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A REVIEW OF CESTODE (PHYLUM: PLATYHELMINTHES) PARASITES REPORTED FROM INDIAN RAPTORS

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INTRODUCTION

The raptorial birds are classified into three orders, all of which evolved independently. Diurnal raptors such as ospreys, vultures, eagles, and hawks belong to the Order Accipitriformes, while other diurnal raptors such as falcons and caracaras belong to the Order Falconiformes. Nocturnal raptors or owls belong to the Order Strigiformes.

We report the presence of 28 species of cestode parasites from the families Accipitridae (8 species), Falconidae (2 species) and Strigidae (2 species) from different states of India.

Cestoda is the name given to a class of parasitic flatworms of the phylum Platyhelminthes. Its members live in the digestive tract of vertebrates as adults and often in the bodies of invertebrates like insects and arthropods as juveniles. The adult tapeworm usually inhabits the alimentary canal of its host, attaching to the mucosa by means of a scolex. They penetrate the intestinal mucosa with the scolex causing inflammation and nodules (Heidenreich, 1997). In a study made by Jones *et al*., 1996 on cestode and acanthocephalan infections in captive bustards in National Avian Research Centre (NARC) and the International Institute of Parasitology in UAE the authors made notable observations on the pathogenic effects of cestodes in these birds. Pathologic findings in the intestinal tract associated with cestode infection included inflammation, mild atrophy, collapse, and fibrosis of the intestinal mucosa. In some birds, the number of parasites was sufficient to partially obstruct the intestinal lumen. The authors discussed about the risk of disease in threatened populations and added that conservationists are becoming concerned especially where captive animals are involved through reintroduction programs. Diseases are thought to cause both mortality or reduce reproductive success. Helminths like cestodes and acanthocephalans may be introduced into captive breeding populations when other birds are imported. Thus within captive breeding and restoration programs strict monitoring and control of parasites is extremely vital.

In a study made by Kubiak and Forbes (2011) on common diseases in birds of prey (Great western Exotic Vets) and published in the website www.gwexotics.com the Veterinarians opined that "Birds of prey are commonly presented to veterinary surgeons in practice and typically comprise injured wild birds, individuals kept for falconry, zoo and conservation exhibits, and captive breeding birds. Endoparasites are common in free living adult raptors, with up to 80% prevalence, but usually cause minimal clinical disease, unless the bird is suffering concurrent illness, nutritional shortage or trauma. These birds and their parasites exist in harmony and are not confined to a limited physical space, so their immediate environment is not subjected to an escalating level of contamination. In contrast, captive raptors are commonly maintained in a limited space, such that any infected

raptor host will constantly contaminate their immediate environment. When the infestation involves parasites with direct life cycles or where intermediate hosts (e.g. snails, arthropods or earthworms) are present within the bird's environment, then life cycles can be completed, and endemic high levels of parasitism and clinical disease are common. Keepers must therefore test for, treat, control and prevent an environmental build-up of such parasites. Antiparasitic medications should not be given unless required as adverse effects are reported, particularly with fenbendazole suspensions, and parasites should be identified so that the correct treatment is given and husbandry can be altered to prevent re-infection. The authors recommend testing raptor faeces for parasites twice annually (at the end of the flying season and again after the moult, before the start of training for the new season".

Santoro *et al*., 2010 made an interesting study on Helminth infestation in birds of prey (Accipitriformes and Falconiformes) in Southern Italy.This study reports the pathological findings associated with helminths that included cestodes in raptors from the Italian peninsula. Helminths that included cestodes were identified in 110/116 (95%) raptors; negative birds were three kestrels, two honey buzzards and one sparrow hawk. Pathological changes associated with helminths were present in 81/110 (74%) birds: 35 buzzards, 13 kestrels, 10 falcons, 10 sparrow hawks, nine marsh harriers and four honey buzzards. Twenty-two (18.9%) birds were considered to have died of parasitic diseases.

There are not many reports on life cycle studies of cestodes in raptors. An arthropod like an insect or mollusk becomes the first intermediate host ingesting cestode eggs that contain the larvae. Once an egg has been eaten by this host, it passes through the stomach wall and encysts in the host's body cavity tissues, where it enters its first larval form. The parasite remains within this host until the arthropod is eaten by the second intermediate host. Small vertebrates, such as the common and pygmy shrews (*Sorex araneus* and *Sorex minutus*) act as paratenic hosts that accumulate encysted larval stages in their bodies, eventually passing the infestation to the definitive host, the bird of prey, when ingested (Cooper, 2005).

