Published online: 17 April 2026

Records of the Hawaii Biological Survey for 2026. Evenhuis, N.L. (ed.). *Bishop Museum Occasional Papers* 175: 23–31 (2026).

ISSN (online) 2376-3191

The Living Legacy of Museums: Rediscovering Endemic Snails and Building the Next Generation of Conservationists[1]

Kenneth A. Hayes[2], Samantha H. Shizuru[3], August Sullivan[3], Graham Talaber[4], Jennifer Jackson[4], Raven Barbera[4], Brendan Wang[5], Norine W. Yeung[3]

Abstract. Hawai‘i’s native land snails are among the most threatened faunas globally, with as much as 65% already lost to extinction. Rediscoveries of presumed-lost species offer not only hope but also proof that sustained surveys, training, and collaborative partnerships are essential to documenting and conserving biodiversity. Here we report the rediscovery of two species from Kaua‘i: *Godwinia caperata* (Gastrodontidae), last seen alive in 1931, and *Hiona exaequata* (Microcystidae), not recorded alive since 1926. These rediscoveries were only possible through broad partnerships integrating scientific surveys, agency and community collaboration, and educational outreach and training programs. Here, in addition to reporting these once in a century rediscoveries, we also argue that museum research, outreach, education, and systematic surveys are not auxiliary, but core requirements for ensuring Hawai‘i’s biocultural heritage endures.

INTRODUCTION

The Hawaiian Islands host one of the richest land snail radiations on Earth, yet have suffered catastrophic losses, with extinction rates estimated to exceed 60% (Solem 1990; Régnier *et al.* 2009; Yeung & Hayes 2018). For decades, as much as 90% of this fauna was presumed extinct, their existence preserved only as silent witnesses in museum collections (Solem 1990; Cowie & Robinson 2003).

Yet rediscoveries across the archipelago remind us that absence of records does not always equal extinction; without sustained surveys, species can persist unnoticed in refugia (Yeung *et al*. 2015, 2018; Hayes *et al.* 2020). These rediscoveries were not chance events, but the result of a deliberate network of conservationists, cultural practitioners. land managers, teachers, and students building the collective capacity to document what remains of Hawai‘i’s snail fauna.

Here, we document the rediscovery of *Godwinia caperata* and *Hiona exaequata*, unseen alive on Kaua‘i for nearly a century, and highlight the collaborative partnerships essential to conserving these threatened biocultural resources.

1. Contribution No. 2026-004 to the Hawaii Biological Survey.

2. National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, MRC 163, 20013, Washington, D.C., USA; email: hayes.ken@gmail.com

3. Hawai‘i Biological Survey, Bishop Museum, 1525 Bernice Street, Honolulu, Hawai‘i 96817-2704, USA; emails: samantha.shizuru@bishopmuseum.org, august.sullivan@bishopmuseum.org, norine@bishopmuseum.org

4. Kaua‘i Forest Bird Recovery Project, 1 Kaumakani Ave., Building 800, Kaumakani, Hawai‘i 96747, USA; emails: gptalaber@gmail.com, jfj55@nau.edu, raven.barbera@gmail.com

5. Natural Area Reserve System, Hawai‘i Department of Forests and Wildlife, 19 E. Kawili Street, Hilo, Hawai‘i, 96720,USA; email: bwang2@hawaii.edu

SYSTEMATIC ACCOUNTS

Stylommatophora A. Schmidt, 1855
Gastrodontidae Tryon, 1866
***Godwinia* Sykes, 1900**
***Godwinia caperata* (A. Gould, 1852)** **Notable rediscovery**
(Fig. 1)

Historical records. Described by Gould in 1852 from Kaua‘i, with no other locality data. Collections in the museum indicate that the last live record was made in 1931, and after more than fifty years of being undetected, it was presumed extinct.

