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Prevalence of Gastrointestinal Parasites in Endangered Captive Javan Gibbons (*Hylobates moloch,* Audebert, 1797) of Taman Margasatwa Ragunan, Jakarta Selatan

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Abstract: Primates living in cages are highly susceptible to parasitic infections. Assessing the level of parasitic infection in endangered animals is important to support animal welfare and develop conservation strategies. The infection status of endoparasites in Javan gibbons has been little reported. This study aimed to identify endoparasites and their prevalence in Javan gibbons in Taman Margasatwa Ragunan (TMR). Fecal samples (N=80) were collected from 4 individual Javan gibbons (1 adult male, 2 adult females, and 1 infant male) in October-December 2024. Fecal samples were preserved with 10% formalin solution and analyzed by the formalin-ethyl acetate sedimentation method. As a result, eggs of the order Strongylida, order Rhabditida (*Strongyloides* sp.), and order Enoplida (*Trichuris trichiura*) were found. Adult males were positively infected with worms of the Strongylida order, whereas infant males were infected with *Strongyloides* sp. and *T. trichiura* with a prevalence of 25%. The endoparasites found in this study are common in captive and wild Javan gibbons. To prevent an increase in infection, direct contact between humans (keepers/visitors) and Javan gibbons should be strictly prevented. This information is useful in developing a health management program for Javan gibbons in TMR as well as completing information related to endoparasites in Javan gibbons in cages.

Keywords: Captive; Endangered; Endoparasites; Javan gibbons, Ragunan

Introduction

Captive animals are highly susceptible to various of parasites. Assessing the susceptibility of endangered species to parasitic infections is important to support animal welfare and develop conservation strategies (Solórzano-García & Pérez-Ponce de León, 2018; Mewius et al., 2021). According to Sirima et al (2021), host phylogenetic proximity, structure and social interactions between individuals can influence susceptibility to parasitic infections.

Endoparasites are parasites that live inside the host's body and cause infection within it. Animals infected with parasites do not always show clinical symptoms although they are potentially pathogenic (Hendrix & Robinson, 2023). Endoparasites that are often found with a high prevalence in primates are *Strongyloides* sp., *Trichuris* sp., *Entamoeba* sp. (Levecke et al ., 2007; Kumar et al ., 2018; Schurer et al ., 2019; Vu et al ., 2021; Dib et al ., 2023), *Ascaris* sp., *Balantidium coli* (Chapman et al ., 2016; Kumar et al ., 2018; Schurer et al ., 2019; Lalremruati & Solanki, 2020), *Ancylostoma* sp. (Kumar et al ., 2018; Vu et al ., 2021), *Giardia duodenalis,*

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Blastocystis sp. (Dib et al ., 2023) and *O. stephanostomum* (Sirima et al ., 2021).

The Javan gibbon (*Hylobates moloch*) is one of Indonesia's endemic primates on the island of Java. Its distribution is limited to the provinces of West Java, Central Java, and the eastern side of the Dieng Mountains (Nijman, 2004; Roos et al., 2014; Supriatna, 2022). Its conservation status according to the IUCN Red List of Threatened Species is endangered. The total population of Javan gibbons in the wild is estimated to be around 4000 individuals (Nijman, 2004, 2020). In addition to their natural habitat, Javan gibbons are also found in ex-situ conservation institutions such as rehabilitation centers and zoos (Nijman, 2006; Nijman et al., 2009). In recent years, research related to the Javan gibbon has mostly focused on behavioral aspects (Mirza Widianto et al., 2022; Widyaningrum et al., 2022; Pradekso et al., 2023), population and habitat suitability (Setiawan et al., 2011; Ario et al., 2018; Widyastuti et al., 2023). Research on endoparasite infection in gibbons in in-situ and ex-situ habitats is still very limited.

Taman Margasatwa Ragunan (TMR) is one of the ex-situ conservation institutions inaugurated in 1966 in Jakarta. Javan gibbons in the TMR are located in the Schmutzer Primate Center, Primate Cage 3, and Primate Cage 4. Until now, there has been no publication on endoparasites in Javan gibbons in Taman Margasatwa Ragunan (TMR). Therefore, this study aimed to identify endoparasites and their prevalence in Javan gibbons in TMR. This report will be useful in developing a health management program for Javan gibbons in TMR as well as completing information related to endoparasites in captive Javan gibbons.

