

THE OCCURRENCE OF *PSITTACOSIS* IN THE EMERALD TREE BOA (*CORALLUS CANINUS*) OF SOUTH AMERICA

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[Abstract]

Corallus caninus – the emerald tree boa of South America – is renowned for the many difficulties it may present whilst kept in captivity. The problems which may occur vary from stress-related symptoms and the refusal to feed and endoparasitic diseases (worm infestations and infections caused by flagellate colonies in the intestines), to the vomiting of prey, also known as ‘*regurgitation*’.



Corallus caninus – the emerald tree boad of S. America (Photo by author).

Swan & Weidner [2002] describe this chronic condition as the *Emerald Vomiting Syndrome* or EVS. This vomiting or regurgitation of prey has often been attributed to stress-related factors or imbalances between humidity and temperatures in the captive environment. As rightly pointed out in a publication by Swan & Weidner [2002], the term '*regurgitation*' is perhaps not an appropriate way to describe these symptoms since regurgitation is usually referred to as a condition in which animals store food in a crop or in their esophagus for later retrieval in order to feed their offspring. This is seen, for example, in numerous species of bird. Vomiting, on the other hand, is a term generally used to describe the abrupt *involuntary evacuation* of the contents of the stomache after the break-down process of food mass in the stomache has begun, as is typically the case in specimens of *Corallus caninus* exhibiting symptoms the *Emerald Vomiting Syndrome* [EVS].

Causal factors of EVS

Many claim that this syndrome – EVS - is generally caused by stress or in part by the imbalance of humidity and temperature in the captive environment of *Corallus caninus*. However, recent studies, amongst others by Swan & Weidner [2002], suggest that the symptoms are only manifest in captive specimens of the emerald tree boa that originate from exporting locations where birds (in particular parrots) are kept for later exportation and introduction into the international pet trade. Swan & Weidner mention this in their paper [2002] in which they also describe situations in which this occurs.

After conducting studies in captive caught specimens of *Corallus caninus*, Swan and Weidner [2002] suspect that the organism known as *Chlamydophila psittaci* is the cause of this condition. The authors also state that their findings are by no means based on true 'scientific' analysis or study.

The same applies to this current paper. It is merely a collection and summary of data and information widely available in literature on this subject, but, at the same time, poses the important question regarding whether EVS is, in fact, a manifest form of *Psittacosis*

in *Corallus caninus*, the emerald tree boa of S. America, or that regurgitation (EVS) can be attributed to a much wider spectrum of disorders (both physical and environmental) in *Corallus caninus*.

The studies conducted by Swan & Weidner revealed that, whilst a certain percentage of specimens collected for the pet trade exhibited symptoms of *Psittacosis* (also known as the *Parrot Disease*), others did not. They attribute this to the fact that some wild-caught specimens of *Corallus caninus* are housed in close proximity to numerous species of tropical bird, for example parrots, before being exported and introduced into the international pet trade. In their article, reference is made to a trapper who kept specimens of *Corallus caninus* segregated from avians whilst awaiting exportation and that it was found that the disease did not occur in those specimens.

Specimens of *Corallus caninus* which were not housed in close proximity to birds whilst awaiting exportation, were not affected by this disease and did not exhibit the characteristic symptoms of *Psittacosis* or *EVS*. The disease was observed only in specimens that had been kept in close proximity to avians after capture. Other species susceptible to this disease include red-tailed boa constrictors and anacondas collected for the pet trade.

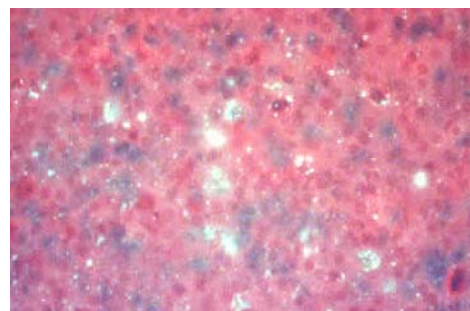
Further studies under clinically defined laboratory conditions with the use of sampled specimens will be required in order to assert these assumptions; these were conditions which could not be provided by Swan & Weidner [2002] at the time their own studies were undertaken. Even so, their claims may have great significance and therefore warrant further scientific investigation by specialists in this field.

