Journal of Avian Medicine and Surgery 22(2):114–122, 2008

Health Assessment of the Ex Situ Population of St Vincent Parrots (*Amazona guildingii*) in St Vincent and the Grenadines

Sharon L. Deem, DVM, PhD, Dipl ACZM, Emily Ladwig, BS, Carolyn Cray, PhD, William B. Karesh, DVM, and George Amato, PhD

Abstract: The St Vincent Amazon parrot (*Amazona guildingii*), listed as a CITES appendix I animal, is endemic only to the mainland of St Vincent and the Grenadines (SVG), Lesser Antilles. A health assessment that included physical examination, hematology, blood parasite evaluation, plasma biochemical analysis, plasma protein electrophoresis, level of exposure to selected infectious agents, and fecal parasites was performed in July 2002 on 37 (51%) of the parrots in the captive population in SVG. Clinical abnormalities noted in the 37 parrots included poor feathers, lipomas, abnormal choanal papillae, obesity, leg ulcers, respiratory abnormalities, cardiac abnormalities, seizure activity, old fractures, missing digits, skin disease associated with mites (*Knemidokoptes* species), oral granuloma, and a thin, friable beak. Only 7 of the birds were clinically normal on physical examination. Results of hematologic testing, plasma biochemical analysis, and plasma electrophoresis were not statistically different between female and male parrots. No blood parasites were found in any of the 32 samples examined. None of the 36 parrots evaluated had antibodies to the 12 infectious agents tested. Of the 21 fecal samples available, *Capillaria* species was detected in 1 bird. Findings from this study, in addition to nutritional, genetic, and husbandry evaluations, have been used to make recommendations to the Forestry Department of SVG for improvements in husbandry and veterinary care of this ex situ population.

Key words: health assessment, hematology, plasma biochemical analysis, plasma protein electrophoresis, ex situ population, avian, St Vincent Amazon parrot, *Amazona guildingii*

Introduction

The St Vincent Amazon parrot (SVP; *Amazona guildingii*), listed as a CITES appendix I animal, is endemic only to the mainland of St Vincent and the Grenadines (SVG), Lesser Antilles. The most recent estimate of the wild population was 450 individuals located in the northern region of St Vincent Island.[1] Threats to the conservation of the wild population include natural disasters (ie, hurricanes and volcanic eruptions), destruction of habitat for lumber and agriculture, predation, and poaching for the pet trade.[1] Additionally, invasive pathogens must be considered a serious threat to the long-term survival of this endangered island species, as demonstrated for other island avifauna.[2]

The SVP has been protected since 1901 and was still common into the 1970s, but lack of legal enforcement resulted in continual off-take from the wild. Under the 1987 Wildlife Protection Act (No. 16) an ex situ population of SVPs was established under the auspices of the Forestry Department, Government of SVG. Citizens were encouraged at that time to come forward, without fear of prosecution, to register their birds so they could be included in the ex situ managed

From the Department of Animal Health, Smithsonian National Zoological Park, 3001 Connecticut Avenue, Washington, DC 20008, USA (Deem); the Department of Ornithology (Ladwig), the Field Veterinary Program (Karesh), and International Programs (Amato), Wildlife Conservation Society, 2300 Southern Boulevard, Bronx, NY 10460, USA; the Division of Comparative Pathology, Miller School of Medicine, PO Box 016960 R-46, Miami, FL 33101, USA (Cray). Present addresses: the WildCare Institute, Saint Louis Zoo, One Government Drive, St Louis, MO 63110, USA (Deem); the American Museum of Natural History, Central Park West at 79th Street, New York, NY 10024, USA (Amato).

population. Sixty founder birds established the ex situ population, which was estimated at 72 birds in 2002.[3] Birds in the ex situ population reside at the Calvin Nicholls Wildlife Complex in the National Botanical Gardens and in custodial care on St Vincent, Bequia, and Mustique Islands.

All parrot species kept in captivity experience several infectious and noninfectious diseases. Many of these diseases are directly and indirectly influenced by the husbandry and nutritional care of these birds, including but not limited to such diseases as traumatic injuries, obesity, malnutrition, and the transmission of infectious agents. In addition to the common diseases of captive parrots, many SVPs in North America are obese and some captive birds have died of infection from *Mycobacterium* species, suggesting that they are be predisposed to these diseases (J. Flanagan, oral communication, 2007).

The ex situ population of SVPs, both on SVG and elsewhere, provides insurance from extinction should a catastrophe such as a hurricane, volcanic eruption, or epornitic extirpate the wild population. The primary objective of this study was to evaluate the health status of the ex situ SVP population in SVG.