Method

Time and place of research

This study was conducted at Taman Margasatwa Ragunan, Jakarta Selatan and the Laboratory of the Department of Biology, Universitas Indonesia. The research was divided into two periods: 1). Period 1, collection of Javan gibbon feces samples in primate cages three and four at TMR in October-December 2024. 2). Period 2, identification of endoparasites in fecal samples at the Biology Department Lab in February-March 2025.

Research subjects

The subjects of this study were four Javan gibbon individuals namely, Adul (14 years old), Neng (20 years old), Rani (23 years old), and Boang (1 year old). Primate cage three contains a pair of adult males and females, namely Adul and Neng. While primate cage four contains a mother and son pair, namely Rani and Boang.

Research Procedure

Collection and Analysis of Fecal Samples of Javan Gibbons in Cages

Samples of freshly excreted feces by the Javan gibbons were taken every two days alternately between cage three and cage four. Feces were taken after all parts of the cage were cleaned by the keeper in the morning. Fresh feces samples were taken as much as 3 grams by keepers using wooden sticks. This activity was conducted without contact with the animals and with the permission of the Ministry of Environment and Forestry Directorate General of Natural Resources and Ecosystem Conservation (No. 167/2024) and Taman Margasatwa Ragunan Management Unit (No. 2033/HM.03.04/2024).

Samples were taken from the center of the feces to minimize contamination with other organisms and the surrounding cage environment (Gillespie, 2006; Flynn & Baker, 2007). All samples were stored in plain tubes and 2 ml of 10% formalin solution was added or until the entire surface of the feces was submerged. Tubes were labeled with the individual's name and date, then stored in a styrofoam box at room temperature. (Chapman et al., 2016; Gillespie, 2006).

Analysis of fecal samples using the formalin-ethyl acetate sedimentation method previously described by (Flynn & Baker, 2007). Samples that have been stored previously were filtered using gauze in a test tube to fill a volume of 10 ml. Then, 3 ml ethyl acetate was added and homogenized using a vortex. The sample was then put into a centrifuge for 5 minutes at 2500 rpm. The supernatant layer formed was discarded to leave a precipitate (pellet) at the bottom of the tube. The pellet was then dripped onto a glass slide to be observed with a 10x and 40x magnification microscope. measurement of endoparasites found using Leica DM500 software. Parasite identification refers to the U.S Centers for Disease Control and Prevention, Klaus et al (2017), Kharismawan et al (2022), and Hendrix & Robinson (2023). *Ancylostoma* sp. and *Necator* sp. (hookworm) eggs were indistinguishable under the microscope. *Oesophagostomum* spp. eggs looked very similar to hookworm eggs and could not be distinguished morphologically (Brooker & Bundy, 2013; CDC, 2017, 2019a). Therefore, we decided these eggs as Order Strongylida.

Data Analysis

Prevalence

Parasite prevalence was obtained by calculating the number of individuals infected with a particular endoparasite species divided by the total number of individuals examined in a given time period (multiplied by 100).(Levecke et al., 2007; Rondón et al., 2017).

$$\frac{\sum \text{individuals infected with a particular parasite species}}{\sum \text{individuals examined}} \times 100 \qquad (1)$$

Result and Discussion

Status of Endoparasites in Sample of Javan Gibbons

The results showed that of the four Javan gibbon individuals examined, only two were positive for endoparasite infection. The endoparasites found came from the Nematoda phylum, namely Order Strongylida, Order Rhabditida: *Strongyloides* sp., and Order Enoplida: *Trichuris trichiura*. (Figure 1). In addition, there were also unidentified eggs and larvae.

