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**Cover: The nine vultures of India, digital art made on Krita by Dupati Poojitha.**

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# Effect of schistosomiasis on captive elephants in Madhya Pradesh, India

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**Abstract:** Schistosomes are parasitic flukes that reside in blood vessels and various host organs. Health monitoring of 51 captive elephants in tiger reserves of Madhya Pradesh revealed a 35% overall incidence of blood flukes. The highest levels of *Bivitellobilharzia nairi* eggs were recorded in elephants in Satpura (67%), Kanha (47%), Bandhavgarh (33%), Pench (25%), and the lowest in Panna Tiger Reserve (14%). Infected animals showed decreased haemoglobin (7.5–11.8 g/dl), and elevated aspartate aminotransferase (65–102 U/L), alanine aminotransferase (85–105 U/L), and blood urea nitrogen (46–65 mg/dl). They also showed symptoms that included dullness/depression and emaciated body condition, which were especially evident in elephants with high *B. nairi* egg counts > 1200–2300 eggs/g.

**Keywords:** Asian Elephants, *Bivitellobilharzia nairi*, blood flukes, haematobiochemistry, granuloma, Schistosomiasis.

Schistosomiasis is a devastating tropical disease, affecting humans and many animal species including African and Asian Elephants (Brant et al. 2013). Schistosomes are unisexual and dimorphic flukes that develop in the blood vessels, and their spiny eggs are responsible for the erosion of parenchymatous tissue which forms granuloma and necrosis in the liver followed by small intestine of the host. The transmission of infection in the definitive host occurs through active skin penetration of furcocercal cercariae, which develops further as an adult parasite in the portal veins. The worm load may lead to morbidity and mortality depending upon intake of furcocercal cercariae of blood flukes, and their sustenance in the host (Agrawal & Shah 1998). In Asian Elephants, *Bivitellobilharzia nairi* has been reported consistently from Indian subcontinent, albeit without information about the disease manifestations (Bhoyar et al. 2014). The study of pathogenic effect of schistosomosis in elephants is still scanty as only Kalapesi & Purohit (1957) have described the disease manifestations characterized by granuloma in the hepatic parenchyma, followed by necrosis or sometimes gastrointestinal bleeding with obstructive uropathy, and severe anaemia. Subsequently, infected elephants become clinically unfit for forest-oriented work owing to a reduction in their agility and potential (Singh & Agrawal 2000). Seeking biodiversity conservation mission and their need-based programmes, the trained elephants of different tiger reserves and national parks have been used for patrolling of wild animals, monitoring distant places, and immobilization of big cats (Shrivastav & Singh 2017). Thus, agility and alertness of trained elephants is a must for such important tasks of wildlife management in protected and non-protected forest areas of India. The present research article deals with disease manifestation, effects on haematology, and serum biochemistry in captive elephants of different tiger reserves.

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## Materials And Methods

Before the collection of biological samples of each elephant from different tiger reserves of Madhya Pradesh, the information on their age, sex, and area from where they were captured or purchased was gathered. For coprodiagnostics, 20 g fecal samples from freshly defecated dung bolus were collected from each elephant in a sterilized container and divided into two parts; one part was collected without preservatives and another was kept in 10% buffered formalin and brought to the laboratory of School of Wildlife Forensics and Health for qualitative, and quantitative analysis of fecal samples. Sedimentation method of Soulsby (1982) was used to screen the *Bivitellobilharzia nairi* eggs in the processed samples of elephants. Furthermore, 4–5 ml of blood of each elephant was also collected by ear vein puncture using 18-gauge needles aseptically in a vaccutainer both in EDTA (Ethylene Diamine Tetra Acetate) coated, and non EDTA serum tubes following the guidelines of Jain (1986). The blood smears were prepared soon after the blood collection and stained with Romanwsky stain for differential leukocytes counts (DLC) as well as screening of haemoprotozoans. Haematological parameters were conducted using semi-auto haematology analyzer (PG–6800 VET) within 12 h of collection of blood, while harvested serum samples were stored at 4–8 °C until further analysis. The serum biochemicals were mainly attributed to liver and kidney function tests and estimated using ERBA diagnostic kits with semi auto analyzer (ARK diagnostics, Mumbai), and the findings were interpreted based on Benjamin (1978).