Materials and Methods

Sample and data collection

The research was conducted in July 2002 in SVG in the West Indies, Caribbean. A total of 37 adult parrots were evaluated. Twenty-four parrots were housed at the Calvin Nicholls Wildlife Complex in the National Botanical Gardens near Kingston (13°12′N, 61°14′W), and 13 were housed at a total of 12 custodian locations on St Vincent and Mustique Islands. Sex of birds (n = 25) had been previously determined with genetic markers.[4]

Parrots were captured by net or hand and then manually restrained for physical examination and biomaterial collections. All birds were handled for approximately 10 minutes for body weight, body score classification (from 1 = thin to 5 = severely obese), physical examination, and blood collection. Body weights were not collected for 2 birds, and body score was not collected for 1 of these 2 birds. Fecal samples were collected opportunistically from any bird that defecated during handling or within minutes of defecation, if observed. Additionally, in those parrots with clinical evidence of mite infestation (n = 2), multiple skin scrapes were collected. All parrots were examined, and samples were collected by 1 veterinarian (S.L.D.). Blood samples (3–4 ml) calculated at approximately ≤1% of body weight, were collected from the jugular vein in syringes precoated with 1000 IU sodium heparin. After sample and data collection, birds were released back into their cage, or kept quietly in a kennel if housed in group aviaries, until all birds in the group were sampled.

Sample handling and storage

Immediately after collection, heparinized blood samples were placed in serum separator tubes (Corvac, Sherwood Medical, St Louis, MO, USA) and maintained at ambient temperature (25–30°C). Blood samples were initially processed in the field within 2 hours of blood collection. Thin blood smears were fixed with 99% methanol. Packed cell volumes (PCVs) were determined with the use of a portable 12-volt centrifuge (Mobilespin, Vulcon Technologies, Grandview, MO, USA), and plasma total solids were measured with a hand-held refractometer (Schulco, Toledo, OH, USA); temperature was calibrated at the site. White blood cells (WBCs) were counted with the BD Unopette Brand Test for Manual Eosinophil Counts (catalog no. 365877, Becton-Dickinson Diagnostics, Preanalytical Systems, Franklin Lakes, NJ, USA). Red blood cells (RBCs) were counted with the BD Unopette Brand Test for Manual RBC Counts (catalog nos. 365850/365851, Becton-Dickinson Diagnostics). The remaining blood was centrifuged for 10 minutes. Plasma samples were heat treated in a water bath at 56°C for 2 hours in accordance with United States Department of Agriculture regulations before importation into the United States. Plasma samples were placed in a −20°C freezer during the 2 weeks researchers were working in SVG and transported to the United States on dry ice. Plasma samples were kept frozen on dry ice in a −80°C freezer in the United States before shipment to laboratories for testing. In those parrots from which a fecal sample was available, fecal material was preserved in 10% buffered formalin. All appropriate export and import permits accompanied the samples during transport. Skin scrapes were evaluated in the field within 15 minutes of collection by light microscopy.

Sample and data analysis

Thin blood smears were stained with Diff Quick (VetLab Supply Inc, Miami, FL, USA) and examined at ×1000 with a count of 100 cells for WBC differentials and 500 cells for blood parasites at the University of Miami School of

Table 1. Pathogen, diagnostic tests performed, antibody titers defined as positive, and number of positive parrots in the evaluation of select infectious agent exposure in captive St Vincent Amazon parrots in St Vincent and the Grenadines.

Pathogen	Test method	Positive titer	Number positive
Avian influenza virus	agar gel immunodiffusion	n/a	0/36
Avian infectious bronchitis virus			
ARK 99	hemagglutination inhibition	≥1:10	0/36
CONN 46	hemagglutination inhibition	≥1:10	0/36
MASS 41	hemagglutination inhibition	≥1:10	0/36
JMK	hemagglutination inhibition	≥1:10	0/36
Infectious bursal disease virus	agar gel immunodiffusion	n/a	0/36
Avian infectious laryngotracheitis virus	indirect immunofluorescence	≥1:10	0/36
Paramyxovirus-1	hemagglutination inhibition	≥1:8	0/36
Paramyxovirus-2	hemagglutination inhibition	≥1:8	0/36
Paramyxovirus-3	hemagglutination inhibition	≥1:8	0/36
Psittacid herpesvirus serotype 1	virus neutralization	≥1:16	0/36
Avian polyomavirus	virus neutralization	≥1:64	0/36

Abbreviation: n/a indicates that there is no positive cut-off point for this test.

