BIODIVERSITAS
Volume 25, Number 8, August 2024
Pages: 2713-2719

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d250844

Short Communication: Records of Java mouse-deer (*Tragulus javanicus* Gmelin, 1788) in the Cisokan forest patches, West Java, Indonesia

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Manuscript received: 10 June 2024. Revision accepted: 22 August 2024.

Abstract. *Megantara EN, Husodo T, Kendarto DR, Mutaqin AZ, Withaningsih S, Wulandari I, Shanida SS, Febrianto P, Hendrawan R. 2024. Short Communication: Records of Java mouse-deer (*Tragulus javanicus *Gmelin, 1788) in the Cisokan forest patches, West Java, Indonesia. Biodiversitas 25: 2713-2719.* Mammals are bioindicators in terrestrial ecosystems due to their influence on the conservation of other species and in maintaining ecosystem balance, such as the Java mouse-deer (*Tragulus javanicus* Gmelin, 1788), which contributes to seed disperser on the forest floor. Information on the presence of Java mouse-deer is still limited to mammalian diversity studies; therefore, little information focuses on Java mouse-deer studies, especially in the non-conservation areas and infrastructure development areas, such as the Upper Cisokan Pumped Storage (UCPS) development in the Cianjur and West Bandung Districts. This study aims to reveal the presence of Java mouse-deer in the UCPS hydropower development area, West Java. The studies were conducted in February 2017, August 2020, and September 2022. Sign survey, camera trapping, and literature review were applied to this study. Java mouse-deer was found for ten years in the UCPS area. Java mouse-deer was found both directly and indirectly (footprints and feces). Java mouse-deer were discovered in 2012, 2017, 2020, and 2022 in the UCPS area. This species was found in the secondary forest (forest patches), shrubs, mixed gardens, and plantations. This species was most abundant in shrubs and mixed gardens near paddy fields with high levels of human activity. In shrub areas, the topography tends to be cliffy with a dense canopy, making it difficult for humans to pass. Shrub cover is dominated by calliandra (*Calliandra calothyrsus* Meisn.), wild sugarcane (*Saccharum spontaneum* L.), siam weed (*Eupatorium odoratum* L.), and billygoat-weed (*Ageratum conyzoides* L.). Java mouse-deer have been encountered for ten years. Agricultural and construction activities affect the opportunities to encounter the species. Longer-term monitoring of the densities will be essential to reveal the population of Java mouse-deer and how its distribution impacted the development of hydropower plants.

Keywords: Chevrotain, small mammals, ungulate

Abbreviations: UCPS: Upper Cisokan Pumped Storage

INTRODUCTION

Wild populations of chevrotain or mouse-deer are declining because of habitat fragmentation, habitat destruction for timber extraction, and poaching (Adila et al. 2017; Jamhuri et al. 2018; Tee et al. 2018; Nguyen et al. 2019; Petersen et al. 2020). The mouse-deer form a family (Tragulidae) of primitive ungulates distributed in South and South East Asia forests and one in Central and West Africa (Gray 2018). Chevrotain species inhabit primary and secondary lowland rainforests and are hunted for food in all parts of their range (Azhar et al. 2014; Luskin et al. 2014). Java mouse-deer continue to occur in forest patches within human-dominated landscapes (Ripple et al. 2015; Noor Khalidah et al. 2021; Rayan and Linkie 2020), and their presence poses challenges for conservation and management (Khoo et al. 2021). Ungulates influence forest structure and composition, are important food sources for predators, and are seed dispersal agents (Ripple et al. 2015). Mammals are considered bioindicators within terrestrial ecosystems due to their role in conserving other species and upholding ecosystem balance (Udy et al. 2021). The mammal species' roles include the dispersal of vegetation seeds, playing a significant role in maintaining the balance of the rainforest ecosystem (Lacher et al. 2019). The mouse-deer are mainly frugivores and dependent on the availability of fruits (Khoo et al. 2021). Thus, understanding the ecological interactions and activities of ungulates in forest patches is critical for their management and conservation (Khoo et al. 2021).