Psittacosis

Psittacosis is a common and potentially serious disease occurring in avians, mammals and humans. The disease is not fully understood and there is still a lot to be learned about the condition. The causal organism, *Chlamydia psittaci*, has recently been renamed *Chlamydophila psittaci* and is found in a wide variety of (tropical) birds, but may also occur in mammals, including humans causing serious illness.

This species of organism is now sub-divided into many subspecies, each affecting a different animal. For example, the type which will affect cats produces an eye-infection called *conjunctivitis* or *blepharitis* (inflammation/infection of the eyelids). In sheep, the disease is said to result in premature abortion and in humans, it has been established that this disease will most probably cause *atypical pneumonia*. The organism producing a genital/venereal disease in humans has now been classified as a separate genus: *Chlamydia trachomatis*.

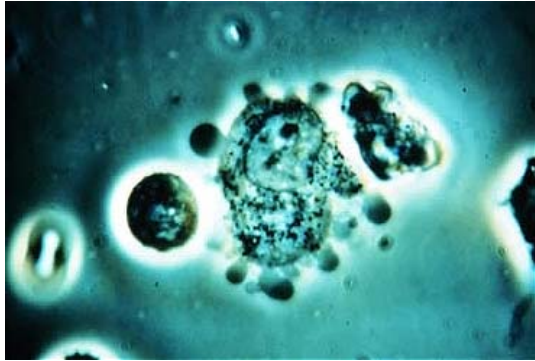
The generic term for the disease produced by *Chlamydophila psittaci* affecting all species – both avian and mammalian - is *chlamydiosis*. When this disease is exhibited in avians, it is called *ornithosis*. When exhibited specifically in psittacine birds, it is designated as *psittacosis*, a designation also used to describe the disease occurring in mammals, including humans.



Fluorescent antibodies associated with infection by *Chlamydia psittaci*, 40X. Courtesy of Dr. Jean Sander & Merck Veterinary Manual

The organism itself is unusual in that it possesses certain characteristics of both bacteria and viruses. It is relatively large and also highly sensitive to antibiotics. It resembles viruses in that it can only develop and

multiply within the cells of its host. The damage is caused by the rupture and further destruction of these cells and the release of toxins into the host's biologic system. *Chlamydia* appear to infect and multiply in most cell-types, thus resulting in a widely variable disease pattern.



Elementary bodies associated with infection of *Chlamydia psittaci*, 100X. Courtesy of Dr. Jean Sander & Merck Veterinary Manual

In *Corallus caninus*, it is said to cause the destruction of HCl-producing cells needed for the break-down of food masses in the stomach.

The organism is also able to survive outside the host for approximately one month if protected by cell debris and protein material (i.e. droppings, nasal discharge etc.). An important aspect of control of the disease is therefore cleanliness and disinfection to remove such debris from confinements in which the host animal is kept.

Members of the *Chlamydiaceae* are so-called nomotile, gram-negative, obligate intracellular organisms that possess a unique developmental cycle consisting of metabolically inactive infectious elementary bodies (EBs) and metabolically active, but non-infectious reticulate bodies (RBs). *Chlamydiae*, on the other hand, replicate in the cytoplasm of host cells within an endosomal vacuole which appears under light microscopy as an intercellular inclusion (see image above).

Chlamydia psittaci is considered a dangerous organism to handle under laboratory conditions. For many years it was a major cause of laboratory-contracted infections. It generally resulted from exposure to and the use of aerosols. The stability of the organism in a laboratory environment is also considered to be a potential danger, also to humans.

Disinfectants found to be highly effective against this organism include ammonium compounds, benzalkonium chloride and formaline-based

compounds. The conventional fumigation of quarantine confinements with the use of formaldehyde gas (formalin and potassium permanganate) has proven to be highly effective against this organism, provided that surfaces have first been adequately cleaned [Jones, Alan K.,].

The natural occurrence of this infection is world-wide and it has been estimated that 1% of all wild birds are infected and therefore also act as carriers. Many avians can retain the organism in their bodies in a *latent state* without immediately showing signs of the disease - these birds are *carriers* and are a persistent risk to other birds and other animals susceptible to the disease.

It appears that the infection or disease is most predominant when external stress-related factors occur, i.e. capture, loss of food sources, change of habitat, transportation, quarantine and relocation. The disease is therefore most commonly observed after recent capture, relocation and importation into the pet trade, particularly in avians. This is also the time when most wild caught animals are stressed, thus resulting in the weakening of their natural biologic resistance.