Medicine, USA. Plasma biochemistry was analyzed on a Chems Kodak 750 XR (Ortho Clinical Diagnostics, Rochester, NY, USA) at the University of Miami School of Medicine. The plasma biochemical analysis included alanine aminotransferase (ALT), aspartate aminotransferase (AST), amylase, calcium, cholesterol, creatine kinase (CK), gamma glutamyl transferase (GGT), glucose, lactic dehydrogenase (LD), lipase, phosphorous, potassium, sodium, triglyceride, and uric acid (UA).

Plasma protein electrophoresis was performed at the University of Miami School of Medicine with SPEP-II agarose gels and the Beckman paragon electrophoresis system (Beckman-Coulter Corporation, Brea, CA, USA). The gels were run according to the manufacturer's instructions.[5] The percentage of protein fractions was quantified by laser densitometry, then fraction values were calculated by multiplying the percentage by the total protein value determined on the routine biochemical analysis. Plasma total solid concentrations were measured in the laboratory with the same type of handheld refractometer as used in the field.

Pathogen, serologic tests performed, antibody titers defined as positive, and number of positive test results are provided in Table 1. Serologic testing for avian influenza, avian infectious bronchitis virus (Ark99, Conn46, Mass41, and JMK), avian infectious bursal disease virus, infectious laryngotracheitis virus, paramyxovirus-1 (PMV-1), PMV-2, and PMV-3 was conducted at the National Veterinary Diagnostic Laboratory, Ames, IA, USA by standardized test methods set forth by the Office International des Epizooties and the American Association of Avian Pathologists.[6–8]

Serologic testing for psittacid herpesvirus serotype 1 and avian polyomavirus was conducted by Dr David Phalen at the College of Veterinary Medicine, Texas A&M University, College Station, TX, USA.[9]

Fecal samples were examined with the use of zinc sulfate and sugar flotation at the New York State Veterinary Diagnostic Laboratory, Cornell University, Ithaca, NY, USA.

Not all blood tests were performed on all individuals because of limited plasma volume or poor quality for some birds. Differences in body weight and results of hematologic testing, plasma biochemical analysis, and plasma electrophoresis for females and males were analyzed by the Mann-Whitney U test ($P \leq 0.05$).[10] All values were recorded as mean ± standard deviation (SD). No data from birds of unknown sex were compared statistically because these comparisons would be difficult to interpret.

Results

Physical examinations

Fourteen females had an average weight of 572 g ± 101 (range 470–850 g) and 11 males had an average weight of 677 g ± 238 (range 430–1200 g). Weight between females and males was not statistically different ($P \geq 0.05$). Ten birds of unknown sex were weighed, averaging 478 g ± 106 (range 240–610 g). Body weight of all 35 birds weighed was 578 g ± 172 (range 240–1200 g). The

Table 2. Clinical findings on physical examination of 37 captive St Vincent Amazon parrots in St Vincent and the Grenadines.

Clinical finding[a]	Prevalence, n (%)	Comments
Normal examination	7 (18.9%)	no abnormalities noted
Poor feathering	10 (27%)	poor feather thought to be due to husbandry and nutritional issues
Lipomas	7 (18.9%)	2 of 7 rated as obese
Abnormal choanal papillae	5 (13.5%)	probable hypovitaminosis A; bird with oral granuloma had normal papillae
Obese	4 (10.8%)	2 of 4 had lipomas
Leg ulcer	3 (8.1%)	all had injuries associated with misplaced bands
Respiratory abnormality	3 (8.1%)	all had abnormal URT sounds; 1 had bilateral crusts on nares
Cardiac abnormality	3 (8.1%)	grade III/VI murmur in 2 parrots; arrhythmia noted in the third
Seizure activity	2 (5.4%)	both parrots recovered shortly after release
Old fractures	2 (5.4%)	1–old left wing fracture and callus; 1–old mandibular fracture
Missing digits	2 (5.4%)	old amputated digits
Severe skin disease	2 (5.4%)	both associated with mites (*Knemidokoptes* species)
Oral granuloma	1 (2.7%)	R/O hypovitaminosis A
Thin, friable beak	1 (2.7%)	suspected nutrition related

Abbreviation: URT, upper respiratory tract.

[a] Many parrots had more than 1 abnormality noted on physical examination.

2 birds that were not weighed had compromised health: seizures in one and a grade III/VI heart murmur in the other (see below). Body scores for the 14 females were calculated as an average of 3.0 ± 0.8 (range 2.0–5.0), 12 males averaged 3.0 ± 1.1 (range 1.0–4.5), 9 birds of unknown sex averaged 2.7 ± 0.7 (range 1.0–3.5), and all 34 birds scored averaged 3.0 ± 1.0 (range 1.0–5.0).