The Upper Cisokan Pumped Storage (UCPS) is being developed by a state-owned hydropower company (i.e., *Perusahaan Listrik Negara* (PLN) (Persero) *Unit Induk Pembangunan Jawa Bagian Tengah* (UIP JBT) (hereinafter: PLN UIP JBT) with a capacity of 1040 MW. It is the first pumped storage type hydropower plant in Indonesia. PLN is committed to sustainability and consistently seeks to balance economic, social, and environmental performances as a manifestation of the 'triple bottom lines' philosophy to achieve sustainable business growth (PPSDAL Unpad 2017). This commitment also includes a commitment to biodiversity, with the ecological policy aiming to prevent environmental pollution and biodiversity degradation in company operation areas. This development was carried out to meet the increasing demand for electricity at peak loads and improve the reliability of the Java-Bali interconnection system. Currently, the development is at the construction stage, with funding assistance from the World Bank. The water source for the UCPS comes from the Cisokan and Cirumamis Rivers. The UCPS development activities include the construction of two dams and reservoirs, transmission lines, power stations, access roads, quarries, and other facilities, which are estimated to require 723.15 ha (consisting of 337.89 ha of community land and state forest area of 385.25 ha) located in West Bandung and Cianjur Districts (PPSDAL 2014). The construction of the hydropower likely impacted the wildlife habitat, including Java mouse-deer (*Tragulus javanicus* Gmelin 1788) (Shanida et al. 2023).

Tragulus javanicus is listed as Data Deficient (DD), partly reflecting the lack of clarity over how many species of chevrotain occur in Java (IUCN 2024). In Java, the available information about the genus refers to *T. javanicus* was found in Ujung Kulon National Park (Pratiwi et al. 2023), Meru Betiri National Park (Rode-Margono et al. 2014), and Gunung Salak near Halimun Salak Mount National Park (Husodo et al. 2024). In Central and East Kalimantan, chevrotains were found by Bersacola et al. (2019). Based on such rationale, this study aims to reveal the presence of Java mouse-deer in the UCPS hydropower development area, West Java. The study results can enrich current knowledge of Java mouse-deer distribution and its habitat and might also serve as a reference for environmental management in the UCPS area.

MATERIALS AND METHODS

Study area

Administratively, the UCPS hydropower plant development area and its infrastructure cover an area of 775.64 ha (Figure 1), located in two districts, namely West Bandung District (two sub-districts) and Cianjur District (three sub-districts). As a tributary of the Citarum River, the UCPS hydropower plant is located in the upper Cisokan River catchment area, which flows from south to north, leading to the Java Sea. The UCPS hydropower plant construction consists of two dams and a reservoir, transmission line, power station, access road, quarry, and other facilities, estimated to require an area of ±723.15 ha. This area consists of a community area of 337.89 ha and a forest area of 385.25 ha in the West Bandung and Cianjur Districts. The outside area of the UCPS is Perhutani land. The UCPS development area consists of various types of vegetation: natural forests, riparians, shrubs, production forests, mixed gardens, monoculture gardens, paddy fields, and swidden cultivations (PPSDAL 2014). The study area is shown on a 1x1 km grid (Figure 1). There are 47 grids in the study area, covering a total of 47 km^2. Those grids were determined based on the Biodiversity Management Plan 2020 (PPSDAL 2020).