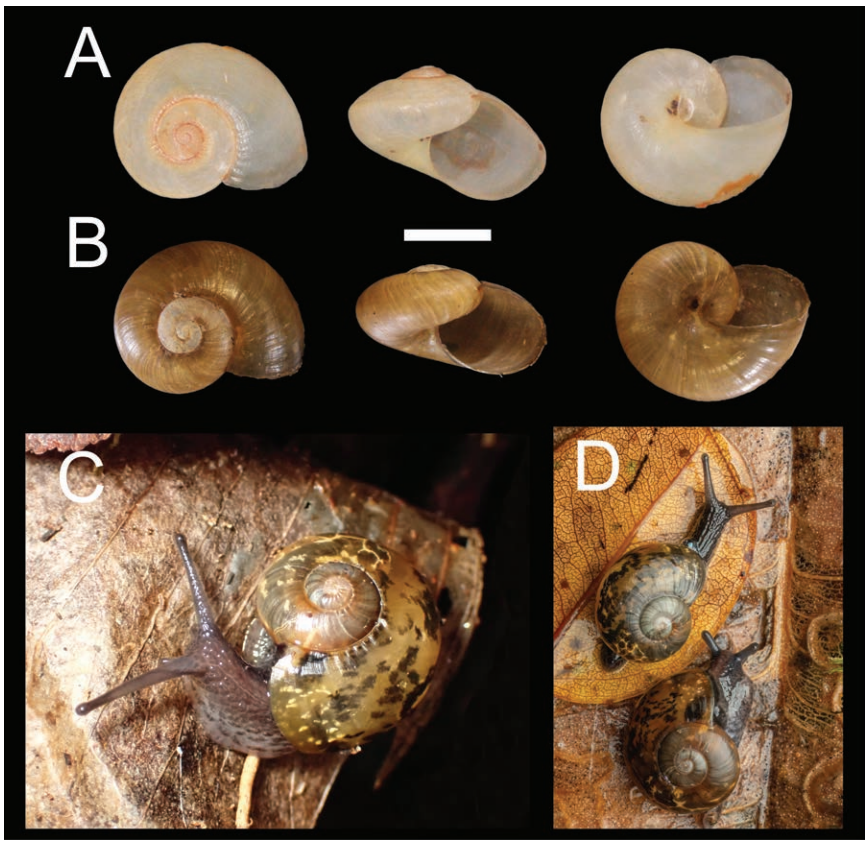

Figure 1. Shell and live images of *Godwinia caperata*. **A**) Lectotype USNM 5409, Kaua‘i; **B**) BPBM 298722, MAL035115, PCMB76024, Kaua‘i; Scale bar = 5 mm. **C**) Live specimen (Photo credit: SHS). **D**) Two live specimens (Photo credit: GT). Note the body patterns that are absent from shells and lost in preserved specimens.

