

Foot stamping and tail flagging by mouse-deer *Tragulus* spp.

Bee Choo Strange¹, Marcus AH Chua²

¹Wild Vigil Network

²Lee Kong Chian Natural History Museum, National University of Singapore

A - Research concept and design, B - Collection and/or assembly of data, C - Data analysis and interpretation, D - Writing the article, E - Critical revision of the article, F - Final approval of the article

Marcus AH Chua  [0000-0002-0229-5127](https://orcid.org/0000-0002-0229-5127)

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Foot stamping and tail flagging in chevrotains (Tragulidae) are poorly understood behaviours often attributed to anti-predator displays or communication. We report rare wild observations of these behaviours during agonistic interactions in lesser mouse-deer (*Tragulus kanchil*) and greater mouse-deer (*Tragulus napu*) in Singapore. In lesser mouse-deer, foot drumming and tail flagging occurred during a territorial dispute between two males, accompanied by a novel pelvis-dropping behaviour potentially linked to scent marking. In greater mouse-deer, tail flagging was observed during a skirmish. These findings suggest foot stamping functions as an intraspecific signal of dominance or resource holding potential, rather than solely as an alarm signal.

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Corresponding author

Marcus AH Chua

Lee Kong Chian Natural History Museum, National University of Singapore;

email: marcuschua@nus.edu.sg

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Bee Choo Strange¹, Marcus A. H. Chua^{2*}

¹ Wild Vigil Network, 29 Transit Road, 4-13, Singapore 778905, Singapore

² Lee Kong Chian Natural History Museum, National University of Singapore, 2 Conservatory Drive, Singapore 117377, Singapore (Corresponding author: marcuschua@nus.edu.sg)

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Abstract

Foot stamping and tail flagging in chevrotains (Tragulidae) are poorly understood behaviours often attributed to anti-predator displays or communication. We report rare wild observations of these behaviours during agonistic interactions in lesser mouse-deer (*Tragulus kanchil*) and greater mouse-deer (*Tragulus napu*) in Singapore. In lesser mouse-deer, foot drumming and tail flagging occurred during a territorial dispute between two males, accompanied by a novel pelvis-dropping behaviour potentially linked to scent marking. In greater mouse-deer, tail flagging was observed during a skirmish. These findings suggest foot stamping functions as an intraspecific signal of dominance or resource holding potential, rather than solely as an alarm signal.

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Foot stamping and tail flagging—behaviours common in artiodactyls—has evolved in different lineages of mammals and is often associated with intra-specific communication or antipredator function (Huang *et al.*, 2025; Randall, 2001). Foot stamping or drumming is thought to have evolved independently in different lineages of mammals, including rodents, carnivorans, artiodactyls, marsupials, lagomorphs, and elephants (Randall 2001). It involves hitting a substrate with the foot to produce sound or seismic vibrations. In artiodactyls, possible functions include alarm or anti-predator behaviour, advertising territory or deterring intruders, intra-specific competition, and courtship (Caro *et al.*, 1995, 2004; Caro and Stankowich, 2010).

In chevrotains (Family Tragulidae), a sister group to all other ruminants, foot stamping is apparently only observed in chevrotains in Southeast Asia (i.e., mouse-deer *Tragulus*) and it is not known to occur in the African (*Hyemoschus*) or the Indian subcontinent (*Moschiola*) lineages (Caro *et al.*, 2004; Ralls *et al.*, 1975; Ridley, 1895). As a basal ruminant, chevrotains do not have many derived characters in ruminants such as antlers and horns, and are generally considered important in the study of ecology and evolution of ruminants (Chen *et al.*, 2019; Hackmann and Spain, 2010; Meijaard, 2011).

The function of foot stamping in mouse-deer is thought to be for communication. Various authors have interpreted it as signaling alarm or warning. However, the context of the message and target is largely unclear. Ridley (1895) stated that mouse-deer stamp their feet to call to each other and individuals may approach the source of the stamping. In Borneo, it was noted that female mouse-deer frequently engage in drumming with their hindlegs simultaneously (Asdell, 1946), although the reason for doing so is unknown. Ralls et al. (1975) observed that both sexes of greater mouse-deer (*T. napu*) do so with one or both hooves simultaneously in captivity, but half of recorded stamping occasions did not result in response from other individuals present. In other occasions, only males responded with stamping their own feet after other individuals of either sex did so.

Tail flagging, which is holding the tail vertically so the underside is displayed, is even less known in mouse-deer. The function of this behaviour is debated to be possibly for intraspecific communication, to confuse predators as a flash display, or could serve no adaptive or multiple functions across artiodactyl species (Caro *et al.*, 2004, 2020; Stankowich, 2008). Ralls et al. (1975) noted that greater mouse-deer often flagged their tail when marking using their inter-mandibular gland. Males tail flagged while pursuing females and during agonistic encounters with other males. Meanwhile, unreceptive females held their tail in a vertical position and squirted urine towards the rear while being pursued. Infants were observed tail flagging on their first day of life. Davison (1980) recorded tail flagging when male lesser mouse-deer (*T. kanchil*) chased each other, but not when marking using their inter-mandibular gland. Caro et al. (2004) considered this a behaviour trait in which little or no information was available for chevrotains.