## Results And Discussion

Impact of schistosomiasis on health status with reference to haematological and biochemical parameters due to blood fluke was envisaged. Overall, 35.2% prevalence of elephant schistosomosis was recorded in different tiger reserves of Madhya Pradesh. The occurrence of *B. nairi* infection in elephants is indicative of a natural nidus of intermediate hosts for animal schistosomiasis that might be owing to presence of the water snails, i.e., *Indoplanorbis exustus* and *Lymnaea luteola* in these national parks, and adjoining endemic areas. Agrawal & Shah (1998) also observed water snails (*I. exustus* and *L. luteola*) in central India, which are responsible for mammalian schistosomiasis in livestock. Nonetheless, stagnant water resources are

**Table 1. Occurrence of *Bivitellobilharzia nairi* eggs in captive elephants.**

| Tiger reserves | No. examined | Found positive | EPG range | Mean EPG±SD |
|---|---|---|---|---|
| Kanha | 15 | 7 (46.6 %) | 1800–2300 | 2000 ± 64.41 |
| Bandhavgarh | 12 | 4 (33.3%) | 800–1200 | 1000 ± 34.62 |
| Panna | 14 | 2 (14.2 %) | 600–1400 | 1000 ± 50.85 |
| Satpura | 6 | 4 (67.0%) | 1200–1800 | 1500 ± 74.8 |
| Pench Tiger | 4 | 1 (25.0%) | 800–1200 | 1000 ± 0.51 |
| Total | 51 | 18 (35.2 %) | 600–2300 | 1500 ± 42.8 |

**Table 2. Haematological profile of *Bivitellobilharzia nairi* infected and non-infected captive elephants.**

| | Parameters | Unit | Non-infected elephants | | Infected elephants | |
|---|---|---|---|---|---|---|
| | | | Range | Mean ± SD | Range | Mean ± SD |
| 1. | Total Erythrocyte Count | $10^6$/µl | 2.61–5.34 | 3.57 ± 0.15 | 2.66–4.77 | 3.43 ± 0.13 |
| 2. | Haemoglobin | g/dl | 12–18.4 | 14.25 ± 0.69 | 7.5–11.8 | 10.06 ± 1.47 |
| 3. | Pack Cell Volume | % | 33.1–64.3 | 44.59 ± 1.67 | 33.5–50.2 | 40.70 ± 1.22 |
| 4. | Mean Corpuscular Volume | fl | 107.6–153.3 | 124.54 ± 1.99 | 107.6–128.2 | 120.88 ± 1.47 |
| 5. | Mean Corpuscular Haemoglobin | pg | 33.3–45.8 | 40.40 ± 0.63 | 33.3–40.6 | 38.122 ± 0.45 |
| 6. | Mean Corpuscular Haemoglobin Concentration | g/dl | 26.6–37.4 | 32.54 ± 0.55 | 26.6–34.6 | 31.57 ± 0.40 |
| 7. | Blood Platelets | $10^3$/µl | 226–744 | 458.65 ± 29.04 | 263–665 | 433 ± 28.90 |
| 8. | Total Leukocyte Count | $10^3$/µl | 7.5–41.1 | 23.01 ± 1.63 | 11.1–31.6 | 20.57 ± 1.34 |
| 9 | Differential Leukocyte Count | | | | | |
| i. | Polymorph | % | 43–71 | 55.21 ± 1.66 | 69–85 | 75.27 ± 1.38 |
| ii. | Lymphocytes | % | 15–38 | 26.52 ± 1.22 | 15–34 | 24.5 ± 1.21 |
| iii. | Monocytes | % | 4.0–24 | 11.65 ± 1.09 | 6–17 | 10.88 ± 0.83 |
| iv. | Eosinophils | % | 2.0–12 | 6.60 ± 0.63 | 8.0–16 | 10.88 ± 0.72 |
| v. | Basophiles | % | 00 | 00 | 00 | 00 |



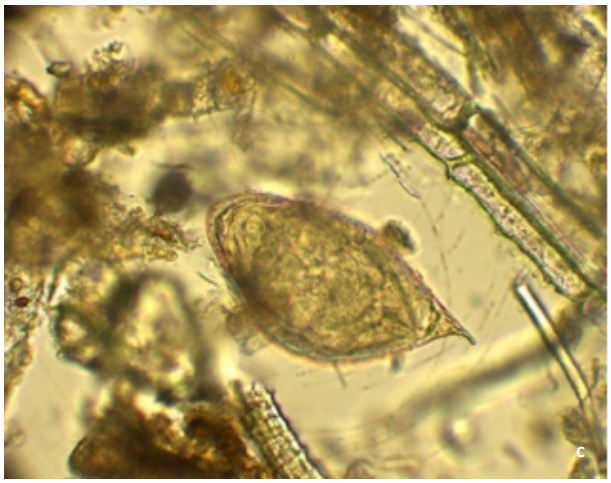


**Image 1. a—Showing grooming of captive elephants beside stagnant water resource | b—Body condition of schistosomes infected elephant | c—Spiny egg of *Bivitellobilharzia nairi* in faeces (400 x). © Dr. K. P. Singh.**

