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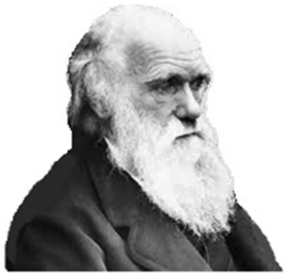

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Seasonal Patterns of Hog Deer (*Axis porcinus*) Antler Development in Sri Lanka

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ABSTRACT

Cervids exhibit an antler cycle closely tied to environmental cues, notably photoperiod, which regulates growth, mineralization, velvet shedding, and casting stages, aligning with seasonal shifts in temperate regions. However, in a tropical country like Sri Lanka, where photoperiod variation is minimal, it remains unclear how introduced cervid species such as the hog deer (*Axis porcinus*) regulate their antler cycles. This study investigates the antler cycle of hog deer aging between one and five years in a tropical environment, focusing on the timing of antler development. Data collected from a captive population in Sri Lanka over five years allowed for detailed classification of antler stages by age, morphology, and season. Three primary stages — Single Spike, Short Forked Antler, and Long Three-Spiked Antler — were observed, with further categorization into Velvet and Hard Antler stages, each displaying distinct timing and progression aligned with resource availability. Notably, antler development in hog deer retained a seasonal structure, with the Velvet Antler phase occurring from February to March and the Hard Antler phase extending from April through January, consistent with the species' reproductive timing in its native range. These results suggest that despite a stable tropical environment, hog deer maintain seasonally adaptive antler patterns, underscoring the persistence of evolutionary traits in non-native settings. This research contributes to understanding cervid biology in tropical ecosystems and informs management strategies for hog deer in Sri Lanka, highlighting the importance of considering seasonal behaviors in conservation efforts as environmental conditions evolve.

***Keywords*:** Antler, Development, Hog deer, Seasonal, Stage

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1. INTRODUCTION

Cervids exhibit a distinct seasonality in their antler cycle, largely influenced by environmental factors such as photoperiod (day length), temperature, and resource availability (Asher, 2011). In temperate regions, where photoperiod changes are pronounced, the stages of the antler cycle — growth, mineralization, velvet shedding, and antler casting — are closely synchronized with seasonal shifts. This alignment allows cervids to time their reproductive activities with periods of optimal resource abundance, maximizing their fitness and survival (Umapathy et al., 2007).

The antler cycle in temperate cervids is primarily regulated by photoperiod, which triggers hormonal changes, particularly in testosterone levels (Bubenik et al., 1991). As day length increases in spring, hormonal shifts stimulate antler growth, during which antlers are covered in “velvet” — a nutrient-rich tissue that supplies blood and minerals for rapid growth. This growth phase generally corresponds with warmer months, when food is abundant, supporting the high energy demands of antler development. Later in the year, rising testosterone levels in late summer prompt the mineralization and shedding of velvet, hardening the antlers in preparation for the rut, or mating season (Kierdorf et al., 2007). During the rut in fall, peak testosterone levels maintain antler hardness, enabling males to engage in competitive displays for mates. After the breeding season, testosterone declines, initiating the casting or shedding of antlers, typically in winter, when conserving energy is vital due to limited resources (Ramesh et al., 2013; Vanpé et al., 2007).

However, in tropical regions like Sri Lanka, where photoperiod changes are minimal, the seasonality of the antler cycle may differ significantly (Weerasekera et al., 2020). Without strong photoperiod cues, tropical cervids may rely more on factors such as rainfall and resource availability to time their antler stages, potentially displaying a more flexible and adaptive cycle. This unique adaptation could allow species like the hog deer (*Axis porcinus*) in Sri Lanka to synchronize their antler growth and reproductive stages with periods of resource abundance, even in the absence of marked seasonal changes in daylight.

This study aims to investigate the antler cycle of hog deer in Sri Lanka, examining how the timing of antler growth, velvet shedding, and casting aligns with local environmental factors such as rainfall and resource availability. By exploring these dynamics, this research seeks to understand how tropical cervids adapt their antler cycles in response to their unique ecological conditions, contributing to the broader knowledge of cervid biology in tropical ecosystems and informing conservation strategies for the hog deer in Sri Lanka.

