A retrospective study on the detection of viral, bacterial, parasitic and fungal diseases among captive exotic birds on a breeding farm in Penang, Malaysia from 2017-2021

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CERTIFICATION

This is to certify that we have read this research paper entitled **'A retrospective study on the detection of viral, bacterial, parasitic and fungal diseases among captive exotic birds on a breeding farm in Penang, Malaysia from 2017-2021'** by Pritam Tamil Selvan, and in our opinion, it is satisfactory in terms of scope, quality and presentation as partial fulfilment of the requirement for the course DVT 55204 – Research Project.

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Thank You

DEDICATIONS

I want to dedicate this treatise to my family, which has been a pillar of strength. A particular ounce of gratitude to my beloved parents, Tamil Selvan and Prem Kaur, for always confiding confidence and believing in me.

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ABSTRACT

An abstract of the research paper presented to the Faculty of Veterinary Medicine, University Malaysia Kelantan, in partial requirement on the course DVT 55204 - Research Project.

The mass importation of those exotic birds has increased the number of households keeping these birds. If not given the proper care, these exotic birds can be infected by bacterial, fungal, parasite or viral pathogens. The importation can lead to the introduction of transboundary diseases such as chlamydiosis, Pacheco's disease and many more. This retrospective study involving exotics birds on a breeding farm was done to know the percentage of detection for viral, bacterial, parasitic and fungal diseases among the exotic birds using results of laboratory disease screening and post-mortem findings of diseased birds from 2017 to 2021, retrieved from farm records. Based on the analysed data, there were zero bacterial and viral infection cases from the samples taken from live exotic birds. However, infectious disease was detected among dead captive exotic birds in which the percentage of bacterial disease that has been detected is the highest (35.7%) in which most of the bacterial infection is caused by *Escherichia coli* (40%) and followed by parasite disease (28.6%) and viral disease (14.3%). In conclusion, the disease detection among live exotic birds was zero indicating that the farm has a good biosecurity measure which keeps the farm free of disease. However, the presence of diseases detected from dead exotic birds suggests the possibility of disease carriers which may lead to an isolated case of infection. Identifying and determining the presence of the disease may aid in developing appropriate preventive strategies and controlling the spread of the disease.

Keywords: Retrospective study, *Escherichia coli,* disease detection, biosecurity.

ABSTRAK

Abstrak kertas penyelidikan yang dibentangkan kepada Fakulti Perubatan Veterinar, Universiti Malaysia Kelantan, dalam keperluan sebahagian daripada kursus DVT 55204 - Projek Penyelidikan.

Pengimportan besar-besaran burung eksotik tersebut telah meningkatkan bilangan isi rumah yang memelihara burung ini. Jika tidak diberi penjagaan yang sewajarnya, burung eksotik ini boleh dijangkiti oleh bakteria, kulat, parasit atau patogen virus. Pengimportan boleh membawa kepada pengenalan penyakit rentas sempadan seperti klamidia, penyakit Pacheco dan banyak lagi. Kajian retrospektif yang melibatkan burung eksotik di ladang pembiakan ini dilakukan untuk mengetahui peratusan pengesanan penyakit virus, bakteria, parasit dan kulat dalam kalangan burung eksotik menggunakan hasil saringan penyakit makmal dan penemuan bedah siasat burung berpenyakit dari tahun 2017 hingga 2021, diambil daripada rekod ladang. Berdasarkan data yang dianalisis, terdapat sifar kes jangkitan bakteria dan virus daripada sampel yang diambil daripada burung eksotik hidup. Walau bagaimanapun, penyakit berjangkit dikesan dalam kalangan burung eksotik dalam kurungan yang mati di mana peratusan penyakit bakteria yang telah dikesan adalah tertinggi (35.7%) di mana kebanyakan jangkitan bakteria adalah disebabkan oleh Escherichia coli (40%) dan diikuti oleh penyakit parasit. (28.6%) dan penyakit virus (14.3%). Kesimpulannya, pengesanan penyakit dalam kalangan burung eksotik hidup adalah sifar menunjukkan bahawa ladang mempunyai langkah biosekuriti yang baik yang memastikan ladang bebas daripada penyakit. Walau bagaimanapun, kehadiran penyakit yang dikesan daripada burung eksotik mati menunjukkan kemungkinan pembawa penyakit yang boleh membawa kepada kes jangkitan terpencil. Mengenal pasti dan menentukan

kehadiran penyakit boleh membantu dalam membangunkan strategi pencegahan yang sesuai dan mengawal penyebaran penyakit.