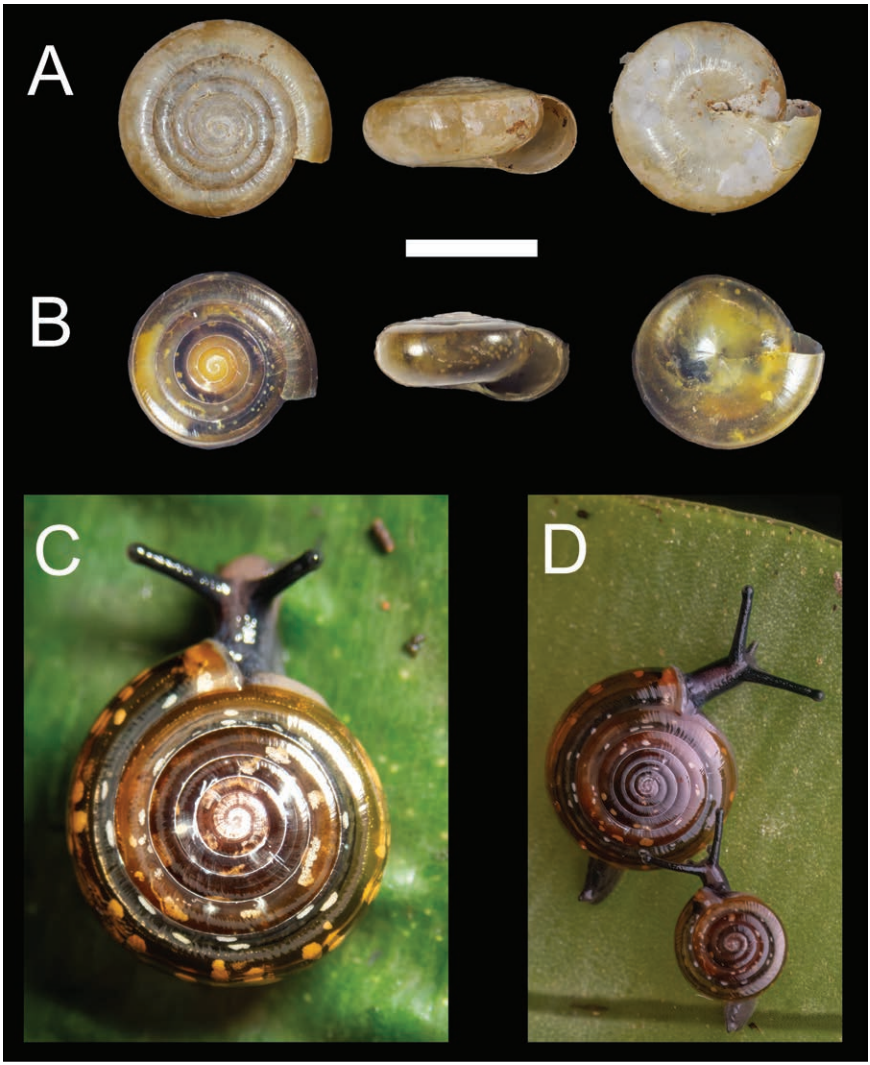

Figure 2. Shell and live images of *Hiona exaequata*. **A)** Lectotype MCZ 169134, Kauaʻi. **B)** BPBM 298704, MAL035103, PCMB 75996, Kauaʻi; Scale bar = 5 mm. **C)** Live specimen image sent to NWY in 2023 (Photo credit BW). **D)** Live specimen from 2025 surveys (Photo credit: GT). Note the body patterns and coloration absent from shells and lost in preserved specimens.

Rediscovery. In early 2025, one of the authors (GT), who had been on the lookout for snails since participating in snail taxonomic workshops organized and led by KAH and NWY, sent a photograph of an unidentified snail that he took while in the mountains of

Kauaʻi. Excitedly, NWY followed up with detailed questions regarding locality, abundance, and behavior. Again, they appeared to match the shell of *G. caperata*. In early September 2025, a team consisting of all coauthors carried out focused surveys and documented multiple live individuals on the ground in leaf litter, and ground vegetation (leaf litter and moss) near fallen logs and other understory habitats. Only a single live individual was seen during day searches. However, a few hours of surveys at night revealed a dozen or more crawling about in the understory leaf litter. Both adults and juveniles were observed, suggesting a persisting, though localized and vulnerable, population.

Material examined. **Kauaʻi**: 1, Nā-Pali Kona Forest Reserve, 02 Sep 2025, R. Barbera, K.A. Hayes, J. Jackson, S.H. Shizuru, A. Sullivan, N.W. Yeung, hand collected (BPBM298703; MAL035102, PCMB75995); 7, Nā-Pali Kona Forest Reserve, 02 Sep 2025, J. Jackson, S.H. Shizuru, A. Sullivan, hand collected (BPBM298722; MAL035115, PCMB76024; MAL035176, PCMB75409).

Microcystidae
***Hiona* H. B. Baker, 1940**
***Hiona exaequata* (A. Gould, 1846)** **Notable rediscovery**
(Fig. 2)

Historical records. Originally described in 1846, *H. exaequata* was last recorded alive in 1926. As with *Godwinia caperata*, more than half a century of absence led to the presumption that this species was extinct.

Rediscovery. The first record of *Hiona exaequata* since 1926 was a photograph taken in March 2023 by BW, whose prior participation in taxonomic workshops facilitated its recognition and submission to NWY for identification. Surveys in September 2025, involving Hawaiian land snail researchers, museum staff, DLNR partners, and community trainees, yielded several live individuals in the same habitat as *G. caperata*. Snails were found on native understory vegetation, again demonstrating the critical value of trained observers working in collaboration.

