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Occurrence of Coccidiosis amongst Different Wild Life and Other Domestic Animals Including Birds: A Review on Comparative Study

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A B S T R A C T

Eimeria is an Apicomplexan protozoan parasite which causes Coccidiosis in different animals. Infection develops mainly in large and small intestine of most wild animals and poultry birds including other pet birds. The disease is pandemically distributed throughout the globe with varieties of species. This clinical situation mostly prevails in different parts of the visceral organs like pancreas, liver and caecum of all animals. The life cycle of the parasite is almost same everywhere and not able to produce any lethal effect to the hosts. Suitable temperature can trigger the entire mechanism of life cycle of the species. The prevention and control of the disease are important otherwise poor reflection will get associated with economic loss in any type of large and small scale production and maintenance of wildlife conservation (captive and free range system). There is no record readily available in any literature about zoonotic importance of coccidiosis.

Introduction

Coccidiosis is a disease produced by *Eimeria sp*, an Apicomplexan protozoan parasite which causes infection mainly in the small and large intestine and particularly caecum of most wild animals, poultry birds and reptiles. In India, apart from wild captive animals and poultry birds, coccidiosis caused by *Eimeria sp* is economically important disease of cattle (Verma *et al.*, 2018), sheep and goats (Satish *et al.*, 2019), Pigs (Murthy *et al.*, 2016) and also rabbits (Sivajothi *et al.*, 2016). The oocysts of what was later called *Eimeria steidai* were first seen by the pioneering Dutch microscopist Antonie van Leeuwenhoek in the bile of a rabbit in 1674. Eimerian coccidian are members of the suborder Eimeriina, and they are typically highly host, organ and tissue specific (Diaz *et al.*, 2010).

Within kangaroos, coccidian infections can lead to clinical disease known as coccidiosis, Occasional outbreaks have been reported with high mortality rates in macropods, however coccidiosis is primarily a disease of hand reared juvenile kangaroos

(Burdiarso *et al.,* 1971; Barker *et al.,* 1972, Beveridge, 1993), Four species of coccidian have been desbribed: E. macropodis Wenyon & Scott, 1925, from Bennett's wallaby (*Protemnodon rufogrisea frutica*, syn. *Macropus bennetti*), and *E. rufusi* Prasad, 1960, from the red kangaroo (*Megaleia rufa*, syn. *Macropus rufus*) (both from animals living in the London Zoological Gardens); *Eimeria marsupialum* Yakimoff & Matschoulsky, 1936, and *E. fausti* Yakimoff & Matschoulsky, 1936, were isolated from the grey kangaroo (*Macropus canguru*, syn. M, giganteus), kept in the Kharkov Zoological Gardens. In 1964, Mykytowycz in his study described seven species of *Eimeria* (E. *wilcanniensis, E. toganmainensis, E. cunnamullensis, E. guggahlinensis, E. purchasei, E, kogoni*, and *E, hestermani*) in wild population of red kangaroo (*Megaleia rufa)* and grey kangaroo (*Macropus canguru*).

Five species of *Eimeria* have been described from the animals of the family *Cervida*e. E. *cervi* Galli-Valerio 1927, from *Cervus elaphus*, red deer and *Capreolus capreolus*, roe deer; *E. wassilewski* Rastegaieff 1930, from *Cervus axis*, spotted deet, *Cervus elaphus*, red deer, and *Cervus albirostris*, Thorold's deet; *E. hegneri* Rastegaieff 1930, from Cervus Canadensis wapiti, *E. gallivalerio* Rastegaieff 1930, from *Cervus elaphus* red deet and *E. zurnii* from Cervus Canadensis and Rangifer species. Seven species of *Eimeria* are recognized as infecting chickens (Gyorke *et al.,* 2012).