Kata kunci: Kajian retrospektif, Escherichia coli, pengesanan penyakit, biosekuriti.

1.0 Introduction

Numerous people practise keeping birds in bondage as luxury items, status symbols, entertainment, or images of Goodluck. Regarding exotic birds, exotic birds are birds whose parents are of a foreign breed. For example, birds from South America imported into Malaysia are known as exotic birds. The most common exotic birds are from the order of Psittaciformes or as well-known as Parrots. Parrots can be subdivided into three categories: true parrots, cockatoos and New Zealand parrots. Like other species, parrots are commonly kept species as companion animals to fulfil their human caretakers' social, emotional, and cognitive needs. These species are found worldwide in subtropical and tropical climates (Bradshaw & Engebretson, 2013). However, parrots also live in temperate latitudes and even on sub-Antarctic islands.

Parrots are well known for their brilliant and spectacular plumage, curved beaks and zygodactyl feet (Bradshaw & Engebretson, 2013). Other orders of birds include Galliformes which consist of peafowls, turkeys, chickens and other land fowls. Apart from that, the rapidly growing source of introducing these non-native birds in Malaysia is increased international trade. The mass importation of those exotic birds has increased the number of households keeping these birds. Apart from importation, there are locally bred birds through captive breeding that shows the growing demand for exotic birds.

If not given the proper care, these exotic birds can be infected by pathogens of bacterial, fungal, parasite or viral origin. The most common diseases affecting exotic birds include Poxvirus infections, Psittacosis (parrot fever), Proventricular dilatation disease (PDD), Candidiasis, Aspergillosis and Polyomavirus. Based on the current findings, *Salmonella* spp. and *Escherichia Coli (E. coli)* are the most common pathogens in birds (Ibrahim *et al.*, 2021). In addition, Psittacine beak and feather disease are the typical viral disease among companion

birds worldwide such as cockatoos, African grey, and lovebirds. (Greenacre, 2005). Moreover, many pet stores sell birds, as the number of people keeping exotic birds in their households is high. Apart from that, there is a zoonotic potential of disease spread by birds that need to be taken into account.

1.1 Problem statement

If given the correct care and attention, Exotic birds can be long-lived and provide a household with not just a new pet but a life-long companion and a new family member. Apart from that, the maintenance of healthy stock in captivity requires an understanding of their psychological as well as their physical requirements. In addition, there are pathogens which are dangerous and cause fatal disease in parrots if not given the proper care. Overseas studies have been conducted to identify the common pathogens in exotic birds, but such studies have never been conducted in Malaysia yet. Even though infectious diseases are very common among exotic birds, those data regarding on it is still lacking and this information need to be taken into account. Apart from that, health management information needs to be included, which includes the vaccination schedule for the common viral diseases in exotic birds such as psittacine beak and feather diseases (PBFD) and Polyomavirus infection, deworming programs and other clinical or epidemiology data. Most health issues are handled on a case-by-case basis without adequate inference to the larger population of birds in captivity within a specific region.

1.2 Research question

A. What is the percentage of detection of viral infection in captive exotic birds on the breeding farm?
B. What is the percentage of detection of bacterial infection in captive exotic birds on the breeding farm?
C. What is the percentage of detection of fungal infection in captive exotic birds on the breeding farm?
D. What is the percentage of detection of parasitic infection in captive exotic birds on the breeding farm?

1.3 Research Hypothesis

The detection of bacteria, viral, fungal and helminthic diseases among exotic birds are high.

1.4 Research objectives

A. To determine the level of detection of viral infection among captive exotic birds in Penang.
B. To determine the level of detection of bacterial infection among captive exotic birds in Penang.
C. To determine the level of detection of fungal infection among captive exotic birds in Penang.
D. To determine the level of detection of parasitic infection among captive exotic birds in Penang.