This brings the current discussion to the points made by Swan & Weidner [2002], where the authors explain the dangers which may exist when other species are held in confinements in close proximity to infected avians in their countries of origin or during and after transit, such as is the case in wild-caught *Corallus caninus* (the emerald tree boa) collected in particular in Guyana, Surinam and other regions of S. America. These are regions where avians are also collected for exportation and introduction into the international pet trade.

When kept in confinements awaiting further transportation, carriers of *Chlamydia psittaci* produce droppings containing the organisms. Avians and other animals are often kept in close proximity with each other in these conditions and due to the extremely contagious nature of the disease are therefore highly susceptible to the organism and resulting infection. The disease may therefore spread very rapidly. Contracting is generally by airborne contact with inhaled fecal dust from dried feces or droppings. The incubation period (the time between the moment of contracting the organism to the manifestation of clear clinical signs) however, is extremely variable and can be confusing when attempts are made to determine the exact source and cause of the infection.

The organism may also reside in the host in a *latent state*, only to be triggered at a later stage under stress-

related conditions (e.g. relocation, transport, new confinement) to produce clinical signs. In the latter case, the onset triggered by these stress factors and may therefore also occur long after the animals have been exported and been placed in their new homes (e.g. at the location of the new owner).

The minimum incubation period documented to date is 10 days, although ongoing studies suggest that this period may vary from between 10-45 days. The maximum period may be from between 9-18 months when in its latent state, i.e. long after exportation of the animals to other countries and into the pet trade, or at the location of its new owner.

This means that regulated quarantine periods have little or no bearing on the recognition of the infection or the time of onset of the infection. Animals may be infected by the organism, but show no clinical signs throughout prolonged periods of quarantine exceeding 3-6 months. This also makes it very difficult to determine the actual source or time of the infection. Outbreaks of the disease may therefore occur in populations of apparently healthy animals that have previously shown no clinical signs of the disease for months or even years. From this, it follows that, contrary to popular belief, avians brought into a country and subjected to relatively long periods of quarantine (3-6 months) cannot be guaranteed to be free from *psittacosis*. In the UK, for example, the quarantine period for imported birds is 35 days, i.e. it ends 6-10 days before the probable maximum period of incubation of the organism is reached, not including those specimens in which the organism may reside in a *latent state*. In many countries therefore, regulated minimum periods of quarantine are most probably ineffective for the purpose of recognising the occurrence of *psittacosis*.

In an attempt to control *psittacosis*, in the US many quarantine stations administer the broad-spectrum antibiotic *Tetracycline* to avians during their stay. This is regulated by US law, but is not the case in many other countries such as the UK and other EU member states. Although some importers in the UK will administer *Tetracycline* as a preventive measure, they are not obliged to do so. In addition, the use of *Tetracycline* does not reliably eliminate the disease or further contaminations by the organism.

Clinical signs of psittacosis

Clinical signs are many and variable. They depend largely on the species involved. Some animals, like cats, are reported to develop serious eye infections like *conjunctivitis* or *blepharitis* (inflammation of the conjunctiva and swollen eye-lids). In avians and reptilians the symptoms most predominant are: loss of

weight and appetite, diarrhoea, vomiting and sometimes respiratory symptoms. These are only the visible signs.

The symptoms observed in EVD in *Corallus caninus* are very similar, but in EVS *vomiting* predominates (24-72 hours after ingestion of prey), together with the refusal to eat and gradual dehydration. There is also a marked weight loss due to continued or prolonged inappetence and vomiting after feeding and the well-being of the specimen affected rapidly diminishes. Proper clinical diagnosis of the disease is difficult since many of these same symptoms may also arise in reptilians as a result of stress and infections by other endoparasitic infections (including *Cryptosporidiosis*) and not all of these signs may be present at any one time. Systemic infections which may also produce many of the same symptoms include e.g. infections cause by flagellates and worms, the common cold in reptilians and the initial stages of *secondary pneumonia* resulting from loss of biologic resistance etc. which, in many cases, may be purely stress-related.

As pointed out by Kolins & White: 'The classic presentation of *Cryptosporidium serpentis* infection in the snake is an animal which regurgitates its meal within four days or less of ingestion. This regurgitation occurs because of decreased gastric lumen size and mucosal irritation. Since the diameter of the stomach has often increased, a noticeable swelling can be visualized and palpated in the mid-body region. The snake may or may not be anorexic, depending on how far the disease has progressed. Often, a mucoid diarrhea is noticed.'

