereol*. 2012;92(1):78–82.
34. Kakati B, Kotwal A, Biswas D, et al. Fluconazole resistant *Candida* oesophagitis in immunocompetent patients: is empirical therapy justifiable? *J Clin Diagn Res*. 2015;9(12):DC16–DC18.
35. Fan S, Liu X, Wu C, Xu L, Li J. Vaginal nystatin versus oral fluconazole for the treatment of recurrent vulvovaginal candidiasis. *Mycopathologia*. 2015;179(1-2):95–101.
36. Wilson A, Delport J, Ponich T. *Candida glabrata* esophagitis: are we seeing the emergence of a new azole-resistant pathogen? *Int J Microbiol* 2014;2014:371631. doi:10.1155/2014/371631
37. Diaz MC, Camponovo R, Araya I, Santander MP, Carrillo-Muñoz AJ. Identification and *in vitro* antifungal susceptibility of vaginal *Candida* spp. isolates to fluconazole, clotrimazole, and nystatin. Article in Spanish. *Rev Esp Quimioter*. 2016;29(3):151–154.
38. Miranda-Cadena K, Marcos-Arias C, Mateo E, Manuel Aguirre J, Quindós G, Eraso E. Prevalence and antifungal susceptibility profiles of *Candida glabrata, Candida parapsilosis* and their close-related species in oral candidiasis. *Arch Oral Biol*. 2018;95:100–107.