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Dynamics of intraerythrocytic parasite infections in the Java common palm civet (*Paradoxurus hermaphroditus*)

Maritrana Putri[1], Umi Cahyaningsih[2], Damiana Rita Ekastuti[3], Ronald Tarigan[3], Pudji Achmadi[3], Isdoni[3], Koekoeh Santoso[3], Agik Suprayogi[3], Hera Maheshwari[3], Aryani Sismin Satyaningtijas[3,*]

[1] Program of Veterinary Medicine, School of Veterinary Medicine and Biomedical Sciences, IPB University, Bogor, Indonesia
[2] Division of Parasitology and Medical Entomology, School of Veterinary Medicine and Biomedical Sciences, IPB University, Bogor, Indonesia
[3] Division of Physiology, School of Veterinary Medicine and Biomedical Sciences, IPB University, Bogor, Indonesia

ABSTRACT: Over seven weeks, this study investigated intraerythrocytic parasitic infections in the Java common palm civet (*Paradoxurus hermaphroditus*). Blood samples were collected immediately after the civet had been brought from its natural habitat. Following the 30-day adaptation period, additional samples were collected weekly. Our findings revealed infections with Babesia sp., Theileria sp., and Anaplasma sp., with infection rates being the highest for *Anaplasma* sp. (0.35 ± 0.05)%, followed by *Theileria* sp. (0.12 ± 0.05)%, and *Babesia* sp. (0.03 ± 0.02)%. Throughout the study period, the infection rates of *Babesia* sp. and *Anaplasma* sp. decreased, whereas *Theileria* sp. showed an increasing trend until the conclusion of the study.

Keywords:
Anaplasma sp., *Babesia* sp., *Theileria* sp., common palm civet

■ INTRODUCTION

The civet (*Paradoxurus hermaphroditus*), a member of the family Viverridae, is a mammal with significant ecological and economic contributions. This genus includes four distinct species: the common palm civet (*Paradoxurus hermaphroditus*), brown palm civet (*Paradoxurus jerdoni*), golden palm civet (*Paradoxurus zeylonensis*), and Mentawai palm civet (*Paradoxurus lignicolor*) (Riffel *et al*. 1989). Civets are critical in forest ecosystems as seed dispersers that facilitate forest rejuvenation. Although their digestive system is not fully efficient, it allows them to excrete hard grains such as coffee beans that are largely undigested, thus spreading viable seeds across the forest floor (Mudappa *et al*. 2010). Beyond their ecological value, civets also have considerable economic importance.

Coffee beans collected from civet droppings are highly valued in the global market as premium-quality coffee (Cahill 2020). Moreover, the perfume industry benefits significantly from the extraction of civet musk, a substance derived from hormones used to produce luxury fragrances (Taye 2009). However, these economic benefits have led to issues concerning animal welfare and illegal trading, necessitating rigorous regulation and monitoring (Lewis-Whelan *et al*. 2024; Nijman *et al*. 2024).

Regarding health, civets are susceptible to various endoparasites, including blood parasites such as protozoa. Commonly found in both domestic and wild animals, *Babesia* sp. and *Theileria* sp. (Penzhorn 2006), and *Anaplasma* sp. (Dyachenko *et al*. 2012), are also concerns for civets. A study by Orkun and Karaer (2017) highlighted the presence of *Babesia vulpes* in foxes and identified multiple Babesian species such as *B. rossi*, *B. crassa*, and *B. occultans* in ticks collected from wild boars and hares. Despite these findings, the prevalence of these parasites in Indonesian civets remains unreported, underscoring the need for comprehensive health assessments to identify and manage diseases in these animals.

■ MATERIALS AND METHODS

Upon acquisition from its natural habitat, blood samples were collected from the civet the next day. The civet underwent a 30-day adaptation period to acclimate to the new environment, after which another blood sample was collected. Subsequently, two more samples were taken at seven-day intervals. Each blood sample was carefully processed, and a drop of blood was spread into a thin smear on a slide, fixed with methanol to preserve cellular structures, and then stained with Giemsa dye for 30 min (Figure 1). Excess dye was washed away under running water to ensure that only the stained cellular components remained, and the slide was air-dried (Aroon *et al*. 2009).

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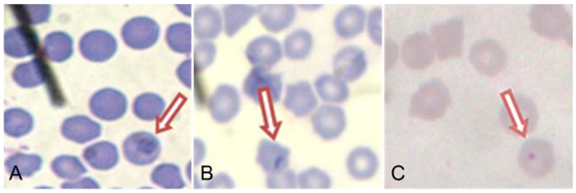

Figure 1. Blood parasites identified in civet blood smears, indicated by arrows: (A) *Babesia* sp., (B) *Theileria* sp., and (C) *Anaplasma* sp.

For microscopic examination, stained blood smears were examined under a microscope using an objective magnification of 100x and an ocular magnification of 10x. This setup facilitated detailed observation of blood parasites. The prevalence of parasites was quantified by counting the parasites per thousand red blood cells (RBCs) and expressing this count as a percentage using the formula (Lehtinen *et al.* 2008):

Number of parasites per 1000 RBCs × 100% .... (1)

■ RESULTS AND DISCUSSION

The extent and severity of parasitic infections within the red blood cells were quantified as the percentage of parasitaemia observed. Table 1 presents the average parasitaemia percentages across different time points for civets infected with *Babesia* sp., *Theileria* sp., and *Anaplasma* sp., each with varying degrees of infectivity. Notably, Anaplasma sp. infections exhibited the highest average parasitaemia rates, particularly on days 1 and 30, with a peak value of 0.38%.

Interestingly, while the parasitaemia levels for *Babesia* sp. remained consistent throughout the study period, from days 1 to 44, *Theileria* sp. demonstrated a notable increase in infection rates on days 30 and 37. This pattern suggests that different dynamics and possibly different immune responses are triggered by each parasite. The pronounced prevalence of *Anaplasma* sp. may be attributed to the diverse array of vectors involved in its transmission compared with the other two parasites. *Anaplasma* sp. can be spread by an extensive variety of vectors, including 20 species of ticks, tabanus flies, mosquitoes, and stable flies, providing multiple pathways for its transmission and increasing the likelihood of infection (Ashadi & Handayani 1992, Hornok *et al*. 2008).

Table 1 Percentage of parasitemia for *Babesia* sp., *Theileria* sp., and *Anaplasma* sp. in civets over a 44-day acclimatization period.

Blood parasite	Blood sampling (Day), parasitemia (%)			
	1	30	37	44
Babesia sp.	0.03±0.08[b]	0.05±0.05[b]	0.02±0.04[b]	0.00±0.00[b]
Theileria sp.	0.05±0.08[b]	0.12±0.19[b]	0.12±0.13[b]	0.17±0.10[b]
Anaplasma sp.	0.38±0.17[a]	0.38±0.10[a]	0.35±0.16[a]	0.27±0.18[a]

Note: Different superscript letters in the same column indicate significant differences at the confidence level of 95% ($p<0.05$).

■ CONCLUSION

In these civets, primary parasitic infections of red blood cells are caused by protozoa (*Babesia* sp. and *Theileria* sp.) and rickettsia (*Anaplasma* sp.). *Anaplasma* sp. showed the highest parasitaemia levels, indicating a stronger infective capacity than *Babesia* sp. and *Theileria* sp.

■ AUTHOR INFORMATION

Corresponding Author

*AS: aryanisa@apps.ipb.ac.id

Division of Physiology, School of Veterinary Medicine and Biomedical Sciences, IPB University, Jln Agathis, Kampus IPB Dramaga, Bogor, 16680, West Java, INDONESIA

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