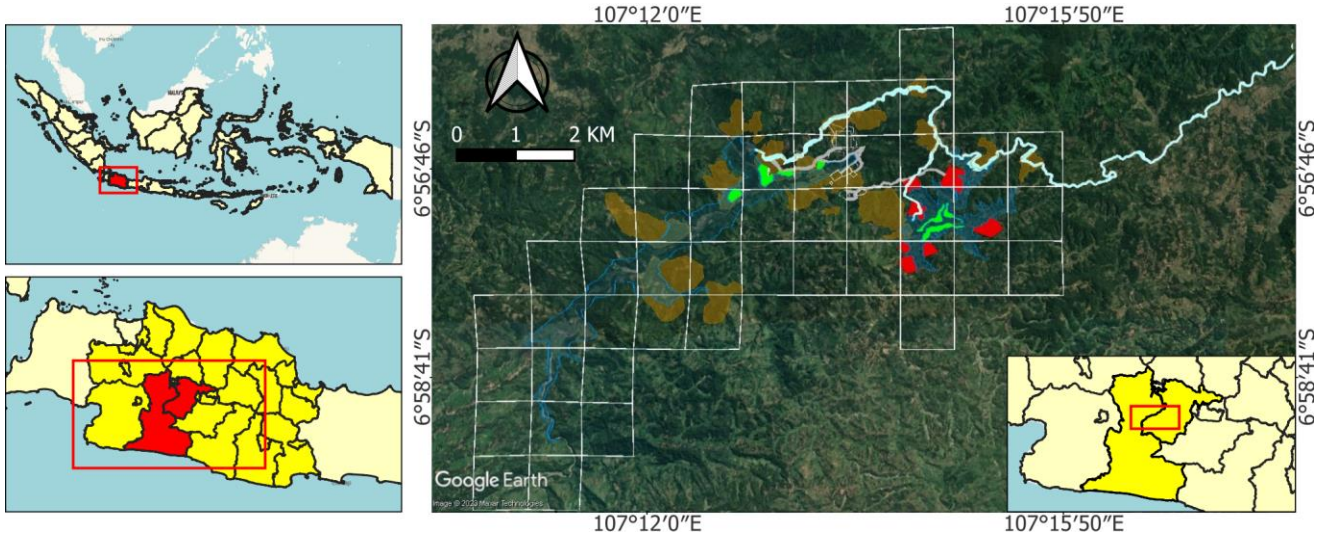

Figure 1. Hydropower plant development area, Cianjur District and West Bandung District, West Java, Indonesia

Procedures

The study was conducted in February (2017), August (2020), and September (2022) during the construction phase. Studies were conducted every two to three years to describe the Java mouse deer's presence during rapid environmental changes due to the construction process. Each year, the observations were conducted for four weeks by 14 surveyors. The study was conducted through qualitative methods, combining several techniques, such as the sign survey, camera trapping, and literature review.

Sign survey

The sign survey was conducted from 06.00 a.m. - 04.00 p.m. (10 hours) for two weeks, looking for footprints and feces left behind. The observation was conducted in several land covers, including natural forests, plantations, mixed gardens, monoculture gardens, riparian, paddy fields, and swidden cultivation. Indirect evidence is advantageous when observing rare, elusive creatures found in low densities that are challenging to capture. Therefore, observing indirect evidence, the presence of medium and big animals was also precisely shown (Campos et al. 2013; Borges et al. 2014; Dereje et al. 2015). Locations were recorded using a GPS (Garmin 62s).

Camera trapping

Camera traps have assessed many ecological processes, including behavior, occupancy, biodiversity, and density (Burton et al. 2015). Ecologists' specific objectives, sampling strategies, and data determine which analytical techniques are employed to evaluate these processes (Keim et al. 2019). Camera traps are widely used in Southeast Asia for conservation and research, particularly for inventorying ground-dwelling large mammal diversity within conservation landscapes (Moo et al. 2017).

We deployed 15 units in 2017, and 9 units in 2020 and 2022, respectively, to optimize the observation time for 24 hours. Per year, after encountering presences (feces or footprints) from the sign survey, we deployed camera traps near presences. We also consider information from previous research and local communities regarding encounters with Java mouse-deer during farming or activities in the forest. Cameras were set between 30 - 50 cm above and perpendicular to the ground. Cameras were set in hybrid mode and left in two weeks. All photographs were checked manually, and the author identified mammal encounters as species (Gray 2018). We selected the exact point of camera placement based on visible animal trails, footprints, animal scents, animal activity areas, and/or near streams (Sasidhran et al. 2016).

Literature review

The literature used as secondary data collection is the final report: A study on flora and fauna in the project area of HEPP "Upper Cisokan Pumped Storage" West Java by The Indonesian Institute of Sciences (2012). They observed in the reservoir area (upper and lower dam). They set 10 camera traps in the reservoir area within three months.

Data analysis

The presence of the Java mouse-deer was tabulated in Microsoft Excel. The presences were mapped into the land cover map using Google Earth, overlaid by the hydropower development plan area (PPSDAL Unpad 2017) to illustrate the Java mouse-deer distribution.

RESULTS AND DISCUSSION

We found 16 findings of feces, footprints, and direct encounters (camera trapping) of Java mouse-deer (Table 1; Figure 3). Several factors influenced the findings: the time of day, the number of surveyors, and the methods applied. The agricultural period also influences wildlife findings related to the intensity of human activities on farmland. We observed 23 grids in 2017, 28 grids in 2020, and 28 grids in 2022 respectively. In February and March 2017, the agricultural phase had entered the 30-45 days planting period, so the level of human activity in an area was lower. Therefore, footprints and feces from Java mouse-deer were observed. However, in August 2022, the agricultural phase was land clearing using the slash-burning method, so human activity at that time was very high. Therefore, the surveyors did not find the Java mouse-deer previously seen in the same area.