Physical examination findings are presented in Table 2. Many parrots had multiple abnormalities, including poor feathers (27%), lipomas (18.9%), abnormal choanal papillae (13.5%), obesity (10.8%), leg ulcers (8.1%), respiratory abnormalities (8.1%), cardiac abnormalities (8.1%), seizure activity (5.4%), old fractures (5.4%), missing digits (5.4%), skin disease (5.4%), oral granuloma (2.7%), and a thin, friable beak (2.7%). Seven (male : female : unknown sex [1:4:2]) of the 37 parrots (18.9%) were free of any abnormal findings on examination. Additionally, papillomas were not evident in the cloacal mucosa of any of the 37 parrots. Two parrots (1:1:0) housed at the aviary had seizure activity after approximately 9 minutes of handling.

Four (2:2:0) of the 37 parrots were obese on the basis of body weight and body score. Two of the obese males also had lipomas. Five (4:1:0) other parrots with lipomas were not judged to be obese on the basis of body weight and body score. Three (2:0:1) of the parrots were emaciated on the basis of body weight and body score. Two (1:0:1) of the emaciated parrots had cardiac abnormalities on auscultation; a murmur (grade III/VI) was noted in one and arrhythmias in the other. The third (male) emaciated parrot had a severe mite infestation. A grade III/VI murmur was auscultated in one other (male) parrot with normal body weight but poor feathers and a lipoma.

Ten (2:3:5) of the 37 parrots had poor feathers. One male parrot had a thin, friable beak of unknown cause. Abnormal respiratory sounds were observed for 3 (2:0:1) of the 37 parrots during handling, and one of these male birds also had bilateral crusting over the nares.

Injuries in the parrots ranged from chronic leg ulcers thought to be associated with leg bands (n = 3; 1:2:0), missing digits (n = 2; 0:2:0), and old fractures of the left wing in one (female) and the mandible in another (female) bird. Other diseases included skin disease associated with mites (n = 2; 1:1:0), a granuloma near the choanal slit (n = 1; 0:0:1), and abnormal choanal papillae (n = 5; 1:2:2). The parrot with the oral granuloma had normal choanal papillae.

Hematology, plasma biochemistry analysis, and plasma protein electrophoresis

The 3 emaciated birds with concurrent severe clinical disease were removed from the data set for blood value calculations. Female and male parrot blood values were not statistically different. Results of hematologic tests are provided in Table 3. No eosinophils or basophils were found on any of the 32 birds evaluated. Results for plasma biochemical analysis are provided in Table 4. Plasma protein electrophoresis results are presented in Table 5.

Table 3. Hematologic results (mean ± SD) of captive St Vincent Amazon parrots in St Vincent and the Grenadines.

Measure[a]	Female	Male	Unknown sex	All birds
Packed cell volume, %	38 ± 4	39 ± 3	42 ± 3	40 ± 4
Range	32–44	36–47	37–46	32–47
N	13	10	9	32
Red blood cells, $\times 10^6$/μl	1.81 ± 0.84	1.62 ± 0.53	2.46 ± 2.45	1.93 ± 1.40
Range	0.10–4.36	0.63–2.28	0.52–8.10	0.10–8.10
N	15	10	9	34
Total solids, g/dl	3.6 ± 1.1	3.6 ± 1.2	3.2 ± 0.9	3.5 ± 1.1
Range	2.3–6.4	2.4–6.3	1.9–4.8	1.9–6.4
N	13	10	9	32
White blood cells, $\times 10^3$/μl	10.0 ± 5.3	7.0 ± 3.1	8.6 ± 4.0	8.7 ± 4.4
Range	3.5–16.4	2.8–14.0	4.6–16.6	2.8–16.6
N	14	10	8	32
Heterophils, $\times 10^3$/μl	6.3 ± 3.7	4.8 ± 2.6	4.1 ± 1.9	5.3 ± 3.0
Range	1.4–13.4	2.1–10.9	0.5–6.6	0.5–13.4
N	14	10	8	32
Lymphocytes, $\times 10^3$/μl	3.8 ± 2.3	2.2 ± 1.0	5.4 ± 4.5	3.7 ± 3.0
Range	0.8–9.0	0.7–3.7	1.1–13.4	0.7–13.4
N	14	10	8	32
Monocytes, $\times 10^3$/μl	0.10 ± 0.07	0.02 ± 0.08	0.01 ± 0	0.01 ± 0.04
Range	0.05–0.15	0–0.16	0–0.06	0–0.16
N	14	10	8	32

[a] No eosinophils or basophils were identified in any of the blood smears.

Serology and Parasitology

No test results were positive for any of the 12 infectious disease agents (Table 1). Of the 21 parrots for which parasite evaluations of a fecal sample were performed, only *Capillaria* species was found in 1 parrot. Two of the parrots had mites (*Knemidokoptes* species) diagnosed by skin scrapes with clinical signs (ie, poor feathers and scaly skin) from severe infestation observed in one of these birds. Blood parasites were not found in the 32 samples examined.