2. MATERIALS AND METHODS

Data on the antler stages of hog deer were collected from a captive population (n=15) in Zoos and Temples of ages ranging from 1 to 5 years in Sri Lanka to analyze variations in antler development across different age groups. For each individual, data were recorded on the age of the captive stags and the antler stages. This observation was done over five years from 2018 to 2024. This approach facilitated comprehensive documentation and categorization of antler development in hog deer within a tropical environment, where photoperiod changes are minimal and resource availability may significantly influence antler growth patterns (Figure 1).

The observed antler stages were classified into categories based on age and antler morphology. This classification enabled a thorough examination of the antler condition in adult hog deer, providing insights into the seasonal progression of antler stages within a tropical context. The dates for each observed antler stage were meticulously recorded.

Figure 1. A male hog deer in hard antler stage from Galathota temple, Rajgama, Sri Lanka (2023-03-22).

3. RESULTS

The antler stages observed in hog deer were categorized into three distinct phases based on age and antler morphology. The first stage, Single Spike, was characterized by antlers with a single point, typically found in one-year-old stags (Figure 2A). The second stage, the Short-Forked Antler, consisted of short, bifurcated antlers commonly observed in two-year-old stags (Figure 2B). The final stage, Long Three-Spiked Antler, represented mature antlers with three prominent points, typical of fully grown adult stags (Figure 3). These classifications provided a clear framework to track antler growth progression across different age groups and under varying environmental conditions.

Figure 2. Antler development in young male hog deer. (**A**) Single spiked antler in a yearling male fawn. (**B**) Short spiked antler in a two-year-old male fawn.

Figure 3. Antler morphology in a stag, displaying three distinct points. (1) Main beam, (2) Brow tine, (3) Forked tine.

For the experimental analysis, only adult stags below five years of age with fully developed, three-spiked antlers were included (Figure 3). The antlers of these stags were categorized into two main stages: Velvet Antler and Hard Antler. The Velvet Antler stage was further subdivided into three phases: Velvet Antler Growing, Velvet Antler Complete, and Velvet Stripping. The Hard Antler stage was divided into two Stages: Hard Antler and Cast Antler. This classification enabled detailed tracking of antler development across the different stages. The Hard Antler stage was observed from April to January next year. The Cast Antler stage was recorded at the end of January and the beginning of February in the same year. All phases of the Velvet Antler stage, including Velvet Antler Growing, Velvet Antler Complete, and Velvet Stripping, were observed at the end of February and the beginning of March in the same year (Figure 4). These observations reflect the seasonal progression of antler development in the studied stags.