2.0 Literature review

2.1 Overview and husbandry of exotic birds

Exotic birds housed under different conditions are due to their behaviour. However, psittacine, especially parrots, are more aggressive than peafowls. These birds are kept in two ways: mixed ornamental aviaries and breeding facilities. In the first type, the cage has an ample wire-netting space of up to 10 m3 and is located outside (Boseret *et al.*, 2013). In addition, the birds can be kept together for their ornamental purposes. In the second type, the birds of the same species are maintained in pairs, taking breeding size and purpose into consideration (Ballard & Cheek, 2016). They are kept indoors, but sometimes they do have partial access outside. Even in both types, new birds are introduced for ornamental diversification in the first case and to bring new blood for diversifying the genetics of the bird in the second case (Boseret *et al.*, 2013). In terms of husbandry, the cage size should be taken into considerations which should matched the size of the bird species. Toys, newspaper, or other items should be placed in the cage as a source of enrichment and owner need to know the importance of it (Ballard & Cheek, 2016).

Performing birds brought to shows or competitions, such as free fly, where exchange or selling could occur, can be a way to transmit pathogens. For example, because of the "kitchen canary", it very well is possible to specify that in the mid-year, the enclosures can be moved outside to permit the bird to sunbathe (Boseret *et al.*, 2013). This could be a condition inclining toward contact between wild also hostage passerines. It is not uncommon for the canaries to escape from the potential cage, which could be a potential risk of disseminating pathogens into the wild population of birds or getting infected. There are several factors that birds can get infected with, which include the host factors that include the state of the bird's defence system, its general health, the presence of concurrent disease, and external stressors. Apart from that,

direct relationships with local breeders and the housing of birds in pet shop facilities can eventually increase the chance of disease transfer (Ballard & Cheek, 2016). As we expand our veterinary knowledge in avian medicine, many diseases from infectious origins are classified as bacterial, viral, helminth and fungal.

2.2 Bacteria

Bacteria is a one-celled organism that lives inside and outside of a bird's body. These organisms presents consistently in the bird's mouth, digestive system, sinus, eyes, skin, and, in general, on all body surfaces. Great microorganisms live in serene concurrence with the bird's body, causing no illness and shielding the bird from abnormal bacteria. These are called good bacterial flora. (*Murphy, 1990*). Bacteria can actually be classified as pathogens, opportunists, transients, and normal flora (Fudge, 2001).

However, bacteria that cause illness are called pathogenic bacteria. These microscopic organisms attack the bird's body and cause diseases. A few microscopic organisms live outside the body cells, like *E. coli* furthermore Klebsiella (*Murphy, 1990*). Different kinds of bacteria live inside the cells, like Chlamydia and Mycoplasma. Microbes that are destructive to certain types of birds may not be destructive to other species. For example, bacteria ordinarily seen in raptors' gastrointestinal lots causing no infection are frequently destructive to psittacine birds (*Murphy, 1990*). The majority of the normal aerobic alimentary flora in psittacine birds, according to current research, is gram positive. Gram-negative microorganisms are frequently seen of as the pathogenic organism; however, many species and strains do not cause disease.

In the weak avian host, some of these opportunists can and do spread disease. Immunosuppression brought on by physical and environmental stress, concomitant illnesses, and malnutrition can all be signs of host compromise (Fudge, 2001).

Moreover, certain bacterial infections that originate from birds can also be zoonotic to humans. For example, the global prevalence of chlamydial infection is estimated to be around 19.5% which indicates birds are an essential source of human Psittacosis. The prevalence is high in several bird orders, which include Galliformes, Columbiformes and Anseriformes (Sukon *et al.*, 2021).

2.3 Virus

Viruses are not genuinely living organic entities. What is more, they are just DNA and a few proteins. The virus is tiny and must be seen with an electron-magnifying lens. Viruses use the bird's body to reproduce and cannot reproduce beyond the bird's body like bacteria. Antibiotics which kill bacteria do not affect viruses. While a couple of antiviral drugs are intended to kill infections, generally, there is no medication to kill an infection after it has attacked a bird's body (*Murphy, 1990*).

In canines and felines, and indeed, even in poultry, vaccines are accessible to give the animal immunity against the virus; however, in colourful birds, only a couple of such trial antibodies are accessible (*Murphy, 1990*). As bird owners become more mindful of the staggering impact of infections on our pet birds, significant medication companies will think about the tremendous cost of making vaccines. Viruses currently are the primary reason for disease in aviaries.

Viruses can, as a rule, be prevented with appropriate quarantine and enclosure plans. Sometimes, even the best clinical administration will not prevent viral infections in the aviary. When these infections happen, the diseases should be recognized rapidly with appropriate necropsy and histopathology and separated (Fudge, 2001). Some viruses can be airborne, and insects spread some, so confinement methods should be complete. Individuals are frequently the coincidental reason for the spread of viruses in the aviary.

