UNIVERSIDADE DE ÉVORA

SCHOOL OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF VETERINARY MEDICINE

EXOTIC ANIMAL CLINIC

REPRODUCTIVE PATHOLOGY IN PSITTACINES

Maria Capelas de Oliveira Sant'Anna

Supervisor | Professor Elsa Leclerc Duarte

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Integrated Masters in Veterinary Medicine

Internship Report

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Abstract

The present report is based on the author's experience throughout performed externships for the conclusion of the Integrated Master's Degree in Veterinary Medicine by the University of Évora.

It is composed of two parts: the first concerns accompanied clinical cases in different exotic species at *Centro Veterinário de Exóticos do Porto* (in Porto, Portugal); the second comprises a bibliographical review regarding the topic "Egg-Binding and Dystocia in Psittacines" and three clinical cases. The second part also includes a chapter regarding the author's personal considerations where the differences between clinical practice of pet and captive birds are concerned, based on the experience at a zoological institution in the Canary Islands, Spain.

Keywords: Exotic animals, Psittacines, egg-binding, dystocia, conservation medicine.

Resumo – Clínica de Animais Exóticos

O presente trabalho é baseado na experiência da autora nos estágios efetuados no âmbito da conclusão do Mestrado Integrado em Medicina Veterinária pela Universidade de Évora.

Este trabalho é composto por duas partes: a primeira concerne os casos clínicos acompanhados em diversas espécies exóticas no Centro Veterinário de Exóticos do Porto (no Porto, Portugal); a segunda consiste numa revisão bibliográfica acerca de "Retenção de ovos e distócia em Psitacídeos", assim como a apresentação de três casos clínicos. A segunda parte inclui também uma secção de considerações pessoais da autora relativas às diferenças entre a prática clínica de aves exóticas como animal de companhia e em cativeiro, baseadas na experiência de estágio numa instituição zoológica nas Ilhas Canárias, Espanha.

Palavras-chave: Animais exóticos, Psitacídeos, retenção de ovo, distócia, medicina da conservação

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ACRONYMS AND ABBREVIATIONS LIST

ACD – Adrenocortical Disease

AVP – Arginine Vasopressin

AVT – Arginine Vasotocin

BID – Twice a day

Ca – Calcium

CBC – Complete Blood Count

CNS – Central Nervous System

CT – Computed Tomography

DNA – Deoxyribonucleic Acid

ELISA – Enzyme-Linked Immunosorbent Assay

FSH - Follicle Stimulating Hormone

GI – Gastrointestinal

GnRH – Gonadotropin-Releasing Hormone

HCG – Human Chorionic Gonadotropin

HVD - Haemorrhagic Virus Disease

IFA – Immunofluorescence Assay

IFAT – Indirect Immunofluorescent Antibody Test

IM – Intramuscular

IV – Intravenous

LH – Luteinising Hormone

LHRH – Luteinising Hormone-Releasing Hormone

Mn – Manganese

MRI – Magnetic Resonance Imaging

N – Nitrogen

NSAID – Nonsteroidal Anti-Inflammatory Drug

ºC – Degrees Celsius

P – Phosphorus

PBFD – Psittacine Beak and Feather Disease

PBFDV – Psittacine Beak and Feather Disease Virus

PGE2 – Prostaglandin E2

PGF2α – Prostaglandin F2α

PTH – Parathyroid Hormone

PTHrP – Parathyroid Hormone-Related Protein

QID – Four times a day

SC – Subcutaneous

SID – Once a day

TID – Thrice a day

TRH – Thyrotropin-Releasing Hormone

VIP – Vasoactive Intestinal Polypeptide

VUND – Vesicular, Ulcerative and Necrotic Dermatitis

I. Introduction and Goals

As more and more people decide to have more than one pet, the tendency to receive a wider variety of species (other than the most commonly seen cat and dog) in practice is increasing.

The world of exotic animals for pets is on the rise and every day we learn more about them and the problems that ail them.

The main reason why the author chose to perform an internship with exotic animals was curiosity and fascination towards them. The reason why an externship in a zoological institution was pursued was due to the profound interest and passion for conservation medicine.

This work is composed of two parts; the first part will be a report of activities executed in the internship, and the second will consist on describing a specific disorder chosen by the author. Personal comparative considerations between husbandry of animals in captivity (based on the externship experience) and pets (based on the internship experience) will be included at the end.

The main goals of this work are to partly demonstrate the wide array of afflictions that occur in various groups of exotic animals, as well as the most commonly found.

II. Internship Report

1. Internship Locations

The author performed two distinct practice periods, at two distinct locations.

The curricular internship was completed at the *Centro Veterinário de Exóticos do Porto* (Exotic Animal Veterinary Centre), in the city of Porto, Portugal, from the fourth of September 2017 to the sixth of February 2018. This clinic is exclusively specialised in exotic animal care and no other type of pet would be allowed inside the facility.

Said establishment was composed of a waiting room for clients and their pet(s), one office used for consultations, a surgery room, a bureau for the staff's personal use, and two rooms for hospitalised patients. These two rooms were purposefully kept at different temperatures (one of which was constantly heated) so as to better accommodate each individual's needs. The venue also had access to a grassy backyard, where some animals could exercise. Office hours were from 10:00 a.m. to 7:30 p.m., Monday to Saturday, closing only during lunch time from 01:30 to 3:00 p.m. Outside the normal work schedule, there was always a practitioner on-call in case any medical emergency should arise.

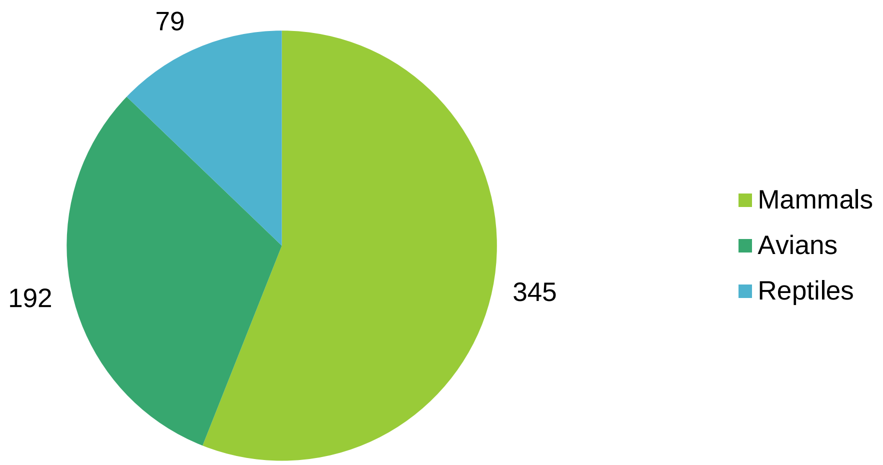
The extra-curricular internship was performed at the clinic of the zoological institution Loro Parque, of the *Loro Parque Fundación*, in the city of Tenerife, in the Canary Islands (Spain) from the fifth of March 2018 to the 27th of April 2018. At this park, the working days would start at 8:00 a.m. and end by 5:00 p.m. Due to the great amount of species encountered in this internship, and due to the small amount of time spent there, case series from this experience will not be included, although there will be some comparative considerations regarding bird patients worth mentioning, especially when it comes to comparing different types of habitats, nutrition and general management.

Besides attending to hospitalised patients at the zoo clinic (among other needed tasks), the author would be allowed to accompany one of the veterinarians on their enclosure consultations and assist with procedures performed.

2. Case Series

Given the great amount of animal species encountered during the curricular internship period, all consultations and cases have been categorised into three animal groups: Mammals, Avians and Reptiles.

Graphic 1 illustrates the number of individuals found for each animal group.



Graphic 1: Distribution of clinical cases by categorisation in Mammals, Avians and Reptiles (n=616).

Throughout the internship period, the author observed a total of 616 different animals, of which 345 were Mammals, 192 were Avians and 79 were Reptilians. The total number of routine consultations, surgical procedures and others will be described in more detail in the following sections.

For matters of simplification this first part will be divided into Preventative, Medical and Surgical Medicine, and other performed procedures for each previously mentioned animal group.

All internal medicine areas of intervention will be presented by decreasing level of occurrence, meaning areas addressed first will have a greater number of cases than the ones mentioned further ahead. Note that for simplification purposes not all sections will be equally developed throughout this report.

2.1. Preventative Medicine

2.1.1. Mammals

In the Mammals' group a total of 74 vaccinations and 163 deworming procedures were performed, throughout a total of 163 routine consultations. The disparity between these numbers is due to the fact that deworming is usually performed twice a year, whereas most vaccines applied in exotic animal clinic are usually administered annually.

For simplification matters, the deworming protocols mentioned in this report will be the ones used specifically at the exotic pet clinic. Most animals of all mammal species (114 individuals) were dewormed by an oral association of Fenbendazole (Panacur ® 2.5%) and Praziquantel (Cestocur ® 2.5%). Ivermectin (Ivomec ® Plus) was used on the remaining 49 individuals.

Ivermectin has the advantage of acting on both internal and external parasitic agents. The clinic's deworming protocol consisted in administering the previously mentioned drugs twice a year as a means of prevention, altering the protocol only in case any parasites were found. External deworming as a means of prevention was mostly directed at animals in regular contact with outdoor spaces or other animals (e.g. spot-on pharmaceuticals such as selamectin).

According to Portuguese legislation (as defined by the Portaria n. º 264/2013 de 16 de Agosto) even though vaccination against certain diseases or zoonoses in Portugal (such as rabies) is mandatory for dogs, it is merely voluntary for cats and other sensitive species, like ferrets. At the clinic, the vaccine formulation for dogs (Nobivac® Puppy-DP) was used, since the existing ferret formulation (PUREVAX® Ferret Distemper) is currently not commercially available in Portugal. PUREVAX® Ferret Distemper is a recombinant vaccine used in ferrets from 8 months of age for prevention of disease caused by the Canine Distemper Virus. Canine distemper in ferrets is pretty much always fatal; even if the animal recovers from the acute phase, it usually does not resist the later disease stages, where the central nervous system (CNS) is affected (Antinoff & Giovanella, 2012). Ferrets may also be immunised against rabies and there are several formulations that may be used on them.

At the clinic, rabbits were immunised against Myxomatosis and Rabbit's Haemorrhagic Disease with the live vaccine Nobivac® Myxo-RHD. It is a specific formulation for the species that (according to its informative leaflet) can be administered from 5 weeks of age and onwards, on a yearly fashion.

Myxomatosis is caused by a poxvirus (transmitted by a flea), which multiplies in the skin around the eyes, nose, base of the ears and genitals. Animals presenting with the acute form of the disease develop swellings and oedema around the multiplication sites, where genital swelling is considered pathognomic. Animals affected by this form almost always perish. Chronic or nodular forms present with pseudo-tumors especially on the ears, nose and paws, which are selflimiting and resolve on their own. Support and treatment directed towards secondary *Pasteurella* sp. infection is applied in these cases. Vaccination and insect control are the best means of prevention (Richardson, 2000a).

The rabbit Haemorrhagic Virus Disease (HVD) is caused by a calicivirus, which replicates in hepatocytes, causing hepatic necrosis. Tissue thromboplastins are released in response, initiating disseminated intravascular coagulation that results in haemorrhages, particularly in the lungs and kidneys. Per-acute and acute presentations are untreatable and almost 100% fatal, whereas supportive treatment may be provided for mild cases. Therefore, vaccination is the best means of control and protection (Richardson, 2000a; Abrantes et al., 2012).

Upon first administration the ferret vaccine requires two booster doses, whereas the rabbits' requires only one application every year. Of a total 74 administered vaccines, 43 were used on rabbits and 31 on ferrets.

In Portugal, to register ferrets as pets, they must be identified with an electronic identification device. A total of six said devices were inserted in mammals, all of them ferrets, which were posteriorly registered by the veterinarian that inserted the microchip.

The female ferret is seasonally polyoestrous and an induced ovulator. Given this fact, non-mated females usually undergo long periods of persistent oestrus and become susceptible to the effects of prolonged hyperoestrogenism, which may lead to bone marrow suppression and consequent anaemia (Lindeberg, 2008; Risi, 2014).

Hormonal injections of alpha coriogonadotropin, which is a recombinant Human Chorionic Gonadotropin (hCG), were applied in five ferrets for oestrus control. These are also commonly known as a 'jill-jab' and are usually applied when the female ferret (or jill) starts showing behavioural signs of oestrus, mainly vulvar swelling. Owners may also opt to do this at the start of breeding season. Usually around 10 days after the injection, jills will no longer display cyclical signs and may remain so for the entire breeding period, preventing pregnancies and associated anaemia (Royal Veterinary College, 2015).

A more viable option in the long run consists in the application of a deslorelin acetate implant (SUPRELORIN ® F Implant), which also presents the advantages of minimising adrenocortical disease (ACD) symptoms. Hormones are stored in a slow-release capsule, which is implanted subcutaneously. It is also noteworthy that the deslorelin acetate implant first induces a period of increased gonadotropins (FSH and LH), which may result in an initial exacerbation of the clinical signs (Risi, 2014).

However, continued exposure to this GnRH agonist eventually downregulates GnRH receptors, affecting the synthesis and release of FSH and LH. For this reason, around two weeks after the implant, signs of oestrus should quickly come to a halt. Consequently, these may be used for both male and female ferrets, preventing the former from being able to impregnate intact jills and the latter from cycling. Albeit effective, it requires subsequent implantations of new capsules after approximately 18 months. Nevertheless, it may still be considered as the safest alternative to neutering (Risi, 2014; Royal Veterinary College, 2015; Jekl & Hauptman, 2017).

2.1.2. Avians

In the Avian group, a total of 63 routine consults were performed. Most consultations consisted in deworming procedures, where the previously mentioned association of fenbendazole and praziquantel was administered to a total of 32 birds, except cockatiels, for which the administration has toxic and sometimes fatal effects (Howard, et al., 2002).

Some birds may regurgitate the orally administered medication. In these situations, the topical administration of ivermectin is a viable option, as was the case for 31 of the individuals. Two animals were outfitted with electronic identification devices and eleven had their wings clipped. No vaccines were administered to any birds.

On many consultations (especially for those animals that had never been medically assessed) the veterinarian would also advise the owners on nutrition and general husbandry. Knowing how to properly feed and care for one’s pet(s) is a major stepping stone towards preventing disease and the author noted many clients needed guidance, given they were generally unaware of their pet’s needs (especially those who had never owned an exotic bird).

2.1.3. Reptilians

A total of 33 routine consultations were performed, of which all animals were dewormed using the fenbendazole and praziquantel association.

Ivermectin was administered to an iguana, due to the presence of external parasites. However, this drug is not suitable for use in all reptilians. For example, in chelonians (turtles) it crosses the blood-brain barrier, resulting in flaccid paralysis and death (Petritz & Chen, 2018) and therefore should not be administered in this type of reptile.

One electronic identification device was applied on an iguana and one of the turtles required corrective beak trimming. The beak is a corneal structure of continuous growth and needs to be worn out to prevent it from growing excessively. It is usually associated to lack of substrate that allows turtles to wear them off, although it may also be related to cases of prognathism or brachygnathia (Silvestre, 2003).

2.2. Clinical Medicine

Table 1 illustrates the distribution of the varied situations witnessed by the author, categorised by animal group. It has the mere purpose of demonstrating to the reader the types of performed consultation, as well as the resulting number of hospitalisations and casualties. Note that total numbers on this table will not correspond with the numbers on table 2.

Table 1: Distribution of clinical medicine observations by situation (n=564).

Clinical Medicine	Mammals	Avians	Reptilians	***Total***
Non-routine consultations	118	88	37	***243***
Hospitalisations	87	44	7	***138***
Follow-up consultations	47	35	32	***114***
Deaths	23	17	2	***42***
Medical emergencies	14	13	0	***27***
Total	**289**	**197**	**78**	***564***

2.2.1. Mammals

Note that the following statistical results will always be “altered in favor” of rabbits, since it is the species most commonly followed in exotic animal practice.

Table 2 illustrates the distribution of internal medicine affections according to medical specialty on mammals. Note that *Encephalitozoon* sp. cases are described in the infectious disease category but are also referred in the neurological disease category in the text (albeit absent from this table).

The author found that some animals had more than one medical episode and often presented for consultation with more than one system affected (e.g. the patient could present with respiratory distress and a parasitic infestation at the same time). This resulted in a greater number of total medical situations (178) compared to the number of non-routine consultations (118) and the number of medical emergencies (14) adding to a total of 132 counting both.

It should be taken into account that in all different internal medicine areas, pathologies were described not only according to the number of cases, but according to the author’s own interest as well.

Table 2: Clinical case distribution according to medical specialty on mammals (n=178).

Medical Specialty	Total observed cases (n)		Fr (%)	
Infectious Diseases		**36**		**20.2%**
Parasites	21		58.3%	
Bacteria	6		16.7%	
Encephalitozoon cuniculi	5		13.9%	
Other fungi	4		11.1%	
Odontology		**35**		**19.7%**
Malocclusion	19		54.3%	
Overgrowth	13		37.1%	
Abscess	2		5.7%	
Periodontitis	1		2.9%	
Musculoskeletal		**19**		**10.7%**
Trauma without fracture	9		47.4%	
Fracture	7		36.8%	
Others	3		15.8%	
Gastrointestinal		**18**		**10.1%**
Hipomotility	12		66.7%	
Obstruction/Impaction	4		22.2%	
Others	2		11.1%	
Oncology		**17**		**9.6%**
Tricofoliculoma	2		11.8%	
Chordoma	1		5.9%	
Undiagnosed mass	14		82.4%	
Dermatology		**13**		**7.3%**
Abscess	7		53.8%	
Dermatitis	6		46.2%	
Pneumology		**12**		**6.7%**
Reproductive and Urinary Disorders		**12**		**6.7%**
Ophthalmology		**9**		**5.1%**
Exophthalmia	2		22.2%	
Other occurrences	7		77.8%	
Neurology		**4**		**2.2%**
Anorexia/ Undiagnosed Cause		**3**		**1.7%**
Total		*178*		*100%*

Infectious Diseases

The author found a total of 36 infectious-related cases throughout the internship period. Regarding parasitic infections there were a total of 21 cases (of which only two consisted in internal parasitism, those remaining were external). The most affected species were guinea pigs (*Cavia porcellus*) with ten cases, followed by ferrets (*Mustela putorius furo*) with seven cases, where the remaining external cases occurred in two rabbits (*Oryctolagus cuniculus*), a golden hamster (*Mesocricetus auratus*) and a pig (*Sus scrofa domesticus*). Guinea pigs were all affected by lice and the ferrets by ear mites. None of the agents were identified by species nor genus.

Regarding fungal infections, a total of five rabbits were affected by the Microsporidia fungi *Encephalitozoon cuniculi.* This is an obligate intracellular parasite, whose spores often provoke lesions in the kidney, brain and spinal tissues (Klaphake & Paul-Murphy, 2012). It has also been described in other mammals and birds, as well as humans (among which immunosuppressed individuals are susceptible) (Harcourt-Brown & Holloway, 2003; Kunzel, et al., 2008; Maestrini, et al., 2017).

Infection usually occurs through the ingestion of food contaminated by infected urine. Sporoplasms accumulate in vacuoles inside reticuloendothelial cells, and upon their rupture, spores are released and invade more cells (Harcourt-Brown & Holloway, 2003). Granulomatous lesions develop in many organs but mainly in the kidney, eye and CNS of affected rabbits (Kunzel, et al., 2008).

Encephalitozoonosis is a common cause for neurological manifestations. Infections caused by *Encephalitozoon cuniculi* usually course in a chronic and latent form in rabbits, where those individuals demonstrating clinical signs often show ocular lesions and exhibit neurological symptoms, usually linked to renal failure (Maestrini, et al., 2017). Vestibular disease is the most commonly found neurological manifestation in these cases, in varying degrees of severity. Animals that are infected *in utero* tend to manifest phacoclastic uveitis (figure 1), which occurs as a result of rupture of the lens and consequent lens material release into the anterior chamber of the eye (Harcourt-Brown & Holloway, 2003).

Diagnosis can be achieved by demonstration of spores by histopathology and detection of antibodies by Indirect Enzyme-Linked Immunosorbent Assay (ELISA) or Indirect Immunofluorescent Antibody Test (IFAT) using the Encephalitozoon antigen for antibody detection. Anti-Encephalitozoon antibody detection, however, does not necessarily mean the agent is the cause for disease, since there are many seropositive rabbits that do not manifest any clinical signs. This means the presence of these antibodies is merely an indicator of chronic infection (Maestrini, et al., 2017; Kunzel, et al., 2008). In the study conducted by Harcourt-Brown and Holloway (2003) collected samples from rabbits were tested for the immunoglobulin G, each test being run with a positive and negative control. Results were considered either positive, negative or borderline should the antibody titre be one-third above the positive control, although no exact titre values were reported.

Figure 1: Phacoclastic uveitis on a rabbit, secondary to *Encephalitozoon cuniculi* (Image kindly provided by CVEP).

One of the possible treatment options consists in administration of fenbendazole (Panacur®; 20 mg/kg orally, SID, for 4 weeks) to kill the parasite. Antibiotics such as enrofloxacin or oxytetracycline may be added to the therapy of animals manifesting neurological symptoms, and corticosteroids (e.g. prednisone or dexamethasone) may be complementarily used to control inflammation. At the clinic, a treatment consisting on daily administration of fenbendazole over the course of 28 days was applied, as described by literature (Kunzel, et al., 2008).

Two guinea pigs and a ferret showed faecal yeast overgrowth, and were treated with nystatin until budding yeasts were no longer observable upon faecal examination. The species of yeast encountered in these faecal samples was not ascertained.

Odontology

The author had the chance to observe a total of 35 odontology cases in mammals.

Rabbits and guinea-pigs were the most affected species, followed by the chinchillas (*Chinchilla laniger*). The majority of cases on rabbits occurred due to dental malocclusion, of which a significant amount presented simultaneous teeth overgrowth (also a very common cause). Note that all animals included in the “overgrowth” category only presented incisor overgrowth where malocclusion was not detected, whereas animals included in the “malocclusion” category simultaneously presented incisor teeth overgrowth.

Malocclusion of incisors, molars and premolars is a syndrome that can include varied situations such as distorted occlusal planes, presence of sharp points associated with mucosal lesions, periodontal disease associated with unnatural teeth mobility and diastema formation, apical and peri-apical alterations with apical elongation and abscess formation (Verstraete, 2003).

Therefore, since both malocclusion and teeth overgrowth are almost always concomitantly present, they should be approached in a similar way.

Rabbit dentition is continuously growing (*elodont*) with long crowns (*hypsodont*), meaning these animals have quite a dynamic dentition, which tends to further complicate dental disease. Rabbits also present lower maximum gapes when compared to rodents, which renders oral examination quite difficult without sedation (Vella & Donnelly, 2012). Examining the oral cavity of a non-sedated patient using otoscopic cones means some lesions may be missed, so the use of vaginal or nasal specula with lighting may provide better visualisation (Graham & Mader, 2012).

Patients will normally present for anorexia and steady weight loss. Most animals will also have an unkept look given their inability to groom themselves. Treatment options include wearing out the overgrown teeth every 3 to 6 weeks (or when necessary), along with any required dietary changes, extraction of the affected teeth and debridement of any present palpable abscesses (Verstraete, 2003).

Should the animal be too stressed to allow proper examination, or performing any kind of procedure, the administration of a sedative may be an effective option. For example, midazolam at a dosage of 0.5 to 1.0 mg/kg injected intramuscularly (IM) appears to be very effective in calming rabbits (Graham & Mader, 2012).