Based on land cover, Java mouse-deer are discovered primarily on densely canopied vegetation, such as shrubs that are difficult for humans to traverse. Our results showed that the *Tragulus kanchil* detection increased with the percentage of canopy cover. This discovery suggests that *T. kanchil* prefers habitats of dense evergreen closed-canopy forests (Hazwan et al. 2020). Java mouse-deer was also discovered on slope areas near streams and waterfalls dominated by calliandra (*Calliandra calothyrsus* Meisn.), wild sugarcane (*Saccharum spontaneum* L.), siam weed (*Eupatorium odoratum* L.), and billygoat-weed (*Ageratum conyzoides* L.). Its encounter with the calliandra shrubs was also evidenced by camera trapping. In general, these areas of calliandra shrubs are fallow land. Java mouse-deer are also found in vegetation with many seedlings, such as near waterfalls and rivers in forest patches. In other studies, *T. kanchil* was higher in an area with abundant food plants, e.g., *Sapium baccatum* (Magintan et al. 2017). Another environmental factor, Pla-ard et al. (2022), found that salt lick sites and water sources increased the probability of the appearance of lesser oriental chevrotain.

Java mouse-deer are also commonly found in mixed gardens and monoculture gardens. In some areas, the mixed and monoculture gardens are adjacent to paddy fields, resulting in high levels of human activity. Finding the species in the mixed and monoculture gardens may be related to food availability. Java mouse-deer footprints were found in the chili and peanut gardens. Near its footprints, some leaves of peanut plants were discovered with bite marks, which were assumed to be from Java mouse-deer. *Tragulus kanchil* can be found in disturbed and fragmented areas (e.g., plantations, rural areas, and degraded forests) across Malaysia (Ramesh et al. 2013; Magintan et al. 2017; Tee et al. 2018; Jambari et al. 2019).

According to the previous study, the logged forest reserves had higher *T. kanchil* detection rates than unlogged forest reserves (Hazwan et al. 2020). The chevrotains (*Tragulus* spp.) were relatively more common in the logged forest than in unlogged forest (Granados et al. 2016). This discovery suggests that Java mouse-deer adapts to anthropogenic disturbances, such as mixed gardens, monoculture gardens, and logged forests).

Based on the study period, some grids were rediscovered with Java mouse-deer. In E1, Java mouse-deer was re-encountered after eight years, F2 was re-encountered after three years, G1 and G2 were re-encountered after five years, and G3 was re-encountered after eight years. In 2020 and 2022, there were fewer Java mouse-deer encounters due to construction and agricultural activities. These activities, particularly land clearing and slash-burning during agricultural phases, may have disrupted their usual habitats and food sources, temporarily reducing their presence or movement to less disturbed areas. Based on camera trap encounters, Java mouse-deer were encountered during the day and at night. In Figure 3, Java mouse-deer were observed to be active during the day at 02:15 p.m. and 03:12 p.m., while in the night encounter, we did not receive information on the exact activity time. They were also active in the morning at 06:31 a.m. and 08:50 a.m. These encounters suggest that the Java mouse-deer is diurnal and crepuscular. The lesser mouse-deer and Java mouse-deer are more active during the day or crepuscular (Gray 2018; Lyamin et al. 2022).