Some infections will not be identified during isolation, like polyoma infection in grown-up birds furthermore Pacheco infection in conures (*Murphy, 1990*). When enough aviculturists figure out the economic loss these infections cause to their aviaries also, the necessary test expected to forestall this misfortune will there be sufficient interest for these tests to turn economically accessible.

Virus detection can be done with virus isolation and serological tests that can prove the nature of the pathogen (Wodak *et al.*, 2011). In Austria, the emergence of the West Nile virus was expected due to the initial finding of the infection in Hungary in 2003/2004. The detection and

molecular analysis were done in 2008 and 2009. Nearly 43.7% of the tested samples using ELISA showed antibody titers (Wodak *et al.*, 2011). Apart from that, the occurrence of Pox virus infection has been reported in which the prevalence of the infection ranges from 0.9 to 12% worldwide (Williams *et al.*, 2021).

2.4 Parasite

Helminth is a general term for worms. They are elongated, round bodies and flat. They are also known as nematodes which can further be subdivided according to the host organ, which includes examples like intestinal roundworms, lung flukes, etc. In commercial poultry, the most common roundworm found is *Ascaridia galli*. Other species, such as *Heterakis gallinarum*, which inhabits the GI tract and *Syngamus trachea*, which inhabits the trachea and lungs. Few drugs are available for treatment, but it is better to prevent the infection by improving the management and sanitation in the aviary.

Apart from that, four genera of blood parasites that commonly infect wild birds include Trypanosoma, commonly known as Avian Hematozoa (Murata, 2002). Based on the present survey, the prevalence of avian Hematozoa among Japanese wild birds is said to be around 10.6% (Murata, 2002).

2.5 Fungi

Fungi are a cross between bacteria and plants. Fungi organisms grow in moist, humid conditions like in Malaysia. Not all funguses cause disease; in truth, most do not. In birds, two fungal infections are common - Aspergillus and Candida (*Murphy, 1990*). These can be killed with disinfectants outside the bird's body and antifungal drugs inside the bird's body. Frequently fungal contaminations happen when antimicrobials kill off the typical bacterial flora. While Candida usually is effortlessly treated, Aspergillosis is exceptionally challenging to treat except if distinguished early and treated forcefully (*Murphy, 1990*). Moreover, it is also challenging to diagnose, which may be caused by differences in the pathogenicity of isolates of *Aspergillus (spp)* and the status of the bird's immune system itself (Jones & Orosz, 2000).

3.0 MATERIALS AND METHODS

3.1 Study population

This research was focused on the exotic birds in a breeding farm at Butterworth, Penang. The farm has many species of exotic birds, including Macaw, Cockatoo, Lory, Finch, Peafowl and many more, and the farm mainly exports its chick overseas.

3.2 Study design

The study design used for this research is a retrospective cross-sectional research design. This descriptive study measures the percentage of bacteria, viruses, parasite and fungal infection detection in exotic birds. The reason this study was chosen is that it is affordable. Once the information is collected from the entire study group, it can be analysed because only single-time reference is being considered.

3.3 Data extraction

The data were collected using laboratory and post-mortem examination results, which contain information on the diseases the bird was infected with from the Malaysian Animal Health Laboratory at Bukit Tengah which was retrieved from farm records. The results are arranged according to the year in an ascending manner, providing information on the diseases the birds were diagnosed with. Collected data was tabulated in Microsoft Excel.

3.4 Data analysis

The data were analysed by doing a descriptive analysis using SPSS software in which the percentage of the detected bacterial, viral, fungal and parasite diseases were calculated by identifying the positive cases from 2017 until 2021. The data collected includes specimens from live birds subjected to molecular detection using PCR and dead birds through post-mortem examination. The data was analysed and presented using a bar chart.

4.0 RESULTS

4.1 Disease detection among live exotic birds from the year 2017 to 2021

Out of the 187 samples detected, zero cases of bacterial and viral diseases were detected from 2017 to 2021 (0%).

4.2 Disease detection among dead exotic birds from the year 2017 to 2021.

Out of the 12 samples detected, the percentage of bacterial disease that has been detected is the highest (35.7%), followed by parasite disease (28.6%). However, the lowest percentage was detected for viral disease (14.3%), as shown in Figure 4.1. For the bacterial disease, the common pathogen detected from the dead birds was *E. coli* and for parasite disease, it was *Ascaridia galli.* Apart from that, the common fungal disease detected was Aspergillosis based from the results obtained.