Different teeth-sets grow at different speeds (e.g. lower incisors grow faster than the upper incisors) and may be influenced by a variety of factors such as age and nutrition, among others. Rabbits chew leafy food in mainly horizontal movements, whereas they masticate harder pellets in a more vertical plain. The latter does not complement a 'normal' chewing action, and does not properly wear out teeth, thus the importance of dietary management. It is important to know that the ingestion of leafy food such as hay and grass is a vital component of a rabbit's diet (Vella & Donnelly, 2012), and the same applies to guinea pigs and chinchillas.

Guinea-pigs mainly presented with malocclusion (figure 2), with a total of eight cases versus two of excessive incisor teeth growth. Regarding chinchillas, most cases were due to incisor overgrowth, with only one suffering from malocclusion.

Figure 2: Dental malocclusion associated with incisor teeth overgrowth on a guinea pig (*Cavia porcellus*) (Image kindly provided by CVEP).

A rabbit and a guinea pig presented with abscesses deriving from dental root infection. Both animals underwent surgery for debridement and marsupialisation of the lesion, and antimicrobial therapy.

The only periodontitis case was on a Richardson's squirrel (*Spermophilus richardsonii*) that came to be hospitalised due to its inability to feed (figure 3). Given the severe state of the squirrel, euthanasia was considered the most humane course of action. However, the patient did not resist its condition and passed away before the decision was made by its owners.

Figure 3: Periodontal infection on a Richardson's squirrel (note swelling of the tongue) (Image kindly provided by CVEP).

Musculoskeletal

Of the 19 cases accounted for in this category, a total of 16 cases were traumatic, where 7 were bone fractures (5 rabbits, one guinea-pig and one hamster). Vertebral fractures are a common occurrence in rabbits, even more so than dislocations. This type of traumatic injury more often occurs at the level of the lumbosacral region as a result of improper handling, or in caged animals that are frightened or startled for some reason (Deeb & Carpenter, 2004). Management of fractures is similar to that of cats and dogs, where either internal or external fixation may be applied (Richardson, 2000a). Diagnosis is achieved through radiographic imaging, and the use of analgesics as part of treatment protocol is paramount, where meloxicam can be safely used for long-term therapy (Deeb & Carpenter, 2004).

Spinal cord injuries may easily occur, even in the absence of vertebral fractures, where dislocation is sufficient to cause sudden paralysis (Patton et al., 2008). At the clinic this was the case for two of the accompanied patients. Animals retaining some hind limb and bladder function at the time of trauma usually have a good recovery prognosis, whereas those individuals that do not control urination or defecation have a poor prognosis (Okerman, 1988). Depending on damage severity animals retaining some function may respond to diuretic and corticosteroid therapy (Richardson, 2000a). Those animals showing no signs of improvement are often candidates to euthanasia (Okerman, 1988; Deeb & Carpenter, 2004).

Vertebral degeneration and spondylosis naturally occur with age, and geriatric patients often develop paresis and paralysis as a result. This was the case for one of the elder rabbits accompanied by the author. Two other rabbit patients presented with arthritis, which is also common among older patients, and may present with soft tissue calcification. Anti-inflammatory and analgesic therapy is advised in these cases (Richardson, 2000a).

There was only one case requiring the removal of the affected limb, on a hamster. Any required amputation procedures may also be performed similarly to those of cats and dogs.

Gastrointestinal

A total of 18 affected animals were observed, of which eleven were rabbits, two were guinea pigs, two were hamsters (of the genera *Phodopus*), two were chinchillas and one was a ferret. Most patients were brought to the clinic with complaints of anorexia, refusal to eat and drink, and faecal retention. Gastrointestinal (GI) stasis or hypomotility proved to be a main cause of disease in rabbits and rodents. Since the passing of faeces and need for continuous ingestion of hay are paramount for their health and wellbeing, this sort of affliction is considered a medical emergency in these animals.

"Rabbits eat approximately 30 times a day, (…) over four to six-minute periods" (Campbell-Ward, 2012). Inappropriate diet may be one of the causes for GI hypomotility, but there are actually many factors that can trigger an episode (e.g. illness, stress, pain). Death is a common outcome for cases left untreated (Oglesbee & Jenkins, 2012).

All patients showing signs of pain or discomfort (e.g. grinding teeth) on arrival should have their abdomen palpated to check for any abnormalities. In most rodents, the cecum is a large and prominent organ, with generally semifluid contents. Thus, proper auscultation should follow suit in order to detect abnormalities, since the absence of intestinal sounds is often a sign of gastrointestinal disorder (Graham & Mader, 2012).

Radiography may be helpful in the identification and exclusion of possible aetiologies (Oglesbee & Jenkins, 2012). Patients admitted with GI stasis or hypomotility would be rehydrated via subcutaneous fluid administration, properly medicated to keep them as comfortable as possible, and force-fed with feeding slurries (rich in water and fiber). Faecal testing should be routine practice for all consultations since it may provide valid initial information regarding the animals' gastrointestinal system. Note that the presence of mucus around faeces is merely an inflammatory response, normal in the rabbit (Vella & Donnelly, 2012).

Rabbits excrete two different types of faecal matter: dry, hard, round pellets and soft ones enveloped in mucus, also known as cecotropes. The former is found individually spread, whereas the latter is found in clusters, which stick to the fur on the anal region. Rabbits ingest these soft faeces directly from the anus and highly benefit from it, since they contain short-chain fatty acids, microbial protein, complex B vitamins, minerals and water. Cecotropes also represent 30% of a buck's nitrogen (N) intake, meaning cecotrophy (the ingestion of faeces) improves protein value in diet and it is a normal, physiological behaviour in rabbits (Vella & Donnelly, 2012).

Sometimes rabbits would not ingest said soft faeces and owners would often bring them to consultation thinking their pet had diarrhoea, making it another common cause for consultation. Nonetheless, cases of non-ingestion of cecotropes should not be considered cases of diarrhoea.

A total of four patients presented with gastrointestinal obstruction; two rabbits with impacted caecum's due to hair accumulation, a hamster with rectal and colonic prolapse, and one chinchilla with intestinal intussusception, which later became a surgical case.

Administered medication in these cases should include a nonsteroidal anti-inflammatory drug (NSAID), but only after proper rehydration and in the absence of renal problems. The most commonly used drug at the clinic was meloxicam, of which recommended dosages of 0.3-0.5 mg/kg injected subcutaneously (SC) BID (twice a day) or SID (once a day) have been described (Oglesbee & Jenkins, 2012).

GI prokinetics (e.g. metoclopramide) were also commonly used throughout the internship, as well as antibiotics (e.g. enrofloxacin, metronidazole) in cases of dysbiosis. Treatment protocol at the clinic also included the oral administration of faecal softeners, such as paraffin (Parafinina® Oral Solution), to facilitate the expulsion of dried faecal matter.

Oncology

The author found a total of 17 oncological cases in mammals. The most affected species were rabbits, guinea pigs and common hamsters (all with four cases each), followed by ferrets (two cases), a golden hamster, a rat and a squirrel. Cases on rabbits will be discussed further ahead on the reproduction diseases section, since most tumors were related to the reproductive tract. The nature of most masses remained undiagnosed.

Of all oncological cases in guinea pigs, two consisted in tricofoliculomas. A tricofoliculoma is the most common subcutaneous tumor to occur in guinea-pigs, and usually presents itself with a very specific single mass at a dorsum-lumbar location (Morant, 2015).

One of the affected ferrets had a spinal tumor on its tail known as a chordoma. This region is where this type of tumour usually develops, although it may also occur in the cervical region. It originates from what is left of the notochord, an embryonary development structure of paramount importance to spine formation. When in the tail, these masses appear lobulated, firm, with no capsule, and may or may not be ulcerated. They commonly develop near the last caudal vertebra (Antinoff & Giovanella, 2012).

Dermatology

Thirteen animals presented for dermatological affections. Guinea pigs were the most affected species (six cases), followed by rabbits (five cases), one chinchilla and one hedgehog (*Atelerix albiventris*). Guinea pigs and the hedgehog presented with varied forms of dermatitis; the rabbits, the chinchilla and one guinea pig presented with abscesses, which either resolved with antimicrobial therapy and manual drainage, or with surgical intervention. Note that masses diagnosed on guinea pigs have been previously discussed in the Oncology section.

Common dermatological lesions include alopecia, scaling, erythema, excoriations or erosions, and sometimes even ulcers. Upon physical examination one should always check the plantar surfaces of the animals' feet. Footpads are specialised areas of thickened skin with an underlying layer of fat deposits which act as shock-absorbents in rodents. Rabbits do not possess said footpads, having great amounts of hair in their paws instead (Palmeiro & Roberts, 2013). Rabbits, guinea pigs and chinchillas would often present at consultation with varying degrees of pododermatitis, due to inappropriate substrate use (Graham & Mader, 2012). Changes in substrate were enough to resolve the mild lesions in some of the patients, and bandaging and topical medicine were applied on wounds whenever necessary.

Diagnosing dermatological affections requires obtaining a previous history as thorough as possible, including feeding habits, since these can influence skin disease. For example, the incidence of skin disease in guinea pigs is dependent on vitamin C intake and increases on low vitamin C diets (Richardson, 2000b). Other than CBC and biochemical testing, one can perform other types of diagnostic testing such as scrapings, culture and sensitivity tests from collected samples, use the Wood lamp to detect dermatophytes, perform a trichogram to evaluate hair condition as well as searching for parasites, and skin biopsies. Treatment is directed towards the cause (Palmeiro & Roberts, 2013).

Pneumology

A total of 12 animals displayed respiratory clinical signs on arrival. Rabbits were also the most affected for this category (five cases), followed by guinea pigs and rats (two cases each), the remaining rodents (*Mesocricetus auratus* and *Mus musculus)* and chinchillas, with one case for each species.

Given their anatomical distribution and connections, rabbits are only able to breathe through their nostrils. This may result in clinical difficulties, namely when it comes to anaesthesia, since rabbits may be normally challenging to intubate and even more so when presented with inflamed upper respiratory tracts. Lung vital capacity remains unchanged in rodents and rabbits, thus "any signs of dyspnoea in rabbits and rodents always point to a poor prognosis" (Vella & Donnelly, 2012).

Pasteurella multocida, *Bordetella bronchiseptica*, species of the genera *Pseudomonas* and *Staphylococcus* are the most commonly found isolates in nasal samples, and infections may be mixed (Lennox, 2012).

All animals that came to the clinic in respiratory distress would immediately receive oxygen, and direct physical examination and handling would be postponed in case the animal was found in critical condition. Auscultation would also be paramount, as well as a complete and meticulous anamnesis. Upon patient stabilisation, owners could opt to perform chest radiography, to further investigate causes of disease. These radiographies are accounted for in the procedures section, further ahead in this document.

Reproductive and Urinary Disorders

This category includes the 12 cases involving either procreative or urinary afflictions. Regarding reproductive issues, there were a total of ten cases. Rabbits were the most affected with a total of four individuals, followed by two guinea pigs and two ferrets, one rat and one hamster (*Phodopus sp*.).

Animals with any neoplasia associated to the reproductive tract are included in this category, since upon first consultation the main cause was not yet defined and was only speculative. These same patients are also considered in the above-mentioned section regarding oncological patients.

It is described that the most commonly found neoplasia in female rabbits is uterine adenocarcinoma (Klaphake & Paul-Murphy, 2012). However, during the author's internship none of the patients' tutors wanted histopathology to be performed on the removed reproductive tissue and so the nature of the masses (speculated to be tumors at the time of their removal) remained undiagnosed.

Some patients underwent abdominal echographical examination, which constitutes an important tool for the detection of abnormal uterine tissue growth (Klaphake & Paul-Murphy, 2012), facilitating differential diagnosis.

There were only two urology cases: a rabbit presenting with urethral dilation and renal *calculi*, and a rat with a urinary infection which was controlled by medication, and later resolved.

Ophthalmology

There were a total of nine ophthalmological cases, of which five occurred in guinea pigs, representing the majority of cases. Of the remaining species, three rabbits and one chinchilla were affected. Two of the guinea pigs suffered from severe exophthalmia and both underwent a surgical enucleating procedure where the affected eye was removed.

Patients presenting with ocular discharge were a common find and would sometimes go hand in hand with varying degrees of nasolacrimal duct obstruction. Most common causes include dental disease and infection. Nasolacrimal cannulation may restore secretion circulation in affected patients (Graham & Mader, 2012).

One of the rabbits presented with unilateral exophthalmos secondary to a retro bulbar abscess (figure 5), as well as slight nasolacrimal duct obstruction due to the increased pressure behind the eye. This animal was hospitalised and submitted to surgery, in order to drain the abscess and restore normal eye position.

Figure 4:Demarcated exophthalmia secondary to retrobulbar abscess in rabbit. Note the general redness of the left eye (Image kindly provided by CVEP).

Neurology

A total of 9 mammals (only 4 are referred on table 2) presented with neurological symptoms. Once again, rabbits were the species most affected, of which five cases were secondary to the presence of *Encephalitozoon cuniculi* (discussed in the infectious disease category).

Note that these 5 cases are not included in the neurology section in table 2. Nevertheless, the author decided to mention them in this text section since encephalitozoonosis is one of the differentials to consider upon receiving a rabbit with neurological symptoms.

The majority of animals presented for at least one neurological symptom, of which the most common were: head-tilt or torticollis (figure 4), rolling, star-gazing, ataxia and posterior limb paresis.

Figure 5: Rabbits presenting vestibular syndrome with varied degrees of head-tilt (Image kindly provided by CVEP).

Differential diagnoses of torticollis include otitis media and interna, cerebrovascular accidents, trauma, neoplasia, encephalitozoonosis, toxoplasmosis or intoxication. Both types of otitis are most commonly caused by *Pasteurella multocida*, but other isolates such as *Staphylococcus* sp., *Pseudomonas* sp. and *Bacteroides* sp. (among others) have been described. Pus may be visualised in the ear canal, and long-term antibiotic therapy for over 6 months is often necessary. Most infections are sensitive to enrofloxacin (Richardson, 2000a).

A prophylactic treatment protocol consisting of orally administrated fenbendazole was applied to those rabbits presenting vestibular syndrome, to prevent further symptom progression in case they were a consequence of *Encephalitozoon cuniculi* infection.

Rats (*Rattus norvegicus*) were the next most affected species with a total of two cases. Both were attributed to the animals' old age and one of these cases culminated with euthanasia. Hamsters and chinchillas were the remaining affected species.

One of the chinchillas presented for low thiamin-related seizures. These can be caused by metabolic imbalances, toxicity, trauma and epilepsy. Most common metabolic causes include low calcium, low thiamine and low blood sugar. Low calcium is often seen in lactating females (diet is advised to be supplemented), hypoglycaemia is rare, and the ingestion of cold food has also been described as a trigger. Thiamine seizures are preceded by circling and tremors, which can be treated with multivitamin B administrations (e.g. Neurobion ®) (Richardson, 2003).

Anorexia of undiagnosed cause

There are multiple possible aetiologies for anorexia, however, the only animals included in this category are those for which the main cause was never diagnosed. A total of three animals (a rabbit, a guinea pig and a hamster) arrived in said condition and were all provided with nutrition and fluid support.

Fluid therapy is aimed at restoring blood volume, normalising cardiac output and optimising tissue oxygenation. It also has the benefit of increasing diuresis, thus helping to eliminate toxic metabolites. Subcutaneous and oral fluid administration is not a viable option for critical patients, hence intravenous and intra-osseous approaches are favoured (Dorrestein, 2000).

All patients had their lack of appetite and responsiveness resolved after support and stimulation, without ever showing any other signs of underlying disease.

2.2.2. Avians

Table 3 illustrates the distribution of internal medicine affections according to medical specialty on birds. Note that for simplification matters not all the different areas will be equally developed throughout the text.

Table 3: Clinical case distribution according to medical specialty on avians (n=139).

Medical Specialty		Total observed cases (n)		Fr (%)	
Musculoskeletal			**42**		**30.2%**
	Trauma	37		88.1%	
	Malformation	5		11.9%	
Infectious Diseases			**36**		**25.9%**
	Fungi	15		41.7%	
	Bacteria	11		30.6%	
	Parasites	7		19.4%	
	Virus	3		8.3%	
Pneumology			**23**		**16.5%**
	Infection	22		95.7%	
	Others	1		4.3%	
Neurology			**12**		**8.6%**
Dermatology			**9**		**6.5%**
	Feather cysts	6		66.7%	
	Abscess	1		11.1%	
	Others	2		22.2%	
Anorexia/Metabolic Disorders			**8**		**5.8%**
	Hypocalcaemia	5		62.5%	
	Unknown cause	3		37.5%	
Reproductive Disorders			**5**		**3.6%**
	Egg-binding & Dystocia	4		80%	
	Others	1		20%	
Ophthalmology			**2**		**1.4%**
Oncology			**1**		**0.7%**
Gastrointestinal			**1**		**0.7%**
Total			*139*		*100%*

Musculoskeletal

A total of 37 traumatic cases comprised the main cause for consultation in birds, of which 14 of the patients presented with self-inflicted wounds. The remaining trauma cases involved fractures, which were treated similarly to mammals, using casts and bandages to promote healing, and appropriate medical therapy, including antibiotics, analgesics and fluid therapy.

Most fractures in smaller species are usually effectively treated by simple tape splinting (Rosskopf, 2003). Fractured hind limbs may be bandaged in a flexed perching position and plucking the feathers of the region is advised to render the bandages more easily applied and later removed (usually 3 weeks after the trauma). For cases requiring external fixation 30-gauge needles may be used as pins and plastic needle guards as stabilising bars (Matos & Morrisey, 2005).

Cases of malformation included neonatal spraddle- or splayed-leg (which was the case for 3 young lovebirds), as well as beak deformities in adults (one turtledove and one Congo African Grey Parrot).

Splay-leg in neonates can result from calcium-phosphorus imbalances or lead intoxications in the parents, incorrect incubation and improper nesting. Nests with slippery surfaces may result in subluxation of the coxofemoral joint, leading to laxity and lateral ligament damage. Chicks with metabolic bone disease and associated tibiotarsal fractures may also develop secondary deformities. Early correction with splints is advised, to avoid the need for corrective osteotomies (Doneley, 2010).

Infectious Diseases

Animals were mostly affected by fungi, followed by bacterial infection, both internal and external parasitic infestations and a few viral affections.

Some cases were due to disease caused by the organism formerly known as Megabacteria. Despite its common name, this long, rod-shaped agent is a gram-positive Ascomycetes yeast called *Macrorhabdus ornithogaster*, and not a bacterium as was usually thought to be. It colonises the proventriculus and proventricular-ventricular junction of birds, affecting both wild and captive psittacines and passerines, among others. Animals usually present with dysphagia, vomiting, diarrhoea and a history of emaciation (Kheirandish & Salehi, 2011). Cockatiels may additionally present with anaemia and melena, and other species have been described to present secondary gastric ulceration (Phalen, 2014).

Diagnosing living birds may be difficult, and the clinician should perform a physical examination, thorough anamnesis,and microscopically observe the agent from proventricular lavages or faecal matter (Kheirandish & Salehi, 2011). Observation can be achieved either by direct smears with fresh samples, or by quick staining using the *Diff-Quick* coloration. The absence of the agent in faeces does not exclude an infection, since birds may not even excrete it at all. Treatment with Amphotericin B on an oral (PO) dose of 25 mg/kg, twice a day (BID) for 14 days seems to successfully eliminate an infection. Nystatin has also been described to be effective (Phalen, 2014).

Both nystatin and amphotericin B were successfully applied at the clinic and proved effective, even though resistances to nystatin by some strains of *M. Ornithogaster* have been described. Other available treatments (e.g. fluconazole, gentian violet) are not advisable on budgerigars, proving either ineffective or toxic in this particular species (Phalen, 2014), and in a study conducted by Kheirandish & Salehi (2011) nystatin proved sufficient treatment for these individuals. In this study the authors also suggest using organic acids such as vinegar to acidify the proventricular environment, given that megabacteria thrives in alkaline pH.

Bacterial infections were varied and no aethiological agents were specifically identified throughout the internship period. Treatment was based on the use of antibiotic in the appropriate dosage, through the appropriate administration route.

Most birds presenting with external parasites proved to have lice. Lice feed on the scales of the skin and feathers, completing their entire life cycle on the host. Diagnosis is usually reached by visual observation, and identification of the species of lice is made possible by microscopical examination. Topical treatment that penetrates the skin (e.g. ivermectin) should be performed more than once in order to kill any existing eggs (AAAP, 2006).

Pigeons (*Columba livia*) often present to consultation with infection by *Trichomonas* sp., since almost all individuals are carriers of this microorganism. This is a flagellated protozoan with a very characteristic morphology, presenting four flagella and a unilateral undulating membrane. It mainly affects the mucosa of the upper digestive tract, usually going no further than the proventriculus, although it may occasionally affect other organs. Lesions usually consist in cheesy-like, white areas that may be circumscribed by hyperaemic zones (McDougald, 2002).

Viral infections also commonly occur, and the author had the chance to accompany patients with suspected Psittacine Beak and Feather Disease (PBFD), caused by a circovirus. All Psittaciformes are susceptible, the disease being transmitted vertically from hen to egg, horizontally via inhalation of viral particles, and by ingestion of contaminated material. Subclinically infected carrier adults are usually able to eliminate the virus without ever presenting any symptoms. When present, clinical signs depend on disease progression, although symmetrical and bilateral feather loss is the common presentation of chronic cases. Endocrine diseases and infectious dermatoses should be discarded when the animal first presents for symmetrical feather loss. Beak and claw necrosis may occur, but it is rare when minimal feather abnormalities are present (Paré & Robert, 2007).

Haematology and serum biochemistry parameters have low diagnostic value since any detected abnormalities are usually related to secondary infections and not the main aetiology (Nett & Tully, 2003). Antibody and antigen testing of animals is paramount for control, as well as proper hygiene and husbandry. Treatment is usually supportive, but other approaches using interferons have been described. Since this virus has immunosuppressive effects, secondary infections may prove fatal (Paré & Robert, 2007).

Pneumology

Dyspnoea was the third main cause for consultation in birds, with a total of 23 cases.

Respiratory disease may affect either the upper or lower respiratory tract. Yet, birds are predisposed to sinusitis, given the complexity of their infraorbital sinuses. Other influencing factors include malnourishment (especially hypovitaminosis A, in which case resistance to infection is decreased), sinus irritation, extreme variations in environmental humidity, congenital malformations (e.g. choanal atresia), neoplasia and aspiration of foreign objects (often seeds) (Doneley, 2010).

A wide variety of infectious agents can colonise the sinuses, including bacteria (typically Gram negative) (e.g. *E. Coli*, *Pasteurella* sp., *Pseudomonas* sp., *Klebsiella* sp., *Enterobacter* sp.), viruses (e.g. Avian influenza, infectious laryngotracheitis), fungi (e.g. *Aspergillus* spp., *Candida* sp.), parasites (e.g. mites and worms, *Trichomonas* sp., *Cryptosporidia*), Chlamydia sp. and *Mycoplasma* sp. Nonetheless, of all agents, gram-negative bacteria and *Chlamydophila psittaci* are the most commonly present (Levine, 2003).

Patients often present with oculonasal discharge, with or without nare occlusion, sneezing, coughing, periorbital swelling and sinus distension. Exophthalmos, periocular feather loss associated with conjunctival swelling and/or conjunctivitis and hyperaemia are also common findings (Forbes, 1998; Levine, 2003; Doneley, 2010).

Proper diet management is important since nutritional deficiencies are differential diagnoses of upper respiratory infection. For example, hypovitaminosis A results in squamous cell metaplasia of the respiratory epithelium, predisposing poorly fed pets to infection (Levine, 2003). Other non-infectious causes include toxins, allergies and foreign-body aspiration, among others (Orosz & Lichtenberger, 2011).