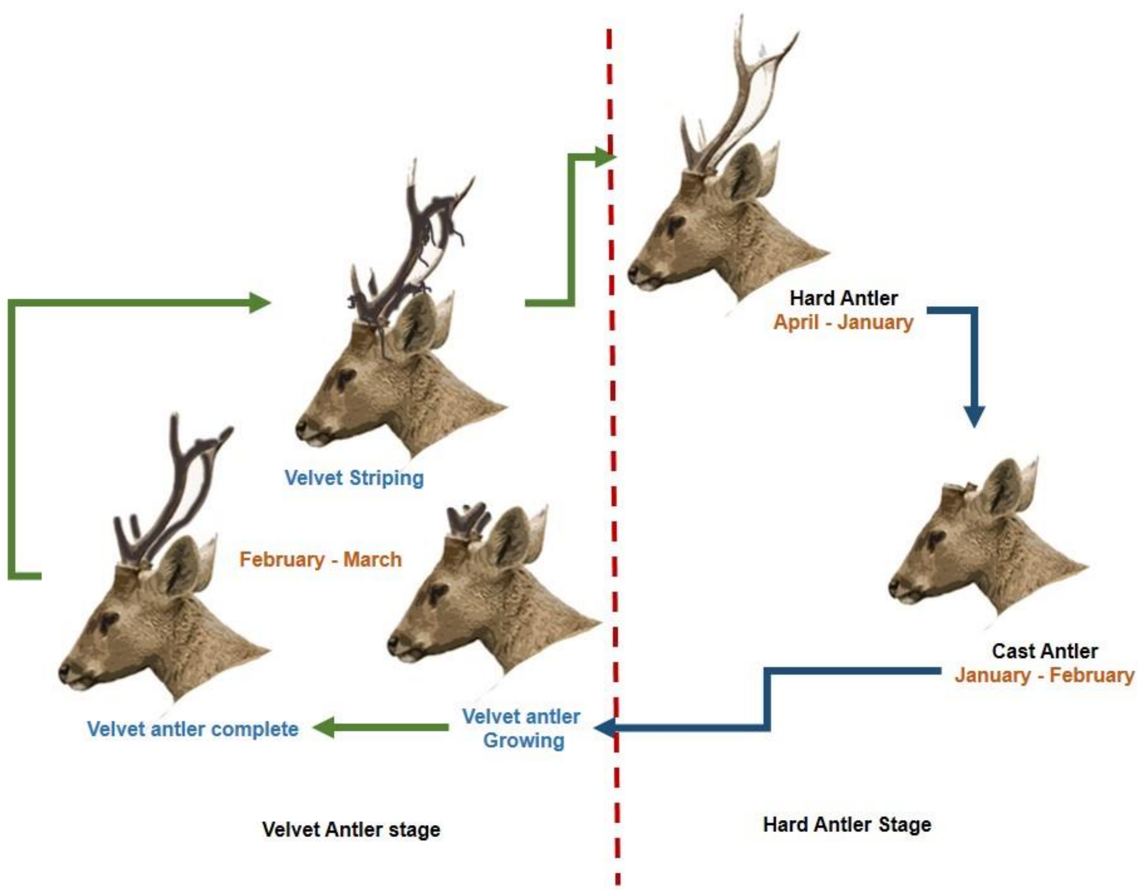

Figure 4. Seasonality of antler growth stages in hog deer, illustrating the progression of antler development throughout the year.

4. DISCUSSION

The results of this study confirm a marked seasonality in hog deer antler growth stages in Sri Lanka, where it is largely considered an introduced species. This seasonality is evidenced by distinct antler phases aligning with environmental cycles, a pattern similar to what has been observed in other tropical and subtropical countries with seasonal climates, in Nepal, and parts of Southeast Asia (Sanat and Dhungel, 2016). In its native range, hog deer exhibit synchronized antler growth that corresponds with the wet and dry seasons, which influence food availability and mating periods. The seasonal cycle appears to be an evolutionary adaptation retained in hog deer populations, even when introduced to new regions such as Sri Lanka, where they must adjust to local climate conditions (McCarthy and Dissanayake, 1994).

In Sri Lanka, hog deer have long been considered non-native, introduced either by colonial settlers or through zoo and wildlife exchanges in the 19th and 20th centuries (McCarthy and Dissanayake, 1994). Their adaptive antler growth patterns, structured by age and morphology, indicate that despite the stable tropical environment, they retain a seasonally responsive reproductive strategy. Hog deer exhibit three distinct antler growth stages based on age: Single Spike in yearling stags, Short Forked Antler in two-year-old stags, and Long Three-Spiked Antler in mature adults. This phased antler morphology aligns closely with seasonal shifts in their native habitats, where a single breeding season often favors competitive displays and social dominance among mature stags (Asher, 2011; Durrant et al., 1996).

In regions such as India and Nepal, hog deer experience annual cycles that align with monsoon-driven wet and dry periods, which impact food availability and prompt breeding activities (Seidensticker, 1986). Studies have shown that antler cycles in these regions are closely tied to rainfall and vegetative growth, which support higher reproductive activity and antler growth during the post-monsoon months (Seidensticker, 1986). Similar seasonality has been observed in Southeast Asia, where hog deer populations follow distinct antler cycles that allow them to maximize reproductive success by timing the growth and hardening of antlers to align with peak breeding periods (Pitra et al., 2004).