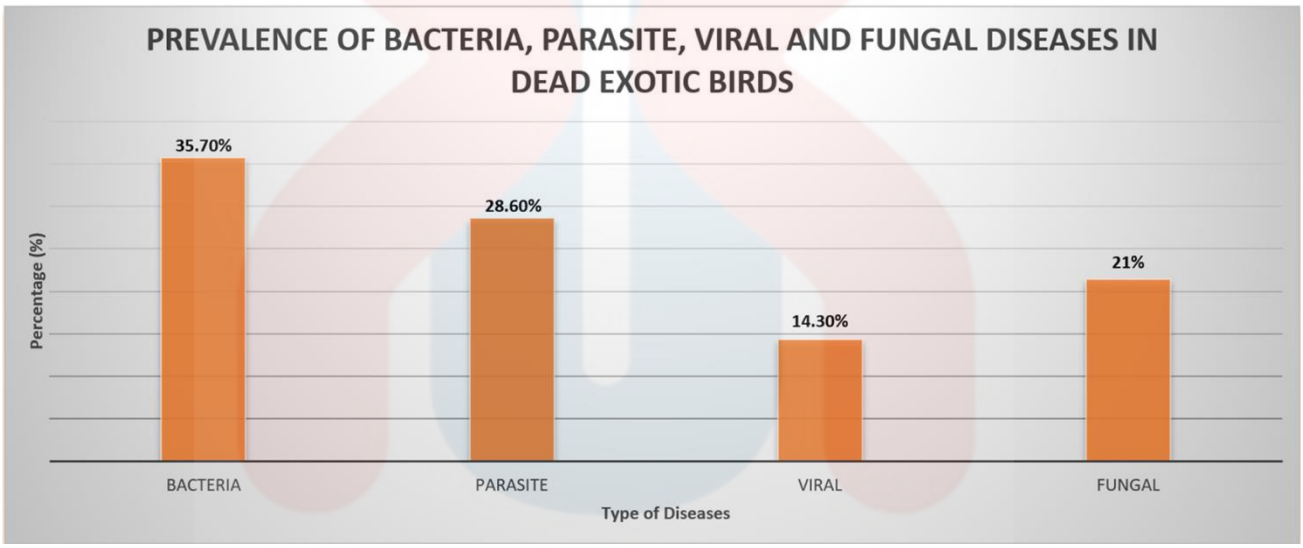

Figure 4.1 shows the disease detection in dead exotic birds from 2017 to 2021 (n=12).

5.0 DISCUSSION

Based on the analysed data, there were zero bacterial and viral infection cases from the samples based on the lab results. The samples are cloacal swabs from live exotic birds such as macaws, cockatoos, parakeets, etc. The zero cases of bacterial and viral infection indicate that the farm has a perfect biosecurity measure which keeps the farm free of disease. The biosecurity measure includes vehicle dip, foot dip and routine cleaning and washing of the cages in the farm using a disinfectant such as Lindores which is done once a week.

This supports that properly implementing a routine cleaning and disinfection program can help minimise contact between birds and infectious agents (Morishita & Derksen, 2021). Moreover, practising biosecurity also reduces the possibility of substantial expenses and revenue loss these aids in safeguarding the farm's potential freedom to transport birds in the future. (Morishita & Derksen, 2021). Apart from that, the farm practises a good quarantine program in which new birds are quarantined for one month and monitored for any sign of illnesses. The key element of any collection of exotic animal's preventative medicine programme is a good and effective quarantine. This is especially true when working with birds because they naturally have the ability to hide their sickness (Stephen J. Hernandez-Divers, 2015). The farm also has a very good husbandry management by providing enrichments like branches or palm fronds to the birds that reduces stress among them. This reduces the chances for the birds to easily get ill.

In contrast to another study done in a wildlife park in UAE, 45.13% were found to be positive for Circovirus that cause Psittacine beak and feather disease (Hakimuddin *et al.*, 2016). The study results show that the mean prevalence of Circovirus which was relatively high, with 190 samples out of a total of 421 samples being found to be positive (Hakimuddin *et al.*, 2016).