Identifying the causative agent of an infection and performing antibiotic sensitivity tests is paramount in these cases. The use of other diagnostic tools, such as contrast radiographic imaging, computed tomography scan (CT) or magnetic resonance imaging (MRI) often makes it possible to localise the source of infection. Polymerase chain reaction (PCR) can be used to detect chlamydia, and it should be performed in all birds with respiratory symptoms (Levine, 2003; Orosz & Lichtenberger, 2011).

Antimicrobial therapy based on culture and sensitivity testing is usually effective when used in early disease stages. In chronic sinusitis cases, however, lavage and drainage of the sinuses may be required to prevent disease perpetuation (Willis & Wilkie, 1999).

Rhinitis can often be accompanied by nare occlusion, resulting from hypertrophy of the skin surrounding the nostrils (or cere), the presence of rhinoliths and others. Causes of sinusitis are like those of rhinitis, where cytological sampling and causative agent culture and identification should also be performed (Doneley, 2010). The accompanied rhinolith case will be mentioned in the surgical medicine section.

Regarding the larger airways (namely the trachea) foreign body obstruction, presence of masses or infectious granulomas represent some of the possible causes for disease. Other than radiographic imaging, CBC and biochemical profiles, diagnostic tracheal endoscopy is advised since it allows direct visualisation of the entire structure. This diagnostic tool also makes removal of obstructing material, performing tracheal lavages and extracting biopsy samples (which can later be used for culture and cytology) possible. An air sac catheter may be placed caudally to provide the patient a secure airway, as well as more comfort breathing while diagnosis and course of treatment are ascertained (Orosz & Lichtenberger, 2011). The author had the opportunity to attend a diagnostic endoscopy and the placement of an air sac catheter on a Congo Grey Parrot.

The only case which did not involve respiratory tract infection occurred in a lovebird, which also presented highly dyspnoeic. Upon radiographical examination, it was possible to observe a tracheal collapse, where one of the tracheal rings seemed to be absent. Patient stabilisation was not achieved and the animal did not resist its condition.

Neurology

Neurological symptoms such as torticollis and paresis have multiple differential diagnoses. All twelve patients accompanied at the clinic showed improvement in their symptoms upon multivitamin administrations (e.g. Axitol Pan®). Therefore, one can assume nutritional deficiency was the main aetiology.

Deficiencies in thiamine (hypovitaminosis B1) cause anorexia, ascending paralysis and opisthotonos, which is compatible with the observed cases (animals recovered within hours after vitamin administration). Riboflavin (B2), pyridoxine (B6), tocopherol (vitamin E) and selenium deficiencies all result in varied neurological symptoms, of which some are irreversible (Doneley, 2010). For example, young birds with deficiencies in tocopherol (a biological antioxidant) can develop encephalomalacia, exudative diathesis and muscular dystrophy, presenting varied neurological symptoms and low survival rates (Dierenfeld, 1989).

Administration of selenium concomitant with vitamin E has proven effective in some cases of paralysis. Nevertheless, it is unusual for animals to suffer from vitamin E deficiency when fed adequate amounts from diets based on seeds (Harper & Skinner, 1998).

Dermatology

Six of the individuals presenting for consultation had developed dystrophic, in-grown feathers (figure 6) that failed to erupt from the skin, forming nodules that were quite noticeable upon physical examination.

The diagnostic approach of dermatological affections in avian patients should include thorough anamnesis (since nutritional deficiencies are often predisposing factors for skin and feather disease in birds) and dermatological tests in a similar way to what is performed on mammals. Note that abnormal feather growth can be associated with viral infections (e.g. avian polyomavirus and circovirus) which should be ruled out (Nett & Tully, 2003).

Feather cysts are mostly found in the pectoral and scapular region, and their development in the absence of other underlying conditions is thought to be of genetic aetiology. Treatment options include removing cystic contents, although this approach is not fully curative, presenting a possibility of relapse. On the other hand, removing the entire feather tract can, as a matter of fact, be curative. The surgical procedures may result in heavy bleeding, where silver nitrate may be used for cauterisation (Rosskopf, 2003).

In the patients attended at the clinic, the location and developing pattern of the lesions, as well as the species affected (mostly canaries) suggested the feather dystrophy was not of viral aetiology, but rather genetic. For these reasons, the animals were admitted for surgery, for lancing and extrusion of follicular contents.

Two of the cases consisted in inflamed feather follicles, for which treatment consisted in administration of antibiotic, multivitamins, anthelmintic and single doses of a non-steroidal anti-inflammatory drug. Only one canary presented with an abscess, which was treated similarly to mammals.

Figure 6: Dystrophic feathers with associated feather follicle cyst on a canary (left), and feather cyst on Amazon parrot (right) (Image kindly provided by CVEP).

Anorexia and Metabolic Disorders

Many birds presented to consultation for symptoms of generalised weakness and/or anorexia. There are many possible causes for any of these situations, and so the author decided to include the five cases in which the cause for anorexia was found to be hypocalcaemia, and those three cases for which the original cause remained undiagnosed.

The birds' organism responds to hypocalcaemia with the production of parathyroid hormone (PTH) by the parathyroid glands, whereas rises in plasma calcium (Ca) levels will suppress this production. PTH promotes calcium mobilisation from the bone to the bloodstream, Ca resorption and simultaneous phosphorus excretion by the kidney, and Ca absorption in the intestine (McDonald, 1988).

Primary hypocalcaemia is usually resultant from excess phosphorus (P) or manganese (Mn) in diet, Ca deficiency, hypovitaminosis D or chronic egg laying in females. Besides calcium, vitamin D3 (which regulates Ca homeostasis) should also be supplied to indoor pets, since exposure to direct sunlight is often suboptimal for its adequate production. Therefore, proper dieting is indispensable for psittacines, since most seeds they feed on present excess P and fat, as well as low Ca levels and low to none vitamin D (Matos, 2008).

Symptoms are variable and dependent on a great number of factors. Avian patients in general often present with weakness, and females commonly present abnormal egg formation and/or egg-binding. In more advanced stages of disease, where bone resorption is impaired and Ca bioavailability is low due to inappropriate dieting, a syndrome consisting of secondary neurological signs (such as ataxia or seizures) may develop and is usually observed in African Grey Parrots (Matos, 2008).

Seizures occurring in African Grey Parrots are related to severe hypocalcaemia in the presence of normal skeletal mineralisation, suggesting this species may have some level of impairment regarding the use of bone calcium to maintain appropriate blood levels. Treatment of this type of metabolic disease includes dietary management to prevent relapses, as well as supportive therapy associated with calcium administration (Rae, 1995).

A possible option for emergency stabilisation treatment comprises the administration of diazepam (0.5 mg/kg IM), calcium gluconate (10-100 mg/kg IM), vitamins A, D and E (3300 IU/kg IM) and subcutaneous fluid therapy (Kirchgessner et al., 2012).

Reproductive Disorders

Lovebirds were the main affected species, with a total of four individuals presenting with cases of egg-binding and/or dystocia. Both disorders will be further developed and discussed in more detail in the second part of this work.

Another lovebird presented with complaints of anorexia. An egg was palpated through the abdomen, and since it was its first oviposition the animal received supportive treatment. After treatment it managed to lay the egg at home and resumed eating, with no further complications.

Ophthalmology

Both animals affected (a canary and a budgerigar) presented with conjunctivitis, and proper antibiotic therapy was pursued.

Conjunctivitis may have multiple aetiologies, most of which are infectious (either bacterial, parasitic, fungal or viral), as well as allergic, due to foreign bodies or neoplastic (Doneley, 2010). Diagnosis should include anamnesis, physical examination, blood testing, cytologies and culture of the present microorganism. Ocular symptoms may present alone, but conjunctivitis often appears associated to upper and lower respiratory disease, meaning antibiotic treatment is dependent on whether local or systemic disease is present (Willis & Wilkie, 1999).

Oncology

One New Zealand red-crowned parakeet (*Cyanoramphus* sp.; also known as a kakariki) presented with an abdominal mass of unknown nature, associated with ascites. Abdominal fluid was drained, but no further treatment other than the required to keep the animal comfortable was pursued.

Gastrointestinal

One turtle dove (*Streptopelia turtur*) presented with cloacal prolapse, which was surgically reduced. Other cases of gastrointestinal-related symptoms had, in fact, infectious aetiologies and are therefore only accounted for in the infectious category.

2.2.3. Reptilians

Table 4 illustrates the distribution of internal medicine affections according to medical specialty on reptiles.

Table 4: Clinical case distribution according to medical specialty on reptilians (n=48).

Medical Specialty		Total observed cases (n)		Fr (%)	
Dermatology			**21**		**43.8%**
	Dermatitis	14		66.7%	
	Abscess	5		23.8%	
	Others	2		9.5%	
Anorexia/Undiagnosed Cause			**10**		**20.8%**
Infectious Diseases			**8**		**16.7%**
	Bacteria	5		62.5%	
	Parasites	2		25%	
	Protozoa	1		12.5%	
Musculoskeletal			**4**		**8.3%**
	Trauma	3		75%	
	Malformation	1		25%	
Gastrointestinal			**2**		**4.2%**
Pneumology			**2**		**4.2%**
Ophthalmology			**1**		**2.1%**
Total			***48***		***100%***

Is it worth noting that the areas of Pneumology and Ophthalmology have been previously developed for other species. As such, these areas will be merely mentioned for reptilian species. Regarding the respiratory system two turtles presented with pneumonia, while a turtle with conjunctivitis represents the only ophthalmological case for reptilian patients.

Dermatology

Dermatological afflictions were the main cause for consultation in reptiles with a total of 21 cases, of which 19 occurred in Chelonids (of various genera), one in a ball python (*Python regius*), and one in a common leopard gecko (*Eublepharis maculiarius*). Most turtles and the ball python presented with varied degrees of dermatitis (figure 7 and 8).

Dermatologic conditions in reptiles are often a reflex of systemic disease, that present in different stages of progression, such as vesicular, ulcerative, and necrotic dermatitis (VUND), albeit sharing the same pathophysiology. Non-infectious causes of VUND include thermal burns (usually localised to areas of exposure that may result in infection), renal disease, neoplastic metastases, autoimmune disease and inappropriate husbandry and/or diet. Iatrogenic localised necrosis and skin-slough often results from the injectable administration of irritating medication, such as enrofloxacin (Maas III, 2013).

Figure 7: Examples of infectious dermatitis in semi-aquatic turtles (Image kindly provided by CVEP).

Figure 8: Ulcerated and osteolytic lesion with highly compromised jaw-bone integrity, resulting from progression of a process of dermatitis in a semi-aquatic turtle (Image kindly provided by CVEP).

Infectious causes include viruses (e.g. genera *Herpesvirus, Papillomavirus*, *Paramyxovirus*), fungi (e.g. genera *Geotrichium* spp., *Fusarium* spp., *Sistrurus* spp. and *Paeciliomyces* spp.), parasites and bacteria (e.g. *Pseudomonas* spp., *Aeromonas* spp., *Salmonella* spp., *Proteus* spp. and *Klebsiella* spp.). Primary viral lesions can be underdiagnosed due to secondary bacterial infections, whereas fungal infections are often only secondary and opportunistic, only a few causing primary diseases (Schumacher, 2006).

Before opting for a course of treatment one should rule out all differential diagnoses, the main ones being thermal or chemical burns, and fungal infections (Hoppmann & Barron, 2007). Blood cultures are indispensable in pretty much all reptiles presenting with dermatitis since the causative agent can often be related to septicaemia. The depth and severity of damage may be perceived through radiographic imaging techniques (Maas III, 2013). Samples can be obtained by aspiration for cytology, and any performed biopsies should be followed by bacterial culture and antibiotic sensitivity tests, so that effective antimicrobials may be used for treatment (Schumacher, 2006).

Treatment should firstly consist on correcting any mal-practice regarding husbandry and dieting, since many issues develop as a result of those flaws (most times an increase in temperature and decrease in humidity is in order). Superficial wounds can be treated topically, whereas more severe cases require systemic antibiotic therapy from 3 to 4 weeks minimum (based on the sensitivity test), where deeper lesions may even require surgical debridement (Hoppmann & Barron, 2007).

Topical medication should be used with caution, since some formulations may be cytotoxic for reptiles or even suppress wound healing (e.g. Chlorhexidine has been reported to provoke toxicity in chelonians upon topical administration). The use of opioids for pain management should be taken under consideration, as well as the use of nonsteroidal anti-inflammatory drugs (NSAIDs) (Maas III, 2013).

Five of the turtles presented with abscesses in varied body locations and four of them were admitted for surgery (figure 9).

Abscesses are encapsulated, localised skin infections that usually derive from wound contamination by existing microorganisms (figure 9). Prognosis is usually quite favourable if the complete abscess can be surgically removed. Before assuming an abscess is present, the clinician should rule out neoplasia and mycotic granulomas. Gram-stained cytology of an aspirate should reveal an inflammatory process in the presence of bacteria, where culture and sensitivity tests should ensue (Hoppmann & Barron, 2007).

Figure 9: Abscess of large dimension on the cervical region of a semi-aquatic turtle (Image kindly provided by CVEP).

The ball python presented with a mild burn in the ventral aspect of the abdomen. Burn lesions occur in all species of reptiles, but are mainly reported in constrictor serpents (such as the ball python) and iguanas, which tend to get too close to heat sources and remain there. Burns appear in varied degrees of severity and may be contaminated. An antibiotic ointment should be applied to the wounded area. Optionally, a systemic antibiotic may also be administered for a fortnight (e.g. Enrofloxacin at 5 mg/kg SID, IM). A single dose of 100 mg/kg of Vitamin C has been described to aid skin regeneration (Silvestre, 2003).

Abnormal shedding of the skin is called disecdysis and is often associated with inappropriate husbandry, such as inadequate temperature and/or humidity, lack of protruding and abrasive substrate to scratch in, or even nutritional deficiencies such as hypovitaminosis A. The primary cause should be ascertained, where bacterial and fungal infections are the main differentials to be ruled out. The retaining of skin in certain body parts may result in localised ischaemia due to tourniquet-like constriction, amputation being advised in cases of necrosis. Treatment includes rehydration and nutritional supplementation (Hoppmann & Barron, 2007).

The leopard gecko presented for a minor case of retained moult, which resulted in the adherence of a skin patch to two of its digits. The owners came to consultation on the same day they noticed the abnormality and so no constriction of the fingers occurred. The veterinarian staff were able to detach the unshod skin with small tweezers.

Anorexia of Undiagnosed Cause

Ten of all reptilians - 4 bearded dragons, 4 turtles, one chamaeleon (*Chamaeleo calyptratus*) (figure 10) and a serpent - came to the clinic with complaints of anorexia. After supportive treatment and rest in the proper environmental temperature, the animals eventually resumed eating and normal activity. Given the patients' swift recoveries and since there no observable abnormalities or underlying conditions, it can be assumed the main cause for anorexia and apathy was improper management, since reptiles require certain temperatures and lighting conditions to stay healthy.

Figure 10: Chamaeleon brought to consultation due to weakness and anorexia (Image kindly provided by CVEP).

Infectious Diseases

Infectious agents pose one of the main reasons for major reptilian population decline in the wild. All infectious cases originated by bacteria and protozoa coursed with gastroenteritis. Gastroenteritis caused by bacteria is quite common among reptiles, being most commonly caused by *Salmonella enterica enterica* and *Salmonella enterica* arizonae. Nonetheless, the type of gastroenteritis caused by the protozoan *Cryptosporidium* sp. also affects many species. Any excessive microorganism proliferation in the digestive tract of reptiles must be preceded by episodes of low immunity. Therefore, all factors capable of provoking immunosuppression can be considered as predisposing factors (such as inadequate temperature, diet, and general inadequate husbandry) (Silvestre, 2003; Schumacher, 2006).

Diagnosis is like that of mammals, including anamnesis, physical examination, haematological and biochemical analysis, imaging diagnostic techniques, coprological tests and cytologies. The most commonly performed faecal examinations are faecal flotation tests and direct faecal smears or saline wet mounts, although the limited amount of excreted faeces for each sample may render routine examinations difficult (Benson, 1999). Bacterium culture and isolation can also be performed, where *Salmonella* sp. is often identified, in which case mortality rates are high (Silvestre, 2003). Treatment is directed towards the cause and based on sensitivity testing.

Musculoskeletal

Almost all causes for consultation were due to traumatic injury, with a total of three shell fracture cases in turtles. The remaining turtle had a shell malformation, which affected one of its hind leg's motility.

Gastrointestinal

Only two animals (one viper and one iguana) presented with gastrointestinal symptoms unrelated to infection. The iguana was obstipated and had slight faecal retention. The viper had suffered an apparent failure in digestion, resulting in stasis and the desiccation of prey remains in its digestive tract. All remaining gastrointestinal cases are assessed in the infectious diseases section above.

2.3. Surgical Medicine

2.3.1. Mammals

A total of 74 surgeries were performed in mammals, irrespective of the species. Table 5 portrays the different areas of surgical intervention:

Table 5: Number of surgical procedures by field in mammals (n=74).

Surgical Field	n	Fr (%)
Odontology	39	52.7%
Soft tissues	16	21.6%
Dermatology	8	10.8%
Oncology	6	8.1%
Ophthalmology	3	4.1%
Orthopaedics	2	2.7%
Total	***74***	***100%***

Odontology

Dental treatments and oral examinations represented more than half of the accompanied surgeries in mammals (over 50% of the surgeries performed).

Included in dental procedures, the author has considered dental treatments with and without tooth extraction and oral examinations under sedation (figure 11). A total of five examinations under sedation were performed. Most dental treatments (a total of 34) (figure 12) did not require extracting any teeth, which was the case for 29 of the individuals, whereas the remaining five required extraction of incisors and/or peg teeth.

Figure 11: Rabbit under sedation for oral examination (Image kindly provided by CVEP).

Figure 12: Lower incisor teeth overgrowth in a rabbit (left); surgically worn incisor on same individual (right) (Image kindly provided by CVEP).

Soft tissues

Both male and female spaying made up most of these surgical cases. Out of all surgeries for this category, the author assisted a total of eight orchidectomies, seven ovariohysterectomies and one intestinal intussusception reduction.

Two of the orchidectomy procedures were performed in domestic pigs (*Sus scrofa domesticus*) and the remaining six in rabbits. For all these cases, surgery was elective, meaning there was no underlying disease or emergent cause for castration.

All seven ovariohysterectomies were performed in rabbits, of which six were performed preventatively and one to remove a neoplastic uterus. One of the elective surgeries culminated with the death of the patient, which never woke up due to anaesthetic complications.

The intestinal intussusception case occurred on a chinchilla that first presented at the clinic for not passing any faeces. After medical treatment failed to have any effects the veterinarians opted for surgery. After surgery, the animal could still not defecate, and both doctors and owners decided euthanasia was the best and less painful course of action to take. A necropsy was performed, and showed evidence of paralytic ileus, along with accumulation of rough consistency faecal matter and great amounts of gas in the congested intestinal loops.

Dermatology

Of all performed surgeries, six consisted on abscess draining and marsupialisation (five in rabbits and one in a chinchilla) and two in the removal of tricofoliculomas (figure 13) in guinea pigs.

Figure 13: Tricofoliculoma on guinea pig (zoomed in on the right) (Images kindly provided by CVEP).

Some of the abscesses in rabbits (figure 14) resulted from chronic dental problems and required many follow-ups for wound cleaning and management.

Figure 14: Mandibular abscess secondary to dental problems in a rabbit (Image kindly provided by CVEP).

Oncology

All surgeries consisted in the removal of masses, most of them with unknown classification since there was no histopathological analysis. Only tricofoliculomas in the guinea pigs (accounted in dermatological surgery), and the chordoma in the ferret (included in orthopaedic surgery) were identified.

Ophthalmology

For this category a total of two surgical procedures were performed, both on guinea pigs. Both patients presented with exophthalmia, where one had its exophthalmic eye reduced under anaesthesia and the other required the surgical enucleation of its exophthalmic eye (figure 15).

Figure 15: Guinea pig undergoing enucleation procedure for its left eye (Image kindly provided by CVEP).

Included in this category is the marsupialisation and draining of a retrobulbar abscess in a rabbit, previously mentioned in mammal ophthalmology.

Orthopaedics

Both orthopaedic surgeries consisted in amputation procedures. The affected hamster had a hind limb removed, and the ferret had the tip of its tail removed due to the presence of a chordoma in the region. Both animals had perfect recoveries.

2.3.2. Avians

Table 6 illustrates the distribution of all performed surgeries in birds, according to its corresponding field.

Table 6:Number of surgical procedures by field in avians (n=20).

Surgical Field	**n**	**Fr (%)**
Dermatology	12	60%
Soft Tissues	4	20%
Orthopaedics	3	15%
Respiratory	1	5%
Total	***20***	***100***

Dermatology

Regarding dermatological procedures under anaesthesia, there were a total of 6 follicular cysts removal procedures, most of them on canaries, and one abscess drainage and marsupialisation. The remaining dermatological procedures were performed without volatile anaesthesia, where all five consisted on corrective beak trimming.

Soft tissues

Regarding soft tissue surgery, there were two egg-implosion procedures (resulting from egg-binding), one suture of the crop on a conure (*Aratinga* sp.) and one cloacal prolapse reduction on a turtle dove (*Streptopelia turtur*).

Orthopaedics

All three orthopaedic surgeries consisted in limb amputations due to traumatic strangling (either by identification ring or string constriction) in canaries.

Respiratory

The only respiratory procedure was the removal of a rhinolith on a grey parrot (figure 16). The rhinolith was removed without any sedation or anaesthesia because upon arrival at the clinic it was almost completely detached from the animal's cere, and its removal was quite facilitated.

Figure 16: African Grey Parrot with rhinolith in its left nostril (left)/Post rhinolith removal (right) (Images kindly provided by CVEP).

The wound that resulted from the rhinolith removal was then disinfected and left to heal by second intention and the animal was medicated accordingly.

A total of fourteen post-surgical consultations were accounted for in birds.

2.3.3. Reptilians

Table 7 illustrates the distribution of all performed surgeries in reptiles, according to its corresponding field. There were a total of five surgeries performed in reptiles (all of them Chelonids).

Table 7:Number of surgical procedures by field in reptiles (n=5).

Surgical Field	**n**	**Fr (%)**
Dermatology	4	80%
Orthopaedics	1	20%
Total	***5***	***100%***

Dermatology

All four procedures consisted in draining of abscesses, where the surgical approach consists in opening and debriding said abscess, removing its contents and enveloping capsule, and irrigating the wound with a disinfectant. The opening is normally left to heal by second intention (to help drain the remaining secretions) but may be sutured shut in cases where it is known only healthy tissue remains (Silvestre, 2003).

Orthopaedics

The other performed procedure consisted on a shell fracture (figure 17) reduction with the use of surgical glue. After proper re-placing of the fragment, the wound was covered by a dressing soaked in topical antimicrobial medication. Systemic antibiotic as well as antifungal medication was also administered since fungal colonies were visible on the coelom through the fracture upon the patient's arrival at the clinic.

Figure 17: Shell fracture on aquatic turtle, zoomed in on the right (Image kindly provided by CVEP).

A total of seven post-surgical follow-ups were accounted for, one of them on an iguana who had previously had an ovariohysterectomy performed (prior to the author initiating the internship) and came for suture evaluation.

2.4. Other procedures

In this chapter, procedures will be described with mammals, avians and reptiles all together since there are only some slight differences between them. The type of procedures approached proved to be the most commonly used at the clinic throughout the author's internship.

For all animals, a total of 442 procedures were performed (during routine check-ups and consults with cause): 212 on mammals, 189 on birds and 101 on reptiles.