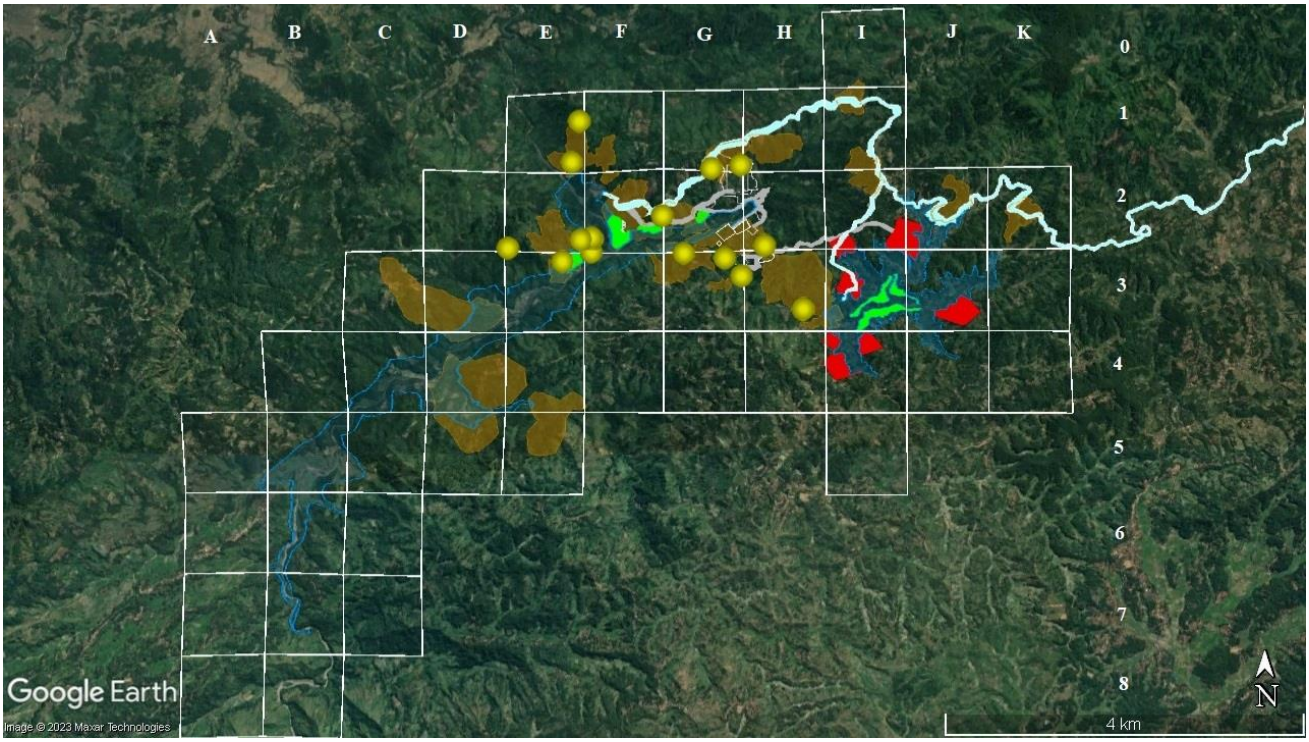

Figure 2. Java mouse-deer distribution in the Hydropower plant development area, Cianjur District and West Bandung District, West Java, Indonesia. Note: □: Switch yard, outlet, administration building, cable termination; ■: Disposal; ■: Reservoir; ■: Permanent Access Road; ■: Temporary Access Road; ■: Biodiversity Important Area; ■: Sliding area; ●: Java mouse-deer's presence

Table 1. The existence of Java mouse-deer in the Cisokan hydropower plant area, West Java, Indonesia

Grids	Years				Land cover types			
	2012	2017	2020	2022	Natural forests	Mixed garden	Shrubs	Plantations
E1	1	0	1	0	+	+	-	-
E2	0	1	0	0	-	-	+	-
E3	0	1	0	0	-	-	+	-
F2	0	3	1	0	-	-	+	+
G1	0	1	0	1	-	-	+	-
G2	1	1	0	0	-	+	+	-
G3	1	0	1	0	+	+	-	-
H2	1	0	0	0	+	+	-	-
H3	0	1	0	0	-	-	+	-
Total	4	8	3	1	3	4	6	1

Sources: Primary Data (2017, 2020, 2022); The Indonesian Institute of Sciences (2012); note: 1-8 & + : presence (footprints/ feces/ direct encounters through camera trap)