Material examined. **Kauaʻi**: 6, Nā-Pali Kona Forest Reserve, coll. 2 Sep 2025, R. Barbera, K.A. Hayes, J. Jackson, S.H. Shizuru, A. Sullivan, N.W. Yeung, hand collected (BPBM 298704: MAL035103, PCMB75996; MAL035174, PCMB75408); 3, Nā-Pali Kona Forest Reserve, coll. 2 Sep 2025, J. Jackson, S.H. Shizuru, A. Sullivan, hand collected (BPBM298721: MAL035117, PCMB76026)

HABITAT, ECOLOGY, AND BEHAVIOR

Both species were rediscovered in native wet-mesic high-elevation forest refugia on Kauaʻi, dominated by ʻōhiʻa ha (*Syzygium sandwicense*) and ʻōhiʻa (*Metrosideros polymorpha*), with ʻōlapa (*Cheirodendron* spp.), alani (*Melicope clusiifolia*), and others. Predominant understory plants included kanawao (*Hydrangea arguta*), uluhe (*Dicranopteris linearis*), ōhelo (*Vaccinium reticulatum*), ʻalaʻalawainui (*Peperomia hesperomannii*), ʻēkaha (*Elaphoglossum crassifolium*, and the non-native kahili ginger (*Hedychium gardnerianum*), yellow ginger (*Hedychium flavescens*) among others (Fig. 3). One notable characteristic of this habitat is that it is relatively undisturbed by ungulates compared with some of the nearby areas. However, the area remains unfenced, leaving these pockets of snail habitat highly vulnerable to disturbance by pigs and deer.