Avian cestode faunas in India have been poorly studied. Southwell (1930) and a few other workers reported a number of cestode species from birds of the Indian region. Cestode parasites from birds of prey have received very little attention, and there is no consolidated published work on cestodes from raptors found in India. In the present study an attempt has been made to prepare a comprehensive list of cestode species from birds of prey, by state, from India. The pathogenic effects caused by cestodes in these birds of prey has been discussed. We also discuss the hosts and distribution for each species of cestode reported.

MEHTODS

The present review has been prepared based on the papers of authors who collected cestode parasites from birds of prey in India and no field work has been done to make the present study. Except for the papers of Johri (1934) and Meggitt (1933) there are no references available mentioning clearly whether the reported parasites were from captive birds of prey or free ranging birds of prey.The authors have also not described in their papers the condition of the hosts. It is not known whether the host was dead, diseased or dying at the time of collection of the parasite. Johri (1934) in his paper 'Report on a collection of cestodes from Lucknow (U.P., India)' mentioned the details of the material collected.The material described in this paper (which included cestodes from raptor hosts) was mainly collected during the years 1928-1930 from Lucknow, either from neighbouring villages or from the local markets and from the Lucknow Zoological garden. Meggitt (1933) collected the cestodes from raptors that were dying in the Calcutta Zoological Garden during 1931. All the cestode parasites reported from Indian raptors by various authors till date have been compiled in the present paper. The papers that have been consulted to prepare the present work had been mostly collected from

published papers on cestodes obtained from birds of prey. The details of each paper and names of each journal have been provided in the section References. Some papers were downloaded from the Internet using keywords such as cestode infections in birds of prey, diseases in raptors caused by tapeworm's etc. The search engines Google and Google Scholar were used.

RESULTS

Host 1: *Milvus migrans* Boddaert, 1783 and *Milvus migrans govinda* Sykes, 1832; Family: Accipitridae; English common name: Black Kite; Total cestode species reported: 9

PARASITE PRESENT

Order CYCLOPHYLLIDEA

Family PARUTERINIDAE

1. *Mogheia ausae* Gore *et al*., 2008; Locality: India: Uttar Pradesh; Site of infection: Intestine

Family DILEPIDIDAE

2. *Paradilepis heirticos* Saxena, 1970; Locality: India: State unknown (Schmidt, 1986); Site of infection: Intestine

3. *Paricterotaenia milvi* Singh, 1952; Locality: India: Uttar Pradesh (Lucknow); Site of infection: Intestine

4. *Parvitaenia buckleyi* Saxena, 1970; Locality: India: State unknown (Schmidt, 1986); Site of infection: Intestine

5. *Parvitaenia yamagutii* Gaikwad and Shinde, 1980; Locality: India: Maharashtra (Nanded); Site of infection: Intestine

Family HYMENOLEPIDIDAE

6. *Oligorchis heirticos* Johri, 1934; Locality: India: Uttar Pradesh (Lucknow); Site of infection: Intestine

7. *Hymenolepis multihamata* Meggitt, 1927; Locality: India: Uttar Pradesh (Lucknow); Site of infection: Intestine

Family DAVAINEIDAE

8. *Raillietina (Paroniella) rangoonica* Subramanian, 1928; Locality: India: Uttar Pradesh (Lucknow); Site of infection: Intestine

9. *Cotugnia govinda* Johri, 1934 Locality: India: Uttar Pradesh Malhiabad (Lucknow); Site of infection: Intestine

Remarks: The subspecies *Milvus migrans govinda* or Pariah kite has been synonymized with the species *Milvus migrans* (Reference:Website AVIBASE).

Host 2: *Circus assimilis* Jardine and Selby, 1828; English Common Name: Spotted Harrier; Family: Accipitridae; Total cestode species reported: 1; Host details: The host was a dying animal in the Calcutta Zoological gardens during 1931 (Meggitt, 1933).

PARASITE PRESENT

Order CYCLOPHYLLIDEA

Family PARUTERINIDAE

1. *Cladotaenia feuta* Meggitt, 1933; Locality: India: West Bengal; Site of Infection: Intestine

Host 3: *Hieraaetus pennatus* Gmelin, 1788; English common name: Booted eagle; Family: Accipitridae; Total cestode species reported: 1; Host details: The host was a dying animal in the Calcutta Zoological gardens during 1931 (Meggitt, 1933).