Here we report for the first time in the wild where lesser mouse-deer were observed to drum their feet and display tail flagging behaviour during an agonistic interaction, and an additional observation of tail flagging behaviour of greater mouse-deer in the wild.

On 30 October 2025, the first author (BCS) heard a rattling sound at around 1733 hrs along the boardwalk of a forested Lower Peirce Trail of the Central Catchment Nature Reserve in Singapore. A few minutes later, a lesser mouse-deer (*T. kanchil*) was seen stamping its hind legs on the forest floor around 3 metres away, on the southern side of the boardwalk. There was no accompanying vocalisation. A video recording was made of its tapping (Supplementary Video). This individual had visible canines protruding out from its mouth, a characteristic of mature male mouse-deer (Fig. 1A). He mostly stamped the ground with alternate hindfoot consecutively, occasionally stamping the forest floor with both hindfeet simultaneously. The stamping behaviour was almost always accompanied with tail flagging—raising of the tail vertically. In a few instances (timestamps 00:16 and 00:46), he would drop his pelvis to the ground with the tail raised after stamping (Fig. 1C).

Stamping was heard from the northern side of the forest (on the opposite side of the boardwalk; discernible from video from about 00:06 onwards), where another male lesser mouse-deer was seen. This individual was smaller than the first male mouse-deer (Fig. 1B). The smaller mouse-deer approached the larger mouse-deer and was chased away twice. The larger mouse-deer made a call while chasing the other individual away.

At 1757 hrs, the larger mouse-deer was still observed tapping its hindlegs on the forest floor (link). The smaller mouse-deer was not seen then. The larger individual later went off to the northern side of the forest and was continued to be seen until 1820 hrs.

On 12 Feb 2026 around 1930 hrs, the second author (MAHC) heard rustling among vegetation in secondary forest near Chek Jawa on Pulau Ubin, Singapore and shortly after observed two greater mouse-deer bounding out of the forest across a dirt trail. Both individuals had their tails raised, showing the white undersides, and continued their skirmish in the forest across the trail. Because of the dark conditions, the sex of both individuals is unknown and footage of the event was not taken.

Based on the observed interactions, foot stamping appeared before and after agonistic interaction between the two mature male lesser mouse-deer. Unlike the ambiguous context often recorded in captivity, the wild behaviour observed here seem to be explicitly directed towards a conspecific rival. The rattling sound produced against the substrate during stamping likely serves as an auditory advertisement of presence and resource holding potential, possibly intended to intimidate the rival without requiring immediate physical contact or skirmish. This could be similar to vocalization or visual displays that convey individual size or quality, and could influence contest structure or outcome (Jennings and Gammell, 2013). As chevrotains live in forest, are generally nocturnal or crepuscular and do not have horns or antlers (Meijaard 2011), foot stamping could possibly be an important honest signal of quality. The dropping of the pelvis to the ground and tail flagging in between stamping is a behaviour that has not been reported in scientific literature. It may suggest scent marking using inguinal or anal glands, perhaps as part of a multi-modal communication to maintain territory or dominance.

The vertical raising of the tail was associated with stamping of the hindlegs in lesser mouse-deer and during pursuit between two greater mouse-deer individuals. This suggests that tail flagging in mouse-deer is not solely a predator confusion mechanism or intraspecific communication. The forest and recreational trail at the first observation site is located close to human habitation, so the animals are likely used to human presence and are not reacting to human presence. Moreover, mouse-deer are not hunted by humans in Singapore. Meanwhile, Stankowich (2008) suggested that tail erection in deer is an antigravity muscle reflex involving contraction of extensor muscles, occurring when the animal is preparing for or engaged in locomotion. In such instances, it may lack antipredator function. Interestingly, Davison (1980) observed territorial fighting between two mature male lesser mouse-deer in the presence of a female individual in Peninsular Malaysia. During the conflict that lasted at least 100 minutes, foot stamping was not recorded, although tail flagging behaviour was observed in both male mouse-deer, and vocalization was heard.

These observations of mouse-deer offer rare insights into chevrotain behaviour. Chevrotains are known to be difficult to observe in the wild because of their shy and typically nocturnal habits (Meijaard 2011). However, the recent population growth of chevrotains in Singapore brought about by effective conservation efforts and wild pig (a resource competitor/predator) decline from African Swine Fever likely enabled these observations to be made more easily

(Chua *et al.*, 2026; Khoo *et al.*, 2021). By documenting foot stamping and tail flagging within an explicit agonistic context in the wild, we support the hypothesis that foot stamping serves as a communicative function between conspecifics distinct from anti-predator displays, while tail flagging in mouse-deer could be a reflex action due to locomotion. Understanding how these ruminants resolve conflict without morphological weaponry of other artiodactyls provides a window into ancestral ungulate behaviour.

Figure caption

Figure 1A. Larger male lesser mouse-deer (*Tragulus kanchil*), B. Smaller male lesser mouse-deer, 1C. Lesser mouse-deer with tail raised dropping pelvis to the ground.

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Supplementary Online Material[Download source file \(32.09 MB\)](#)

Supplementary Video