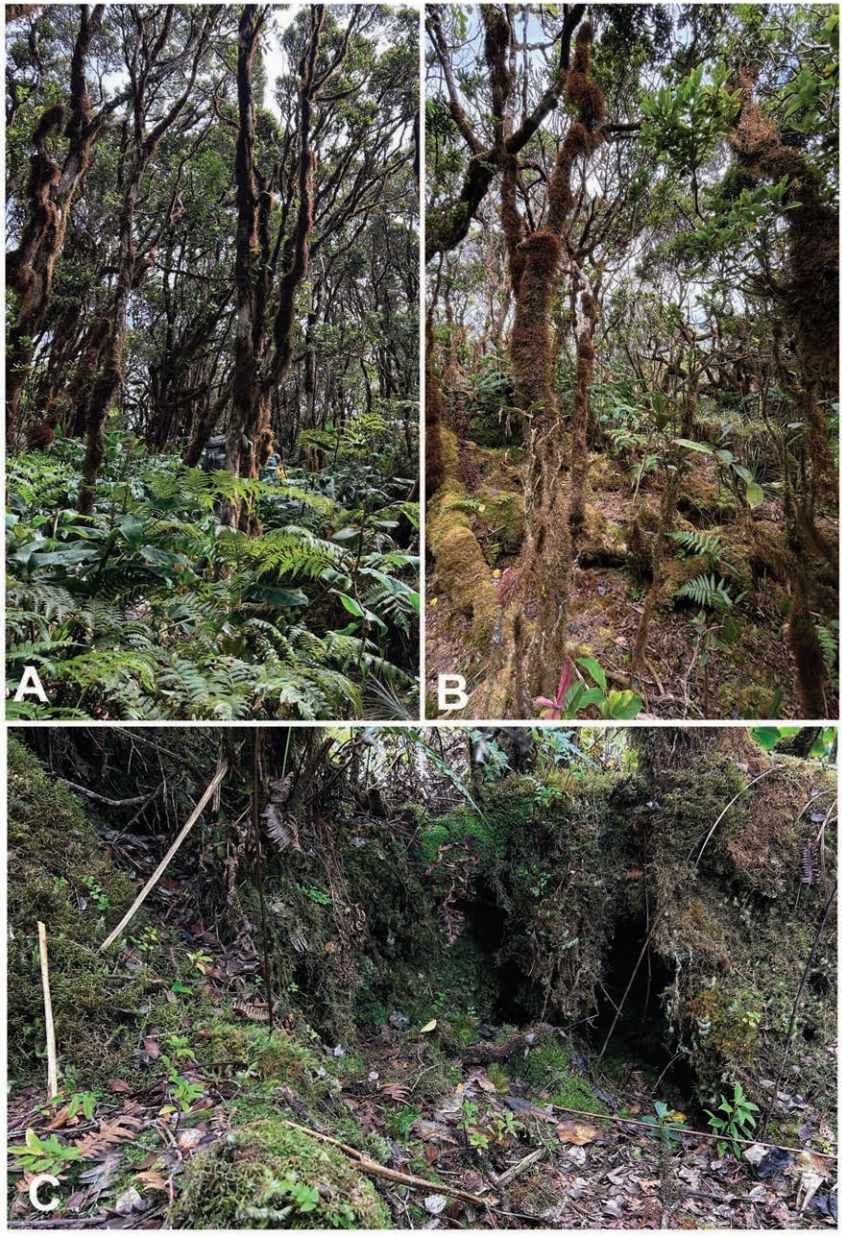

Figure 3. Canopy and understory habitats where *G. caperata* and *H. exaequata* were rediscovered. **A)** Dense ʻōhiʻa canopy and thick understory dominated by ferns and ginger. **B)** ʻŌhiʻa canopy with mixed leaf litter from sparse understory dominated by moss and a mixture of native and non-native vegetation. **C**) Typical leaf litter and moss habitat where these two species were active at night but hidden during the day under moss covered logs and vegetation.

Godwinia caperata was observed crawling on and in deeper leaf litter composed of a diversity of leaves from several of the above-mentioned plants. They are occasionally on low lying vegetation and moss. In the leaf litter its cryptic shell coloration blends seamlessly (Fig. 1) but this is not the reason the researchers missed them during the day. During dry conditions of the day, individuals retreated deep into moss mats and under fallen logs, resurfacing only under cooler and high humidity conditions of the evening. This behavior of retreating to moist refuges under logs likely contributed to this species' persistence, and to the lack of records.

Hiona exaequata, while in the same general habitat, tended to be associated with thinner, primarily ʻōhiʻa leaf litter, and was more often seen crawling on understory vegetation. Similar to *Godwinia caperata*, it was more active after sunset. Feeding observations suggest detritivory or microbivory on fungal hyphae and biofilms, consistent with ecological strategies of other microcystids, including another ground dwelling Hawaiian endemic, *Kaala subrutila*, which is found on Oʻahu. Together, these rediscoveries echo the case of *Endodonta christenseni* from Nihoa, which persisted in bunch grasses but remained undescribed (Hayes *et al.* 2020).

Across these examples, persistence is driven by extreme microhabitat specificity and 'concealment-specialist' behaviors that allow species to remain undetected despite their physical presence. This stands in contrast to the typical detection patterns for the more frequently monitored Hawaiian Achatinellinae (i.e., *Achatinella*, *Partulina*, *Perdicella, Newcombia*) where rarity is often a factor of numbers rather than behavior. For the lineages discussed here, detection is a function of behavioral state and moisture levels, meaning they are nearly invisible to standard visual encounter surveys during dry or diurnal periods. Consequently, the rediscovery of such 'invisible' taxa highlights the need for more than just nocturnal sampling; it necessitates the availability of trained and persistent taxonomists who prioritize species discovery and documentation as the foundation of conservation.

DISCUSSION

The persistence of *Godwinia caperata* and *Hiona exaequata* into the 21st century provides a rare counter-narrative to the catastrophic extinction rates, possibly exceeding 10% per decade, documented for other Pacific Island snails (Régnier *et al.* 2015). These rediscoveries validate the 'refugia hypothesis' for Hawaiian micro-taxa: that even after a century of presumed absence, lineages can persist in microhabitats, and we need to keep looking.

Critically, our findings demonstrate that 'extinction' is often a premature label applied to data-deficient taxa. The gap between the last record of these species and their current detection was not a failure of the snail persistence, but a failure of the sampling effort to reach them. By integrating a robust taxonomic framework with the collective effort of conservation partnerships, we can bridge this gap. This shift from incidental discovery to systematic, expert-led documentation is the only reliable way to ensure that Hawaiʻi's biodiversity is accounted for before it is truly lost.