It is important to differentiate *Cryptosporidiosis* from other causes of regurgitation and gastritis. Suboptimal temperatures, inappropriate prey size, stress, and foreign body obstructions are other potential causes of regurgitation. Hibernation associated necrotizing gastroenteritis, parasitism from other protozoa and nematodes, viruses, *Salmonella* and other bacteria can all cause similar signs, but the gastric swelling is pathognomonic for *Cryptosporidiosis*.

From this, it follows that not all symptoms seen in *psittacosis* can be attributed to the presence of *Chlamydophila psittaci*, which makes any positive diagnosis based upon symptoms alone far from conclusive. Any accurate diagnosis must therefore be supported by further clinical laboratory tests, otherwise the assumption that these symptoms are caused by *Chlamydophila psittaci* may only be considered as speculative. In many cases, blood samples will only demonstrate antibodies, which only means that the reptile has been exposed to *chlamydhila* at some time. That in itself would

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support the theory by Swan & Weidner [2002] that the organism must have been contracted during its stay in confinements in close proximity to avians before, during or after exportation.

In order to be of any relevance, blood tests would need to be repeated 10-14 days later for the results to be suggestive of recent infection. The organism can be identified in blood samples only during the multiplication stage of the organism and because this period is only limited, negative results would not always implicate that the specimen does not have the disease. The most effective means of diagnosing the infection in *Corallus caninus* would be a post-mortem (autopsy) examination of the carcas or immediate examination and laboratory analysis based upon cultures of the organism collected from fresh feces or post-mortem material.

Typical signs would be similar to those found in other septic infections: inflammation of the stomache and destruction of the stomache lining cell structures, enlargement of the spleen and liver and inflammation of the membranes of the air sacs, heart and peritoneum, i.e. the transparent membrane that lines the abdominal cavity.

There are other tests available for detecting *Chlamydophila* antigen in feces, e.g. ELISA (Enzyme Linked Immunosorbent Assay), which provides quicker results on samples that contain the organism. Other tests developed for testing for the presence of this organism include Latex Agglutination (L.A.) and Direct Fluorescent Antibody (F.A.). However, PCR technology using *Chlamydophila psittaci*- specific DNA probes has proven to be the most effective method of identification.

Treatment

The treatment of *psittacosis* may not be as simple as it may seem. The drug of choice in avians and reptilians is one of the Tetracycline group, to which the *Chlamydial* organism is sensitive. *Doxycycline* is a semi-synthetic tetracycline clinically developed in the early 1960s by Pfizer Inc. and also marketed under the brand name *Vibramycin*. *Vibramycin* received FDA approval in 1967, becoming Pfizer's first once-a-day broad-spectrum antibiotic. Other brand names include: Monodox, Periostat, Vibra-Tabs, Doryx, Vibrox, Adoxa, Doxyhexal and Atridox.

The drug needs to be administered according to a regime which will produce an effective dose for a sufficient period of time. Provided that a precise diagnosis is made quickly enough, treatment with Tetracycline or *Erythromycin* will usually produce a rapid response, but not if the condition is diagnosed

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too late or mistaken for other conditions which exhibit similar symptoms, or if the infection has been present for a longer period of time.

Erythromycin is a macrolide antibiotic that has an antimicrobial spectrum similar to or slightly wider than that of penicillin and has proven to be highly effective in the treatment of acute outbreaks of *Chlamydia*.

According to Swan & Weidner [2002] 'The apparent successful dose used for gastric *Chlamydophilal* infection in emerald tree boas is 25mg/kg orally, daily for ten consecutive days.

Treatment for shorter periods of 5-10 days will often produce a rapid clinical improvement, but the reptile will not be cured and relapses may occur. The antibiotic only acts on organisms when they are growing and multiplying, and since the *Chlamydia* can exist dormant (i.e. in a latent state) in cells for some time, the drug will be useless during these periods of latency.

Additionally, the prolonged use of antibiotic can itself pose problems of imbalance of the normal intestinal flora, producing diarrhoea and malabsorption conditions, or secondary infection by opportunist fungi or yeasts. There may also be some immunosuppressive effects to the drug and it can be difficult to maintain therapeutically effective levels of the tetracycline within the cells. Tetracycline also reacts with calcium in the diet to limit its absorption, so diets with high calcium levels in animals undergoing treatment with the drug should be avoided.