In contrast, other deer species in Sri Lanka, such as Sambar (*Rusa unicolor*) and Spotted deer (*Axis axis*), exhibit aseasonal antler cycles, an adaptation thought to be influenced by Sri Lanka's stable tropical climate (Weerasekera et al., 2020). The lack of pronounced seasonality in antler growth stages in these native species likely reflects their evolutionary adaptation to continuous food availability and the absence of environmental pressures to synchronize breeding events (Tyler et al., 2020). For these species, a flexible antler and reproductive cycle may enhance their ability to exploit resources and breeding opportunities year-round, rather than being limited to a specific season as in the hog deer (Putman and Flueck, 2011).

In our study, the categorization of hog deer antlers into Velvet and Hard Antler stages and their respective phases — Velvet Antler Growing, Velvet Antler Complete, Velvet Stripping, Hard Antler, and Cast Antler — provides a comprehensive framework to analyze seasonality in antler growth. Notably, the Velvet Antler stages observed in February and March align with a period when other tropical populations of hog deer would also begin preparing for breeding, suggesting that even in a non-native tropical environment, hog deer retain the seasonally adaptive antler growth patterns characteristic of their species (Durrant et al., 1996). The Hard Antler phase documented from Mid of March 2018 to January 2023 likely corresponds to the primary breeding season, consistent with the patterns observed in native ranges where hard antlers are advantageous for male-male competition during mating season (Durrant et al., 1996; Tripathi et al., 2019).

These findings underscore the resilience of hog deer's evolutionary adaptations, even in non-native environments, and highlight how introduced species may retain seasonally structured life-history traits despite new environmental conditions.

This research contributes to understanding the impacts of seasonality on cervid antler development across different climates and provides valuable insight into managing introduced species in tropical ecosystems. The persistence of antler seasonality in hog deer, even in Sri Lanka, suggests that wildlife managers should consider the species' seasonal behaviors when planning conservation and control efforts, especially as climate change and habitat fragmentation may affect the timing and availability of resources (Davis et al., 2016).

5. CONCLUSION

This study reveals that hog deer in Sri Lanka, despite being introduced to a tropical environment, retain distinct seasonal antler growth stages — a trait that contrasts with the aseasonal cycles observed in native Sri Lankan deer like Sambar and Spotted deer. The hog deer's antler stages, structured by age and morphology, suggest they maintain reproductive and growth patterns from their native, more seasonal habitats. These findings underscore the persistence of evolutionary adaptations in introduced species, providing valuable insights for managing hog deer populations in tropical settings. Understanding these patterns is essential for conservation planning, particularly as environmental changes continue to affect ecosystem dynamics.

References

[1] Asher, G.W. (2011). Reproductive cycles of deer. *Animal Reproduction Science*, 124(3–4), 170–175. https://doi.org/10.1016/j.anireprosci.2010.08.026

[2] Bubenik, G.A., Brown, R.D. and Schams, D. (1991). Antler cycle and endocrine parameters in male axis deer (*Axis axis*): Seasonal levels of LH, FSH, testosterone, and prolactin and results of GnRH and ACTH challenge tests. *Comparative Biochemistry and Physiology -- Part A: Physiology*, 99(4), 645–650. https://doi.org/10.1016/0300-9629(91)90144-2

[3] Davis, N.E., Bennett, A., Forsyth, D.M., Bowman, D.M.J.S., Lefroy, E.C., Wood, S.W., Woolnough, A.P., West, P., Hampton, J.O. and Johnson, C.N. (2016). A systematic review of the impacts and management of introduced deer (family Cervidae) in Australia. *Wildlife Research*, 43(6), 515–532. https://doi.org/10.1071/WR16148

[4] Durrant, B.S., Oosterhuis, J.E., Johnson, L., Plotka, E.D., Harms, P.G. and Welsh, T.H. (1996). Effect of testosterone treatment on the antler cycle of an Indian hog deer (Cervus porcinus) with low endogenous level of testosterone. *Journal of Zoo and Wildlife Medicine*, 27(1), 76–82.