Discussion

In this study, we conducted health assessments of 51% (37/72) of the ex situ SVP population in SVG in 2002. The overall health of this population, on the basis of physical examinations was rated as poor because of a high prevalence of clinical abnormalities (81.1% of the birds). Many of the clinical abnormalities observed in these parrots were probably related to inadequate husbandry and nutrition; thus, with increased attention to their care, almost all the clinical abnormalities observed could be easily prevented.

The use of the hematology, plasma biochemical analysis, and plasma protein electrophoresis values from this study as baseline values for healthy SVPs should be done cautiously in that only 18.9% of the birds were free of all clinical abnormalities. However, the data set presented here does not include blood values from the 3 emaciated birds, which were the only parrots noted to have outliers in blood parameters (data not shown). Additionally, the values in this study are similar to those found for several *Amazona* species.

A few hematologic values had minor differences compared with those recorded for SVPs in North America and for *Amazona* species in general.[11–13] The WBC, PCV, and RBC values were lower in the SVPs in this study when compared with the 9 parrots in the North American population,[11] which was probably a reflection of the poor overall flock health of these parrots. The lack of eosinophils or basophils in any of the 32 SVPs we examined is an interesting finding. In *Amazona* species, eosinophils and basophils are uncommon in peripheral blood; however, most studies have some birds within the population with 1 or both of these cells present.[11–14]

Table 4. Results of plasma biochemical analysis (mean ± SD, range) of captive St Vincent Amazon parrots in St Vincent and the Grenadines.

Analyte	Female (n = 15)	Male (n = 10)	Unknown sex (n = 9)	All birds (n = 34)
ALT, IU/L	3 ± 1	3 ± 0	3 ± 0	3 ± 1
Range	3–8	3	3	3–8
AST, IU/L	145 ± 83	162 ± 78	130 ± 39	146 ± 72
Range	65–393	85–342	88–216	65–393
CK, IU/L	20 ± 0	26 ± 12	20 ± 0	22 ± 7
Range	20	20–50	20	20–50
LD, IU/L	182 ± 78	187 ± 106	146 ± 42	174 ± 80
Range	100–312	113–442	100–220	100–442
GGT, IU/L	10 ± 1	11 ± 3	1 ± 0	11 ± 2
Range	9–12	9–18	1	1–18
Amylase, IU/L	31 ± 5	31 ± 3	32 ± 6	31 ± 5
Range	30–48	30–39	30–49	30–49
Lipase, IU/L	1 ± 0	1 ± 0	1 ± 0	1 ± 0
Range	1	1	1	1
Cholesterol, mmol/L	5.87 ± 1.76	5.62 ± 1.61	5.80 ± 2.02	5.78 ± 1.74
Range	3.06–10.46	3.32–8.16	3.65– 9.35	3.06–10.46
Triglyceride, mmol/L	2.57 ± 1.04	1.74 ± 0.89	1.31 ± 0.45	1.66 ± 0.88
Range	0.78–3.59	0.70–3.50	0.79–2.23	0.70–3.59
Glucose, mmol/L	12.0 ± 2.4	11.9 ± 1.3	11.2 ± 0.9	11.8 ± 1.8
Range	8.3–16.1	10.4–14.7	10.0–12.8	8.3–16.1
Calcium, mmol/L	2.08 ± 0.38	2.03 ± 0.35	1.95 ± 0.25	2.03 ± 0.33
Range	1.33–2.90	1.43–2.80	1.55–2.30	1.33–2.90
Phosphorous, mmol/L	1.10 ± 0.32	1.20 ± 0.29	1.26 ± 0.68	1.16 ± 0.42
Range	0.48–1.78	0.71–1.52	0.78–2.97	0.48–2.97
Potassium, mmol/L	3.4 ± 0.8	3.0 ± 0.9	2.8 ± 0.5	3.1 ± 0.8
Range	1.8–4.7	1.9–4.9	2.3–4.0	1.8–4.9
Sodium, mmol/L	144 ± 13	146 ± 9	141 ± 6	144 ± 10
Range	115–160	125–155	127–145	115–160
Uric acid, μmol/L	59.5 ± 29.7	77.3 ± 65.4	65.4 ± 29.7	66.4 ± 41.6
Range	17.8–119.0	29.7–243.9	35.7–136.8	17.8–243.9

Abbreviations: ALT indicates alanine aminotransferase; AST, aspartate aminotransferase; CK, creatine kinase; LD, lactic dehydrogenase; GGT, gamma glutamyl transferase.