Even though the number of imported birds received for testing steadily increased over the years in the farm, with proper implementation of biosecurity measures, quarantine and good husbandry practice, the viral and bacterial detection among live exotic birds seems to be negative.

However, the percentage of bacterial disease detected among dead birds was 35.70%. Escherichia coli causes most bacterial infections with a percentage of 40% followed by Pasteurellosis (30%) and Salmonellosis (30%). Even though the farm has a good biosecurity measure, other factors that cause the infection could be stress from transportation or the introduction of new cage mates that might be carrying the disease in the farm. The farm usually imports birds from other countries and are quarantined and most of the time the workers might be in contact with the newly arrived birds during unpackaging from the box. This tends to increase the risk for the workers to transfer the disease to the healthy birds in the farm that might cause the birds to die in the farm. Thus, the ideal quarantine site should be an area completely isolated from the current bird collection in order to prevent any physical contact or transmission of infectious agents to the healthy ones (Stephen J. Hernandez-Divers, 2015).

About 28.6% of dead exotic birds had parasite infections. Worm parasites are the primary culprits of the parasitic infection (*Ascaridia galli*). Due to the farm's faulty deworming routine, parasitic worm infestation has likely been detected more frequently than usual. Furthermore, the most reported species in commercial table egg production systems are *Ascaidia galli* (Ogbaje, 2012).

Detection of fungal infection is about 21.4% among dead exotic bird and the commonly encountered fungal infection was Aspergillosis. Aspergillosis is caused by the species *Aspergillus fumigatus*, a ubiquitous, saprophytic fungus capable of causing severe and life-threatening illness in birds. Due to the exposure pathway, Aspergillosis typically affects birds' respiratory systems (Jones & Orosz, 2000). Detecting this fungal infection in the farm could be due to the environment the bird is kept in, including high humidity or dampness that has predisposed the birds to the spores (Jones & Orosz, 2000). *Aspergillus fumigatus* was isolated from birds studied on Tahiti Island with a prevalence of 0.15 (Blanvillain *et al.*, 2021).

The lowest percentage detected among dead birds is a viral infection. This supports the fact that the farm's good biosecurity measures ensured the lowest possible detection of viral infection. This supports a study in which a total of 349 birds collected during the research on Tahiti Island were examined for viral illness. Even though none of the viruses tested for was found, some of them can still be around with a low prevalence (Blanvillain *et al.*, 2021).

6.0 CONCLUSION

In conclusion, the disease detection among live exotic birds on the farm from the year 2017-2021 was zero indicating that the farm has a good biosecurity measure which keeps the farm free of disease. However, diseases were detected from dead exotic birds, including bacterial, parasite, fungal and viral, and it turns out that bacterial disease had the highest percentage due to Poor husbandry management and many more. Hence, this study references the disease detected throughout these five years. Thus, enhanced control measures and a robust monitoring system should be implemented to reduce infectious diseases among exotic birds (Ibrahim et al., 2021).

7.0 RECOMMENDATIONS

A few setbacks were encountered when conducting this study which included incomplete data. The incomplete data includes the predisposing factors of the exotic birds being infected by bacterial, parasite, fungal and viral infection. Hence, these data were excluded from the study. Therefore, complete data must be obtained with proper record keeping for proper analysis, which could give better results for a meaningful interpretation. In addition, these data should be collected and kept on the farm for future reference and used for future research for more precise results. Besides that, the disease detection done in this study was infectious among exotic birds. To investigate the association between non-infectious diseases and exotic birds, a retrospective study on non-infectious disease detection among exotic birds on the farm should be done in future.

8.0 REFERENCES

1. Brittingham, M., Temple, S., & Duncan, R. (1988). A SURVEY OF THE PREVALENCE OF SELECTED BACTERIA IN WILD BIRDS. *Journal Of Wildlife Diseases*, *24*(2), 299-307. DOI: 10.7589/0090-3558-24.2.299

2. Boseret, G., Losson, B., Mainil, J., Thiry, E., & Saegerman, C. (2013). Zoonoses in pet birds: review and perspectives. *Veterinary Research*, *44*(1). DOI: 10.1186/1297-9716-44-36

3. Ibrahim, S., Wei Hoong, L., Lai Siong, Y., Mustapha, Z., C. W. Zalati, C., & Aklilu, E. et al. (2021). Prevalence of Antimicrobial Resistance (AMR) Salmonella spp. and Escherichia coli Isolated from Broilers on the East Coast of Peninsular Malaysia. *Antibiotics*, *10*(5), 579. DOI: 10.3390/antibiotics10050579