The procedures incorporated in this chapter include: analysis (table 8), treatments (table 9), imagiology (table 10), necropsy and euthanasia (table 11). All mentioned procedures do not include those performed in hospitalised patients, applying to outpatients only.

Table 8: Distribution of performed analytical procedures by animal group.

Analysis Procedure	Mammals n	Mammals fr	Avians n	Avians fr	Reptiles n	Reptiles fr
Urinary Strip	30	46.9%	-	-	-	-
Faecal direct examination	13	20.3%	26	51%	4	23.5%
Cytology	12	18.8%	13	25.5%	5	29.4%
Biochemistry	4	6.3%	3	5.9%	1	5.9%
Haemogram	3	4.7%	8	15.7%	5	29.4%
Serology (Encephalitozoon antibody detection)	2	3.1%	-	-	-	-
Blood smears	-	-	-	-	2	11.8%
Sexing	-	-	1	2%	-	-
Total	**64**	**100%**	**51**	**100%**	**17**	**100%**

The urinary strip test is a simple and quick method of testing the concentration of particular substances found in urine, as well as measuring pH levels. This test was only performed on mammals.

Substances measured by this test include protein, glucose, nitrites, ketones, bilirubin, urobilinogen, and the presence of red and white blood cells. Albeit simple, it is a helpful first-hand test, allowing veterinarians to build a diagnostic route according to the altered parameters. Note that this test may occasionally provide unreliable information (e.g. external contamination of the urine may alter results) (Institute for Quality and Efficiency in Health Care, 2016).

Direct faecal examination was a commonly used test at the clinic, and was mostly used on birds, followed by mammals and a few reptiles. Sometimes this examination would indicate the presence of parasites and fungi that may cause disease, helping first-hand choice of medical approach, even though final diagnosis was not yet reached.

Cytologies were also common practice and throughout the author's internship were mostly performed on birds and mammals, with only five in reptilians. For this category, the author has considered any kind of cytology, be it of cerumen, skin lesions, mucus, among others. Faecal samples were excluded from this category since they have already been included in the faecal direct examination category.

The only kind of blood test examined at the clinic would be blood smears. All other types of blood testing (e.g. haemogram, biochemical analysis) had to be performed *ex situ.* Examining blood smears could allow visualisation of abnormalities and maybe pinpoint towards a possible affliction, thus facilitating diagnostic and treatment direction. All bird haemograms were performed at the clinic through evaluation of blood smears.

The drawing of blood made it possible to perform other kinds of test, which was the case for two rabbits and one parrot. The parrot had its blood drawn for a sexing DNA test, so it could thus be differentiated into male or female.

Both rabbits were tested for contact with the parasite *Encephalitozoon cuniculi.* Rabbits develop serum antibodies against the agent within three weeks after contact (Rox et al., 1979) and the test measures serum immunoglobulins. According to the results, some conclusions may be drawn, but this still does not fully guarantee the parasite is the one causing disease in the animal. More specific information regarding serum titration of antibodies anti-encephalitozoon may be found in the internal medicine infectious category of mammals.

Table 9: Distribution of performed treatment procedures by animal group.

Treatment Procedure	Mammals n	Mammals fr	Avians n	Avians fr	Reptiles n	Reptiles fr
Medication administration	43	44.8%	48	38.7%	20	25.6%
Wound assessment and cleaning	16	16.7%	13	10.5%	9	11.5%
Bandaging/Casting	13	13.5%	31	25%	3	3.8%
Support	13	13.5%	29	23.4%	30	38.5%
Topical applications	11	11.5%	3	2.4%	16	20.5%
Total	**96**	**100%**	**124**	**100%**	**78**	**100%**

Regarding treatment procedures, a wide array of medications were administered, according to each animal's situation. Every exact type of medication administered will not be mentioned in this report, but pharmaceuticals such as non-steroidal anti-inflammatories, corticosteroids and antibiotics are included. Birds were the recipient of most administrations, followed by mammals and reptiles. Note that some of the animals coming to follow-up consultations had medication administered when the owners were unable to do so at home.

Every animal presenting with wounds and any kind of lesion would undergo a process of cleaning and disinfection of the area, sometimes followed by application of bandages, as needed. Most animals presenting to the clinic for wound assessment were mammals, followed by almost as many birds, and reptiles.

Most animals that came for bandaging or casting of traumatised limbs were birds, followed by mammals. Bandages and casts were 'built' specifically for each animal and each clinical situation. Given the reduced size of most patients, the clinical staff had no choice but to be the most creative possible when it came to it. Some of the procedures accounted for occurred in the same individual (accompanied by the author in subsequent follow-ups), as was the case of a guinea pig requiring repeated bandaging of feet affected by pododermatitis.

The support category includes forced feeding, administration of fluids (by any routes) and any kind of vitamin complex. Each animal group had a specific formula, adequate for nutritious requirements, and administered at the proper temperature. Mammals would be mouth fed with syringes full of what at the clinic we called the 'Critical Care' mix. It consisted on rabbit feed pellets softened in water, mixed with flour gruel (the kind used to feed human infants: Nutribén®) to improve palatability and consistency.

Birds would be fed with specialised recovery formula, for enteral nutritional support. This formula comes in a powder, which would then be mixed with hot water, and administered at a temperature of approximately 38ºCelsius (never more than 39º to 40º C so as not to burn the patients' sensitive digestive tracts). Forced or gavage feeding in birds is enacted with the use of a metal probe, which should be inserted towards the crop applying proper technique, in order to avoid aspiration pneumonia.

Reptiles would be fed similarly to birds, also using metal probes. At the clinic a mix of dog wet food (Restorative Care a/d Hill's®) softened in water was used for carnivorous reptiles, whereas herbivorous species were fed with the same mix used for rabbits. It would also be heated to around 38ºC, and never more than 39ºC. Since reptiles have slower metabolisms, forced feedings were sometimes not required on a daily basis, and often occurred approximately every other 48 hours. Forced feeding is a way of managing the patient's weight when it fails to feed by itself, providing support during recovery periods until the animal can eat on its own again.

Table 10: Distribution of performed imaging procedures by animal group.

Imaging Procedure		Mammals n	Mammals fr	Avians n	Avians fr	Reptiles n	Reptiles fr
Radiography	Without contrast	13	39%	7	77.8%	3	75%
	With contrast	1	3%	-	-	-	-
Echography		18	18	55%	-	-	1
Echocardiography		1	1	3%	-	-	-
Endoscopy		-	-	-	2	22.2%	-
Total		33	100%	9	100%	4	100%

Regarding imaging techniques (table 10), only radiographies were performed *in situ* at any time required. Three distinct veterinarians would bring their specific equipment for the remaining procedures (at appointed dates) and perform the required examinations.

Radiographic imaging techniques were applied in many different animals, presenting varied symptoms: respiratory, gastrointestinal and reproductive, among others.

Echocardiography was performed on a guinea pig suspected of having a cardiac condition. Unfortunately, no final diagnosis was reached due to the animals' small size compared to the probe, not allowing clear visualisation of structures and any possibly existing alterations.

A whole of two endoscopies were observed in birds during the author's internship. One was performed on a dyspnoeic hospitalised grey parrot in an attempt to understand the origin of its respiratory distress. The veterinarian in charge of the examination proceeded to place a catheter in the animal's caudal air sac, which greatly improved its condition (albeit not fully eliminating its distress). During examination there were no alterations found in the air sacs and upon tracheal endoscopy no specific lesions were found.

The second endoscopy observed by the author at the Porto clinic was performed prior to a necropsy procedure on an animal that was not a patient at the center and is therefore not accounted for in the number of total animals.

Table 11: Distribution of other performed procedures by animal group.

Other procedures	**Mammals n**	**Mammals fr**	**Avians n**	**Avians fr**	**Reptiles n**	**Reptiles fr**
Euthanasia	14	73.7%	2	40%	2	100%
Necropsy	5	26.3%	3	60%	-	-
Total	**19**	**100%**	**5**	**100%**	**2**	**100%**

Regarding other types of procedure (table 11), a total of 18 medically assisted deaths and a total of 8 necropsies were performed. Both procedures would only be performed pending owner written consent.

Euthanasia procedures would be preceded of sedative administration, in order to get the animal more relaxed and in less pain. The drug used at the clinic was sodium pentobarbital, which deeply anesthetises the animal, causing respiratory failure with consequent asystole and heart failure (Direção Geral de Alimentação e Veterinária - DGAV, 2016).

III. Monography

1. Introduction

The species on which this work will mainly focus on are a part of the Kingdom Animalia, Phylum Chordata, Class Aves and Order Psittaciformes (Integrated Taxonomic Information System, 2013).This order includes three different families, Psittacidae, Cacatuidae and Loriidae. The first includes the vast majority of parrot species (such as Amazons, Macaws, Conures, Budgerigars, African Grey Parrots, among others); the following includes the existing 18 species of cockatoos and the cockatiel; the third includes the lories and lorikeets. The animals in this Order may be generally referred to as Psittacines (Coles, 2005; Seibert & Sung, 2010).

Most species are mainly found in tropical and subtropical regions from various continents (Africa, Asia and America, among others) but especially in rainforests, where they group in larger numbers due to the availability of many varieties of both fruit trees and flowers. A smaller number of species inhabits the more temperate regions of New Zealand and Australia (Coles, 2005). These animals can adapt to different types of environment, be they more arid, mountainous or rich in foliage (Seibert & Sung, 2010).

Some authors consider many Australian psittacine species to be nomadic and migrate to forage for food and water, whereas species adapted to tropical climates usually remain in a more localised area where they can find supplies (Lightfoot & Nacewicz, 2006). Other authors believe that no species can be considered truly migratory, although some present nomadic behaviour, which is the case of the African Grey Parrot (*Psittacus erithacus*) that leaves its roosting site to forage for food before returning (Coles, 2005).

Psittacines are highly social birds; most of them live in flocks which include many different families. Even though most couples are monogamous and mate for life (Coles, 2005), there are still many different reproductive systems that can be applied by these species, where a female may bond with several males and vice versa, or both sexes have multiple partners (Seibert & Sung, 2010).

Behaviour and vocalisation are two very important communication tools for these animals, but peaceful cohabitation in such complex groups is dependent on its hierarchy, where the presence of both submissive as well as more assertive individuals permits a lower incidence of aggression (Seibert & Sung, 2010). Mating and reproduction in colonial species are facilitated due to these social interactions, once a group settles on a breeding site (Elphick et al., 2007).

Most birds in this order have diets mainly based in plants and can be classified as florivores. These can be further subcategorised into granivory (consuming grain or seeds; e.g. budgerigars and cockatiels), frugivory (mainly fruit; e.g. many macaws) and nectarivory (nectar and pollen). Besides the species specialised in particular foodstuffs, there are many psittacines that consume food from more than one of the aforementioned categories. For instance, nectarivores such as lories and lorikeets which possess the ability of collecting pollen and nectar from flowers (made possible by their highly specialised long and ciliated tongue) are also known to ingest berries, blossoms, seeds, fruit and insects. Some species, such as the Kea (*Nestor notabilis*) may even be categorised as omnivorous given the wide variety of consumed ingredients, including animal matter (Koutsos et al., 2001; Seibert & Sung, 2010).

Foraging for food is very important for reproductive matters, since the passing of food between birds - also known as allofeeding - is a well-known part of courtship behaviour. Courtship behaviours may include allopreening (grooming of each other's feathers), tail-wagging, bowing and vocalisations, among many others (Coles, 2005; Seibert & Sung, 2010).

These birds are hole-nesters, meaning they prefer to nest in cavities, chambers or hollows under hanging vegetation or rock. This particularity may well be the most important detail regarding psittacine breeding. After mating, both male and female contribute towards preparing the nest, but only the female incubates the eggs once they are laid. Psittacine eggs are generally white, relatively small and thin-shelled and usually laid on alternate days (every 48 hours). Larger species usually have bigger laying intervals, producing smaller clutches of one to three larger-sized eggs and spend more time in incubation and nestling. In contrast, smaller species may lay up to 11 eggs in one clutch and present shorter laying intervals (Pollock & Orosz, 2002; Coles, 2005; Spoon, 2006).

In psittacines, the incubation process is started as soon as the first egg is laid, contrarily to most galliforms which lay an entire clutch beforehand (Pollock & Orosz, 2002). This means that parrot chicks deriving from the first eggs will be progressively older and more advanced, resulting in heterogeneous clutches, where some may even become twice the size of their siblings (Coles, 2005). This marked asynchrony means the youngest psittacine chicks often die as a result (Spoon, 2006).

Newborn psittacines are altricial: they are born blind, featherless, incapable of neither feeding nor protecting themselves and therefore entirely dependent upon their parents for survival (Seibert & Sung, 2010). They are nidicolous (remaining in their nest), and ptilopaedic (covered in down after birth) (Harcourt-Brown, 2000). Because of this, for the first week of their development, the mother never leaves the nest, depending solely on the male to feed her, so that she may feed the hatchlings by regurgitation in return. On the second week after hatching, the babies are able to better maintain their body temperature, allowing the female to leave the nest for short periods of time, while the male feeds them. After these first critical weeks, both parents leave the nest for successively longer periods of time as the fledglings grow (Coles, 2005).

Juvenile parrots that are old enough to leave their nests usually form large foraging groups and engage in group play with its members (Seibert & Sung, 2010). The time to reach sexual maturity varies according to size and species (Coles, 2005). In larger psittacines (such as Amazons, African Grey Parrots, bigger cockatoos and macaws) it can take around three to six years to reach maturity. Pionus parrots, smaller cockatoos and macaws may be mature at two to four years of age, lories and lorikeets at around two to three years, whereas conures at one and a half to two years. Budgerigars, lovebirds and cockatiels can take between six months to a year to reach maturity (Joyner, 1994).

2. Anatomy and Physiology of the Female Reproductive Tract

The female bird reproductive tract presents only its left side fully and functionally developed. Mature hens of most species possess a left ovary and oviduct, since the right ovary and oviduct regress before hatching, although some species and individuals (like raptors) may present vestigial right-side organs (some may even be functional) (Joyner, 1994). "In cases of persisting right genital organs, double oviducts are less frequently observed than double ovaries" (Jacob & Bakst, 2007).

A fully developed tract means an increased mass, unnecessarily adding to flight efforts. This is why most wild birds severely diminish size, mass and function of their reproductive system during non-breeding season (regression) and regrow it at the onset of each breeding season (recrudescence) (Elphick et al., 2007). Another example of weight-reducing adaptation includes the laying of eggs that are externally incubated (Pollock & Orosz, 2002).

The left ovary is closely attached to the dorsal coelomic wall through the short mesovarium (mesovarian ligament) and located caudally to the lung and cranial to the cranial division of the kidney. In immature birds it is elongated and flat with small follicles, which enlarge with maturation and during breeding season, gaining the appearance of a cluster of heterogeneous grapes (Evans, 1982).

With sexual maturation ovarian gyri become prominent and appreciable, and the follicles grow bigger. The coloration of the ovary varies, being darker or brighter, depending on species and individual (Joyner, 1994). A stalk of smooth muscle, vessels and nerves suspends the follicle which contains a large primary oocyte surrounded by a multi-layered wall (Harcourt-Brown, 2005). At the moment of ovulation the contracting muscles of the follicular stalk cause the stigma to split (Pollock & Orosz, 2002), causing the mature (secondary) oocyte to be released from the ovary and captured, so to speak, by the first part of the oviduct – the infundibulum (Jacob & Bakst, 2007).

A total of six arteries arise from branches emerging from the aorta to supply the ovary and oviduct. The main blood supply to ovary and oviduct originates from the ovario-oviductal artery which is a ramification of the left cranial renal artery. The cranial ovario-oviductal artery that supplies the infundibulum and magnum arises from under the ovary making it difficult to see in the surgical field, and during procedures it may easily rupture upon lifting of the infundibulum. These particularities may render reproductive surgery complicated. Analog vessels assure venous blood return to the vena cava (Jenkins, 2000; Scagnelli & Tully Jr, 2017).

After ovulation occurs, the follicle rapidly regresses and is absorbed. The follicular lumen is replaced with hypertrophied granulosa cells, which are then invaded by vessels. In time the cells eventually regress since there is no post-ovulatory corpus luteum in birds. It may be that some cells persist and continue secreting hormones, which may result in cystic follicles (Pollock & Orosz, 2002).

During non-breeding season, when the hen is involved in incubation, follicles usually undergo one of two types of atresia. Bursting atresia occurs when the follicular wall ruptures and yolk is released into the coelomic cavity or the ovary, where it is harmlessly reabsorbed. In cases of invasion atresia, the follicle is invaded by theca and granulosa cells, and *in situ* yolk absorption takes place. Normal atresia can be perceived as a vesicular lesion, which progresses to the envelopment of the entire structures, where both larger and smaller follicles are absorbed. The former may undergo cystic degeneration, and the latter may inclusively become covered in scar-like areas of connective tissue. The process of atresia usually begins with the largest follicles (Joyner, 1994; Pollock & Orosz, 2002).

The oviductal wall consists of mucosa with underlying submucosa, external layers of smooth muscle and epithelial covering of peritoneum. The mucosal layer possesses two prevalent types of cell: ciliated and glandular goblet-like cells, whose distribution varies along the oviduct. Mucosal folds slightly spiral along the entirety of the duct, helping to rotate the egg as it progresses. External (longitudinal fibers) and internal (circular fibers) layers of smooth muscle aid both in propelling the egg and transporting sperm through peristalsis (Pollock & Orosz, 2002).

The oviduct is suspended from the dorsal coelomic wall by a sheet of peritoneum which forms the dorsal and ventral ligaments. The former connects the coelom to the oviduct, and the latter extends ventrally from the duct. The ventral ligament thickens into a muscular cord that caudally fuses with the vaginal smooth muscles (Jenkins, 2000).

There are five portions that compose the entirety of the oviduct (figure 18). The first part is called the infundibulum. Its proximal end is a thin and transparent, funnel-like section (called *fimbria*) which opens into the coelom facing the ovarian pocket and engulfs the ovum upon ovulation. Capture of the ovulating ovum is aided by the anatomical arrangement of the left abdominal air sac, which surrounds the ovary in its ovarian pocket, except in its caudal portion, thus directing the "falling" ovum towards the opening of the infundibulum. The distal portion is tubular and thicker in comparison and its glandular grooves may contain sperm. It is in the tubular region (known as chalaziferous region) that the chalaziferous albumen is added, along with the paired structures known as chalazae which twist and tighten as the ovum travels down the oviduct (Joyner, 1994; Jenkins, 2000; Pollock & Orosz, 2002; Harcourt-Brown, 2005).

Fertilisation of the egg must occur in the proximal funnel-like part of the infundibulum in the period of time between its release from the ovary and it being covered in albumen (also known as egg white). This is made possible because sperm is stored in the glandular grooves and tubular glands of this portion of the oviduct. Approximately an hour later the egg moves on to the next portion (Joyner, 1994; Harcourt-Brown, 2005; Scagnelli & Tully Jr, 2017).

The second region known as the magnum is highly glandular and is also the largest and most coiled of all oviduct portions, possessing a greater number of large mucosal folds. It deposits most of the albumen which is mainly secreted by numerous tubular glands, along with sodium, magnesium and calcium. The egg remains here for several hours (Joyner, 1994; Scagnelli & Tully Jr, 2017).

The magnum is followed by the isthmus, less muscular and glandular, with less prominent mucosal folds. It is in the isthmus that the inner and outer shell membranes are added, thanks to the presence of glands which produce the sulfur-containing amino acids required for shell formation. Small amounts of protein are also added to the albumen and shell calcification is initiated. After one to two hours, the egg moves on to the uterus (or shell gland), where it will spend most of its time (Joyner, 1994; Pollock & Orosz, 2002).

The uterus is ovoid, short, with leaf-like lamellae composed of folds of muscle and gland cells, holding the egg in place for shell deposition between 20 to 26 hours. It has a thin and narrow cranial portion, and a pouch-like caudal portion which will hold the egg in place. Here, the egg enlarges to a plump shape and absorbs water and electrolytes which are incorporated into the albumen. This is followed by the deposition of a calcium carbonate and protein-composed shell, as well as the cuticle (which renders the egg a shiny appearance) and shell pigment. The embryo is able to respire through existent pores, which stretch from the shell membranes to the surface of the egg. The uterus becomes highly vascularised during active laying. The egg’s sharp end points caudally, although in some species it may turn just before oviposition. Egg transit times vary, albeit proportionally, among aviary and companion birds (Joyner, 1994; Jenkins, 2000; Harcourt-Brown, 2005).

The fifth and most muscular part of the oviduct is the short s-shaped vagina, which aids the uterus during egg expulsion and where sperm is stored in spermatic fossulae (which is the case for many species). It is separated from the previous structure by the uterovaginal sphincter and meets its end at the cloaca, being separated from it by a membrane that deteriorates upon sexual maturity in some species. At the onset of oviposition, the uterovaginal sphincter relaxes and the uterine smooth muscles propel the egg into the vagina. Neurons in the cloaca respond to the egg’s presence and initiate a bearing down reflex which aids the passing of the egg through the vent. The opening of the oviduct's lumen into the cloaca mostly occurs near the onset of the first lay (Joyner, 1994; Pollock & Orosz, 2002; Harcourt-Brown, 2005). Subsequent oviposition interval for most psittacine species is 48 hours (Scagnelli & Tully Jr, 2017).

After mating, a portion of the sperm is stored in the fossulae near the sphincter region. The passage of the egg through the cloaca may result in stimulation of sperm release in rapid waves, and some is able to reach the infundibulum within minutes. Viable sperm can be stored and released throughout several days. Sperm migration throughout the oviduct is aided by smooth muscle contractions as well as the presence of ciliated cells with cilia beating towards the infundibulum (Harcourt-Brown, 2005; Pollock & Orosz, 2005).

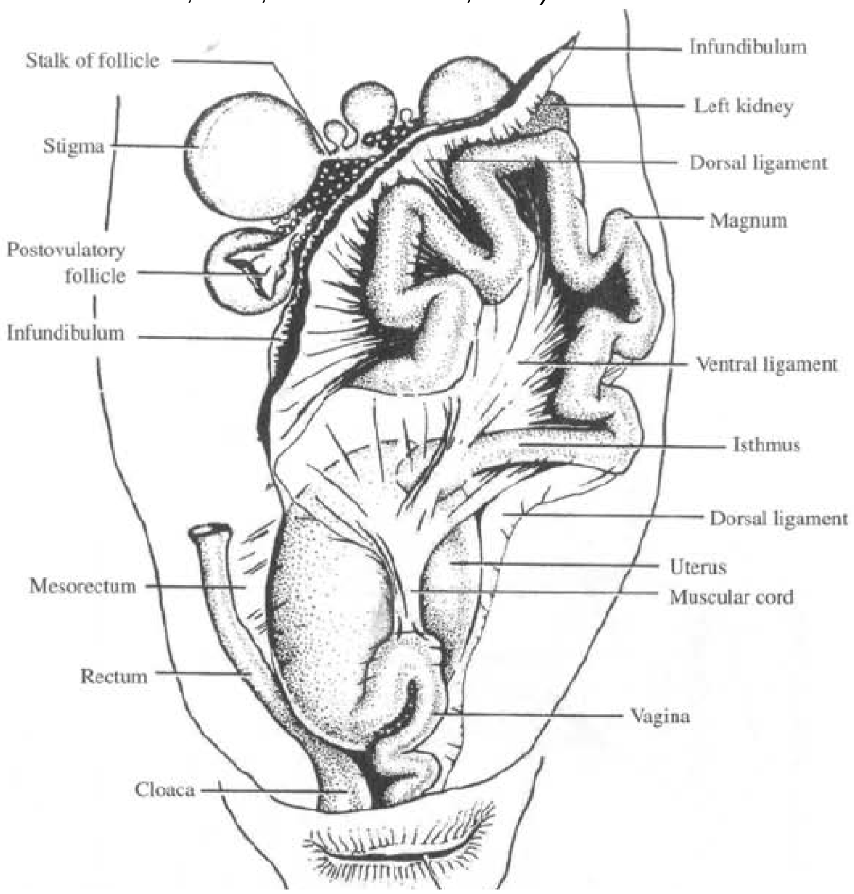


Figure 18: Representation of the Avian Female Reproductive Tract from a ventral view. (Adapted from Jenkins,2000).