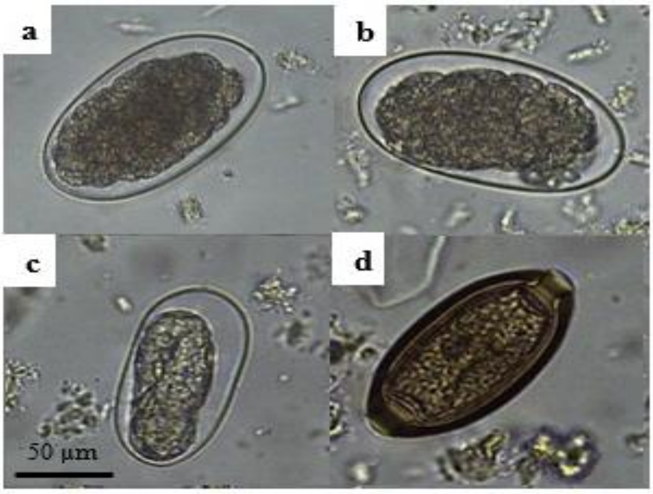

Figure 1. Endoparasites found in javan gibbons. The three detected helminth orders were: (a&b) the order Strongylida, c) the order Rhabditida (*Strongyloides* sp.), d) the order Enoplida (*Trichuris trichiura*). Scale bars = 50 µm

A total of 80 samples were collected from Adul (n=20), Neng (n=20), Rani (n=20) and Boang (n=20). Boang (infant) individuals were infected with two endoparasite species from two different orders, *Strongyloides* sp. and *T. trichiura*. Young individuals who are still in the growth stage are very susceptible to infection because their immune systems are not yet fully developed (Holsapple et al., 2003; Garbutt et al., 2014). Adul (adult) individuals were infected with only one order, Strongylida. The prevalence of each endoparasite taxa was 25%. Neither of the infected individuals showed any clinical symptoms. The full results are presented in Table 1.

Table 1 Endoparasites Taxa of Four Javan Gibbons in Taman Margasatwa Ragunan (N= 80)

Host	Order	Species	Prevalence (%)
Adul	Strongylida	-	25
Neng	-	-	-
Rani	-	-	-
Boang	Rhabditida	*Strongyloides* sp.	25
	Enoplida	*T. trichiura*.	25

These results are not much different from the research of Siagian et al (2024) at Maharani Zoo, reporting the presence of eggs and larvae of *Strongyloides* sp. in Javan gibbons with a prevalence of 33.33%. Fauzi et al (2021) and Siagian et al (2021) reported *T. trichiura* parasitic infection in Javan gibbons at the Javan Primate Rehabilitation Center The Aspinall Foundation Indonesia Program with a prevalence of 26,3% and 5,6%, respectively. In addition, worm infections from the order Strongylida in Javan gibbons (ex-situ) have also been reported previously in the research of Irawan et al (2011) in the Javan Gibbon Center. The variety of worm orders found in the TMR is similar to the results of research by Kharismawan et al (2022) on wild javan gibbons at Petungkriyono Forest. The results of Malintan et al (2024) on the wild javan gibbon populations at Taman Nasional Gunung Halimun Salak also reported endoparasite infections from the same three orders.

Similar infections were also reported in wild white-handed gibbons (*Hylobates lar*) at Khao Yai National Park, Thailand. *Trichuris* sp. and *Ternidens* sp. were reported with the highest prevalence of 91,30%, *Strongyloides fuelleborni* (56,52%), and *Trichostrongylus* sp (13,04 %). In addition, *Necator* sp., *Ascaris* sp., protozoa, and trematode infections were also found (Gillespie et al., 2013). Another study was conducted on agile gibbon (*Hylobates agilis*) and siamang (*Symphalangus syndactylus*) at Serulingmas Zoo, Banjarnegara. *Trichostrongylus* sp. and *Strongyloides* sp. infected agile gibbon and siamang. *Trichuris* sp. and *Cooperia* sp. infections were reported only in siamangs (Ningtias et al., 2023). Individual immune responses may influence infection rates (Klein, 2004; MacIntosh et al., 2010).

Hookworms (*Ancylostoma duodenale and Necator americanus*), *T. trichiura, Strongyloides stercoralis*, and *S. fuelleborni* belong to the group of Soil Transmitted Helminths (STH) or Geohelminths (Jourdan et al., 2018; Janwan et al., 2020). STH often cause massive infections in zoo animals because they do not require an intermediate host in their life cycle (Pencheva, 2013).