4. Greenacre, C. (2005). Viral diseases of companion birds. *Veterinary Clinics of North America: Exotic Animal Practice*, *8*(1), 85-105. doi: 10.1016/j.cvex.2004.09.005

5. Doneley, R. (2009). Bacterial and Parasitic Diseases of Parrots. *Veterinary Clinics of North America: Exotic Animal Practice*, *12*(3), 417-432. doi: 10.1016/j.cvex.2009.06.009

6. Krawiec, M., Piasecki, T., & Wieliczko, A. (2015). Prevalence of*Chlamydia psittaci*and Other*Chlamydia*Species in Wild Birds in Poland. *Vector-Borne and Zoonotic Diseases*, *15*(11), 652–655. https://doi.org/10.1089/vbz.2015.1814

7. Murphy, J. (1990). Infectious disease prevention and control in adult Exotic birds. *afa Watchbird*, 19-22.

8. Khoo, L.L., Hasnah, Y., Rosnah, Y., Saiful N., Maswati, M.A & Ramlan, M. (2010). The Prevalence of Avian pathogenic *Escherichia coli* (APEC) in peninsular Malaysia. *Malaysian Journal of Veterinary Research*, 1(1), 27-31.

9. Morishita, T. Y., & Derksen, T. (2021). Biosecurity. *Backyard Poultry Medicine and Surgery: A Guide for Veterinary Practitioners*, 107-116.

10. Hakimuddin, F., Abidi, F., Jafer, O., Li, C., Wernery, U., Hebel, C., & Khazanehdari, K. (2016). Incidence and detection of beak and feather disease virus in psittacine birds in the UAE. *Biomolecular detection and quantification*, *6*, 27-32.

11. Graham, C. L., & Graham, D. L. (1978). Occurrence of Escherichia coli in feces of psittacine birds. *Avian Diseases*, 717-720.

12. Blanvillain, C., Saavedra, S., Withers, T., Votýpka, J., Laroucau, K., Lowenski, S., & Modrý, D. (2021). Screening of diseases in wild exotic birds on Tahiti Island – implications for French Polynesian conservation. Pacific Conservation Biology.

13. Ogbaje, C. I., Agbo, E. O., & Ajanusi, O. J. (2012). Prevalence of Ascaridia galli, Heterakis gallinarum and Tapeworm infections in birds slaughtered in Makurdi township. *International Journal of Poultry Science*, *11*(2), 103-107.

14. Jones, M. P., & Orosz, S. E. (2000). The diagnosis of Aspergillosis in birds. Seminars in Avian and Exotic Pet Medicine, 9(2), 52–58.

15. Wodak, E., Richter, S., Bagó, Z., Revilla-Fernández, S., Weissenböck, H., Nowotny, N., & Winter, P. (2011). Detection and molecular analysis of West Nile virus infections in birds of prey in the eastern part of Austria in 2008 and 2009. Veterinary microbiology, 149(3-4), 358-366.

16. Murata, K. (2002). Prevalence of blood parasites in Japanese wild birds. Journal of Veterinary Medical Science, 64(9), 785-790.

17. Williams, R. A., Truchado, D. A., & Benitez, L. (2021). A review on the prevalence of poxvirus disease in free-living and captive wild birds. Microbiology Research, 12(2), 403-418.

18. Sukon, P., Nam, N. H., Kittipreeya, P., Sara-In, A., Wawilai, P., Inchuai, R., & Weerakhun, S. (2021). Global prevalence of chlamydial infections in birds: A systematic review and meta-analysis. Preventive Veterinary Medicine, 192, 105370.

19. Stephen J. Hernandez-Divers, Bv. (2015). World Small Animal Veterinary Association World Congress Proceedings, 2005. VIN.com. https://www.vin.com/apputil/content/defaultadv1.aspx?id=3854110&pid=11196&print=1

20. Fudge, A. M. (2001). Diagnosis and treatment of avian bacterial disease. In Seminars in avian and exotic pet Medicine (Vol. 1, No. 10, pp. 3-11).

21. Romagnano, A., & Hadley, T. L. (2017). Psittacine behavior, husbandry and enrichment. Exotic Animal Medicine for the Veterinary Technician, 73-82.