The entirety of the structure occupies most of the left abdomen during active egg laying, whereas during non-breeding season its size considerably decreases. It is usually thin and uniform in dimension in the pre-ovulatory period (Joyner, 1994).

To quote Harcourt-Brown (2005) *"It is traditional to describe the egg moving down (…). In reality (…) the egg is relatively static in the coelomic cavity whilst the oviduct moves over it by peristalsis."*

Some authors consider approximately three general stages of follicular development, in which the first is the longest (inclusively lasting months to years) and occurs in all species. Primary oogenesis begins in the female embryos and meiosis is arrested until the activated follicles start growing in adulthood. Stage two includes the enlargement of the oocyte (Harcourt-Brown N. H., 2005) during breeding season due to the deposition of yolk in small vacuoles within, and is influenced by the production of both follicle stimulating hormone (FSH) and luteinising hormone (LH) by the adenohypophysis (controlled by the hypothalamus). For wild, free-ranging birds stage three occurs only in the presence of a mate and is preceded by courtship and nesting behaviour. It consists on rapid yolk deposition, and upon its completion either ovulation or atresia of the ovarian follicles will follow (Joyner, 1994).

Other authors defend that three phases of follicular development can be considered for seasonal-laying birds: prenuptial acceleration phase, culmination phase and refractory period. The first occurs during the onset of lay, when follicles start developing in a hierarchical fashion to prevent them from reaching maturity simultaneously. Follicular development is most active on the second phase, when egg-laying begins. The final resting or refractory phase is characterised by the decrease in size of follicles and ovary, along with ovary quiescence (Pollock & Orosz, 2002). A normal developing follicle consists of theca, basal lamina, granulosa cells, perivitelline lamina and yolk layered in a concentric distribution (Joyner, 1994).

Estrogens and androgens are secreted by thecal interstitial cells of small pre-ovulatory follicles (Hudelson & Hudelson, 1996). High levels of estrogen prime the granulosa cells of large pre-ovulatory follicles to produce progesterone and prostaglandins. Thus, estrogen leads to an LH surge, albeit indirectly via an increase in progesterone levels (Pollock & Orosz, 2002).

Ovulation from a developing follicle is dependent on this LH peak, which is potentiated by increasing concentrations of estrogen produced by ovarian thecal and interstitial cells. LH levels start rising about three weeks before the first ovulation and then peak an average 6 to 8 hours just before ovulation. LH increases levels of androgens, estrogens (steroidogenesis) and progesterone (Hudelson & Hudelson, 1996), as well as it is responsible for restarting meiosis before ovulation. Even though release of LH is primarily dependent on secretion of LHRH, it may also be stimulated by progesterone and non-physiologic amounts of testosterone and corticosterone (Pollock & Orosz, 2002).

Progesterone production from the largest follicle is stimulated by LH (Hudelson & Hudelson, 1996). This hormone inhibits estrogen receptors, acting as an estrogen-antagonist (Mans & Taylor, 2008). Levels start increasing around 1 week before ovulation, peaking (similarly to LH) 6 to 8 hours before ovulation. This increase is paramount for the occurrence of an LH peak, since both hormones act in a positive feedback system, meaning LH itself also stimulates progesterone production. In turn, LH and prolactin cause ovarian granulosa cells to maintain progesterone production, in order to hinder additional ovulation as well as inciting physiological changes, thus influencing motherly behaviour (Pollock & Orosz, 2002). While progesterone levels remain elevated, the ovary and accessory reproductive organs and tissues regress (Joyner, 1994).

Some psittacine species, such as the budgerigar, are determinate layers, meaning they lay a fixed number of eggs and therefore terminate egg production after laying the entire clutch in order to proceed to incubation. For this reason and because shell calcification is under its control, exogenous progesterone should be used with the utmost caution in psittacines, and only after an entire clutch has been laid (if cessation of egg-laying is desired) because these animals will replace the eggs removed from the nest. Its administration 2 to 24 hours before the ovulation onset has great impact, being capable of inducing a pre-ovulatory LH surge and therefore a premature ovulation and molt. Follicular atresia may even be prompted by the administration of the hormone around 36 hours before the peak of ovulation (Hudelson & Hudelson, 1996; Pollock & Orosz, 2002).

Oviduct growth and hypertrophy during breeding season in wild birds is dependent on the estrogen secreted by the ovary. Prolactin and progesterone interact with estrogen to stimulate the oviducts' growth and secretory activities (Joyner, 1994). Estrogen levels in the plasma are at their highest 4 to 6 hours before ovulation, therefore coinciding with the surge of LH and progesterone in the laying female bird (Mans & Taylor, 2008).

Estrogens induce the synthesis of transport proteins for testosterone, cortisol and thyroxin in the liver (Mans & Taylor, 2008) and promote blood calcium-binding protein synthesis (e.g. albumen, ovalbumin), vitellogenesis and oviductal gland formation. Along with androgens they contribute towards the development of secondary sex characteristics, increasing food intake, inducing nest-building, courtship behaviour and male-type behaviour (e.g. territoriality), initiating physiologic medullary ossification (Hudelson & Hudelson, 1996), as well as playing a part in the development of brood patches or incubation patches (regions of increased vascularity, epidermal thickening and oedema resultant from the joined action of estrogen and prolactin (Pollock & Orosz, 2002).

Increasing estrogen levels result in increasing total plasma calcium levels required for shell formation, from 9mg/dL reaching up to 20 or 30 mg/dL. However, this amount is insufficient since calcium can be quickly depleted from the bloodstream. Therefore, increased intestinal calcium absorption and cortical bone mobilisation is required to replenish blood levels. Before and during egg lay there is also a greater amount of renal and circulating Vitamin D3 (Joyner, 1994) or cholecalciferol, which stimulates intestinal calcium and phosphorus absorption and mediates bone remodeling (Haussler, 1986). It is known that the presence of an egg in the uterus acts as a stimulus for active transport and passive diffusion of calcium from the bloodstream into the shell gland. The transfer is facilitated by the vasorelaxant Parathyroid hormone-related protein (PTHrP), which increases blood flow to the uterus (Mans & Taylor, 2008).

The physiologic process of calcium depositing into nonpneumatic long bones (especially femur and tibiotarsus but also radius and ulna) is known as polyostotic hyperostosis and occurs approximately 10 to 14 days before egg formation and laying. This process results in the formation of spicules that may completely fill the medullary cavity. To assure reproduction calcium requirements are met, female psittacine diets should be supplemented with the mineral to prevent signs of deficiency. Calcium deficiency is usually exacerbated by the ingestion of high-fat and low-calcium diets, which decrease its absorption at an intestinal level (Roudybush, 1999; Hadley, 2010).

Prostaglandin F2α (PGF2α) is released from the larger follicles about 15 to 60 minutes before ovulation, causing pre-ovulatory contractions in the shell-gland. Its levels increase before oviposition, and drastically decrease after the process is completed. Prostaglandins contract the smooth muscle of both vagina and oviduct, and therefore influence egg transport and expulsion. They are also thought to mediate the effect of oxytocin (also produced by the posterior pituitary) on inducing premature oviposition. The oviposition process may take seconds or hours (Joyner, 1994; Hudelson & Hudelson, 1996).

LH levels in females are at their highest during egg-laying, start decreasing from the incubation period, but increase yet again (in both genders) if a second clutch is laid. These levels in males are at their highest during nest-searching, and their lowest during egg laying. Prolactin levels increase in both genders during egg laying, peak during incubation and then progressively decline towards basal levels (Joyner, 1994).

Prolactin is produced in the anterior pituitary gland by prolactin-producing cells termed lactotrophs and is involved in many physiological processes in the bird (Mans & Taylor, 2008). It stimulates birds to invest more in reproduction and can be associated to the number of eggs laid in a clutch (clutch size being determined by the time taken to reach prolactin peak), intensity of brood care and ovarian regression (induced by administration of great amounts of prolactin). An increase in its levels is secondary to tactile stimulation of neuronal pathways, upon physical contact with laid eggs (Pollock & Orosz, 2002).

These pathways stimulate neurons to release vasoactive intestinal polypeptide (VIP), considered a major prolactin-releasing factor. Thyrotropin-releasing hormone (TRH) also stimulates prolactin secretion and induces photorefractoriness. Suppression of LH, FSH and LHRH can be associated to rising prolactin. However, it is important to note that the association between prolactin and LH varies across avian species. With increasing prolactin comes the end of lay and total regression of the reproductive tract, which are often associated to the postnuptial replacement of feathers; a process known as molt. In some species molt can occur before the onset of breeding season (Pollock & Orosz, 2002; Mans & Taylor, 2008).

3. Anatomy and Function of the Avian Egg

The egg is composed of a shell, germinal disc, yellow yolk, yolk membranes and albumen. The egg shell consists of outer and inner shell membranes, testa and cuticle. After being laid, an air cell is produced at the blunt end of the egg, representing the separation between both shell membranes. Around 98% of the shell consists of an organic matrix of calcite (a crystalline form of calcium carbonate) which composes the testa. This matrix encases all nutrients required for embryonic development. The shell is most commonly of smooth texture (Pollock & Orosz, 2002; Reynolds & Perrins, 2010).

The cuticle is the outermost layer of the shell. It repels water, reduces losses through evaporation and acts as an external barrier against microorganisms. Albeit allowing gaseous exchanges, the shell protects the embryo from dehydration and environmental pathogen contamination. It also presents as a source of calcium for skeletal development, becoming progressively thinner throughout the incubation period (Pollock & Orosz, 2002; Reynolds & Perrins, 2010).

The germinal disc represents the remnants of the nucleus in non-fertilised eggs, whereas in a fertilised ovum this same portion is called the blastoderm and represents the dividing embryonic cells. Yolk is mostly made of lipoproteins and phosphoproteins and represents the main nutritious source for the embryo. There are a total of four yolk membranes (two provided by the follicle and two by the infundibulum) which act as a barrier between yolk and albumen, although still allowing water and electrolyte exchanges (Pollock & Orosz, 2002).

The albumen suspends the embryo in a reasonably aqueous setting and its main solid component is ovomucin, which is mainly protein and nourishes the embryo. This portion has two components, dense and thin, where dense albumen has higher ovomucin concentrations compared to thin albumen. The egg possesses an inner and outer layer of thin albumen interspersed with a middle layer of dense albumen. The chalaziferous layer surrounding the yolk membranes is a part of the dense albumen and the chalaza are the twisted strands of ovomucin fibers which help keep the yolk suspended in the albumen (Pollock & Orosz, 2002).

Egg size is usually correlated with the size of the parent and eggs of altricial species are often smaller than those of precocial species. Shape can be related to the female's pelvic mould (where elongated eggs can be associated to narrower pelvis') and is also considered to be dependent on the species. Colour variation is contingent to the relative amounts of present pigments: porphyrins (red-brown) and biliverdins (blue-green), which are deposited as crystals through the calcified testa (Pollock & Orosz, 2002). The time for egg production and its passage through the oviduct is species-dependent, as is the total number of eggs in one clutch (Hadley, 2010).

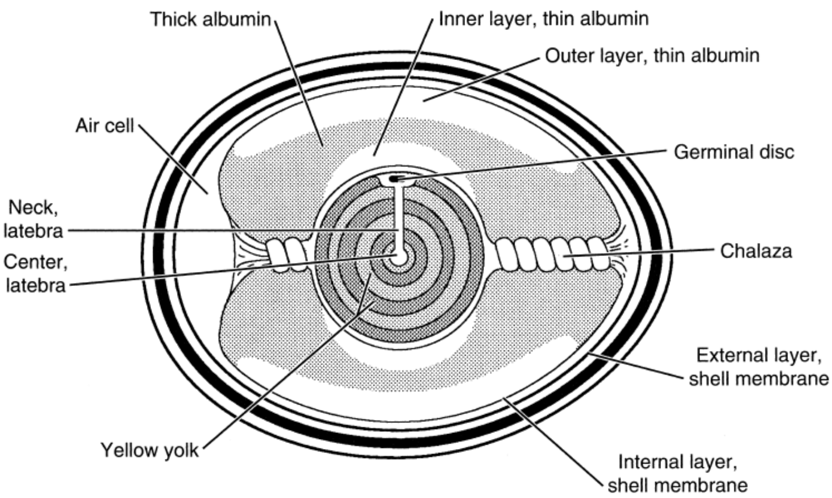


Figure 19: Diagram of the longitudinal section of an egg (Adapted from Pollock & Orosz, 2002).

Calcification of the shell results in a significant depletion of ionised calcium levels. The main calcium sources for shell deposition include intestinal absorption, renal control of calcium levels and bone calcium mobilisation. Increasing levels of vitamin D3 before and during shell formation result in greater absorption of calcium in the duodenum and jejunum. Renal excretion of calcium is usually proportional to calcium intake outside the egg-laying period. In times of active laying rising estrogen levels increase the number of parathyroid hormone (PTH) receptors, allowing greater activity of PTH itself, diminishing calcium excretion in the urine (Pollock & Orosz, 2002).

4. Factors Influencing the Reproductive Behaviour of Psittacines

There are many factors and environmental stimuli prompting reproductive activity control, such as photoperiod, rain, temperature, the presence of a real or imaginary mate, the presence of nesting material, vocalisations or even the administration of exogenous hormones. Of the aforementioned cues, photoperiod seems to be the most significant for most avian species. Photoperiodic effect is not the same in birds adapted to different climates, being less important in places where there are only slight variations in day length throughout the year, and more important to those adapted to temperate zones and demonstrating seasonal reproductive activity.

Nonetheless, day length variations may also stimulate tropical and equatorial species in captivity, when no other environmental cues are present (Joyner, 1994; Pollock & Orosz, 2002).

Light is assumedly recognised by photoreceptors in the retina and pineal gland, although these may not be ultimately required for day length detection since "deep-brain" extraretinal photoreceptors exist in the hypothalamus. Information is transmitted from the pineal gland via melatonin secretion, increasing its levels during the night and lowering them during the day (Mans & Taylor, 2008).

Longer days stimulate the release of luteinising hormone-releasing hormone (LHRH), promoting the secretion of gonadotropins FSH (whose role is not yet quite understood) and LH which stimulates steroidogenesis. Exposure to light, however, need not be continuous as long as it occurs during the animals' photosensitive phase (typically 13 to 17 hours after onset of dawn, or after onset of dusk, depending on the species). Maximal photostimulation is achieved with 12 to 14 hours of light, but normal laying can occur from 12 to 18 hours of light. Among psittacines, cockatiels have proven the most sensitive species to photostimulation (Pollock & Orosz, 2002). Other environmental factors besides light time, such as lack of water or food, may result in the suppression of reproductive hormones (Joyner, 1994).

Rainfall is especially significant for tropical and desertic species, acting as a cue for reproduction regardless of the time of year. Temperature and precipitation directly influence food availability, which in turn affects reproductive behaviour since starvation inhibits gonadal development. In a similar way, if birds exposed to short day lengths are provided with enough food, they may remain reproductively active, counteracting the effects of decreased light hours. Extreme temperatures act as stressors, inhibiting semen production in males and reproductive activity altogether (Pollock & Orosz, 2002; Enkerlin-Hoeflich et al., 2006).

For cavity-nesters the presence of any usable paraphernalia for nest building, or even the presence of a nest box (many times the case for pet birds) strongly influences reproduction. Other types of behaviour such as hiding and seeking dark places, regurgitating and copulating with objects are consistent with the onset of reproduction (Scagnelli & Tully Jr.,2017).

After laying a maximum of one or two clutches most wild psittacines become photorefractory, meaning they enter a period of reproductive dormancy despite being exposed to long day lengths. Gonads regress in a drastic manner, interrupting lay and any nesting behaviour in anticipation of worsening conditions. Gonad photosensitivity in most species is usually not regained until the individuals are exposed to shorter day lengths. Photorefractoriness is usually followed by postnuptial molt, which often coincides with the period between the end of reproductive season and the onset of autumn or migration periods (Pollock & Orosz, 2002).

It should be noted that all the aforementioned factors are more commonly determinant in wild adult parrots, whereas pet birds are not affected by many of such limitations or at least not in the exact same ways (e.g. lack of food versus malnutrition from unbalanced diets). Still, any abnormal external stimuli such as excessive exposure to light, inadequate temperatures and/or humidity, social stress induced by humans or new animal partners will all act as stressors which may restrict the reproductive behaviour of companion animals (Krautwald-Junghanns et al., 1998).

On the other hand, bonding with the human caregiver in an exaggerated way may predispose towards unwanted behaviour such as attempts at preening, allofeeding and copulating with the person in question. Masturbating, demonstrating aggressiveness towards the remaining members of a household and defending the cage may also occur as a result of that inappropriate bond (Seibert L. M., 2006).

5. Egg-binding and Dystocia

The reproductive tract of every bird meets its endpoint at the cloaca, as well as the urinary and gastrointestinal systems, meaning disease in any of them will most likely share a similar pathogenesis. Reproductive disease is often multifactorial, complicating both diagnostic approaches and means of treatment, albeit rendering them similar, no matter the cause (Joyner, 1994).

Predisposition for disease is greater in females which are first-time layers; breeding out of season; presenting persistent right oviduct; single pets strongly bonded to owner or inanimate objects; allowed to produce multiple clutches without rest period, especially if eggs or chicks are pulled from the nest; with previous history of reproductive problems (Doolen, 1999).

Healthy animals signal oviposition by wagging their tails, exhibiting signs of straining, decreasing frequency in defecation whilst increasing faecal volume and presenting with wide stance. The whole process can take from seconds to several hours. $PGF2\alpha$ together with vasotocin stimulate powerful contractions in the myometrium. Prostaglandin E1 and E2 (PGE1 and PGE2) enhance the effect of $PGF2\alpha$ in the uterus, while simultaneously relaxing the uterovaginal sphincter and vagina. PGE levels fall a couple hours after oviposition. Prostaglandins, progesterone and estrogen stimulate the release of arginine vasotocin (AVT), whose levels double 2 to 3 hours before oviposition and peak during the oviposition period, which also causes the uterus to contract (Pollock & Orosz, 2002).

Failure in the passage of the egg through the oviduct at a normal rate is a condition known as egg-binding (or delayed oviposition), whereas dystocia is considered as a mechanical obstruction of the egg in the caudal reproductive tract (including oviduct, uterus, vagina or vaginal-cloacal junction). Any obstruction and primary reproductive disease should be considered in these cases (Romagnano, 2005; Scagnelli & Jr, 2017). The egg can become retained anywhere along the entire reproductive tract, but it is often found lodged in the cloaca, frequently presenting a calcified shell (Smith & Smith, 1992). The “normal” oviposition period may vary greatly, but eggs are usually passed within 24 hours (Krautwald-Junghanns et al., 1998).

There are several aetiologies related to egg-binding and dystocia occurrence: nutritional deficiencies (vitamin E, selenium, calcium, protein); reproductive tract dysfunction; excessive (chronic egg laying) or abnormal egg production; age of hen; inappropriate or non-existent nesting place; reproductive tract neoplasia, hernia or infection; lack of exercise and obesity; inadequate temperature; genetics (Matos & Morrisey, 2005; Romagnano, 2005). Egg-binding is often a common sequel to ovarian neoplasia (Pollock & Orosz, 2002) and among psittacines it most commonly occurs in budgerigars, cockatiels and lovebirds (Rosen, 2012).

Improper nutrition resulting in deficiencies in vitamin E, calcium and selenium are one of the greatest causes for reproductive disease. Not only does diet influence smooth muscle contractions, but it also influences proper egg formation. Chronic egg-laying should also be considered an important predisposing factor, since it often results in abnormalities and damaging of oviduct muscles (Scagnelli & Tully Jr.,2017).

Chronic egg-layers are those females consistently laying clutches without having a mate or outside the usual breeding season. Changes in photoperiod, temperature, bonding with other birds or toys, being provided nesting materials and even inappropriate bonding with the human owner may lead to this condition. The most commonly affected psittacine species are lovebirds and cockatiels. These hens are thus naturally predisposed to dystocia and osteoporosis due to calcium storage depletion and may inclusively suffer pathologic fractures and energy source depletion. Therefore, it is of great importance to supplement birds with calcium, as well as minimising their exposure to external triggers (Hadley, 2010; Rosen, 2012).

Processes of dystocia more frequently affect the same psittacines egg-binding does, as well as cockatoos and amazon parrots (Hadley, 2010). Dystocia may result in life-threatening circulatory disorders, shock and nerve paralysis, all secondary to compression of renal and pelvic vessels and nerves. Abnormal defecation and urination can lead to metabolic disturbance, such as GI ileus and obstructive renal disease. Pressure necrosis caused by the lodged egg can result in rupture of the oviduct. Dystocia and egg-binding will be addressed together since most risk factors and causes pertain to both disorders (Romagnano, 2005; Rosen, 2012; Scagnelli & Jr, 2017).

5.1. Diagnostic Approach

Symptoms of egg-binding and dystocia are more common and severe in smaller species (e.g. budgerigars, cockatiels and lovebirds) compared to larger ones, meaning therapy should also be more aggressive. In egg-binding cases, the patient often presents depressed and lethargic, vocalising less and with increased respiratory rate. Stance is wider than normal, and in more severe cases the animal does not perch and may also present with paresis or paralysis (unilateral or bilateral) (Romagnano, 2005).

Previous history should be as complete as possible and include the animals' diet, since hypocalcaemia (a frequent cause) is usually secondary to diets with inadequate amounts of calcium. Low vitamin A levels can result in increased thickening of mucus and the oviduct's mucosal epithelium, whereas low levels of calcium, vitamin E and selenium usually culminate with decreased muscle tone. In cases where diet is appropriate and supplemented, the animal may present aberrant calcium metabolism, which also leads to hypocalcaemia (Doolen, 1999; Romagnano, 2005).

History should also include any recent egg-laying and behavioural changes, such as nest-building, masturbation, regurgitant feeding, increased territoriality and aggression, and increased intimacy with owner or natural mate. Fewer droppings with increased faecal volume are also indicative of straining, and faecal matter may be found stuck to feathers in the vent region (Doolen, 1999). Seamless vent winking indicates continuous straining and effort from the abdominal muscles to try and expel an egg (Hadley, 2010).

A thorough physical examination should take place. Increases in abdominal volume are noticeable, the cloaca is usually swollen and an egg is often palpable (if calcified). Palpating the cloaca may shed a light on the positioning of the egg and possibly reveal the primary cause of dystocia. Other common symptoms found in more advanced stages include depression, tail wagging and dyspnoea, fluffed feathers and lameness or paresis of the left leg secondary to nerve compression. Severely ill birds will be found in the bottom of their cage in states of extreme lethargy and great respiratory distress. Decreased appetite or anorexia, regurgitation, vomiting and straining are also possible clinical signs. In more severe cases vascular compromise may occur, and animals may present 'blue-white' feet (Romagnano, 2005; Hadley, 2010; Scagnelli & Jr, 2017).

In the absence of prolapse, when no egg is palpated through the abdomen, radiographic testing should ensue. A ventrodorsal or standing projection may help specify the location of the egg (Hadley, 2010). The presence of well-developed medullary bone (hyperostosis) should be evident in radiographies of animals with adequate calcium reserves for producing eggs. One or more, fully or partly calcified eggs may be visualised in the abdomen (figure 20) (Romagnano, 2005).