The most common coccidian of snakes fall into 2 genera, *Eimeria* and *Isospora* (Greiner, 2003). Roudabush (1937) has reported Eiported Eimeria in the gall bladder of three species of snakes; *Coluber constrictor, Coluber constrictor flaviventris* and *Masticophis flagellum flagellum*, Phisalix (1921) described a coccidium *Eimeria zamenis* from a snake *Zamenis sp*. *Eimeria conanti* had been reported by Mc Allister and Upton (1989) and Mc Allister *et al.,* (1990) from *Nerodia* spp., includidng Mississippi green water snakes *N. cyclopion* and *N. erythrogaster transversa* (type host) and Brazos water snakes *N.harteri harteri*. McAlliste *et al.,* (1995) had also reported *E. conanti* in threatened *N. harteri paucimaculata* from Concho Country, Texas. The detailed study of Mc Alliste *et al.,* (1995) in the Southcentral and Southwestern United States had documented *Eimeria helmisophi* from snake *Carphophis amoenus helenae* and *C. amoenus vermin* in Arkansas; *Eimeria aryni* from snake *Diadophis punctatus arnyi; Eimeria attenuate, Eimeria hydrophi, Eimeria natrici, Eimeria sipedon, Eimeria tenuis from snake Nerodia erythrogaster flavigaster; E. sipedonfrom the host N. erythrogaster transversa; E. cyclopion, Eimeria iowaensis, E. natricis, Eimeria serpenticola and E. sipedon* from snake *N. fasciata confluens* from Arkansas; *E. conancti*, from snake *N harteri paucimaculata, Eimeria rhombifera, E. rhombifera, E tenuis* from snake *N. rhombifer rhombifer, E. hydrophis, E. natricis, E. sipedon, E. serpenticola and E. tenuis* from snake *N. sipedon pleuralis, E. iowaensis* from the snake *Thamnophis elegans vagrans, E. marcianus marcianu, E. attenuate, E. natricis and E. serpenticola* from snake *T. proximus, T. proximus rubrilineatus, Eimeria striatula, Eimeria desotoensis* from snake Virginia striatula, *Eimeria desotoensi, Eimeria hobartsmithi* from the snake *V. valeriae elegans* (McAllister *et al.,* 1995).

Clinically significant genera of *Eimeria* in snake were also reported by Momin *et al.,* (1990). Crocodilians have been infected by only 8 species of *Eimeria* throughout the globe were reported in captive as well as wildlife by McAllister *et al.,* 1990. The most common protozoan parasites of reptiles including tortoise, crocodilians and snakes were *Eimeria* (Upon *et al.,* 1989).

General life cycle (Cervids, Macropods, Reptiles and Poultry birds)

Stages of coccidian in chickens appear both within the host as well as outside. The developmental stages in the chicken give rise to a microscopic egg (oocyst) that is passed out in the droppings. Under favourable conditions of oxygen, humidity and temperature, the oocyst develops within one to two days to form a sporulated oocyst, which is capable

of infecting other chickens. At this stage, the oocyst contains eight bodies (called sporozoites), each of which is capable of entering a cell in the chicken's intestine after the oocyst is eaten. When sporozoites enter the cells, they divide many times producing either a few or many offspring (merozoites). The numbers produced depend on the species of coccidian involved. Each merozoite, in turn, may enter another intestinal cell. This cycle may be repeated several times. Because of this cyclic multiplication, large numbers of intestinal cell are destroyed. Eventually, the cycle stops and male and female sex cells are produced. The male fertilizes the female to produce an oocyst, which ruptures from the intestinal cess and passes in the droppings. Thousands of oocysts may be passed in the droppings (Fig.1) of an infected chicken (Kennedy, 2001). After considering significant literatures, It has been seen that in Cervids, Macropods and snakes the life cycle of *Eimeia* is more or less the same. In reptiles, the *Eimeria* oocysts are infected when passed in the faeces. Oocysts of all others must develop in an abiotic environment to produce infective oocysts containing sporozoites. Ingestion of sporozoites is freed in the gastrointestinal tract through the enzymatic action of the hosts.

Host range and specificity

Specificity means that parasites only are capable of infecting certain host species and not others. *Eimeria* is considered the most specific and the species of this genus usually only infect a single genus of host or species in very closely related genera. It is to assume that species of *Eimeria* parasitizing a species in a particular group of reptiles will not be found in other groups of reptiles, at least not as definitive hosts and that these *Eimeria* will not infect other classes of vertebrates (Joyner, 1982).