PARASITE PRESENT

Order CYCLOPHYLLIDEA

Family PARUTERINIDAE

1. *Cladotaenia fania* Meggitt, 1933; Locality: India: West Bengal (Kolkata); Site of Infection: Intestine

Host 4: *Gyps indicus* Scopoli, 1786; English Common Name: Long billed vulture; Family: Accipitridae; Total cestode species reported: 3

PARASITE PRESENT

Order CYCLOPHYLLIDEA

Family ANOPLOCEPHALIDAE

1. *Taufikia indica* (Johri, 1934) Khalil *et al*., 1994; Locality: India: Uttar Pradesh (Lucknow); Site of infection: Intestine

2. *Taufikia magnisomum* (Southwell, 1930) Spasskii and Spasskaja, 1974; Locality: India:

State Unknown (Schmidt, 1986); Site of infection: Intestine

Family DAVAINEIDAE

3. *Raillietina* sp. (Reference: Johri, 1934) Locality: India: Uttar Pradesh (Lucknow); Site of infection: Intestine; Host details: The host *Gyps indicus* was collected during the years 1928-1930 from Lucknow, either from neighbouring villages or from the local markets and from the Lucknow Zoological Garden (Johri,1934).

Host 5: *Neophron percnopterus* Linnaeus, 1758; English Common name: Egyptian vulture; Family: Accipitridae; Total cestode species reported: 6

PARASITE PRESENT

Order CYLOPHYLLIDEA

Family ANOPLOCEPHALIDAE

1. *Taufikia percnopteri* (Singh, 1952) Khalil *et al*., 1994; Locality: India: Uttar Pradesh (Lucknow); Site of infection: Intestine

2. *Taufikia ghoshi* Capoor, 1966; Locality: India: Uttar Pradesh (Allahabad); Site of infection: Intestine

3. *Taufikia lucknowensis* (Saxena, 1967) Khalil *et al*., 1994; Locality: India: Uttar Pradesh (Lucknow); Site of infection: Intestine

4. *Taufikia irregularis* (Saxena, 1968) Khalil *et al*., 1994; Locality: India: Uttar Pradesh (Lucknow); Site of infection: Intestine

5. *Taufikia luteus* (Saxena, 1968) Khalil *et al*., 1994; Locality: India: Uttar Pradesh (Lucknow); Site of infection: Intestine

6. *Taufikia melanotus* (Saxena, 1968) Khalil *et al*, 1994; Locality: India: Uttar Pradesh (Lucknow); Site of infection: Intestine

Host 6: *Sarcogyps calvus* Scopoli, 1786; English common name: Red headed Vulture; Family: Accipitridae; Total cestode species reported: 1

PARASITE PRESENT

Order CYLOPHYLLIDEA

Family ANOPLOCEPHALIDAE

1. *Taufikia kolhapurensis* Kadam *et al*., 1981; Locality: India: Maharashtra (Kolhapur); Site of infection: Intestine

Host 7: *Accipiter badius* Gmelin, 1788; English common name: Shikra; Family: Accipitridae; Total cestode species reported: 1

PARASITE PRESENT

Order CYLOPHYLLIDEA

Family ANOPLOCEPHALIDAE

1. *Cladotaenia pauciuterina* Khan, 1984; Locality: India: Andhra Pradesh; Site of infection: Intestine.

Host 8: *Butastur teesa* Franklin, 1831; English Common name: White-eyed buzzard; Family: Accipitridae; Total cestode species reported: 1

PARASITE PRESENT

Order CYLOPHYLLIDEA

Family DAVAEINIDAE

1. *Idiogenes butasteri* Chatterjee, 1954; Locality: India: Uttar Pradesh (Allahabad); Site of infection: Intestine

Host 9: *Falco tinnunculus* Linnaeus, 1758; English common name: Common Kestrel; Family: Falconidae; Total cestode species reported: 1 Host details: The host was a dying animal in the Calcutta Zoological gardens during 1931 (Meggitt, 1933).

PARASITE PRESENT

Order CYLOPHYLLIDEA

Family PARUTERINIDAE

1. *Cladotaenia cylindracea* Bloch, 1782; Locality: India: Andhra Pradesh; Site of infection: Intestine.

Host 10: *Falco jugger* Gray, J.E., 1834; English common name: Lagger falcon; Family: Falconidae; Total cestode species: 1

PARASITE PRESENT

Order CYLOPHYLLIDEA

Family: AMABILIDAE

1. *Laterochites rajasthanensis* Mukherjee, 1970; Locality: India: Rajasthan; Site of Infection: Intestine

Host 11: *Ketupa zeylonensis* Gmelin, 1788; English Common name: Brown Fish owl; Family: Strigidae; Total cestode species: 1; Host details: The host was a dying animal in the Calcutta Zoological gardens during 1931 (Meggitt, 1933).