A striking behavioral contrast characterized these rediscoveries. For many frequently monitored Hawaiian land snails, such as the Achatinellinae, nocturnal surveys are a cornerstone of conservation monitoring. While their detectability, and thus monitoring efficiency, may increase at night when they are more active and conspicuous under focused

lights of a headlamp, they nonetheless remain in searchable daytime positions. However, while the high-contrast beam of a headlamp increases the detection probability for larger, often brightly colored tree snails, many of the smaller, non-achatinelline taxa (e.g., *Tornatellides*, *Elasmias*, *Philonesia*) may be missed entirely. For these taxa, the loss of ambient light and reduced spectral contrast at night make resolving minute, cryptically colored shells against complex substrates nearly impossible.

In contrast, *Godwinia caperata* and *Hiona exaequata* represent a third category of detection difficulty: 'concealment-specialists' that are not only smaller and non-charismatic but are physically absent from searchable surfaces during the day. This intersection of behavioral crypsis and taxonomic neglect explains why such lineages can persist 'in plain sight' for a century, eluding both traditional daytime searches and the nocturnal protocols optimized for arboreal fauna. This pattern of diurnal retreat into deep interstitial refugia is a behavior well-documented in continental gastropods for water conservation and predator avoidance (Cook 2001; Speiser 2001; Okechukwu *et al.* 2014) but less reported for Hawaiian arboreal taxa. Whether strictly nocturnal or cathemeral and tied to microclimatic shifts, their 'hidden in plain sight' behavior underscores why rediscoveries of ground-dwelling micro-taxa require diverse survey strategies that move beyond the protocols optimized for more visible, leaf-estivating fauna.

The rediscovery of the two species presented herein parallels previous finds of *Auriculella pulchra*, *Laminella venusta*, and *Endodonta christenseni*, affirming that many Hawaiian taxa persist 'in plain sight', overlooked until targeted by expert-led surveys. These successes demonstrate that detection is a byproduct of building a diverse scientific workforce. Crucially, this involves 'cultural grounding'; integrating traditional Hawaiian knowledge ('ike kūpuna) and place-based relationships into scientific protocols. This approach ensures that conservation is not merely a technical exercise, but one that respects the biocultural significance of the species and fosters a deeper connection between the observers and the 'āina (land). When early-career biologists are trained within this dual framework of rigorous taxonomy and cultural context, the capacity to identify and safeguard cryptic lineages is significantly enhanced.

The documented persistence of these populations is an opportunity for immediate intervention. To prevent the irreversible loss of these remnant lineages and others, we propose the following conservation roadmap:

Habitat Protection: Immediate construction of ungulate-resistant fencing is required to protect identified refugia from pig-mediated habitat degradation. This represents a high-impact, low-cost intervention for ground-dwelling taxa.

Ex Situ Safeguarding: Establishment of robust captive populations to serve as a genetic hedge against extirpation from stochastic events in the wild.

Applied Ecological Research: Prioritizing studies on the microhabitat requirements and life history of these species to optimize captive rearing and identify critical habitat for potential future translocations.

Expanded Targeted Surveys: Implementation of landscape-scale surveys across Kaua'i in similar high-moisture refugia. These efforts must utilize multi-temporal protocols, including nocturnal sampling to detect 'concealment-specialists', to clarify the full extent of species' distributions.

CONCLUSION

The rediscovery of these two Kaua‘i endemics after a century of silence proves that the ‘extinction’ of Hawai‘i’s malacofauna is not yet a closed book. However, the survival of these lineages is fragile. These findings are not merely taxonomic records, but a call to shift our conservation paradigm toward a more inclusive, culturally grounded, and taxonomically rigorous framework. By investing in the people who look, the methods used to find, and the partnerships required to protect, we can ensure that these rediscovered legacies do not vanish a second time.