Pathogenesis

In Poultry birds

Coccidiosis occurs most frequently in young birds. Old birds are generally immune as a result of prior infection. Severe damage to the caeca and small intestine accompany the development of the coccidia. Broilers and layers are more commonly infected, but broiler breeders and turkey and pheasant poultry are also affected. Coccidiosis in chickens is generally classified as either intestinal or caecal (Kennedy, 2001). *E. tenella* and *E. necatrix* are the most pathogenic and cause bloody sessions, high morbidity and mortality in native chickens (Jacob and Duma, 2009; Morris *et al.*, 2007). *E. acervulina, E. maxima and E brunette* also cause clinical diseases. The lesions and symptoms of small intestinal coccidiosis may be confused with other pathological lesions caused by different diseases, *e.g*., viral diseases of birds. One of the species of coccidia cause a type of condition in the intestinal mucosa that has been referred to as chronic coccidiosis (the thicken spongy appearance of the mucosa). Entire gross lesions are whitish colonial form fade out or going light is as common symptom of small intestinal coccidiosis, although, this reaction does not necessarily infer a chronic condition. Severely infected chickens with some of the intestinal coccidia may lose body weight also (Dickinson, 1942).

The most common pathological changes in birds particularly in the intestine are inflammation of the gut wall with petechiae and sloughing of epithelia or complete villar destruction resulting in extensive haemorrhage along with the caudal part of the rectum. These characteristic changes and others have been utilized in the widely accepted visual system for scoring the severity of lesions in different parts of the intestine (Johnson and Reid, 1970).

In Macropods

The little information is available on which coccidia species cause actual disease. Other species of coccidia infest the liver, particularly of rabbits, but the importance of these parasites in macropods is not known. Only parasites which burrow deep into the cells of the intestinal wall and rupture the nucleus of these cells cause significant disease. Clinical signs are due to destruction of the intestinal

lining (epithelium and often the underlying mucosa). This can cause bleeding into the intestinal lumen catarrhal inflammation and diarrhoea. Coccidia do not produce toxins but affected animals die of dehydration, due to fluid loss and of shock. Oocycts can be identified in faeces by salt or sugar floatation method. The number of oocysts in faeces is influenced by the stage of infection, age and immune status of the host. The result must be related to the clinical signs. The finding of numerous oocysts of a non-pathogenic species concurrent with diarrhoea does not constitute a diagnosis of clinical coccidiosis. Although recovered animals are suspected to carry the pathogen, this can be advantageous if it stimulates immunity in the next generation. Coccidiosis can, however, develop in recovered animals. Scraping from the mucosa of the small intestine showed numerous coccidia in various stage of development. Generally the measurement of oocysts in fresh smears was found from 24-31 µ in length and from 14-19 µ in width. Inflammatory cells were found in mucosa and submucosa of the ileum. They were particularly numerous in the areas of diphtheroid inflammation towards the end of small intestine. The lesions became less severe and the number of parasites decrease (Winter, 1959).

In Cervids

Eimeria spp. causes gastrointestinal disorders such as diarrhoea with an admixture of mucus or blood, vomiting and, consequently, a significant loss in body weight. The parasite spreads in water and contaminated feed. Microscopic examination was also insufficient in connection to different parts of the tissue of the lumen (Lima *et al.*, 1980; Peeters *et al.*, 1984). The general pathological picture in small ruminants (deer) is that of a catarrhal enteritis (jejunum, ileum, caecum, possibly proximal colon), which is congestive and more or less haemorrhagic with mucus and fibrin (Khodakaram Tafti and Mansourian, 2008; Koudela and Bokova, 1998). An important lesion of oedema can also be noticed in the mucosa and sub mucosa. Small greyish white lesions of 1-2 mm in diameter speckling the mucosa are characteristics (Koudela and Bokova, 1998). They are a coalescence of the different stages of the parasites (macroschizonts, gametocytes, oocysts). Sometimes more prolific lesions can be observed in small ruminants, *i.e.*, large nodules in the intestinal lumen and whose pathogenic role has not been confirmed. The histopathological lesions showed loss of surface epithelial cells and villious atrophy associated with first generation schizonts and crypt destruction or hyperplasia associated with gamonts (Gregory and Catchpole, 1987; Taylor *et al.*, 2003)

In Reptiles

The most species of *Eimeria* that develop in reptiles are considered non pathogenic. Gross changes observed in intestinal villi were either fused or lost because of the presence of infection. Large number of oocysts was seen in the lamina propria and spleen. Hind gut was a site of the damage contents were mainly blood and sloughed intestinal lining. Blood vessels in the tunica propria leaded into the lumen after the epithelial lining destroyed. The epithelium was hyper plastic and inflammatory cells were packed in the mucosa. In turtles severe exudative enteritis and necrotizing zone in the intestine is very common. In many cases encephalitis was present and scizonts were detected around the blood vessels in the brain, kidney and occasionally in the thyroid gland. The normal gastric mucosal morphology is lost due to connective tissue development and glandular disintegration (Jacobson, 1993).