Doxycycline is available as 'Vibramycin syrup' and is administered orally. This is probably preferable for single, handleable specimens of *Corallus caninus*. It may be administered by means of a catheter inserted into the esophagus. Since this technique involves handling and therefore stressing the reptile at regular intervals, this may sometimes be impractical since it may also contribute to additional stress. Injectable forms of the drug are also available but may cause irreparable muscle damage when administered over a longer period. Injectable forms are therefore not recommended.

Currently, there has been success in the treatment of *psittacosis* using the newer quinolone antibiotics, such as enrofloxacin, also marketed under the name *Baytril*. This drug is more palatable and stable in the drinking water, and in its injectable form it is less likely to produce more muscle damage than are the tetracyclines. It appears also that cure rates may be obtained in 14-21 days. *Baytril* is widely available as an effective antibiotic for use in reptiles.

However, there is evidence to suggest that apparent 'cures' using *any* of these drugs described above are in fact only clinical improvements and do not produce a long-term sustainable cure of the infection and full elimination of the organism. Additionally, excessive or prolonged doses of these drugs in *Corallus caninus* may, in many cases, prove to be fatal and should therefore be administered with great caution and care - Swan & Weidner [2002].

Cell destruction

If EVS is in fact attributed to the presence of *psittacosis*, other complications may occur in *Corallus caninus*, as explained by Swan & Weidner [2002]. Since the infection, if left untreated for a longer period of time, has a highly destructive effect on the cells walls of the stomache in *Corallus caninus*, this may result, over time, in the permanent loss of HCl producing stomache cells. These HCl-producing cells are needed during the first stages of food processing in the stomache of the snake, i.e. for the conversion of prey into a 'slush'-like mass which is normally processed further along the alimentary tract (small intestines) before feces are produced.

This would account for the bone remnants found in excretions of feces by *Corallus caninus* as reported by Swan & Weidner [2002], where food masses have not been full processed during this initial 'slushing stage' in the stomache. The 'slushed food mass' is the result of the effects of the break-down effect of HCl-producing cells in the stomache during the first few days following acceptance and presence of prey in the stomache. The destructive effect of *psittacosis* causes permanent, irreparable damage to these HCl-producing cells which are essential for the initial breakdown of food masses.

If this breakdown is not possible or substantially impaired, prey accepted and taken by *Corallus caninus* cannot physically continue down the alimentary tract and is therefore vomited up as a result. Therefore, until a positive diagnosis is obtained, specimens of *Corallus caninus* should preferably be fed smaller meals in order to allow for the possible destruction of cell tissue and loss of HCl-producing cells in the lining of the stomache. If the destruction of cell tissue is severe, over time this will inevitably lead to the death of the snake (in which case euthanasia may be considered). However, if the destruction of HCl-producing cells is halted at a relatively early stage of the infection (by effective therapy), the remaining HCl-producing cells would enable the snake to survive the infection, provided that smaller prey is offered.

The present author's own findings seem to suggest that the breakdown of prey in the stomache of *Corallus caninus* takes longer than is generally assumed. In a collection of recently imported wild-caught Guyana specimens, only one of the 10 specimens exhibited symptoms similar to those seen in *psittacosis* by vomiting prey 48-72 hours after being fed. The prey vomited was found to be more or less fully intact and had not, after 72 hours, been substantially reduced by the HCl-producing cells.

It was recorded that this vomiting occurred only after excessive spraying and misting in the confinement had occurred. It did not affect other specimens kept and cared for under exactly the same conditions and obtained from the same source in Guyana. On other occasions, this same individual would readily accept prey and produce healthy looking feces days after, without bone remnants present in the feces.

Perhaps in this case, the vomiting may be attributed to stress-related factors or increased sensitivity of the individual to the abrupt and relatively high degree of humidity caused by spraying. The specimen was not clinically diagnosed as having *psittacosis* and no treatment with antibiotics had yet been initiated after the symptoms were observed. Analysis of the feces proved negative for worm and flagellate infections [the specimen had recently been treated preventively for worms and flagellates].