Plasma biochemical values were unremarkable and similar to reported values.[11,13,15] Cholesterol and triglycerides were not statistically significant between the females and males in this study. This could be a function of our low sample size in that female parrots tend to have higher cholesterol and triglyceride levels because of the requirements for the production of eggs.[16] This lack of statistical difference between the sexes could also be related to the poor overall reproductive state of the females, which fits with the poor breeding success of this population.

In the parrots with clinical abnormalities, we did not find differences in blood values on the basis of physical findings (data not shown). The 1 exception was the 4 obese parrots that had higher cholesterol (8.11 mmol/L ± 1.59, 313 mg/dl ± 61) and triglyceride (2.79 mmol/L ± 1.02, 247 mg/dl ± 79) values than those in the 30 nonobese parrots (cholesterol 5.4 mmol/L ± 3.4, 209 mg/dl ± 131; triglyceride 1.48 mmol/L ± 0.75, 131 mg/dl ± 67). Of the 2 birds with seizure activity after the brief period of handling, neither bird had any outliers in their blood values. In the 1 male parrot

Table 5. Results of plasma protein electrophoresis (mean ± SD) of captive St Vincent Amazon parrots in St Vincent and the Grenadines.

Measure	Female (n = 15)	Male (n = 10)	Unknown (n = 9)	All birds (n = 34)
Total solids, g/dl	3.4 ± 0.8	1.5 ± 0.7	3.1 ± 0.9	3.3 ± 0.8
Range	2.1–4.9	2.4–4.8	1.4–4.3	1.4–4.9
A/G ratio	2.25 ± 0.79	2.69 ± 0.84	2.60 ± 0.70	2.50 ± 0.80
Range	1.17–4.48	1.12–3.88	1.70–4.10	1.12–0.48
Prealbumin, g/dl	0.54 ± 0.20	0.59 ± 0.18	0.70 ± 0.20	0.59 ± 0.21
Range	0.13–0.86	0.34–1.02	0.40–1.00	0.13–1.02
Albumin, g/dl	1.75 ± 0.66	1.87 ± 0.52	1.60 ± 0.60	1.74 ± 0.61
Range	0.58–2.97	1.45–3.19	0.40–2.70	0.44–3.19
Alpha-1 globulin, g/dl	0.09 ± 0.06	0.07 ± 0.03	0.07 ± 0.03	0.08 ± 0.04
Range	0.03–0.23	0.02–0.13	0.04–0.11	0.02–0.23
Alpha-2 globulin, g/dl	0.17 ± 0.06	0.15 ± 0.05	0.18 ± 0.10	0.17 ± 0.07
Range	0.11–0.31	0.06–0.22	0.08–0.43	0.06–0.43
Beta globulin, g/dl	0.46 ± 0.09	0.51 ± 0.32	0.40 ± 0.09	0.46 ± 0.19
Range	0.28–0.57	0.24–1.33	0.27–0.77	0.24–1.33
Gamma globulin, g/dl	0.37 ± 0.20	0.29 ± 0.15	0.20 ± 0.08	0.30 ± 0.17
Range	0.14–0.67	0.14–0.56	0.10–0.32	0.10–0.67

Abbreviation: A/G ratio indicates albumin to globulin ratio.

with the thin, friable beak, the calcium value (1.9 mmol/L, 7.6 mg/dl) was nonremarkable and in the midrange for all parrots in this study.

Plasma protein electrophoresis, an increasingly important diagnostic modality for nondomestic species, can provide information about chronic or acute inflammatory processes.[5,17,18] Baseline values must be determined for each species. Table 5 reports the first known values for SVPs. Values from this study are similar to those found in several other *Amazona* species.[18]

The total solid results from the field (3.5 mg/dl ± 1.1) differed from the laboratory (3.3 mg/dl ± 0.8), even though the same diagnostic technique and instrument were used to obtain both values. This discrepancy could be a result of an inaccuracy of the refractometer in companion avian species because of the interference by high concentrations of other refractive compounds in plasma, such as chromogens, lipids, and glucose.[19,20]

Although we found no positive titers to any of the 12 infectious agents for which we tested, results from the serologic evaluations on these birds must be interpreted cautiously in that several of these tests are validated in domestic fowl and none are validated for SVPs.[21] Additionally, of the 3 serotypes of psittacid herpesvirus, we only tested for serotype 1 and thus cannot rule out that serotypes 2 and 3 were present in these birds. In an earlier study, positive serologic titers to psittacine herpesvirus were reported for the captive SVPs on SVG.[22] Agents such as psittacine beak and feather disease virus, *Chlamydophila psittaci*, and *Mycobacterium* species, not tested for this study due to logistical constraints, should be included in future studies of infectious disease agents of this population.