Radiographic diagnosis of egg-binding in the presence of soft-shelled or laminated eggs proves extremely problematic. These types of egg appear as diffuse swelling of soft tissues, compatible with coelomitis or a coelomic mass, where the proventriculus and ventriculus may be displaced with constriction of the abdominal and thoracic air sacs. Upon the use of a radiographic contrast medium, intestines will appear cranially and ventrally displaced resulting from reproductive disease (Krautwald-Junghanns et al.,1998; Matos & Morrisey, 2005).

Figure 20: Example of the radiographic presentation of a retained calcified egg (Adapted from Rosen & Lynsey, 2012).

Ultrasonography makes diagnosing dense soft tissues and increased soft tissue density possible (Krautwald-Junghanns, Kostka, & Hofbauer, 1998). As such, it is an important tool for diagnosing soft-shelled eggs, ectopic (when infundibulum fails to engulf the ovum) soft-shelled or shell-less eggs and salpingitis not visible on radiographs. This method also permits the differentiation of oviductal masses from other caudal masses. Visible follicles on the ovary indicate the hen's potential for further ovulation and egg formation (Bowles, 2005; Romagnano, 2005).

When the primary cause of dystocia is yet to be ascertained a complete blood count (CBC) and biochemistry analysis should be undertaken in a stabilised patient. This type of examination could provide vital information regarding the patient's white cell count and kidney function (very important since the left kidney is often pressed down by the bound egg) (Hadley, 2010).

In egg-bound birds CBC results often reveal leukocytosis with concurrent heterophilia. Serum biochemistry panels often present hypercholesterolaemia, hyperglobulinaemia, elevated creatine phosphokinase and alkaline phosphatase. Elevated calcium levels may indicate the female is actively laying, whereas decreased levels may be indicative of nutritional deficiency or chronic egg laying (Scagnelli & Jr, 2017). Elevated protein and cholesterol levels support the fact that the hen is ovulating (Bowles, 2005). Other abnormalities may be attributed to the bird's health status and amount of stress at the time of sample collection (Romagnano, 2005).

5.2. Treatment

5.2.1. Medical Treatment

Stabilising the egg-bound patient is a top priority in all cases and subcutaneous administration of fluids is often the first step to be taken, although an initial intravenous bolus may be required. Intravenous or intraosseous catheters should be applied in case of severe dehydration. Heat and oxygen supplementation, along with nutritional support and pain management are paramount upon attempting stabilisation. Calcium should be administered in all cases, and the patient should be kept comfortable, preferably in a heated (between 29º C to 32ºC), humid environment, with as less light as possible (Romagnano, 2005; Rosen, 2012). A nonsteroidal anti-inflammatory drug (NSAID) such as meloxicam (0.1 to 1.0 mg/kg) or an opioid such as butorphanol (1-4 mg/kg IM) may be used as pain relievers in these patients (Hadley, 2010).

In the presence of any kind of prolapse, the tissue must be cleaned with sterile saline, reduction should be attempted with the help of lubricant and administration of parenteral antibiotics based on cloacal culture and sensitivity tests should be applied (Romagnano, 2005), although enrofloxacin (15 mg/kg, IM) is usually effective in a first approach. A prolapsed oviduct should be reversed with care; if simply pushed into the cloaca, it may remain everted (Doolen, 1999).

For those animals that have been straining for less than a day, which are not depressed, are still perching and present no prolapse, providing a safe and warm environment along with vent lubrication and calcium administration is often enough for the egg to be laid. Nonetheless, the animal should always be closely monitored in case its condition does not improve and further action is required (Doolen, 1999; Bowles, 2005).

Hormone and prostaglandin therapy can be used to treat egg-binding by inducing contraction of the oviduct. The egg should be expelled if the reproductive tract is intact, there are no adherences nor obstructions and the egg is not ectopic. Since this sort of therapy requires appropriate calcium levels to be effective, calcium gluconate (at 10%, 50-100 mg/kg) should be administered intramuscularly prior to its use (Bowles, 2005; Hoppes, 2018).

According to studies PGF2α or dinoprost tromethamine (Lutalyse ®) binds to high-affinity receptors in the uterus, causing uterine contraction. Prostaglandin E2 (PGE2) or dinoprostone, albeit ineffective on calcium mobilisation in and of itself, seems to potentiate the effects of PGF2α in the uterus. On the other hand, in the vagina high-affinity binding sites for PGE2 are abundant, and high concentrations of this prostaglandin block binding sites for PGF2α (in the vagina), resulting in relaxation of the uterovaginal sphincter and vagina, while enhancing the action of PGF2α (calcium mobilisation and shell gland contraction) (Hudelson & Hudelson, 1996) and oxytocin (Pollock & Orosz, 2002).

The administration of both prostaglandins increases the concentration of arginine vasotocin (AVT), which is the equivalent to mammalian arginine vasopressin (AVP) and oxytocin, albeit being more potent than them. AVT, PGF2α and oxytocin all induce uterine contraction, yet do not relax the uterovaginal sphincter (Hertelendy et al., 1996). For this same reason neither prostaglandins nor oxytocin should be administered if said sphincter is not dilated, since it could lead to reverse peristalsis, making it possible for the uterus to rupture, putting the animal through a great deal of pain (Rosen, 2012). If adhesions are suspected, or uterine integrity is questionable (possibility of perforation or obstruction) one should also refrain from using any of these drugs (Scagnelli & Tully Jr, 2017).

Nonetheless, oxytocin can be used to treat uncomplicated cases of egg-binding and dystocia. It can be administered at 0.5 UI/kg IM or SC every 30 to 60 minutes, or at 5 UI/kg IM once. It is important to keep in mind that any present hypocalcaemia or hypoglycaemia should be treated prior to administration (Pollock & Orosz, 2002) and that repeated muscle contractions rapidly deplete calcium and glucose reserves of the patient (Scagnelli & Tully Jr, 2017). Since oxytocin targets the uterus alone and provokes fewer systemic reactions its use is preferable over that of PGF2α (Hudelson & Hudelson, 1996). All intramuscular injections should be applied in the region of the pectoral muscles (Tully Jr.,2000).

PGE2 (Prepidil Gel ®) can also be applied topically to the uterovaginal sphincter (0.1 mL/100-g bird), resulting in contraction of the oviduct and simultaneous relaxation of the sphincter, which may expel the egg within minutes. Gloves are paramount for the veterinarian staff's security, since this drug can cause abortion in women, but it is currently commercially unavailable. PGF2α is usually parenterally administered (0.02-1.0 mg/kg IM) and may cause hypertension and bronchoconstriction, being contraindicated in the presence of liver disease. PGF2α may be used topically in cases of uterine prolapse, aiding in tissue shrinkage (Bowles, 2005) and stopping bleeds. Oxytocin may also be applied topically for the same effects (Pollock & Orosz, 2002).

5.2.2. Behavioural Modification

Chronic egg-layers and those that have experienced dystocia have indication for behavioural modification. If the animal has chosen a human owner as a substitute mate, that person is advised to spend less time with the bird until it stops laying eggs. If the animal associates any objects to reproductive behaviour (e.g. masturbation, regurgitation), such as the nest box, mirrors or toys, those should be removed from the animal's presence. No eggs should be removed from the cage since most psittacines are indeterminate layers and will lay other eggs to replace the lost ones. Reducing light time drastically to only 8 to 10 hours each day may also stop the laying process. Birds accustomed to short day lengths should not get any light time during their photosensitive phase (13 to 17 hours after dawn) (Pollock & Orosz, 2002).

5.2.3. Preventive Measures for Chronic Egg-Layers

Hormonal therapy is an approach to be used on females which are chronic egg-layers in an attempt to prevent disease. Females laying excessive amounts of eggs exhaust their reproductive tract and calcium reserves and are thusly predisposed towards egg-binding and dystocia (Bowles, 2005).

Human Chorionic Gonadotropin (HCG) is indicated in cases of dystocia and chronic egg-laying. It produces a similar effect to that of LH, stimulating production and release of progesterone, affecting the progesterone/LH ratio indispensable for ovulation. Gonadal activity can be altered via negative feedback effect, in a way that decreases gonadotropin secretion. Care should be taken so administration occurs before the rise in levels of estrogen, so ovulation is halted. Should it be used under already elevated or rising estrogen (during follicular maturation), it may actually induce ovulation, instead of preventing it, rendering it more effective when applied midcycle (Lightfoot & Nacewicz, 2006; Mans & Taylor, 2008).

HCG can be administered at a dose of 250-500 IU/kg intramuscularly. After the first dose, if a second egg is laid, dose should be repeated on day 3 after the first shot. If a third egg is laid, another dose should be repeated on day 7. It represents a safer alternative with less side-effects when compared to medroxyprogesterone and levonorgestrel. Still, its effect is not consistent and patients may produce antibodies and become refractory to treatment. In order to avoid any immune-based response to the hormone, it is advised to add dexamethasone to the shot (Bowles, 2005).

Leuprolide acetate (Lupron ®) is a long-acting Gonadotropin Releasing Hormone (GnRH) agonist that increases release of LH and FSH (Lightfoot & Nacewicz, 2006). It is mostly used to control egg overproduction, but besides chronic laying it is also indicated for ovarian or oviductal disease, cloacal prolapse and persistent ovulation post-salpingohysterectomy. Upon initial injectable administration a temporary increase in sex steroid hormones with transient worsening of symptoms may occur (Pollock & Orosz, 2002; Hadley, 2010). Its monthly depot administration eventually results in pituitary GnRH receptors down-regulation, thus preventing the release of gonadal steroid hormones (Mans & Taylor, 2008). As a result, tissues and functions dependent on said hormones are quiesced, and resulting diseases either improve or resolve. For birds under 300 grams, three doses between 700 to 800 μg/kg IM each, administered every 14 days is usually adequate (for recalcitrant cases a dose of 1000 μg/kg IM is advised). For birds heavier than 300 grams a dose of 500 μg/kg IM is advised. This drug can be administered together with HCG, without significant adverse effects (Bowles, 2005).

Medroxyprogesterone acetate is the repositol form of progesterone. It causes follicular atresia and stops egg-laying from weeks to several months (Pollock & Orosz, 2002). Albeit effective, it has been proved to result in undesirable transient or permanent side effects such as polyuria/polydipsia, obesity, lethargy, hepatic lipidosis, diabetes mellitus, thromboemboli, hepatic cirrhosis, immunosuppression and even death. It is therefore not recommended, along with levonorgestrel, whose administration may carry the same side effects as medroxyprogesterone. The use of tamoxifen has also been described. This nonsteroidal anti-inflammatory drug causes animals to develop leukopaenia, which resolves after therapy discontinuation (Bowles, 2005; Lightfoot & Nacewicz, 2006). Recurrence of excessive egg-laying can only be prevented by performing a salpingohysterectomy (Hadley, 2010).

5.2.4. Manual extraction

Animals with more severe signs, that have been straining for over 24 hours, on which the previously mentioned approach has not resulted in oviposition within a day, the extraction of the egg is highly advised. Bound eggs may be removed manually under volatile anaesthesia with isoflurane, or via ovocentesis (Doolen, 1999).

For a manual approach, the cloaca should be massaged with the help of lubricated cotton-tip swabs in twirling motions. Massaging the lower coelom and vaginal opening may induce relaxation and expulsion of the egg and may be safer than digitally manipulating the egg itself, which can result in oviductal rupture or egg collapse. Pressure upon the vaginal opening and uterovaginal sphincter should aid in dilation (Scagnelli & Jr, 2017). Care should be taken upon applying pressure to the abdomen, so the egg is not pushed against any structures such as the kidney, air sacs and spine (Doneley, 2010). To prevent any damage, the egg should be gently manoeuvred caudally and pressure should be applied from the sides, instead of ventrodorsally (Doolen, 1999).

5.2.5. Ovocentesis

Should the attempt at manual expression fail, ovocentesis and egg deflation is necessary. Ovocentesis can be performed transcloacally (deemed to be the safer method) or transcoelomically. A speculum may be used to help visualise the egg though the vent for a transcloacal approach. A large needle (20- or 22-gauge attached to a 12 mL or 20 mL syringe) is then introduced in the egg to aspirate its contents, all the while collapsing it with the aid of external pressure. Egg-shell fragments may be manually removed if caudal enough in the oviduct or left in the shell gland, in which case radiographic confirmation is required to assure all fragments have been passed within 24 to 36 hours after surgery (Doneley, 2010; Hadley, 2010; Scagnelli & Jr, 2017).

In case the egg has a more cranial position and its direct visualisation through the vent is not possible, transcoelomical ovocentesis should ensue. The egg should be gently pressed against the ventral abdominal wall, the needle inserted through the skin and into the egg from a lateral approach to prevent damage to other organs. From there, the procedure goes the same as before, with aspiration of contents into a syringe, while manually collapsing the shell. The complete expulsion of remaining fragments should be confirmed via radiographic imaging. The risk of infection due to shell fragment retention can be minimised through uterine lavage with warm sterile saline, however, in case fragments are withheld for over 36 hours, further irrigation or surgical laparotomy is advised (Doolen, 1999; Bowles, 2005; Scagnelli & Jr, 2017).

Following ovocentesis hormonal treatment applied for chronic laying hens may also be used to prevent egg production throughout the period of recovery. For all cases of dystocia and ectopic eggs, in case of oviductal rupture, torsion, necrosis, actual mechanical obstruction or where previous treatment has failed, surgery is indicated (Scagnelli & Jr, 2017). Bacterial culture and sensitivity tests should be performed prior to surgery. For all animals not meant for reproduction that require surgery, a salpingohisterectomy would be the best approach since it would eliminate all predisposing factors and secondary diseases (Bowles, 2005).

5.2.6. Reproductive Surgery

Prior to surgery there may be indication for blood transfusion in patients with hematocrits under 30% (when postponing the procedure is not an option) or when a high volume of blood loss is expected. In all cases fluid therapy, antibiotics and pain relievers are indicated. Animals should be fasted less than 1 hour before being submitted to anaesthesia, so as to empty the crop from fluid contents. Regurgitation with subsequent aspiration does not seem problematic or easily occurring with this fasting protocol, especially when the patient is intubated (Jenkins, 2000).

Nonetheless, reproductive surgery is a difficult task in birds, especially when it comes to ovariectomy procedures for there is great difficulty in removing the ovary due to its close location to the cranial aspect of the kidney, near the adrenal gland and major vasculature. The standard approach for avian salpingohysterectomy is a left coeliotomy (Doneley, 2010). Minimally invasive endoscopic surgical techniques are also available for birds (Hadley, 2010) although it requires specialised training (Hoppes, n.d.).

Following surgery all animals should be carefully checked for temperature, dehydration and amount of blood loss. Use of buprenorphine (0.02 to 0.05 mg/kg IM BID or TID) or butorphanol has been described as effective for post-surgical pain management. All patients still refusing to eat more than one hour after surgery have indication for parenteral nutrition or gavage feeding (Jenkins, 2000).

5.3. Possible complications

Upon extraction attempt via ovocentesis, there are several possible complications: retroperistalsis which drives the egg into ectopic positioning within the coelom; egg rupture; trauma, laceration, avulsion and haemorrhaging of the oviduct; shell fragments or yolk coelomitis (Bowles, 2005).

Chronic laying, egg-binding and dystocia predispose towards the development of secondary inflammation of the oviduct and mesosalpinx (salpingitis), as well as the shell gland (metritis). Yolk-related coelomitis can be associated to both situations and reverse peristalsis, which pushes yolk from the oviduct into the abdomen. Animals with the condition will present with abdominal distension and dyspnoea resulting from fluid accumulation in the coelom (Doneley, 2010).

In cases of yolk coelomitis marked leucocytosis can be observed, and reproductively active females may present hypercalcaemia. Ultrasonography findings are compatible with fluid accumulation and no organomegaly is present. Upon abdominocentesis, collected fluid should present a yellow-pink coloration and may be noninflammatory or inflammatory, with or without sepsis. Since yolk acts as a nidus for infection, peritonitis may result, leading to secondary ascites (Caruso et al., 2002). The majority of cases require coeliotomy for abdominal lavage and salpingohysterectomy, although fluid drainage along with administration of antibiotics, NSAID's and hormones may present as short-term solutions (Doneley, 2010). Even though postoperative yolk peritonitis following salpingohysterectomy procedures may occur, it hardly ever does. Nonetheless, one should keep in mind that prognosis for surviving ruptured eggs related to oviductal adhesions or infection can be guarded to poor (Hadley, 2010).

When adhesions form between a retained egg and the oviduct, another complication may occur; other eggs may start descending while the first one is yet to be removed. Most cases require surgical intervention and when the oviduct is damaged beyond repair there is no other option but to perform salpingohysterectomy. Histopathological analysis of the extracted tissues should ensue to exclude the presence of neoplasia (Hadley, 2010). Prolapses of the oviduct or cloaca can also occur secondary to dystocia, abnormal eggs and/or egg-laying resultant from nutritional deficiencies (Pollock & Orosz, 2002; Hadley, 2010).

5.4. Nutrition as a prophylactic measure

A well established and balanced nutritional base is of great importance, since during the periods of egg-production psittacines do not tend to increase their food intake. A quality diet should allow the bird to deposit enough stores to be mobilised later on to accommodate the requirements throughout the laying period (Harper & Skinner, 1998). It is not advisable for parrots to eat in a selective manner, since this type of feeding renders a once balanced diet into a deficient one and malnourished birds are more likely to become ill (Harcourt-Brown, 2000).

Protein in the diet presents a source of both essential amino acids and nitrogen, the latter being used to synthesise the nonessential amino acids. Protein quality should be as high as possible to prevent imbalances between essential and nonessential amino acids. Growing fledglings require around 15% to 20% of protein in their diet, whereas adult parrots have requirements of 10% to 14% to maintain weight (Harper & Skinner, 1998).

Fat in the diet constitutes an energy and a source of essential fatty acids (linoleic acid being the most important in birds). It also acts as a carrier of fat-soluble vitamins (e.g. Vitamins A and D). Carbohydrates also present as an energy source, albeit being mobilised faster than fat. Still, since the ceca of psittacines is pretty much absent or vestigial, they present little to no capacity of hindgut fermentation of carbohydrates. Calcium is considered to be adequate for larger psittacines at 1% and smaller psittacines from 0,3% to 0,8%. This mineral is intimately related to phosphorus and vitamin D (Harper & Skinner, 1998; Koutsos et al., 2001).

Seeds and nuts contain high levels of oil and phosphorus and are deficient in calcium, vitamin A and sometimes iodine. Increased levels of phosphorus and fat result in inhibition and limitation of calcium absorption, respectively. Vitamin D levels in seed diets are usually appropriate, contrarily to levels of vitamin A and its precursors (β carotenes) (Harper & Skinner, 1998; Stahl & Kronfeld, 1998).

Therefore, all-seed mixtures sold in pet shops do not cover a balanced diet for parrots. Birds quite enjoy seeds and often become highly accustomed to them, later rejecting any other kind of food; yet, its sole consumption leads to health problems in the long run, and dietary adjustment is important in these cases. Fruits and vegetables have a low-calorie content compared to nuts and contain high levels of fibre, vitamin A and C. Nonetheless, they generally lack minerals (particularly calcium), protein and vitamin D (Harcourt-Brown, 2000). Avocado should not be fed to birds, due to its toxic effects (Stahl & Kronfeld, 1998).

Clutch formation requires large investment of lipid and protein, besides micronutrients such as essential fatty acids, amino acids, vitamins and ions (Reynolds & Perrins, 2010). Inadequate calcium levels result in the production of thin-shelled eggs and since the mineral is primarily obtained from medullary and cortical bone resorption in these cases, female layers being fed inappropriate calcium amounts may thus experience bone-thinning and easily suffer fractures (Roudybush, 1999).

Besides calcium, cholecalciferol supplementation is indicated in cases of egg-binding and dystocia since it simultaneously promotes intestinal calcium absorption and increases the number of calcium-binding proteins in the shell gland. However, it may produce toxic effects upon excessive administration, having an antithyroid effect, downregulating the parathyroid gland and permanently affecting calcium metabolism (Harper & Skinner, 1998; Pollock & Orosz, 2002).

All-in-one ration formulations represent an easier way of ensuring animal's requirements are met, while preventing the problems that result from selective feeding. Even so, one should bear in mind that psittacines in the wild are very specific about the foodstuffs they consume. Even though birds have been proven to have less taste acuity compared to mammals, it has also been suggested they have more improved abilities in detecting nutrients and therefore have a tendency towards rejecting new diets, sometimes to the point of starvation. As such, dietary change if needed should be gradual and the bird's weight and droppings should be closely monitored, especially in those individuals with underlying disease (e.g. hepatic lipidosis) (Stahl & Kronfeld, 1998; Koutsos, Matson, & Klasing, 2001).

Psittacine breeders should have in mind that, besides disease, proper nutrition of the female influences the permeability of the vitelline membrane surrounding the lipid and nutrient-rich yolk (that progressively "feeds" the embryo throughout incubation periods) and is therefore indispensable for producing viable eggs (Elphick et al., 2007).

6. Clinical case summary

Of the reproductive clinical cases to be presented the first two resolved solely with medical treatment, and the third resolved with surgical intervention only.

6.1. Medical Resolution

6.1.1. Case 1: Paco Piti

Patient name: Paco Piti

Species: *Agapornis* sp.

Common name: Lovebird

Date of Birth: Unknown

Anamnesis: The owner brought the animal to the clinic referring behavioural alterations and considering her to be apathic. The animal had never laid any eggs prior to the consultation, so it could be assumed it was its first lay. There were no other pets in the house. The patient showed some appetite, and its normal diet consisted of seeds, vegetables, and cuttlefish bone. The female had no previous history of any other disease.

Physical examination: Body condition was good and appropriate. The animal presented with abdominal distension and some degree of tail-bobbing. Upon abdominal palpation the clinician could feel an egg, which was also visible through the vent. According to the clinician's experience it seemed oviposition was soon expected.

Treatment: Calcium (Calcium-Sandoz®) and a multivitamin complex (Axitol Pan®) including vitamin A, B, D and E were administered in the consultation and both substances were prescribed for administration at home.

Outcome: Given its stable condition the owner did not wish to admit the animal and preferred to take it home. The next day the egg was laid and no further complications arose.

6.1.2. Case 2: Limãozinho

Patient name: Limãozinho

Species: *Agapornis* sp.

Common name: Lovebird

Date of Birth: Unknown

Anamnesis: This animal presented to the clinic with complaints of anorexia and apathy. The owner noticed her on the bottom of the cage and mentioned she had not eaten since the night before. The patient's laying period had begun two months prior to the consultation, and the owner mentioned an egg had been laid around two weeks before. Her diet consisted mainly on seeds and apples, meaning there was not much variety of nutritious foodstuffs

Physical examination: The animal seemed weak, was not perching nor eating, and presented at the bottom of the cage. The patient also presented with a wide stance, and tail-bobbing indicating dyspnoea. The egg was not palpable on physical examination.

Complementary examination: Upon radiographical examination it was possible to confirm the presence of an egg.

Treatment: The animal was admitted and placed in the warm room, with minimal lighting and noise. Shredded paper towels were placed inside its cage, so the animal could have a nest to lay the egg in. Since the animal had not been eating nor drinking, support fluid therapy was applied. Calcium and oxytocin (Facilpart®), as well as vitamins were administered, and the animal was left to rest. Her condition remained stable even though slight dyspnoea and straining were still evident.

Outcome: The female was able to lay the egg the following day (figure 21), and no manual extraction or surgical intervention was required. She was discharged with a prescription for continued calcium treatment in the drinking water and received injectable administration of vitamins at the clinic before going home.