used for grooming and bathing of captive elephants in different tiger reserves of central India where snail populations breed (Image 1a). The highest occurrence of infection was recorded in Satpura (67.0%) followed by Kanha (46.6%), Bandhavgarh (33.3%), Pench (25%), and lowest (14.2%) in Panna Tiger Reserve of Madhya Pradesh (Table 1). Singh & Agrawal (2000) have also recorded higher prevalence (32.8%) of *B. nairi* infection in captive elephants of Kanha Tiger Reserve while Islam (1994) recorded only 16% infection of schistosomosis in captive elephants of Kaziranga National Park. This might be owing to difference in geographical distribution and timing of wallowing, and bathing of elephants in the stagnant water resources as release if furcocercal cercariae takes place during morning hours (Agrawal & Shah 1998). Hence, the prevalence rate of Schistosomes differs with seasonal variations and might be owing to the availability of stagnant waterholes.

The complete blood count (CBC) analysis showed decreases in hemoglobin percentage (7.5–11.8, 10.06 ± 1.47 g/dl) in schistosome-infected elephants. Changes in differential leukocyte count, including eosinophilia, were recorded, particularly in elephants in which higher EPG of *B. nairi* eggs was reported. Biochemical changes included elevation of aspartate aminotransferase (AST = 65–102 85 ± 21.6 U/L), alanine aminotransferase (ALT = 85–105 91 ± 17.4 U/L) and blood urea nitrogen (BUN = 46.2–65.5 58.2 ± 13.7 mg/dl), indicated in the obstruction in the liver and kidney function showed chronic phase of the disease (Table 2). Singh & Agrawal (2000) have also encountered an increased level of SGPT and SGOT in infected elephants of Kanha National Park. The considerable alteration in the blood profiles are indicative of effects of parasitimia on liver, small intestine, mesenteric veins probably causing granuloma followed by necrosis. Similar findings have been reported by Bhoyar et al. (2014) during haematobiochemical studies of elephants infected by *B. nairi.* Therefore, schistosomiasis may be controlled specifically in captive elephants through change in routine bathing in the stagnant river pockets as the water snails mostly release mammalian cercariae after sunrise early in the morning hours (Dorsey et al. 2002). The present study may be useful in determination of haematobiochemical parameters of infected and non-infected elephants with diagnosis of schistosomosis in elephants to control the disease burden in different tiger reserves in addition to health monitoring, and diseases diagnosis of captive elephants in different tiger reserves for smooth functioning, and conducting the wildlife health management aspects.

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**Table 3. Serum biochemistry of *Bivitellobilharzia nairi* infected and non-infected captive elephants.**

| | Parameters | Unit | Non-infected elephants | | *B. nairi* infected elephants | |
|---|---|---|---|---|---|---|
| | | | Range | Mean ± SD | Range | Mean ± SD |
| 1. | Aspertate Transaminase | IU/L | 10.56–81 | 40.30 ± 5.08 | 65–102 | 85 ± 21.60 |
| 2. | Alanine Amino Transminase | IU/L | 12.17–45.4 | 6.31 ± 0.54 | 85–105 | 91 ± 17.40 |
| 3. | Alkaline Phosphatase | IU/L | 34–118.8 | 65.30 ± 4.63 | 34.2–101.4 | 66.06 ± 4.74 |
| 4. | Total Bilirubin | mg/dl | 0.1–1.4 | 0.68 ± 0.08 | 0.1–2.9 | 0.96 ± 0.17 |
| 5. | Total Protein | g/dl | 4.68–10.2 | 7.72 ± 0.28 | 4.52–9.8 | 7.89 ± 0.27 |
| 6. | Creatinine | mg/dl | 1.2–2.44 | 1.89 ± 0.08 | 1.2–3.2 | 1.89 ± 0.12 |
| 7. | Blood Urea Nitrogen | mg/dl | 9.5–40.1 | 23.13 ± 1.96 | 46.2–65.5 | 58.2 ± 13.70 |
| 8. | Uric Acid | mg/dl | 10.4–12.8 | 11.08 ± 0.13 | 12.4–16.4 | 13.41 ± 0.26 |

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