Economic Importance

Coccidiosis, as one of the most significant diseases of poultry, costs the World's commercial chicken producer at least US$ 1.5 billion every year (Arabkhazaeli *et al.*, 2013; 2014). The disease results overall in 51.38% mortality in the poultry industry worldwide (Cocciforum, 2007). Very important is the finding that almost 70% of this estimated cost is due to subclinical coccidiosis, by impact on weight gain and feed conversion rate. One of the reasons for these remarkable findings is probably the difficult diagnosis of subclinical

coccidiosis, which prevents the industry to evaluate the best possible strategies for control of coccidiosis. Moreover, drug resistance was described recently on Romanion broiler farms to monensin, salynomicin, nicarbazin, rebenidine, lasalocid, and diclazuril (Gyorke *et al.,* 2011a; Gyorke *et al.,* 2012). In case of wild animals ten economic importance is not prominent, commercially due to non availability of huge production of wildlife; there is no direct scope and marketing facility.

Epidemiology/Epizoology and Transmission

In poultry birds and Macropods and Cervids

Deep litter content is with high moisture and warmth of 25-30˚C, favours oocysts sporulation of coccidia (David, 2000). It was also observed that oocyst sporulation is delayed or not even occur at 10˚C. In dry conditions, while at 45-50˚C oocysts could sporulate within a day and under optimal conditions of temperature (21-30˚C), adequate moisture and oxygen, oocysts could sporulate abd become infective within 1-2 days or could get destroyed at 56˚C for one hour (Trees, 1999; Etuk *et al.,* 2004; Musa *et al.,* 2010). Animals of any age are susceptible to coccidiosis but most animals get infected in the early few weeks of life (Chookyonix *et al.,* 2009). Coccidiosis has been reported about 3 days following ingestion of large numbers of sporulated oocysts (Urquhart *et al.,* 1996) the incubation period for intestinal coccidiosis was reported to be 5 days while that of caecal coccidiosis was 5-6 days (Chookyonix *et al.,* 2009; Musa *et al.,* 2010).

The transmission or spread of coccidian is very easily accomplished. A survey has shown that coccidian have been found in chickens from commercial poultry flocks in all sections of the world. Coccidia are without question the most common and widespread disease producing animals parasites found on commercial poultry farms. These parasites are so widespread and easily carried from one flock of chickens to another that any thought of complete eradication is entirely out of the question. One of the most important factors in this transmission is the fact that a constant source of infection is available from healthy carriers. The parasites are so widespread and are usually in the process of constant reproduction. The mechanical transmission of infection to young stock is very simple. The most common means of mechanically carrying coccidian would seem to be on the footwear of the person who takes care of the birds.

Flies, free-flying birds and animals may also be factors in mechanically carrying coccidian (Dickinson, 1942). The same procedure of transmission is also applicable in this domain but there is no such clear reference available in this score. Greiner (2003) express that lack of zoonotic potential or concern for human health is not clearly mentioned in any available literature.

Prevention and Control

In Cervids

Stress should be minimized

Young susceptible animals should be kept in clean and dry areas

Feeding and watering devices should be kept clean and clear from faecal contamination

Oocyst can be killed by heat, direct sun light and drying

Keep litter dry and stirred frequently. Remove wet spots and replace with dry litter

Ration containing coccidiostats should be used in time of treatment as well as prevention (Hamid *et al.,* 2018; Kennedy, 2001)