Figure 21: Egg laid by the patient from case 2 (Image kindly provided by CVEP).

6.2. Surgical Resolution

6.2.1. Case 3: Scali

Patient name: Scali

Species: *Agapornis* sp.

Common name: Lovebird

Date of Birth: -- / 05 / 2013

Anamnesis: The owner brought Scali for consultation upon finding her on the bottom of the cage, looking apathic and non-responsive. There were also complaints of anorexia, although it seemed the animal kept drinking water. The owner also mentioned the animal had seemed completely normal the day before.

This female cohabited with another lovebird, albeit kept in separate cages. According to the owner, the patient had a history of laying eggs two times per year and the year before had laid many eggs. The second-to-last egg in the clutch had been laid months before consultation and the last one the week before. Its diet used to be based on a complete all-in-one ration but had changed to commercial seed mixtures a month before.

Physical examination: The animal presented with extreme apathy, muscle tremors, drooped wings, altered stance, abdominal dilation and dyspnoea. On auscultation increased breath sounds were noticeable at the level of the air sacs. No egg was palpable through the abdomen.

Complementary examination: A radiographic examination was pursued, and the presence of an egg at the level of the utero-vaginal transition was confirmed.

Treatment: Given her state, Scali was immediately admitted and received support fluid therapy and calcium. After oxytocin administration she had still not been able to pass the egg, her condition showing no signs of improvement. Ovocentesis was then pursued. The egg was imploded transcloacally, with the animal under anaesthesia with isoflurane (figure 22). The bigger shell fragments were removed, but not all pieces could be retrieved without overly manipulating the surrounding (already frail) tissues. Given the apparent frailty of the oviduct, and because there had been a certain degree of manipulation, antibiotic treatment with enrofloxacin was initiated.

Figure 22: Patient from case 3 undergoing transcloacal ovocentesis under isoflurane (Image kindly provided by CVEP).

Outcome: After post-surgical stabilisation, the patient was discharged with prescribed medication to be continued at home. Post-surgical management included oral administration of meloxicam (Meloxidyl®), tramal and enrofloxacin (Baytril ®), as well as calcium and vitamin supplements to be added to the drinking water.

Table 12 contains some of the medication referred along the text with respective dosages. For some of the active principles the table also includes the recommended dose for psittacines according to the Exotic Animal Formulary (Carpenter, 2004).

Table 12: Doses of active substances mentioned in the text, as well as those recommended for psittacines according to *Exotic Animal Formulary* (p.n.r: when necessary).

Active substance(s)	***Recommended dose (*according to Exotic Animal Formulary for psittacines)***
Calcium Gluconate 10%	50-100 mg/kg IM or 5-10 mg/kg SC, IM q12h p.r.n*
Vitamins K3, B1, B2, B6, PP, H, B12, A, D3, E, B5 and choline (Axitol Pan®)	0.1 mL/kg PO, SID (dose used at the clinic)
Meloxicam	0.1-0.2 mg/kg PO, IM q24h*
Tramal	0.2 mL/kg, PO, TID (dose used at the clinic)
Butorphanol	1-4 mg/kg IM
Buprenorphine	0.02-0.05 mg/kg IM, BID/TID
Enrofloxacin	15 mg/kg IM; 1st approach or 15 mg/kg PO, q24h*
Oxytocin	0.5 IU/kg IM; may be repeated in 60 min (appropriate for cases of egg-binding and dystocia) * or 5 IU/kg IM, once

6.3. Discussion

Regarding all clinical cases, I believe the best course of action was pursued. Indeed, there are drugs which would be more potent than oxytocin, such as arginine vasotocin. Unfortunately, this substance is not commercially available.

One could have also used PGE2 topically in the cloaca, in order to ensure the relaxation of the uterovaginal sphincter, but Prepidil ® gel is also not commercially available at the moment.

For all cases, hypocalcaemia and hypoglycaemia were addressed first as recommended by the cited authors, via calcium and fluid therapy administration. Both admitted animals (cases 2 and 3) were placed in quiet, warm yet oxygenated spaces to help minimise stress levels.

Upon initial physical examination all animals were observed thoroughly but as quickly as possible, to minimise stress and to prevent the animal's condition from worsening due to handling. For this same reason, radiographic examination of the first patient was not pursued since the egg was palpable right upon primary evaluation. This was not the case for patients 2 and 3, where no egg could be felt through the abdomen, requiring the exam to be performed for confirmation. Both patients received oxygen and were medicated with calcium, analgesic drugs and a NSAID prior to radiographic examination.

Both admitted animals were checked on regularly and never left unattended for long.

7. Final Considerations

7.1. Differences between management of pet and captive birds

It has come to the author's understanding that even though there were some common species between both internship and externship locations, the kind of medicine and approach can never be quite the same. Firstly, it is important to differentiate work at the clinic and work at the zoo.

7.1.1. Working at the clinic

At the clinic, all attended animals were pets and had individual ownership, with individual financing. This often meant that certain types of procedure and acts of investment were conditioned by the owner's economic situation. Animals would also be attended by consult with the owner only. Be it a routine or an emergency consult, clinical choices and approaches are ultimately authorised by the client when one works at any pet clinic.

The clinic did not possess a fully equipped laboratory and had restricted means of analysis *in situ,* meaning biochemical and blood analysis had to be executed by independent laboratories. This would sometimes condition the time of results after sample collection, especially for late-night consults (when said laboratories would no longer send couriers to pick up samples). Despite the lack of some equipment, clinicians would often analyse blood and faecal smears, which proved to be essential diagnostic methods, albeit not as sensitive and specific as laboratory exams.

First-time consults always included a management briefing, where the veterinarian in attendance would tutor the owner(s) regarding their pet's nutrition, general welfare, environmental enrichment, preventative procedures such as deworming (and vaccination protocols for mammals), among other topics.

Since most people usually own one animal and every animal has at least one keeper, the clients' concern towards their pet was more focalised. Any required treatment was always directed towards the individuals, and this was made possible by the lower numbers of hospitalised animals at the centre, compared to the zoo's clinic. Even so, treatment is always more conditioned, because funding is not always predictable and monetary concerns often speak loudest.

The centre had the minor disadvantage of not being able to perform echographical nor endoscopic imaging at will, requiring the external consult of a specialist (schedules and availability were also conditioned by the owners' own timetables) that brought the required apparatus. Another minor disadvantage regarding imagiology techniques would be the time it took to reveal carried radiographies (not digitally revealed yet). Nonetheless, even though it took longer to develop the radiographic images the machine used was a mammograph, which allowed better definition and structure visualisation, particularly in smaller species.

7.1.2. Working at the zoological institution

At the zoo birds were part of a collection, owned by a foundation, thus there was no lack of investment towards treating them. Financial injections were directed to groups of animals, all of which were part of the site's collection. It should also be noted that there were many departments at function, each with its own duties and responsibilities. Since there was no individual ownership *per se*, medical decisions were enacted according to the attending veterinarians' agreement for the majority of actions and procedures. Immediate action was not dependent on individual financing and authorisation and therefore critical patients would receive all possible and available means of care as soon as they required them.

Immediate action was permitted except when it came to assisted death. Euthanasia would only be performed in chronic, untreatable cases in which it was considered a merciful death so as not to prolong any unnecessary pain. It would be authorised by a document signed by the head of the Foundation and by the chiefs of the departments involved.

Since there were no consults *per se*, much time was spent at the zoo's fully equipped laboratory. Biochemical and blood analysis would be run daily, along with cytologies and faecal smears, as well as flotation tests to detect the presence of parasite eggs. Samples brought from various departments ranged from mammals to cetaceans, to birds and reptilians, among others. Microbiological procedures such as cultures and antibiotic sensitivity tests were also common, as well as cytologies (performed by the nurse and veterinary auxiliary).

One visible advantage was the clear duty division at the clinic. This meant that most of the time feeding the animals was not the concern of the veterinarian staff. Feeding was controlled by the staff of specific departments (birds were fed by the Parrot Department, the Mammals Department brought food for mammalian patients, and so on) and was therefore more controlled and balanced (twice a day, alternating seeds and fruit), as well as directed towards the species.

Treatment however, due to the great number of hospitalised patients to care for, and the daily preventative care and analysis daily requirements, was more generalised. Not all patients could be assessed daily, and follow-ups were sometimes less frequent compared to the pet clinic. Nonetheless, despite being less aimed, there would be no conditioning of treatment for financial reasons.

It is important to emphasise that not all means of treatment were practical, meaning an animal's excessive size and greater anaesthetic requirements could absolutely put a stopper to a medical plan. It should be kept in mind that some animals in the collection could never be closely examined without sedating the individual in question (e.g. felines, primates, etc.).

Diagnostic means included radiographic, echographic and endoscopic equipment. Surgical procedures were not as common, but at the zoo the staff handled more traumatic cases (attacks, to be more specific) than at the pet centre. Laser therapy was a common weekly practice and sessions in parrots, penguins and orcas were observed by the author during the externship period. This kind of therapy was directed towards accelerating the scarring and healing process of tissues. During the whole working period, its efficacy was noticeable (albeit subjectively) by the author.

7.1.3. Behaviour of pets versus captive wild animals

It is also important to differentiate the behaviour of pets that are kept in a home from wild animals in captivity.

Birds that are kept as pets often feel lonelier and are therefore more prone to boredom and acts of self-mutilation. Most first-time owners do not have a realistic vision when it comes to the space their pet requires and it is a common occurrence among first-time bird owners. To feel comfortable, birds require cages that allow them to spread and flap their wings without damage.

Feeding is always more artificial, since all-in-one rations currently commercialised contain most nutrients required for a healthy animal. Still, alimentary mistakes are common, especially for clients who bring their pets to a veterinary service centre only years after acquiring them.

Animals grow accustomed to certain types of food, similarly to people, and dietary adjustments get proportionally harder with age. Most people are also unaware certain supplements may be required at certain periods in time and may inclusively be advised in order to further balance dietary requirements.

Habitat and self-hygiene is also a major disease prevention factor, since a cleaner cage could positively influence animal health, whereas a dirty cage would facilitate microorganisms' growth and (faecal) self-contamination. This is the owner's responsibility and depends on the time and effort invested in it.

Normal behaviour is also far more conditioned when a bird lives inside a person's house. What the animal considers as external stimuli is at its farthest from what is actually experienced in the wild. Single-animals often create close relationships with their keepers in the absence of a partner of the same species, which may result in abnormal behaviour, depending on the situation.

The advantage in dealing with patients that are pets is that in general they are partially used to human-handling, which facilitates physical examinations and better observation of behaviour at consults (less scared animals make it easier to spot "real" abnormalities). These animals also tend to be less stressed when manually contained. Owners more closely related to their pet also help facilitate examination and sample collection, rendering the animals more trustful and less prone to defensive reactions.

Captive birds at the zoo would inhabit external enclosures, with conditions closer to the ones found in the wild. The daily cleaning of enclosures was mandatory and more controlled, habitats being regularly cleaned (twice a day) and diet being balanced; supplements were added to the food of all birds at the park's collection when required, as well as deworming drugs and prescribed medication. Besides the environment itself, practically no animals were kept alone (minimum of two individuals whenever possible) and most lived daily in social groups.

Due to the conditions available, birds were freer to exhibit normal behaviour, more similarly to what is found in the wild. Even though most of these animals were raised by human hands, the author found them to be generally less sociable when compared to pets. This meant many procedures were performed under anaesthesia (decision also influenced by the animal species in question and type of procedure). Animals had no close relationship with the veterinarians, although some exceptions were noticed.

7.1.4. Regarding both locations

Upon discussion with veterinarians at both sites, the author can afford to make a subjective observation that cases of egg-binding and dystocia appeared more commonly in pets.

Animals living at home often lack adequate supplementation, environment and an animal companion of the same species to stimulate natural behaviour and egg lay. Animals living in captivity appeared to have more fertility-related problems as well as embryonary and neonatal constraints but were still able to demonstrate natural reproductive behaviour. Even though there was more control towards a group of animals, individualised control was not always possible at the zoo.

Captive couples had the chance to hatch their own eggs and babies were collected after birth for hand-feeding and more controlled care. It was noted that the occurrence of neonatal malformations (especially affecting the hind limbs) and improper healing of the umbilical scar (omphalocoele) were the most common affections among zoo hatchlings.

Nonetheless, this assumption is merely subjective and based on the author's observations throughout the whole internship year. At the centre in Porto we seldom attended bird breeders which would be more concerned about infertility issues than clients who owned pets. In fact, any existing fertility issues in pets may often be discarded or missed because owners are more concerned with their animal's general health instead of the fact that it is not producing any offspring. Given this fact and without any studies to support it, one cannot truly assume which type of reproductive pathology is more common in which bird population. Nor is it possible to truly state that fertility issues are more or less frequent in birds in captivity than in pet birds without a proper statistical approach and subsequent result analysis.

After all, to quote Spoon (2016) *"(…) management practices in the wild and in captivity that preserve the behavioural variation in a species and fulfil the behavioural needs of individuals will likely have the most success in breeding productivity and long-term conservation goals".*

IV. Conclusion

It came as a surprise to the author to become so interested in birds, most particularly the incredibly intelligent psittacines. Before starting the main internship in Porto, the author's knowledge on any avian species was next to none, and it has now expanded immensely, especially regarding nutrition, handling and basic medical approaches.

Animal reproduction had always presented as one of the most interesting and appealing subjects to the author, even before deciding to invest in exotic animal medicine, and long before entering the university. The fact that birds are such particular creatures, with features so different from those of the more commonly known (and loved) mammals, awoke a great interest and passion the author never knew possible.

Upon coming across the first cases of egg-binding, the newly gained interest to learn about the disease and other related pathologies were paramount for the decision of writing this document. Both the internship and externship experiences are most cherished and have contributed immensely towards the author's formation in the less explored, so to speak, areas of preventative medicine and general handling of many different exotic species.

Exotic and wild animal medicine is on the rise, and the author deeply relates to the principles of conservation medicine. Acquiring more knowledge regarding exotic and wild animal medicine is not only important for conservation efforts but is also crucial for the wellbeing of the growing numbers of exotic pets.

It is safe to say that expectations have been surpassed, and the benefits of the whole experience have been more than positive, instilling a greater drive and passion to help these living beings which, in the end, are actually more similar to man than most think: our beloved animals.

V. Bibliography

Abrantes, J., Loo, W.V., Pendu, J.L., & Esteves, P.J. (2012). Rabbit haemorrhagic disease (RHD) and rabbit haemorrhagic disease virus (RHDV): a review. *Veterinary Research, 43*. doi:https://doi.org/10.1186/1297-9716-43-12

Antinoff, N., & Giovanella, C. J. (2012). Musculoskeletal and Neurologic Disease. In *Ferrets, Rabbits and Rodents: Clinical Medicine and Surgery* 3rd ed. K. E. Quesenberry, & J. W. Carpenter, (Eds), Elsevier Inc, St. Louis, Missouri, United States of America, pp. 136-138

Benson, K. G. (1999). Reptilian Gastrointestinal Diseases. *Seminars in Avian and Exotic Pet Medicine, 8*(2): 90-97. doi:https://doi.org/10.1016/S1055-937X(99)80041-3

American Association of Avian Pathologists (AAAP) (2006) *Avian Disease Manual,* Boulianne M. (Ed), 6th ed., B. R. Charlton , Athens, Georgia, United States of America, ISBN 0-9789163-0-1, p. 140

Bowles, H. L. (2005). Evaluating and Treating the Reproductive System. In *Clinical Avian Medicine* G. J. Harrison, & T. Lightfoot (Ed.), Spix Publishing, Palm Beach, Florida, United States of America, ISBN:0975499408, Vol. I, pp. 5-17

Campbell-Ward, M. L. (2012). Gastrointestinal Physiology and Nutrition. In *Ferrets, Rabbits, and Rodents: Clinical Medicine and Surgery* 3rd ed., K. E. Quesenberry, & J. W. Carpenter (Eds), Elsevier Inc, St. Louis, Missouri, United States of America, ISBN:978-1-4160-6621-7, p. 183

Carpenter, J. W. (2004). *Exotic Animal Formulary* (3rd ed.), Saunders, Manhattan, Kansas, United States of America. ISBN 10: 0721601804 , pp. 53

Caruso, K. J., Cowell, R. L., Meinkoth, J. H., & Klaassen, J. K. (2002). Abdominal Effusion in a Bird. *Veterinary Clinical Pathology, 31*(3): 127-128.

Coles, B. H. (2005). Species and Natural History. In *BSAVA Manual of Psittacine Birds* 2nd ed., N. Harcourt-Brown, & J. Chitty, British Small Animal Veterinary Association, Gloucester, United Kingdom. ISBN: 0-905214-76-5, pp. 1-6

Deeb, B. J., & Carpenter, J. W. (2004). Neurologic and Musculoskeletal Diseases. In *Ferrets, Rabbits and Rodents: Clinical Medicine and Surgery* 2nd ed., K. E. Quesenberry (Ed), Saunders, St. Louis, Missouri, United States of America, ISBN: 0-7216-9377-6, pp. 207-208

Dierenfeld, E. S. (1989). Vitamin E Deficiency in Zoo Reptiles, Birds, and Ungulates. *Journal of Zoo and Wildlife Medicine, 20*(1): 3-11. Retrieved from https://www.jstor.org/stable/20094907

Direção Geral de Alimentação e Veterinária - DGAV. (2016). *Resumo das Característica do Medicamento.* Retrieved from http://www.medvet.simposium.pt: http://www.medvet.simposium.pt/RCM/Index/291

Doneley, B. (2010). *Avian Medicine and Surgery in Practice: Companion and aviary birds,* Manson Publishing Ltd., Queensland, Australia, ISBN: 978-1-84076-112-2, pp. 135-140; 209-222

Doolen, M. D. (1999). Straining and Reproductive Disorders. In *Manual of Avian Medicine,* G. H. Olsen, & S. E. Orosz, Elsevier Health Sciences, London, United Kingdom, ISBN:0815184662, pp. 183-185

Dorrestein, G. M. (2000). Nursing the sick bird. In *Avian Medicine* 2nd ed. J. T.N Tully, G. Dorrestein, & A. Jones (Eds), Reed Educational and Professional Publishing Ltd 2000, Oxford, United Kingdom, ISBN: 0-7506-3598-3, p. 109

Elphick, C. S., Reed, J. M., & Delehanty, D. J. (2007). Applications of Reproductive Biology to Bird Conservation and Population Management. In *Reproductive Biology and Phylogeny of Birds* (EDIÇÃO). B. G. Jamieson (Ed.), Science Publishers, New Hampshire, United States Of America, ISBN: 978-1-57808-444-9, Vol. 6B, pp. 367-372

Enkerlin-Hoeflich, E. C., Snyder, N. F., & Wiley, J. W. (2006). Behavior of Wild Amazona and Rhynchopsitta Parrots, With Comparative Insights from Other Psittacines. In *Manual of Parrot Behavior* 1st ed., A. Luescher, (Ed). Blackwell Publishing, Ames, United States of America, p. 16. doi:10.1002/9780470344651

Evans, H. E. (1982). Anatomy of the Budgerigar. In *Diseases of Cage and Aviary Birds* 2nd ed., M. L. Petrak (Ed), Lea & Febiger, Massachussets, United States of America, ISBN: 081210692X, pp. 164-167

Forbes, N. A. (1998) Avian Respiratory Disease. *The Veterinarian Quarterly, 20*: 67-69, doi:10.1080/01652176.1998.10807420

Graham, J., & Mader, D. R. (2012) Basic Approach to Veterinary Care. In *Ferrets, Rabbits, and Rodents: Clinical Medicine and Surgery* 3rd ed., K. E. Quesenberry, & J. W. Carpenter (Eds), Elsevier Inc., St. Louis, Missouri, United States of America, ISBN: 978-1-4160-6621-7 pp. 174-181

Hadley, T. L. (2010) Management of Common Psittacine Reproductive Disorders in Clinical Practice. *Veterinary Clinics of North America: Exotic Animal Practice* 13: 429-438. doi:10.1016/j.cvex.2010.05.006

Harcourt-Brown, F. M., & Holloway, H. K. (2003) Encephalitozoon cuniculi in pet rabbits. *The Veterinary Record, 152*(14): 427-431, doi:10.1136/vr.152.14.427

Harcourt-Brown, N. H. (2000) Psittacine Birds. In *Avian Medicine* 2nd ed., J. T.N Tully, G. Dorrestein, & A. Jones (Eds), Reed Educational and Professional Publishing Ltd, Oxford, United Kingdom, ISBN: 0-7506-3598-3, pp. 139-143

Harcourt-Brown, N. H. (2005) Anatomy and physiology. In *BSAVA Manual of Psittacine Birds* 2nd ed, N. Harcourt-Brown, & J. Chitty (Eds), British Small Animal Veterinary Association, Gloucester, United Kingdom, ISBN: 0-905214-76-5 pp. 16,17

Harper, E. J., & Skinner, N. D. (1998) Clinical Nutrition of Small Psittacines and Passerines. *Seminars in Avian and Exotic Pet Medicine, 7*(3): 116-127. doi: 10.1016/S1055-937X(98)80002-9

Haussler, M. R. (1986) Vitamin D Receptors: Nature and Function. *Annual Review of Nutrition,* 6: 527-562. doi:10.1146/annurev.nu.06.070186.0025

Hertelendy, F., Shimada, K., Tóth, M., Molnár, M., & Tanaka, K. (1996) Regulation of Oviposition. *Advances in Organ Biology, 1*: 31-59. doi: 10.1016/S1569-2590(08)60067-1

Hoppes, S. M. (2018) *Reproductive Diseases of Pet Birds.* Retrieved June 01, 2018, from MSD Manual Veterinary Manual: https://www.msdvetmanual.com/exotic-and-laboratory-animals/pet-birds/reproductive-diseases-of-pet-birds

Hoppmann, E., & Barron, H. W. (2007) Dermatology in Reptiles. *Journal of Exotic Pet Medicine, 16*(4): 210-224. doi:10.1053/j.jepm.2007.10.001

Howard, L. L., Papendick, R., Stalis, I. H., Allen, J. L., Sutherland-Smith, M., Zuba, J. R., Rideout, B. A. (2002) Fenbendazole and Albendazole Toxicity in Pigeons and Doves. *Journal of Avian Medicine and Surgery*, 16(3): 203-210. doi:10.1647/1082-6742(2002)016[0203:FAATIP]2.0.CO;2

Hudelson, K. S., & Hudelson, P. (1996) A Brief Review of the Female Avian Reproductive Cycle with Special Emphasis on the Role of Prostaglandins and Clinical Applications. *Journal of Avian Medicine and Surgery, 10*(2): 67-74

Institute for Quality and Efficiency in Health Care. (2016). *Understanding urine tests*. Retrieved June 06, 2018, from U.S National Library of Medicine: https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0072534/

Integrated Taxonomic Information System database (2013). *Psittaciformes*. Retrieved May 17, 2018,from:https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=177404#null

Jacob, M., & Bakst, M. R. (2007). Developmental Anatomy of the Female Reproductive Tract. In *Reproductive Biology and Phylogeny of Birds* 1st ed, B. G. Jamieson (Ed), Science Publishers, Enfield, USA, ISBN: 978-1-57808-386-2, Vol. 6A, pp. 140-175

Jenkins, J. R. (2000) Surgery of the Avian Reproductive and Gastrointestinal Systems. *Veterinary Clinics of North America: Exotic Animal Practice, 3*(3): 673-692

Joyner, K. L. (1994). Theriogenology. In *Avian Medicine: Principles and Application* 1st ed, B. W. Ritchie, G. J. Harrison, & L. R. Harrison (Eds), Wingers Publishing, Lake Worth, Florida, United States of America, ISBN: 0-9636996-0-1, pp. 748-802