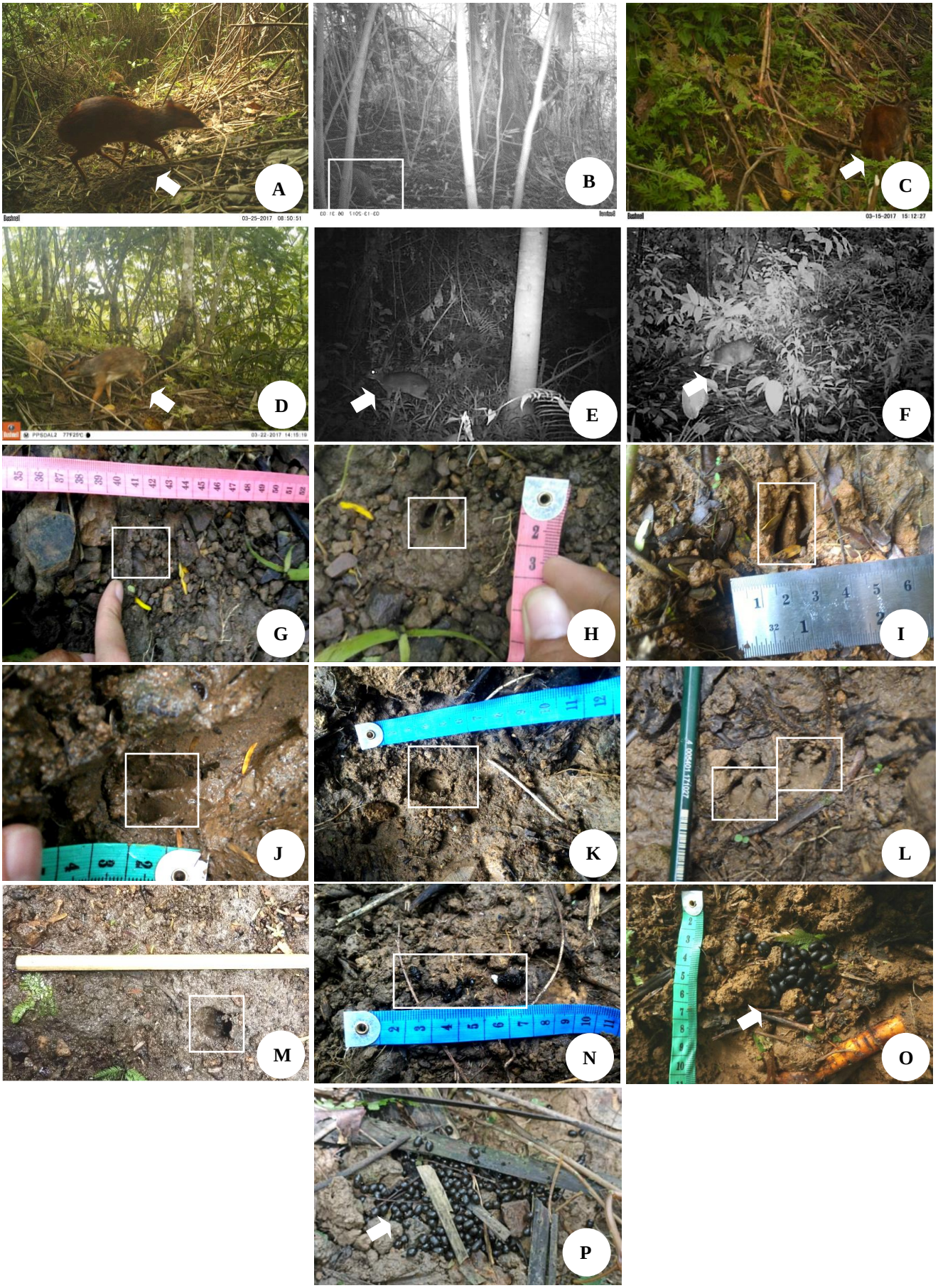

Figure 3. Existences of Java Mouse-deer; A-F. Camera trapping (2012 & 2017), G-M. Footprint (2017), N-P. Feces (2017, 2020, 2022). Sources: The Indonesian Institute of Sciences (2012), PPSDAL UNPAD (2017), CESS (2020), Primary Data (2022)

Based on their distribution, 13 of 16 Java mouse deer were found within the UCPS plan area (Figure 2). This discovery suggests that Java mouse-deer habitat and home ranges overlap with development areas and will be threatened by development if they continue to settle in these areas. Although the other findings were found further away from the UCPS construction area, the noise generated during construction can disturb all animals, including Java mouse-deer. The Java mouse-deer may move away from the construction area towards the settlement area adjacent to the monoculture gardens, mixed gardens, and fallow land/shrubs, such as the settlement in the grid of 3F, 4F, 4G; the fallow land/shrubs and mixed gardens in the grid of 2D, 1F, 0E, and 0F.

In conclusion, Java mouse-deer have been encountered for ten years in the UCPS area. They are most commonly found in shrubs, followed by mixed gardens with high levels of human activity. Agricultural and construction activities affect the opportunities to encounter the species. Longer-term monitoring of the densities will be essential to reveal the population of Java mouse-deer and how its distribution impacted the development of hydropower plants.

ACKNOWLEDGEMENTS

Acknowledgements were given to PT. PLN UIP JBT (Hydropower Company), *Perum Perhutani* (Forestry Company), Rector and *Direktorat Riset dan Pengabdian kepada Masyarakat* (DRPM) of Universitas Padjadjaran, Sumedang, Indonesia through Academic Leadership Grant (ALG) - Prof. Dr. Erri Noviar Megantara, PUIPT CESS (*Pusat Unggulan IPTEK Perguruan Tinggi* Center of Environment and Sustainable Science), Universitas Padjadjaran, researcher team, surveyor team, and the local community.

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