Published online: 23 April 2018 ISSN (online): 2376-3191

Records of the Hawaii Biological Survey for 2017. Edited by Neal L. Evenhuis. *Bishop Museum Occasional Papers* 123: 11–17 (2018)

A Lost Species of Salt Marsh Snail: *Blauneria gracilis* Pease, 1860 (Gastropoda: Ellobiidae) in the Hawaiian Islands[1]

Carl C. Christensen[2]
Bishop Museum, 1525 Bernice Street, Honolulu, Hawai'i 96817-2704, USA;
email: carl@bishopmuseum.org

INTRODUCTION

Blauneria gracilis Pease, 1860 was described from the "Sandwich Islands" (*i.e.*, the Hawaiian Islands) without more precise locality; its author later commented on the living animal and the habitat preferences of the species (Pease 1860, 1869). Kay (1979: 493) stated that the species "has not been recorded since its original description" and there are no known observations of living *B. gracilis* in the Hawaiian Islands since the mid-19th century. There are, however, several recent finds of dead shells of this species, mostly from archaeological contexts. Athens *et al*. (1994) and Cowie *et al.* (1995) recorded a single specimen from an archaeological site on O'ahu, collected in 1993, and Cowie *et al*. (1995) briefly reported another specimen from Moloka'i, also from an archaeological excavation, collected in 1982. Severns (2011: 424, pl. 193, fig. 6 [not fig. 5 as stated in caption]) illustrated a specimen found in beach drift at Hana, Maui. This note provides additional information on the O'ahu and Moloka'i records cited by Cowie *et al*. (1995), reports two additional records from archaeological sites on O'ahu, reviews available information on the ecology of *B. gracilis* and other members of the genus, and clarifies the status of the designated lectotype of the species. Notwithstanding the loss of many of the coastal wetlands formerly inhabited by *B. gracilis* and the lack of recent observations of living examples of this species, it probably survives in the Hawaiian Islands and may be encountered by those conducting biological surveys of such sites, especially in sedge marshes and mangrove swamps.

METHODS AND MATERIALS

Federal and state historic preservation laws establish procedures to mitigate the adverse effects of development projects on historic properties and may require implementation of archaeological survey, excavation, and salvage efforts. These may include analysis of non-marine molluscs and other faunal remains. The present report is based on specimens from recent such studies and other material held by Bishop Museum.

Material examined. HAWAIIAN ISLANDS: "SANDWICH ISLES": Andrew Garrett, coll., *ex* Garrett. (BPBM 1584, 6 spms. [Fig. 1]); **O'AHU**: Waikīkī, Tax Map Key [TMK] 1-2-3-038:006, sidewalk adjacent to Kona Street next to Ala Moana parking structure, test excavation T-207, in sediment 135–170 cm below surface, Stratum IIB. Cultural Surveys Hawai'i, Inc., 2012 (BPBM 277005, 3 spms. [Fig. 2]); Waikīkī, TMK 1-2-6-005:001, Fort DeRussy Military Reservation, Loko Kaipuni, Hawai'i State Inventory of Historic Places [HSIHP] Site 50-80-14-4573, Profile 21, Manhole KA 2, Station KA 1+50, Stratum II, 180–200 cm below surface. Cultural Surveys Hawai'i, Inc., 2015 (1 spm.; archived at U.S. Army Garrison Hawaii, Cultural Resources Program Curation Facility, Schofield Barracks, Hawai'i); **MOLOKA'I**: Kūpeke, TMK 2-5-7-6:11, inland (north) of the pond and seaward

1. Contribution No. 2018-003 the Hawaii Biological Survey.
2. Research Associate, Hawaii Biological Survey, Bishop Museum, 1525 Bernice Street, Honolulu, Hawai'i 96817-2704, USA

(south) of highway, House Lot no. 11, archaeological excavation TP2, layers 2/3/4, depth ca. 30–50 cm below surface. Paul H. Rosendahl & Mikk Kaschko 1982 (BPBM 274968, 1 spm. [Fig. 3]).

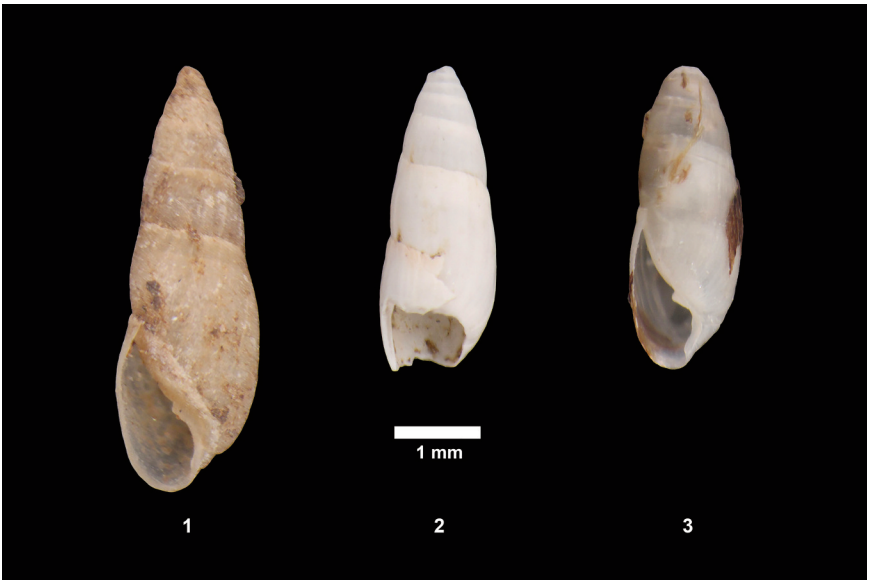
DISCUSSION

Andrew Garrett was a contemporary and correspondent of William Harper Pease and visited the Hawaiian Islands at various times from 1847 to 1863 (Thomas 1979); thus Bishop Museum's Garrett specimens (BPBM 1584) date from approximately the same period as does Pease's type material.