Endoparasites life cycle

The order Strongylida includes some of the most commonly found gastrointestinal parasites and pathogens in vertebrate animals (Flynn & Baker, 2007). Female strongylid nematodes produce large numbers of eggs (depending on the species) that are excreted with feces into the environment. Larvae that are ingested and enter the host's body continue to develop into adults and produce eggs again. This process lasts about 3-4 weeks (Roeber et al., 2013).

Strongyloides sp. infection causes Strongyloidiasis disease. Symptoms include shortness of breath, diarrhea, weight loss, and severe constipation. The life cycle is complex between the free-living and parasitic cycles (Johnson-Delaney, 2009; CDC, 2019; Tangtrongsup et al., 2019). Females can produce around 40 eggs per day (Ganesh & Cruz, 2011). Scattered single eggs are found in the feces of mild infections. In severe infections, the eggs are chain-like and enclosed in a thin membrane (Bradbury, 2021). *Strongyloides* sp. have a high zoonotic potential (Mapagha-Boundoukou et al., 2024). A fatal case of Strongyloidiasis has been reported in white-handed gibbons (*H. lar*) in Thailand (DePaoli & Johnsen, 1978).

Trichuriasis is caused by infection with the worm *T. trichiura*, which is often found infecting humans and animals such as primates. Mild infections are usually asymptomatic, but severe infections can cause anemia and digestive problems. The female worm starting to lay eggs 60-70 days after infection. They can produce approximately 3,000 to 20,000 eggs per day. Transmission occurs through feces or orally, where the host accidentally puts soil containing *T. trichiura* larvae along with food into its mouth (Johnson-Delaney, 2009; Brooker & Bundy, 2013; CDC, 2024). A single infection of *Trichuris* sp. causing death has been reported in hamadryas baboons (*Papio hamadryas*) (Eo et al., 2019).

Sources of Parasites Infection

In this study, the food source in primate cage three was placed in a container, but sometimes it was also spread directly on the cage floor. In cage four, the feed was spread directly on the floor of the cage because it did not have a food container. According to Vu et al (2021), Parasitic infections can come from contaminated food sources. The adult male (Adul) in primate enclosure 3 was observed to interact with visitors who provided food. During the study, infant (Boang) was observed to have the most direct contact with visitors, such as taking food given to them or simply touching their hands.

Close contact between humans and primates presents significant health risks between them (Mapagha-Boundoukou et al., 2024). Contaminated water sources and direct contact with humans also facilitate the spread of parasites in the cage environment (Teo et al., 2019; Otranto et al., 2021; Zhang et al., 2025). Zoo keepers can also be a source of parasite spread through the footwear, clothing, hands and equipment they use (Rahman et al., 2023).

The prevalence of parasites in primates in zoos can vary depending on cage hygiene practices, prevention, and anthelmintic treatment (Li et al., 2015; Pencheva, 2013). These measures have been implemented at TMR, namely, daily enclosure cleaning and routine deworming every 3 months to suppress and prevent infection. To reduce the risk of parasite transmission and support the successful development and welfare of animals in zoos, parasite control should be a priority in zoo animal management (Li et al., 2015; Mewius et al., 2021; Otranto et al., 2021).

Conclusion

This study found endoparasites from the Order Strongylida, Order Rhabditida (*Strongyloides* sp.), and Order Enoplida (*T. trichiura*) in 2 Javan gibbon individuals in TMR. The endoparasites found in this study are common in captive and wild Javan gibbons. Two males (adult and infant) were positive for endoparasites, whereas two adult females were negative for infection. Captive animals can be exposed to parasites from contaminated food and drink sources, contact with other vertebrates in the cage environment, and direct interaction with humans. The results obtained show that Javan gibbons infected with endoparasites are still declared in normal condition by the team of doctors because they do not affect their daily behavior. To prevent an increase in infection, preventing direct contact between humans (keepers/visitors) and Javan gibbons should be done more strictly.

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Author Contributions

Conceptualization, APS, LS, and SN; methodology, APS, LS, and SN; validation, LS and SN; formal analysis, APS, LS, and SN; investigation, LS and SN; resources, APS, LS, and SN; data curation, APS, LS, and SN; writing—original draft preparation, APS, LS, and SN; writing—review and editing, APS, LS, and SN; visualization, APS; supervision, LS and SN; project administration, APS, LS, and SN; funding acquisition, APS. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The author declares that she has no conflict of interest.

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