The finding of just 1 bird with endoparasites (5%) is similar to other studies in which endoparasites are at a low level in free-ranging and captive parrots in South America.[14,23,24] However, it is interesting to note that the captive parrots in our study did not have a higher prevalence of intestinal parasites in that the housing of these parrots should be conducive to increased parasite loads. Of the 2 parrots (5%) with *Knemidokoptes* mites, 1 was emaciated and clinically ill whereas the other was in good body condition and appeared clinically healthy. We found no blood parasites in any of the 32 samples examined. This is in agreement with findings from other psittacine species in the Neotropics.[14,23–26]

Even though the SVP has been the National Bird since 1979 and the St Vincent Parrot Conservation Consortium (SVPCC) was established in the 1980s, the health status of the wild and captive SVPs in SVG is little known, and

basic veterinary care for the ex situ population is limited on the islands. Periodic visits by consulting avian veterinarians do occur (this study for example), and the SVPCC veterinary advisors are available for consultation. However, we believe that additional support is necessary for this CITES I bird. The captive ex situ population should be seen as insurance against species extinction: it is for this reason that several studies have been conducted to understand the genetic structure of the population.[3,4]

Findings from this study, in addition to nutritional, genetic, and husbandry evaluations, were used to make recommendations to the Forestry Department of SVG for improvements in husbandry and veterinary care. Recommendations that we made on the basis of the results of this study emphasized the need for general flock husbandry and veterinary care. Many of the common clinical findings we detected, such as poor feathers and obesity, could be managed with basic avian husbandry and veterinary and nutritional support. Specific recommendations made included having a 45-day quarantine period for all birds recruited into the ex situ population and testing of those birds for infectious agents before admittance into the population. Annual ''well bird'' examinations should be performed and thorough necropsies conducted on any parrot that dies. An annual or biennial infectious disease panel should be performed because these parrots are constantly exposed to poultry, free-ranging wild birds, and a variety of confiscated parrots also housed at the Wildlife Complex. Advanced training in avian medicine should be provided to veterinarians on the island to ensure these recommendations are carried out and to improve diagnostic and therapeutic capabilities for noninfectious and infectious diseases. Improvements in veterinary, husbandry, and nutritional care should be moved forward in conjunction with continued genetic management of the population.

Additionally, it is imperative that studies be conducted to determine the health status of the free-ranging SVPs and to determine to what infectious disease agents the wild population has been exposed.[22] The ex situ SVP parrots serve as ambassadors for the species and as a source for reintroduction should the wild population be extripated or reduced to some nonviable level. For successful reintroduction, the reintroduced population should be free of pathogens, its health status should be known before release, and the health status of the wild populations into which it is being introduced must be known.[27]

In this study, we evaluated the health of the SVP ex situ population in SVG. Our findings indicate the need for improved veterinary care of this captive population. This study also highlights the importance of complete health assessments of captive populations of wildlife that could be used in reintroduction or restocking programs.[27–30] Additionally, we suggest that data on the health status of the in situ population be obtained. The long-term survival of this island endemic species can only be achieved if healthy and reproductively successful individuals remain.

Acknowledgments: We gratefully acknowledge B. Johnson, O. Josyln, R. Knight, C. Thomas, F. Providence, D. Edwards, D. Roberts, and L. Quammie for logistics and technical support in SVG; V. Greco, K. C. Kahler, and L. J. Starr for help with sample processing and travel logistics; and J. Flanagan for helpful comments on this manuscript.

References

1. Christian CS. The challenge of parrot conservation in St Vincent and the Grenadines. *J Biogeogr*. 1993;20:463–469.
2. Wikelski M, Foufopoulos J, Vargas H, Snell H. 2004. Galápagos birds and diseases: invasive pathogens as threats for island species. http://www.ecologyandsociety.org/vol9/iss1/art5. Accessed May 1, 2007.
3. Russello MA, Amato G. Ex situ population management in the absence of pedigree information. *Mol Ecol*. 2004;13:2829–2840.
4. Russello MA, Amato G. Application of a noninvasive, PCR-based test for sex identification in an endangered parrot, *Amazona guildingii*. *Zoo Biol*. 2001;20:41–45.
5. Cray C, Tatum LM. Applications of protein electrophoresis in avian diagnostics. *J Avian Med Surg*. 1998;12:4–10.
6. Hanson RP. Newcastle disease. In: Domermuth CH, Purchase HG, William JE, eds. *Isolation and Identification of Avian Pathogens*. 2nd ed. College Station, TX: American Assn of Avian Pathologists; 1980:63.
7. Office International des Epizooties. *Manual of Standards for Diagnostic Tests and Vaccines*. 3rd ed. Paris, France: Office International des Epizooties; 1996.
8. Purchase HG, Arp LH, Domermuth CH, et al, eds. *A Laboratory Manual for the Isolation and Identification of Avian Pathogens*. 3rd ed. Dubuque, IA: Kendall/Hunt; 1989.
9. Phalen DN, Wilson VG, Graham DL. Organ distribution of avian polyomavirus DNA and virus-neutralizing antibody titers in healthy adult budgerigars. *Am J Vet Res*. 1993;54:2040–2047.