Treatment

Whether we are dealing here with *EVS* or *psittacosis*, or even *Cryptosporidiosis*, it is most probably recommendable to carry out the following preventive treatment of specimens of wild-caught specimens of *Corallus caninus* when signs similar to those presented in *psittacosis* are observed. This preventive treatment would merely have the purpose of alleviating symptoms in an attempt to combat any possible infection by *Chlamydophila psittaci*. Whether it is effective or not depends on the underlying cause. Obviously, if symptoms diminish considerably or disappear after treatment with an antibiotic like Baytril, there would be reason to suggest that an infection was the probable cause, but not necessarily caused by *psittacosis*. If symptoms persist after treatment with an antibiotic, this would then suggest that other causes for the symptoms are present and should therefore be investigated (e.g. flagellate infections, worms, stress-related causes). In order to rule out infections by worms and/or flagellates, the recommended treatment would be as follows:

A - treatment (following analysis of feces or preventively) of worm infestations by administering

Panacur (or similarly effective drug) to eliminate the possibility of worm infections as the underlying cause;

B – treatment of flagellate infections (either preventively or following positive results of feces analyses) by administering *Flagyl* (or similar drug) to eliminate a flagellate infection as the underlying cause. (This treatment should only be performed on the basis of positive laboratory results.)

C – the oral administration of *Baytril* as a preventive measure, following the above regime in order to assist in elimination or alleviation of EVS in *Corallus caninus*.

CONCLUSION

In summary, therefore, it may be concluded that *psittacosis* is a disease that has long been recognised, but is yet still not fully understood. Many symptoms observed in EVS show great similarity with the signs most predominant in *psittacosis* for which there is, to date, no known long-term cure. Preventive treatment with an effective antibiotic from the tetracycline group of drugs seems to be the only remaining option in such cases, unless a positive diagnosis for *psittacosis* is made. Even then, the prognosis for specimens of *Corallus caninus* exhibiting these symptoms from prolonged periods is very poor.

Until further scientific studies are conducted under controlled laboratory conditions, any assumptions that EVS in *Corallus caninus* should be attributed to *psittacosis* may therefore only be considered as speculative. *Cryptosporidiosis* caused by *Cryptosporidium serpentis* must also be ruled out.

However, due to the severity of the condition and the high mortality rate observed in individual specimens of *Corallus caninus* (and to some extent in e.g. *Boa c. constrictor* and *Eunectes notaeus*) captured for the pet trade, further comprehensive scientific investigation is warranted by specialists in this field.

It is important to differentiate *psittacosis* and *Cryptosporidiosis* from other causes of regurgitation and gastritis. Suboptimal temperatures, inappropriate prey size, stress, endoparasitic infections (caused by flagellates and worms) as well as foreign body obstructions in the alimentary tract are other potential causes of regurgitation.

Additionally, strict hygiene, disinfection, longer periods of quarantine and isolation of all newly captured specimens of *Corallus caninus* are of paramount importance in controlling the disease, as is the segregation of avians from other wild-caught species in their countries of origin during and after

storage and transport, whilst these animals await exportation and introduction into the collections of private breeders, herpetologists and zoos.

Literature

- Jacobson**, Elliott R., DVM, PhD Jorge Orós, DVM Sylvia J. Tucker, BS David P. Pollock, BS Karen L. Kelley Robert J. Munn, MS Brad A. Lock, DVM Ayalew Mergia, PhD Janet K. Yamamoto, PhD, Partial characterization of retroviruses from boid snakes with inclusion body disease, [American Journal of Veterinary Research](#), February 2001, Vol. 62, No. 2, Pages 217-224
- Jackson, Kate.**, Nathan J. Kley, Nathan J., & Brainerd, Elizabeth L., How snakes eat snakes: the biomechanical challenges of ophiophagy for the California kingsnake, *Lampropeltis getula californiae*, Department of Zoology, University of Toronto
- Jones, Alan K.**, Understanding *Psittacosis* (Parrot Fever)
- Kolins, D.**, & White, M. Randy, 1996, *Cryptosporidiosis in Snakes*
- Oxtoby, G. P.**, Observations on Anorexia in African pythons, *Journal of the British Herpetological Society* [June, 1986]
- Satie**, Andréa & Karasaw, M., (incl. Reinaldo José da Silva, Luciene Maura Mascarini, Thoma Henrque Barrella*, Carlos Albertode Magalhães Lopes*, Occurrence of *Cryptosporidium* (Apicomplexa, Cryptosporidiidae) in *Crotalus durissus terrificus* (Serpentes, Viperidae) in Brazil
- Swan & Weidner**, 2002, The Source of Vomiting in the Emerald Tree Boa (*Corallus caninus*)
- The Merck Veterinary Manual**