WILD ANIMALS
RESEARCH AND REVIEWS

EDITORIAL
Published Online: April 4, 2025
https://doi.org/10.31893/wild.2025002

Can conditioned taste aversion be used to mitigate snow leopard predation in the Himalayan region?

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Keywords: wildlife management, conditioned food aversion; predators; human-wildlife coexistence, coexistence conservation, human-wildlife conflicts

There has been a notable increase in snow leopard predation in the Himalayan region (Gaire and Acharya, 2023), leading to significant livestock losses and escalating human–snow leopard conflicts (Karki and Panthi, 2021; Tiwari et al., 2020). Current predator management strategies primarily rely on lethal methods, including shooting, culling, trapping, and poisoning (Naha et al., 2020). Non-lethal measures to reduce large felids predation such as foxtail lights have also been tested (Ohrens et al., 2019; Naha et al., 2020). However, evidence suggests that lethal predator removal is often ineffective and costly (Lennox et al., 2018), while foxtail lights have been also reported to attract rather than repel certain predator species, such as foxes (Ohrens et al., 2019; Hall and Fleming, 2021). Other commonly used deterrent techniques, including noise makers and visual repellents, have also proven ineffective due to predator habituation (Hockings, 2016). These limitations underscore the urgent need for alternative methods to mitigate predation and promote sustainable coexistence between predators and prey (Tobajas, 2024).

Conditioned taste aversion (CTA), also referred to as conditioned food aversion, is a behavioral conditioning technique in which animals associate a specific food with a negative stimulus (Garcia et al., 1974). This phenomenon has been documented in a wide range of species, including snails, insects, fish, amphibians, reptiles, mammals, and birds (Snijders et al., 2021). Experimentally, CTA involves pairing a conditioned stimulus (e.g., a specific taste) with an unconditioned stimulus (e.g., a malaise-inducing agent) (Tobajas et al., 2019a,b; 2020a). Studies have demonstrated that such pairings can induce strong aversions to the conditioned taste or odor, resulting in reduced consumption or complete rejection of the treated food or prey (Snijders et al., 2021).

This method has potential applications in preventing predators from consuming toxic or endangered prey species (Kelly et al., 2018; Tobajas et al., 2020b, 2021) and in reducing livestock predation by wild carnivores (Gustavson et al., 1974; Ellins et al., 1977; Tobajas et al., 2020c; Cassaigne et al., 2023). Research on CTA has been conducted in both captive and wild settings, involving species such as ravens and raccoons (Nicolaus et al., 1983; Avery et al., 1995), coyotes preying on sheep (Gustavson et al., 1974; Horn, 1983), red foxes (Vulpes vulpes) (Maguire et al., 2009; Tobajas et al., 2020b, 2021; Andrewartha et al., 2023), rats (Slouzkey et al., 2013), rhesus monkeys (*Macaca mulatta*) (Pebsworth and Radhakrishna, 2020), and recently jaguars (*Panthera onca*) (Cassaigne et al., 2023). Various malaise-inducing agents have been used in these studies, including levamisole, thiabendazole, thiram, lithium chloride, synthetic estrogen 17-alpha-ethynylestradiol, apomorphine, cinnamomide, and cyclophosphamide (Snijders et al., 2021). The results indicate that CTA can effectively induce aversion in many species. However, translating these findings into practical field applications presents challenges, as behaviors observed in controlled settings may not always be replicated in wild environments. This is particularly relevant for wildlife management, where external factors such as prey availability, environmental complexity, and individual predator behavior may influence outcomes. Additionally, inconsistencies in experimental replication and concerns regarding the use of toxic substances have hindered the broader adoption of CTA (Tobajas et al., 2020c; Snijders et al., 2021), leading to skepticism among wildlife managers regarding its feasibility for large-scale predator management.

Existing research highlights the potential of CTA for mitigating predation by large carnivores, but further investigation is needed to refine its application in a species-specific and context-dependent manner (Selonen et al., 2022). In the case of snow leopard predation, CTA could serve as a viable non-lethal alternative, particularly given its relatively low cost compared to methods such as fencing. Moreover, it aligns better with ethical considerations than traditional lethal control, an essential factor in managing a threatened species like the snow leopard. However, key challenges must be addressed before CTA can be effectively implemented in the Himalayan region:

 Received: January 22, 2025 | Accepted: March 20, 2025

1. Implementation of CTA in snow leopards: Further research is needed to determine the most effective CTA agents for felids, a largely unexplored area (Snijders et al., 2021; but see Cassaigne et al., 2023). Although thiabendazole has shown promise as an aversive agent (Cassaigne et al., 2023), its large dosage requirements could increase its detectability, posing challenges for practical application. Identifying new, undetectable substances with a high safety margin is crucial (Tobajas et al., 2019a). Additionally, determining the optimal deployment strategies for CTA in snow leopard habitats is complex, given the species' extensive home ranges and the logistical difficulties of operating in remote, mountainous regions.
2. Comparison with other methods: A systematic evaluation is necessary to determine whether CTA represents a more effective, cost-efficient, and sustainable alternative to existing predator management strategies, such as fencing and traditional livestock husbandry by shepherds. This assessment should include a comparison of CTA's effectiveness in mitigating human–snow leopard conflicts relative to other non-lethal and lethal control measures.
3. Ethical considerations: While CTA is more humane than lethal control, it still induces temporary discomfort in the predator and, although applied in a controlled manner, carries certain risks. Therefore, it is essential to ensure that CTA applications are conducted ethically and do not inadvertently harm snow leopard populations or non-target species.

While CTA presents a promising tool for mitigating snow leopard predation, further research is necessary to refine and validate its application in natural environments. The potential for CTA to enhance human–wildlife coexistence in the Himalayan region warrants exploration, but careful consideration must be given to ethical concerns and unintended ecological consequences. We advocate for the development of innovative, non-lethal approaches to managing human–wildlife conflicts, emphasizing coexistence conservation strategies that foster coexistence between snow leopards and local livestock production systems (Tobajas et al., 2024).

Ethical Considerations

Not applicable.

Conflict of Interest

The author declares no conflicts of interest.

Funding

This work was not supported by any entity and had no funding associated with it. Jorge Tobajas was supported by a postdoctoral contract from the "Plan Propio de Investigación Enrique Aguilar Benítez de Lugo 2024" of the University of Cordoba.

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