Kheirandish, R., & Salehi, M. (2011) Megabacteriosis in Budgerigars: diagnosis and treatment. *Comparative Clinical Pathology, 20*: 501-505

Kirchgessner, M. S., Jr., T. N., Nevarez, J., Guzman, D. S.-M., & Acierno, M. J. (2012) Magnesium Therapy in a Hypocalcemic African Grey Parrot (*Psittacus erithacus*). *Journal of Avian Medicine and Surgery, 26*(1): 17-21

Klaphake, E., & Paul-Murphy, J. (2012) Disorders of the Reproductive and Urinary Systems. In *Ferrets, Rabbits, and Rodents: Clinical Medicine and Surgery* 3rd ed., K. E. Quesenberry, & J. W. Carpenter (Eds), Elsevier Inc., St. Louis, Missouri, United States of America, ISBN: 978-1-4160-6621-7 pp. 207-209

Koutsos, E. A., Matson, K. D., & Klasing, K. C. (2001) Nutrition of Birds in the Order Psittaciformes: A Review. *Journal of Avian Medicine and Surgery, 15*(4): 257-275

Krautwald-Junghanns, M.-E., Kostka, V., & Hofbauer, H. (1998) Observations on the significance of diagnostic findings in egg-binding of Psittaciformes. *The Veterinary Record* 143: 498-502

Kunzel, F., Gruber, A., Tichy, A., Edelhofer, R., Nell, B., Hassan, J., Joachim, A. (2008) Clinical symptoms and diagnosis of encephaitozoonosis in pet rabbits. *Veterinary Parasitology, 151*: 115-124. doi:10.1016/j.vetpar.2007.11.005

Lennox, A. M. (2012). Respiratory Disease and Pasteurellosis. In *Ferrets, Rabbits and Rodents: Clinical Medicine and Surgery* 3rd ed., K. E. Quesenberry, & J. W. Carpenter (Eds), Elsevier Inc., St Louis, Missouri, United States of America, ISBN: 978-1-4160-6621-7 p. 205

Levine, B. S. (2003) Common Disorders of Amazons, Australian Parakeets, and African Grey Parrots. *Seminars in Avian and Exotic Pet Medicine, 12*(3): 125-130. doi:10.1053/saep.2003.00020-3

Lightfoot, T., & Nacewicz, C. L. (2006). Psittacine Behavior. In *Exotic Pet Behavior: Birds, Reptiles and Small Mammals*. T. B. Bays, T. Lightfoot, & J. Mayer (Eds), Saunders Elsevier, St. Louis, Missouri, United States of America, ISBN: 0–4160–0009–7 pp. 51-98

Lindeberg, H. (2008) Reproduction of the Female Ferret (Mustela putorius furo). Reproduction in Domestic Animals, 43(2): 150-156. doi: 10.1111/j.1439-0531.2008. 01155.x

Maas III, A. K. (2013) Vesicular, Ulcerative, and Necrotic Dermatitis of Reptiles. *Veterinary Clinics of North America: Exotic Animal Practice,* 16(3):737-755. doi:10.1016/j.cvex.2013.05.007

Maestrini, G., Ricci, E., Cantile, C., Mannella, R., Mancianti, F., Paci, G., Perrucci, S. (2017) Encephalitozoon cuniculi in rabbits: Serological screening and histophatological findings. *Comparative Immunology, Microbiology and Infectious Diseases, 50*: 54-57. doi: 10.1016/j.cimid.2016.11.012

Mans, C., & Taylor, W. M. (2008) Update on Neuroendocrine Regulation and Medical Intervention of Reproduction in Birds. *Veterinary Clinics Exotic Animal Practice* 11: 83-105. doi:10.1016/j.cvex.2007.09.003

Matos, R. d. (2008) Calcium Metabolism in Birds. *Veterinary Clinics: Exotic Animal Practice, 11*(1): 59-82. doi: 10.1016/j.cvex.2007.09.005

Matos, R. d., & Morrisey, J. K. (2005) Emergency and Critical Care of Small Psittacines and Passerines. *Seminars in Avian and Exotic Pet Medicine, 14*(2): 90-105

McDonald, L. J. (1988) Hypocalcemic Seizures in an African Grey Parrot. *The Canadian Veterinary Journal, 29*(11): 928-930. doi:17423170

McDougald, L. R. (2002). Protozoarios. In *Enfermedades de las aves* 2nd ed., B. Calnek (Ed), El Manual Moderno, Mexico, ISBN-10: 9684268181, pp. 924,925

Morant, O. M. (2015) Alopecia en dorso y flancos en cobayas (*Cavia porcellus*): Dos casos clínicos. *Clínica Veterinaria de Pequeños Animales, 35*(4): 241-246

Nett, C. S., & Tully, T. N. (2003) Anatomy, Clinical Presentation and Diagnostic Approach to Feather-Picking Pet Birds. *Compendium, 25*(3): 206-219. Retrieved from http://www.vetfolio.com/dermatology/anatomy-clinical-presentation-and-diagnostic-approach-to-feather-picking-pet-birds

Patton, N.M., Hagen, K. W., Gorham, J. R. & Flatt R. (2008) Miscellaneous. In Domestic Rabbits: Diseases and Parasites, A Pacific Northwest Publication, Oregon, United States of America, p.27. Retrieved from: https://extension.oregonstate.edu/sites/default/files/documents/8426/rabbit-parasite-disease-pnw310-e.pdf

Oglesbee, B. L., & Jenkins, J. R. (2012). Gastrointestinal Diseases. In *Ferrets, Rabbits, and Rodents: Clinical Medicine and Surgery* 3rd ed., K. E. Quesenberry, & J. W. Carpenter (Eds), Elsevier Inc., St. Louis, Missouri, United States of America, ISBN: 978-1-4160-6621-7, pp. 193-201

Okerman, L. (1988) *Diseases of pet rabbits,* Blackwell Scientific Publications, Oxford, London, United Kingdom, ISBN: 0-632-02254-X, pp. 78,103

Orosz, S. E., & Lichtenberger, M. (2011) Avian Respiratory Distress: Etiology, Diagnosis, and Treatment. *Veterinary Clinics of North America: Exotic Animal Practice, 14*: 241-255. doi:10.1016/j.cvex.2011.03.003

Palmeiro, B. S., & Roberts, H. (2013) Clinical Approach to Dermatologic Disease in Exotic Animals. *Veterinary Clinics of North America: Exotic Animal Practice, 16*: 523-577. doi:10.1016/j.cvex.2013.05.003

Paré, J. A., & Robert, N. (2007) Circovirus. In *Infectious Diseases of Wild Birds* , N. J. Thomas, D. B. Hunter, & C. T. Atkinson (Eds), Blackwell Publishing, Iowa, United Stated of America, ISBN-13: 978-0-8138-2812-1, pp. 195-199

Petritz, O. A., & Chen, S. (2018) Therapeutic Contraindications in Exotic Pets. *Veterinary Clinics of North America: Exotic Animal Practice, 21*(2): 327-340

Phalen, D. N. (2014) Update on the Diagnosis and Management of Macrorhabdus Ornithogaster (Formerly Megabacteria) in Avian Patients. *Veterinary Clinics of North America: Exotic Animal Practice, 17*: 203-210. doi: 10.1016/j.cvex.2014.01.005

Pollock, C. G., & Orosz, S. E. (2002) Avian reproductive anatomy, physiology and endocrinology. *The Veterinary Clinics of North America: Exotic Animal Practice*, 5:441-474. doi:10.1016/S1094-9194(02)00010-5

Portaria nº 264/2013 de 16 de agosto. Diário da República nº 157/2013 - I Série. *Programa Nacional de Luta e Vigilância Epidemiológica da Raiva Animal e Outras Zoonoses*. Ministérios das Finanças, da Administração Interna e da Agricultura, do Mar, do Ambiente e do Ordenamento de Território

Rae, M. (1995) Endocrine Disease in Pet Birds. *Seminars in Avian and Exotic Pet Medicine, 4*(1): 32-38. doi:10.1016/s1055-937x(05)80007-6

Reynolds, S. J., & Perrins, C. M. (2010) Dietary Calcium Availability and Reproduction in Birds. In *Current Ornithology,* C. F. Thompson, Springer Science+Business Media Illinois, United States of America, ISBN: 978-1-4419-6420-5, Vol. 17, pp. 31-32. doi:10.1007/978-1-4419-6421-2

Richardson, V. (2000a) *Rabbits: Health, Husbandry and Diseases*, Blackwell Science Ltd, Oxford, United Kingdom, ISBN: 0-632-05221-X , pp. 108-143;

Richardson, V. (2000b) *Diseases of Domestic Guinea Pigs* 2nd ed., Blackwell Science Ltd., Oxford, United Kingdom, ISBN: 0-632-05209-0 , pp. 1-2

Richardson, V. (2003) *Diseases of Small Domestic Rodents* 2nd ed., Blackwell Publishing Ltd., Oxford, United Kingdom, ISBN: 1-4051-0921-1, pp. 41-42

Risi, Emmanuel (2014) Control of Reproduction in Ferrets, Rabbits and Rodents. Reproduction in Domestic Animals 49(2):81-86. doi: 10.1111/rda.12300

Romagnano, A. (2005) Reproduction and Paediatrics. In *BSAVA Manual of Psittacine Birds* 2nd ed., N. Harcourt-Brown, & J. Chitty (Eds), British Small Animal Veterinary Association, Gloucester, United Kingdom, ISBN: 0-905214-76-5, pp. 223-226

Rosen, L. B. (2012) Avian Reproductive Disorders. *Journal of Exotic Pet Medicine* 21: 124-131. doi:10.1053/j.jepm.2012.02.013

Rosskopf, W. J. (2003) Common Conditions and Syndromes of Canaries, Finches, Lories and Lorikeets, Lovebirds, and Macaws. *Seminars in Avian and Exotic Pet Medicine, 12*(3): 131-143. doi:10.1053/saep.2003.00023-9

Roudybush, T. E. (1999) Psittacine Nutrition. *Veterinary Clinics of North America: Exotic Animal Practice, 2*(1): 111-125. doi:10.1016/S1094-9194(17)30142-1

Rox, J. C., Hamilton, R. C., & Attwood, H. D. (1979) An Investigation of the Route and Progression of *Encephalitozoon cuniculi* Infection in Adult Rabbits. *The Journal of Protozoology, 26*(2): 260-5. ISSN: 0022-3921

Royal Veterinary College (2015). *Beaumont Sainsbury Animal Hospital.* Retrieved June 06, 2018:https://www.rvc.ac.uk/Media/Default/Beaumont%20Sainsbury%20Animal%20Hospital/documents/caring-for-your-ferret.pdf

Scagnelli, A. M., & Jr, T. N. (2017) Reproductive Disorders in Parrots. *Veterinary Clinics of North America: Exotic Animal Practice*, 20(2):485-507. doi:10.1016/j.cvex.2016.11.012

Schumacher, J. (2006) Selected Infectious Diseases of Wild Reptiles and Amphibians. *Journal of Exotic Pet Medicine, 15*(1), 18-24. doi:10.1053/j.jepm.2005.11.004

Seibert, L. M. (2006) Social Behavior of Psittacine Birds. In *Manual of Parrot Behavior* A. Luescher (Ed), Blackwell Publishing, Ames, United States of America, ISBN: 9780813827490, pp. 43-47

Seibert, L. M., & Sung, W. (2010) Psittacines. In, *Behavior of Exotic Pets* 1st ed, V. V. Tynes (Ed.), Wiley-Blackwell, Chichester, ISBN: 978-0-8138-0078-3, pp. 1-10

Silvestre, A. M. (2003) *Enfermedades de Los Reptiles* 1st ed., Reptilia Ediciones, Barcelona, Spain, ISBN: 84-607-6510-5, pp. 16-25;73-75

Smith, S. A., & Smith, B. J. (1992). *Atlas of Avian Radiographic Anatomy* 1st ed., W. B. Saunders Company, Philadelphia, United States of America, ISBN: 0-7216-3652-7, p. 44

Spoon, T. R. (2006) Parrot Reproductive Behavior, or Who Associates, Who Mates, and Who Cares? In *Manual of Parrot Behavior*, A. Luescher (Ed), Blackwell Publishing, Ames, United States of America, ISBN: 9780813827490, p. 63

Stahl, S., & Kronfeld, D. (1998) Veterinary Nutrition of Large Psittacines. *Seminars in Avian and Exotic Pet Medicine, 7*(3): 128-134. doi: 10.1016/S1055-937X(98)80003-0

Tully Jr, T. N. (2000) Psittacine Therapeutics. *Veterinary Clinics of North America: Exotic Animal Practice, 3*(1): 59-89

Vella, D., & Donnelly, T. M. (2012) Basic Anatomy, Physiology, and Husbandry. In *Ferrets, Rabbits and Rodents Clinical Medicine and Surgery* 3rd ed., K. E. Quesenberry, & J. W. Carpenter (Eds), Elsevier Saunders, St. Louis, Missouri, United States of America, ISBN: 978-1-4160-6621-7 pp. 157-165

Verstraete, F. J. (2003) Advances in Diagnosis and Treatment of Small Exotic Mammal Dental Disease. *Seminars in Avian and Exotic Pet Medicine, 12*(1): 37-48. doi:10.1053/saep.2003.127877

Willis, A. M., & Wilkie, D. A. (1999) Avian Ophthalmology, Part 2: Review of Ophthalmic Diseases. *Journal of Avian Medicine and Surgery, 13*(4): 245-251. doi: 10.1647/02-017

VI. Annexes

Tables 13, 14 and 15 from the first annex concern the mammal, avian and reptile species encountered by the author throughout the internship. The presentation included in the second annex was made by the author and displayed at the *Centro Veterinário de Exóticos* during the internship period.

Annex I – Exotic species encountered

Table 13: Common and scientific names of all mammalian species encountered by the author throughout the internship at CVEP and corresponding total individuals (N=346).

Mammal Species (Total = 346)

Common name (N)	**Scientific Name**
Rabbit (166)	*Oryctolagus cuniculus*
Guinea pig (77)	*Cavia porcellus*
Ferret (49)	*Mustela putorius furo*
Chinchilla (15)	*Chinchilla laniger*
Siberian hamster (14)	Genera *Phodopus sp.*
Brown rat (8)	*Rattus norvegicus*
Golden hamster (5)	*Mesocricetus auratus*
Hedgehog (3)	*Atelerix albiventris*
Domestic pig (2)	*Sus scrofa domesticus*
Richardson's squirrel (2)	*Spermophilus richardsonii*
Ground squirrel (2)	Genera *Tamnias sp.*
Prairie dog (1)	Genera *Cynomys sp.*
Striped skunk (1)	*Mephitis mephitis*
House mouse (1)	*Mus musculus*

Table 14: Common and scientific names of all avian species encountered by the author throughout the internship at CVEP and corresponding total individuals (N=185).

Avian Species (Total = 185)	
Common name (N)	**Scientific Name**
Lovebird (48)	Genus *Agapornis*
Grey Parrot (33)	*Psittacus erithacus*
Canary (30)	*Serinus canaria*
Cockatiel (19)	*Nymphicus hollandicus*
Amazon Parrot (14)	Genera *Amazona*
Budgerigar (12)	*Melopsittacus undulatus*
Common pigeon (10)	*Columba livia*
Turtledove (4)	*Streptopelia turtur*
Chicken (3)	*Gallus gallus domesticus*
Conures (3)	Genera *Aratinga*
Timneh parrot (2)	*Psittacus timneh*
Gouldian finch (2)	*Chloebia gouldiae*
Timor Zebra Finch (2)	*Taeniopygia guttata*
Parakeet (1)	Genera *Pyrrhura*
Greenfinch (1)	*Carduelis chlorus*
Crimson Rosella (1)	*Platycercus elegans elegans*
Kakariki (1)	Genera *Cyanoramphus*

Table 15: Common and scientific names of all reptilian species encountered by the author throughout the internship at CVEP and corresponding total individuals (N=79).

Reptilian Species (Total = 79)

Common name (N)	**Scientific Name**
Turtles (50)	Genera *Graptemys*
	Genera *Trachemys*
	Genera *Pseudemys*
	Genera *Chinemys*
	Genera *Testudo*
	Genera *Mauremys*
Bearded Dragon (13)	*Pogona vitticeps*
Serpents (5)	Genera *Vipera*
	Genera *Morelia*
	Genera *Panterophis*
	Genera *Python*
Iguana (4)	*Iguana iguana*
Chamaeleon (3)	*Chamaeleo calyptratus*
Leopard gecko (2)	*Eublepharis macularius*
Blue tongued skink (1)	Genera *Tiliqua*
Axolotl (1)	*Ambystoma mexicanum*

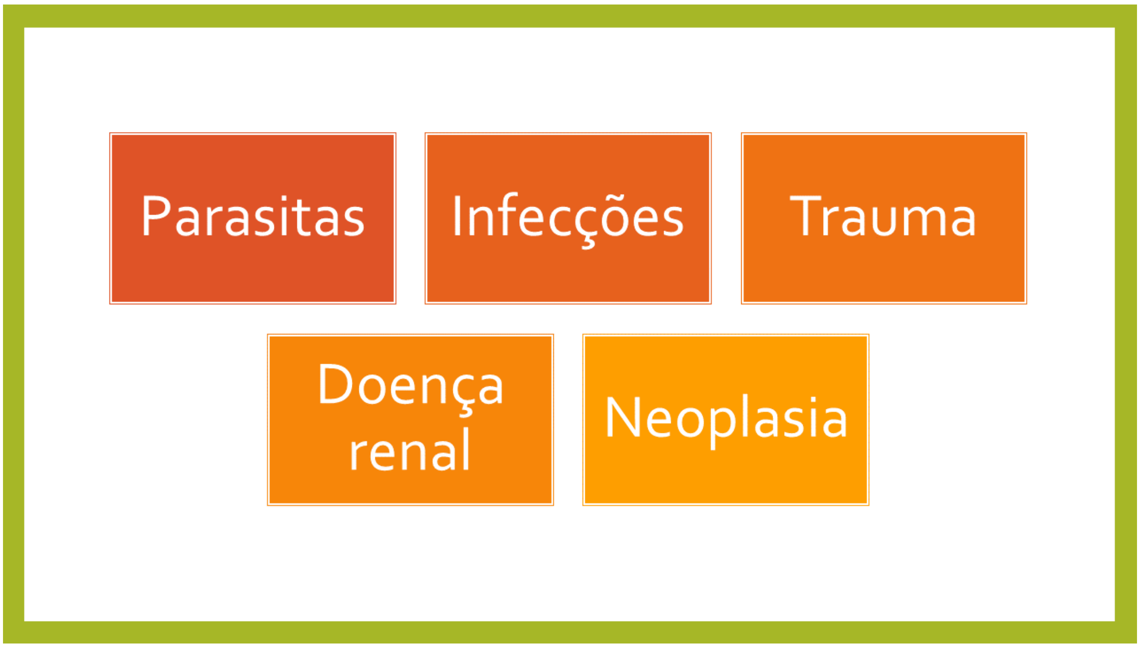
Annex II – “Hedgehog Basic Care and Husbandry”

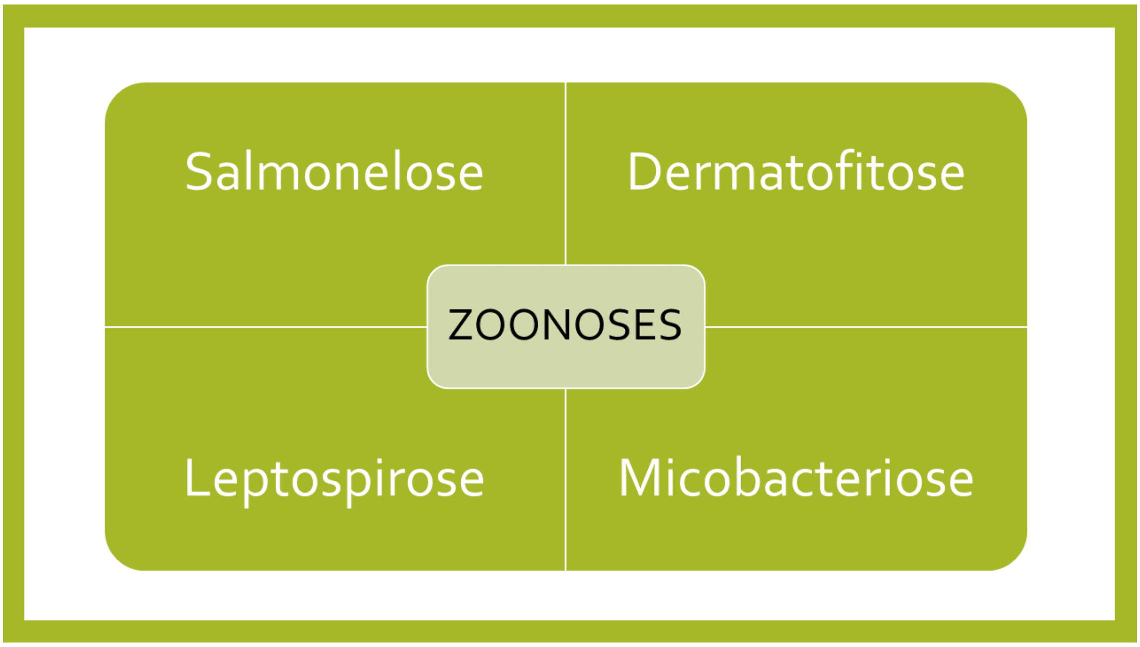
Alojamento

- Paredes altas
- Sem fios no chão
- Esconderijo
- Substrato mole e absorvente
- Individual ou grupo
- 25 a 30 graus

Nutrição

- Na natureza:
  - Insectos
  - Pequenos vertebrados
  - Fruta
  - Fungos
- Em cativeiro:
  - Comida de gato
  - Ração comercial suplementada
  - Evitar dieta exclusivamente insectívora
  - Comida seca
  - Evitar frutos secos, cereais e leite


Parasitas
Infecções
Trauma
Doença renal
Neoplasia


Salmonelose
Dermatofitose
ZOONOSES
Leptospirose
Micobacteriose

Exame físico e anestesia

- Maioria requer sedação
- Injectáveis não aconselhados
- Atropina pré-anestésica (hipersalivação)
- Anestesia volátil
  - Isoflurano/Sevoflurano
  - Indução 3 a 5%
  - Manutenção 0.5 a 3%
- Intubação (?)

Outros procedimentos

- Colheita de sangue:
  - Cefálica
  - Safena lateral
  - Jugular
  - Veia cava
- Colheita de urina e fezes
- Medicação oral
- Medicação injectável
- Medicação tópica (banhos)

Hospitalização

- Evitar ao máximo
- Providenciar esconderijo
- Gaiola de parede lisa ou grades
- Aquecimento
- Alimentação forçada desafiante
  - Faringostomia
  - Esofagostomia

Cuidados preventivos

- Exame físico completo na 1ª consulta
  - Pele e espinhos
  - Mucosas
  - Auscultação cuidadosa
  - Palpação abdominal
  - Dentição e lesões orais (febre aftosa)
  - Exame directo fezes (protozoários)
  - Testes flutuação fezes
- Outros
  - Cultura dermatófitos (DTM)
  - Exame serúmen
  - Hematócrito
  - Radiografia

Bibliografia e Webgrafia

- https://www.pinterest.pt/explore/porcos-espinhos/
- https://www.pinterest.pt/explore/baby-hedgehogs/
- https://www.pinterest.pt/pin/288441551107103952/
- https://www.dreamstime.com/royalty-free-stock-photography-four-toed-hedgehog-atelerix-albiventris-image17000517
- Elisabeth A. Simone-Freilicher *et al*, *Hedgehog care and husbandry*