10. Sokal RR, Rohlf FJ. *Biometry, the Principles and Practice of Statistics in Biological Research*. 2nd ed. New York, NY: WH Freeman Co; 1981.
11. Physiological Data Reference Values for the Saint Vincent Amazon (*Amazona guildingii*) [CD-ROM]. Apple Valley, MI: International Species Information System; 1999.
12. Samour J. Appendix II: Hematology reference values. In: Samour J, ed. *Avian Medicine*. Philadelphia, PA: Mosby; 2000:320–344.
13. Fudge AM. Laboratory reference ranges for selected avian, mammalian, and reptilian species. In: Fudge AM, ed. *Laboratory Medicine: Avian and Exotic Pets*. Philadelphia, PA: WB Saunders; 2000: 375–400.
14. Deem SL, Noss AJ, Cuéllar RL, Karesh WB. Health evaluation of free-ranging and captive blue-fronted Amazon parrots (*Amazona aestiva*) in the Gran Chaco, Bolivia. *J Zoo Wildl Med*. 2005;36:598–605.
15. Samour J. Appendix III: Blood chemistry references values. In: Samour J, ed. *Avian Medicine*. Philadelphia, PA: Mosby; 2000:345–374.
16. Johnson AL. Reproduction in the female. In: Whittow GC, ed. *Sturkie's Avian Physiology*. San Diego, CA: Academic Press; 2000:569–596.
17. Zaias J, Cray C. Protein electrophoresis: a tool for the reptilian and amphibian practitioner. *J Herp Med Surg*. 2002;12:30–32.
18. Cray C, Rodriguez M, Zaias J. Protein electrophoresis of psittacine plasma. *Vet Clin Pathol*. 2007;36:64–72.
19. Lumeij JT, Maclean B. Total protein determination in pigeon plasma and serum: comparison of refractometric methods with the biuret method. *J Avian Med Surg*. 1996;10:150–152.
20. Harr KE. Clinical chemistry of companion avian species: a review. *Vet Clin Pathol*. 2002;31:140–151.
21. Hietala SK, Gardner IA. Validity of using diagnostic tests that are approved for use in domestic animals for nondomestic species. In: Fowler ME, Miller RE, eds. *Zoo and Wild Animal Medicine, Current Therapy 4*. Philadelphia, PA: WB Saunders; 1999:55–58.
22. Greenwood AG. Veterinary support for in situ avian conservation programmes. *Bird Conserv Int*. 1996;6:285–292.
23. Gilardi KVK, Lowenstine LJ, Gilardi JD, Munn CA. A survey for selected viral, chlamydial, and parasitic diseases in wild dusky-headed parakeets (*Aratinga weddellii*) and tui parakeets (*Brotogeris sanctithomae*) in Peru. *J Wildl Dis*. 1995;31: 523–528.
24. Karesh WB, del Campo A, Braselton WE, et al. Health evaluation of free-ranging and hand-reared macaws (*Ara* spp.) in Peru. *J Zoo Wildl Med*. 1997;28:368–377.
25. White EM, Greiner EC, Bennett GF, Herman CM. Distribution of the haematozoa of Neotropical birds. *Revista Biol Trop*. 1978;26:43–102.
26. Bennett GF, Garvin MC, Bates JM. Avian hematozoa from west central Bolivia. *J Parasitol*. 1991;77:207–211.
27. Woodford MH. *Quarantine and Health Screening Protocols for Wildlife Prior to Translocation and Release into the Wild*. Paris, France: Office International des Epizooties, Veterinary Specialist Group/Species Survival Commission of the World Conservation Union (IUCN), Care of the Wild International and the European Association of Zoo and Wildlife Veterinarians; 2001.
28. Cooper JE. Historical survey of disease in birds. *J Zoo Wildl Med*. 1993;24:256–264.
29. Fontenot DK, Terrell SP, Malakooti K, Medina S. Health assessment of the Guam rail (*Gallirallus owstoni*) population in the Guam rail recovery program. *J Avian Med Surg*. 2006;20:225–233.
30. Mathews F, Moro D, Strachan R, et al. Health surveillance in wildlife reintroductions. *Biol Conserv*. 2006;131:338–347.