PARASITE PRESENT

Order CYCLOPHYLLIDEA

Family HYMENOLEPIDIDAE

1. *Hymenolepis finta* Meggitt, 1933; Locality: India: West Bengal; Site of Infection: Intestine

Host 12: *Asio flammeus* Pontoppidan, 1763; English common name: Short- eared owl; Family: Strigidae; Total cestode species: 2

PARASITE PRESENT

Order CYCLOPHYLLIDEA

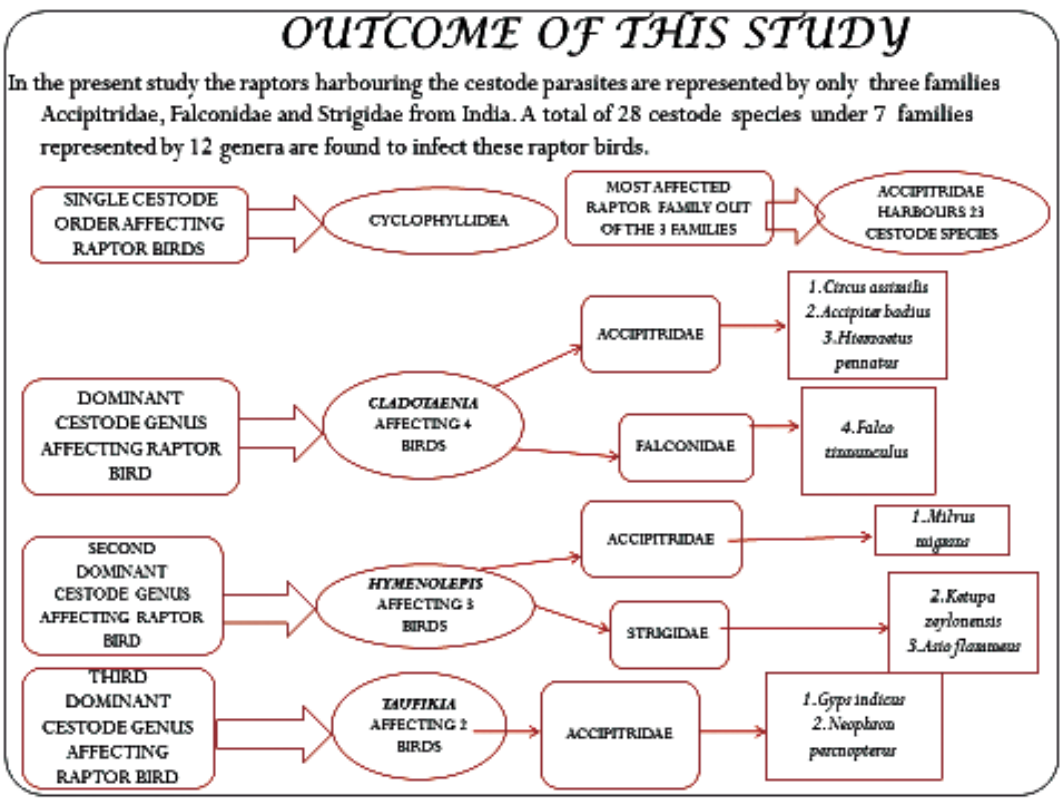
Family HYMENOLEPIDIDAE

1. *Hymenolepis minutissima* Meggitt, 1927; Locality: India: Aruanchal Pradesh; Site of Infection: Intestine

2. *Hymenolepis spinosa* Linstow, 1906; Locality: India: Aruanchal Pradesh; Site of Infection: Intestine

Eight species of raptors from Family Accipitridae viz. *Milvus migrans*, *Circus assimilis*, *Hieraaetus pennatus*, *Gyps indicus*, *Neophron percnopterus*, *Sarcogyps calvus*, *Butastur teesa* and *Accipiter badius*, 2 species of raptors from Family Falconidae viz. *Falco tinnunculus* and *Falco jugger* and 2 species of raptors from Family Strigidae viz. *Bubo zeylonensis* and *Asio flammeus* are found to harbour cestode parasites. In all, 28 species of cestode parasites are reported from these birds of prey. The raptor birds affected by cestode infections have been reported from six states of India which are Rajasthan and Maharashtra in the west, Uttar Pradesh in the central part, West Bengal in the east, Andhra Pradesh in the south eastern part of India and Arunachal Pradesh in the extreme north east of the country. Based on our review of the literature, the present study reveals that the maximum number of affected birds have been reported from the state of Uttar Pradesh.