ACKNOWLEDGMENTS

We thank Mapuana O’Sullivan, Hawai‘i Department of Land and Natural Resources (DLNR), for enduring support in our efforts to document native land and freshwater invertebrates, and Dr. Lisa “Cali” Crampton from the Kaua‘i Forest Bird Recovery Project for her help facilitating these surveys that lead to the rediscovery of these species. We also extend our appreciation to Dr. David R. Sischo, Snail Extinction Prevention Program Coordinator with DLNR, and his team, whose collaborative partnership and unrelenting efforts have helped keep more than 70 species of Hawaiian land snails from disappearing. Thanks to DLNR, DOFAW and other agencies for permits and collaboration, landowners for access, Bishop Museum staff for collections and curatorial support, and the many students, teachers, and community partners who contributed to surveys and training. Support for this work was provided in part by grants from the US Fish and Wildlife Service (F20AC11607) to KAH and NWY, US Department of Agriculture (PPA721) to NWY and KAH, and the National Science Foundation awards (DEB-2301564, DBI 1902328) to NWY and KAH. This is contribution No. 12098 to University of Hawai‘i School of Ocean and Earth Science and Technology.

REFERENCES

Cook, **A**. 2001. Behavioural ecology: on doing the right thing, in the right place at the right time, pp. 447–487. *In*: Barker, G.M. (ed.), *The biology of terrestrial molluscs*. CABI Publishing, Wallingford, UK.

Cowie, **R**.**H**., **Evenhuis**, **N**.**L**. **& Christensen**, **C**.**C**. 1995. *Catalog of the native land and freshwater molluscs of the Hawaiian Islands*. Backhuys Publishers, Leiden.

Gould, **A**.**A**. 1846. Descriptions of new shells from the Sandwich Islands and other localities. *Proceedings of the Boston Society of Natural History* **2**: 141–145.

Gould, **A**.**A**. 1852. *United States Exploring Expedition during the years 1838–1842*. Vol. 12, Mollusca and Shells. Gould & Lincoln, Boston.

Hayes, **K**.**A**., **Slapcinsky**, **J**., **Sischo**, **D**.**R**., **Kim**, **J**.**R**. **& Yeung**, **N**.**W**. 2020. The last known *Endodonta* species? *Bishop Museum Occasional Papers* **138**: 1–15.

Okechukwu, **R**.**I**., **Igbokwe**, **E**.**C**. **& Omaliko**, **C**.**M**. 2014. Circadian variation in locomotor and feeding periods of two land snail species (*Archachatina marginata* and *Achatina achatina*). *Journal of Molluscan Studies* **80**(4): 471–478.

Régnier, **C**., **Fontaine**, **B**. **& Bouchet**, **P**. 2009. Not knowing, not recording, not listing: numerous unnoticed mollusk extinctions. *Conservation Biology* **23**: 1214–1221.

Régnier, **C**., **Bouchet**, **P**., **Hayes**, **K**.**A**., **Yeung**, **N**. **W**., **Christensen**, **C**.**C**., **Chung**, **D**.**J**., **& Cowie**, **R**.**H**. 2015. Extinction in a hyperdiverse endemic Hawaiian land snail family and implications for the underestimation of invertebrate extinction. *Conservation Biology* **29**(6): 1715–1723.

Solem, **A**. 1990. How many Hawaiian land snail species are left? And what we can do for them. *Bishop Museum Occasional Papers* **30**: 27–40.

Speiser, **B**. 2001. Food and feeding behaviour, pp. 259–288. *In*: Barker, G.M. (ed.), *The biology of terrestrial molluscs*. CABI Publishing, Wallingford, UK.

Yeung, **N**.**W**., **Chung**, **D**., **Sischo**, **D**.**R**. **& Hayes**, **K**.**A**. 2015. Rediscovery of *Auriculella pulchra*. *Bishop Museum Occasional Papers* **116**: 49–51.

Yeung, **N**.**W**., **Bustamente**, **K**.**M**., **Sischo**, **D**.**R**. **& Hayes**, **K**.**A**. 2018. Rediscovery of *Newcombia canaliculata* and *Laminella venusta*. *Bishop Museum Occasional Papers* **123**: 31–36.

Yeung, **N**.**W**., **& Hayes**, **K**.**A**. 2018. Biodiversity and extinction of Hawaiian land snails: how many are left now and what must we do to conserve them—a reply to Solem (1990). *Integrative and Comparative Biology* **58**: 1157–1169 . https://doi.org/10.1093/icb/icy043