[5] Kierdorf, U., Kierdorf, H. and Szuwart, T. (2007). Deer Antler Regeneration: Cells, Concepts, and Controversies. *Journal of Morphology*, 268, 726–738. https://doi.org/10.1002/jmor

[6] McCarthy, A.J., and Dissanayake, S.B. (1994). Status of the hog deer in Sri Lanka. *Oryx*, 28(1), 62-66. https://doi.org/10.1017/S0030605300028301

[7] Pitra, C., Fickel, J., Meijaard, E. and Groves, C.P. (2004). Evolution and phylogeny of old world deer. *Molecular Phylogenetics and Evolution*, 33(3), 880–895. https://doi.org/10.1016/j.ympev.2004.07.013

[8] Putman, R. and Flueck, W.T. (2011). Intraspecific variation in biology and ecology of deer: Magnitude and causation. *Animal Production Science*, 51(4), 277–291. https://doi.org/10.1071/AN10168

[9] Ramesh, T., Kalle, R., Sankar, K., Qureshi, Q. and Downs, C.T. (2013). Aspects of breeding biology of chital (Axis axis) and sambar (Rusa unicolor) in the Western Ghats. *Acta Ethologica*, 16(3), 147–155. https://doi.org/10.1007/s10211-013-0145-5

[10] Sanat K. and Dhungel, B.W.O. (2016). Ecology of the Hog deer in Royal Chitwan National Park, Nepal. *Wildlife Monographs*, 119, 3–40

[11] Seidensticker, J. (1986). Large carnivores and the consequences of habitat insularization: Ecology and conservation of tigers in Indonesia and Bangladesh. In: *Cats of the World: Biology, Conservation, and Management*, Tiger Ecology and Conservation, pp. 1–41.

[12] Tripathi, S., Basumatary, S.K., Singh, Y.R., McDonald, H.G., Tripathi, D. and Singh, L.J. (2019). Multiproxy studies on dung of endangered Sangai (Rucervus eldii eldii) and Hog deer (Axis porcinus) from Manipur, India: Implications for paleoherbivory and paleoecology. *Review of Palaeobotany and Palynology*, 263, 85–103. https://doi.org/10.1016/j.revpalbo.2019.01.008

[13] Tyler, N.J.C., Gregorini, P., Parker, K.L. and Hazlerigg, D.G. (2020). Animal responses to environmental variation: Physiological mechanisms in ecological models of performance in deer (Cervidae). *Animal Production Science*, 60(10), 1248–1270. https://doi.org/10.1071/AN19418

[14] Umapathy, G., Sontakke, S.D., Reddy, A. and Shivaji, S. (2007). Seasonal variations in semen characteristics, semen cryopreservation, estrus synchronization, and successful artificial insemination in the spotted deer (Axis axis). *Theriogenology*, 67(8), 1371–1378. https://doi.org/10.1016/j.theriogenology.2007.01.019

[15] Vanpé, C., Gaillard, J.M., Kjellander, P., Mysterud, A., Magnien, P., Delorme, D., Van Laere, G., Klein, F., Liberg, O. and Hewison, A.J.M. (2007). Antler size provides an honest signal of male phenotypic quality in roe deer. *American Naturalist*, 169(4), 481-493. https://doi.org/10.1086/512046

[16] Weerasekera, D.S., Perera, S.J., Nanayakkara, D.K.K., Herath, H.M.S.S., Rathnasekara, A.N. L. & Ranawana, K.B. (2020). The Antler Cycle and Fecal Testosterone of Male Sambar Deer Rusa unicolor unicolor at the Horton Plains National Park in Sri Lanka. *BioMed Research International*, 2020, 1-7. https://doi.org/10.1155/2020/6903407