In the present study the raptors harbouring the cestode parasites are represented by only three families Accipitridae, Falconidae and Strigidae from India.This result may be due to



the listing of cestode parasites from birds of prey available from recorded literature. The present work revealed that only cestodes of the Order Cyclophyllidea (7 families, 12 genera, 28 species) have been documented to parasitize these birds of prey. Amongst the three families of raptors the family Accipitridae harbours the maximum number of cestode parasites which are 23 in number. The cestode genera *Cladotaenia* followed by *Hymenolepis* and *Taufikia* are found to be the most dominant amongst the twelve cestode genera infecting these birds of prey.

DISCUSSION

In the present case, pathogenicity of tapeworms is associated with raptors acting as suitable hosts. The record of compatible clinical signs indicates that intestinal symptoms are usually associated with the parasitosis. In some studies, cestodes were present in extremely high numbers without any apparent incidence on the mortality rate (Lacina and Bird, 2000). However, cestodes reported from some raptors are associated with signs such as diarrhoea and weight loss (Heidenreich, 1997). Little is known of the pathological effects of parasitic infestations in raptors (Krone, 2000; Krone and Cooper, 2002; Lacina and Bird, 2000). Cachexia and partial luminal obstruction of the duodenum were found to be associated with the cestode Cladotaenia sp. in three marsh harriers in a study on helminth infestations in birds of prey on Accipitriformes and Falconiformes in Southern Italy by Santoro et al (2010). In this study, Santoro et al. (2010) reported that the infection caused by helminths in raptors of Southern Italy of the families Accipitriformes and Falconiformes resulted in parasitic lesions, in these birds. The pathological findings showed the highest percentage of damage caused by helminth infection by acanthocephalans, trematodes, nematodes and cestodes in the form of parasitic lesion in these birds of prey. The other damages showed a lesser percentage in affected birds. These damages included trauma, starvation / cachesia, gunshot wounds, electrocution, infectious diseases and poisoning. Santoro *et al.* (2010) concluded that parasitic infestations in raptors appear to cause little or no distress to healthy individuals, but helminths can lead to serious health problems when combined with other factors or at times of stress (Krone and Cooper, 2002; Lacina and Bird, 2000). In addition to direct effects induced by known pathogenic species, helminth infestations may affect flying performance (Tarello, 2006, 2007) and predatory effectiveness (Illescas – Gomez *et al.,* 1993) as well as predisposing to secondary trauma (Borgsteede *et al.,* 2003). Most of the birds in this study showed traumatic injuries, but whether helminths contributed to debilitation and consequently trauma is unknown.

However, little is known about the pathogenicity of cestodes and their prevalence in raptors from India. There seems to be a direct link between the percentage of shrews (paratenic hosts) in the diet of raptor species and the incidence of infestation (Michalek, 1984). A specific therapy for treating raptors has not been established yet although other avian species have been treated with fenbendazole at a dose of 20 mg/ Kg for five days (Heidenreich, 1997). Treatment with ivemectin (Ivomec, Merial) at a dose of 20 mg/Kg was found to be apparently safe (Lierz, 2001) and highly effective in raptors.

Raptors form important components of the food chain, help in disease management, are friends of farmers and act as ecological gauge. The present study provides insight into the diversity of cestodes infecting Indian raptors, as well as the host-parasite relationships involved. We hope our review will aid conservationists, raptor rehabilitators and veterinarians who are working to save threatened and endangered raptors with cestode infections.

SUMMARY

Tapeworm infection is rarely reported as a problem in raptorial birds. However, when infection loads are high, the pathogenic effects of cestodes can be diverse. Heavily infested birds usually show general impairment, listlessness, apathy, dull, ruffled plumage, weight loss, anaemia and leg weakness. Cestode infections can occasionally cause poor growth and even mortality. Herein, using reports from the literature, we review the presence of 28 species of cestode parasites from 12 species of birds of prey from the families Accipitridae, Falconidae and Strigidae

reported from different states of India. All the parasites were reported to be collected from the intestine of the host. In most of the published papers that have been consulted to prepare the present review, the details of whether the host had been collected from the wild or was in captivity is not clearly mentioned. No details are also available about the raptor host being found dead, diseased or dying. Johri (1934) and Meggitt (1933) have given some details of the condition of the hosts collected in their papers. We discuss in the Indian context, the importance of cestode infections in conservation management of raptors.

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