Fig.1 Caecal coccidiosis in poultry bird

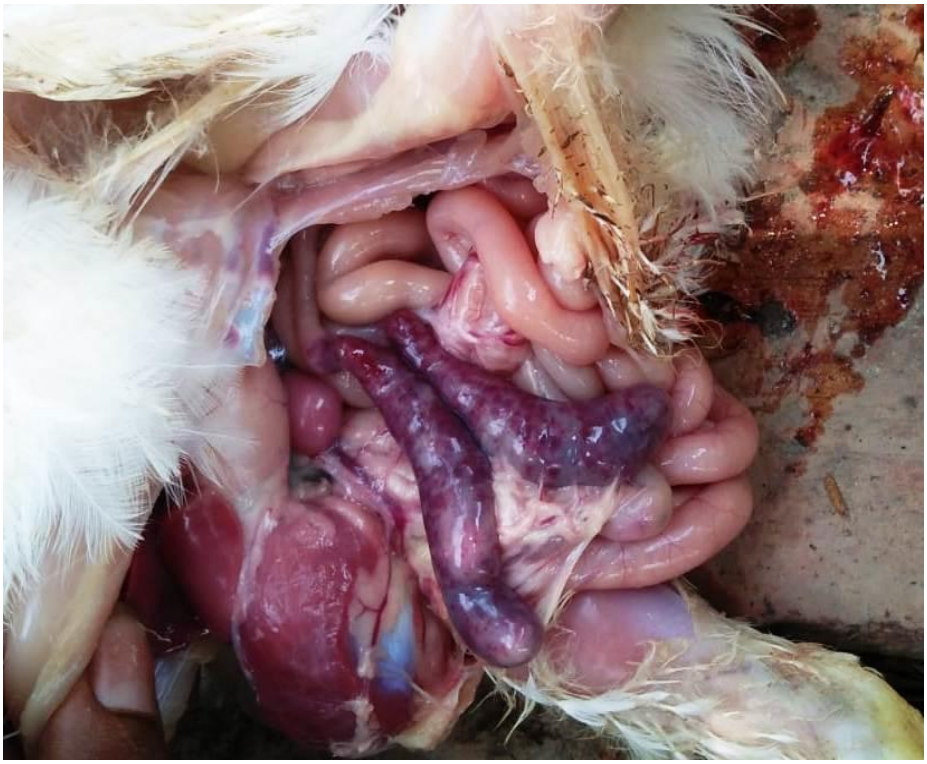

Fig.2 Intestinal coccidiosis in poultry bird

In Macropods

Coccidiosis within wild populations of kangaroos is difficult to prevent or control. Overcrowding and damp conditions enhance survival of oocysts leading to accumulation in the environment (Barker *et al.*, 1972).

In Poultry Birds

The prevention of coccidiosis is based on chemoprophylaxis and vaccination.

Coccidiostats are popularly used in feed and drinking water in time of clinical condition depending upon situation and dose.

Better hygiene and management is very important to control the disease widely in nature and moisture control of the litter is also one of the cardinal points for better health management through time to time litter turning.

Ammonium Sulfate can also be used in the litter to control coccidiosis as wekll as to combat bad odour from the litter.

The larger dosage of live sporulated oocysts the more severe effects of the Coccidia on the bird, the good use can be made on this knowledge to develop a programme of control for the individual poultry industry (Dickinson, 1942).

In Reptiles

Good husbandry practice is mandatory.

Avoid over-crowding; otherwise mixed infection can interfere (Rao and Acharjyo, 1991).

Periodical faecal test is important for parasitic control.

Proper medicines and good diet is necessary to maintain better immunity.

Mechanical vectors such as cockroaches and filth flies must be controlled time to time.

Coccidiosis is a persistent problem in the globe. Most of the animals and birds were asymptomatic, but showing low feed conversion rates. Local breeds of chickens are less susceptible to the infection. Eastern grey kangaroos are more prone to coccidiosis than other kangaroos. Overcrowding is the factor of spreading and transmission of the disease. Outbreaks can be controlled by scientific management (Clean water and good quality of feed to be supplied). Topics covered with introduction and history, lifecycle, economic importance, epidemiology, transmission, prevention and control caused by the infection. Lastly significant concerned with avion coccidiosis is widely available, whereas in wildlife, scientific literature is scanty. On the whole, sanitation and good hygiene is able to control the disease in farm management as well as free range system or in captive through regular faecal sample examination and periodical use of anthelmentics is strongly advocated.

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