As noted above, Cowie *et al*. (1995) briefly noted two then-recent finds of *B. gracilis* but said nothing of the archaeological contexts from which they were recovered. The single O'ahu specimen of *B. gracilis* they reported was obtained from an excavation at Kewalo, Waikīkī, O'ahu, located near the intersection of Pi'ikoi Street and Kapi'olani Boulevard and designated as HSIHP Site No. 50-80-14-4847. The site was marshland prior to its reclamation and urbanization in the 1920s; pollen analysis indicated that sedges were abundant. Other fresh- and brackish-water mollusks present at the site included "*Assiminea* sp." and "?*Tryonia* sp." (Athens *et al*. 1994). The former is presumably the species now known as *A. parvula* (Mousson, 1865) and the latter is undoubtedly the species now known as *T. porrecta* (Mighels, 1845). Cowie *et al.* (1995) also noted the recent collection of a single specimen of *B. gracilis* from Moloka'i. This specimen (BPBM 274968) was obtained from a sediment core taken immediately south (seaward) of Kūpeke Fishpond, HSIHP Site No. 50-60-04-206, at a location probably once under cultivation for taro (Rosendahl 1982). Also present were *T. porrecta, Melanoides tuberculata* (Müller, 1774), *Tarebia granifera* (Lamarck, 1816), and *A. parvula, Physella* cf. *acuta* (Draparnaud, 1805), and a damaged specimen tentatively identified as *Ferrissia californica* (Rowell, 1863) (Bishop Museum collection records, BPBM 274963–274970).

More recently, three specimens of *B. gracilis* (BPBM 277005) were obtained in an archaeological excavation near the Ala Moana Shopping Center (Christensen 2013). Pollen analysis indicated that the site was a sedge marsh as the pollen record was dominated by pollen of Cyperaceae (Cummings 2013); historic records indicate that the site was marshland in 1897 but had become urbanized by 1919 (Hammatt 2013). Other aquatic mollusks present included *T. porrecta, M. tuberculata, T. granifera*, and *A. parvula* (Christensen 2013). An additional specimen of *B. gracilis* was obtained during archaeological excavations at Fort DeRussy in Waikīkī, in the vicinity of the former Loko Kaipuni Fishpond. The site was buried under coral fill in the 1920s during construction of the Ala Wai Canal and is now heavily urbanized. Other aquatic mollusks present included *Theodoxus neglectus* (Pease, 1861), *T. porrecta, M. tuberculata*, and *P.* cf. *acuta* (Christensen 2017).

In addition to the Hawaiian records discussed above, *B. gracilis* has also been reported from Mauritius (Nevill 1878; Griffiths & Florens 2006), the Mariana Islands (Moellendorff 1900) and Tahiti (Grasset 1884). Two additional species of *Blauneria* have been described from the Indo-Pacific region: *B. leonardi* Crosse, 1872, reported from New Caledonia (Crosse 1872a, b) and Queensland, Australia (Hedley 1901), and *B. quadrasi* Moellendorff *in* Quadras & Moellendorff, 1895, reported from the Philippines (Quadras & Moellendorff 1895; Habe 1980), Okinawa (Romero *et al*. 2016), Malaysia (Raven & Vermeulen 2007), Vietnam (Vermeulen & Maassen 2003; Raven & Vermeulen 2007), and Singapore (Tan & Woo 2010). Severns (2011: 424, pl. 193, figs. 7 [not fig. 6 as stated in caption]) figured a specimen identified as *B. quadrasi* from an unspecified locality. It is unclear, however,



Figs. 1–3. *Blauneria gracilis* Pease, 1860. **Fig. 1.** BPBM 1584a. "Sandwich Isles." **Fig. 2.** BPBM 277005a. Waikīkī, O'ahu. **Fig. 3.** BPBM 274968. Kūpeke, Moloka'i.

whether this non-Hawaiian material is in fact conspecific with *B. gracilis* as the status of the various described members of the genus vis-à-vis each other remains uncertain (Backeljau *et al*. 1987); in particular, no recent author has critically examined the relationships of *B. gracilis*, *B. leonardi*, and *B. quadrasi*.

Pease (1869: 60) reported that *B. gracilis* "is found in the crevices of stones overflown at high tide" and is never found "on the sides or tops of stones when the tide was out but [only] around their bases where the water stood in little pools." Speaking of non-Hawaiian species, Martins (1996: 186) commented that "*Blauneria* commonly lives in mangroves at the high-tide mark in the sediment under rocks and decaying branches" and that it "lies buried in the black sediment, and under rocks and rotting vegetable matter at the high-tide mark". The occurrence of various species of *Blauneria* in salt marshes, in mangrove swamps, and under rocks and rotting vegetation at the shoreline has also been noted by Marcus & Marcus (1965), Griffiths & Florens (2006), Raven & Vermeulen (2007), and Andrade *et al.* (2014).

Kay (1965) designated as lectotype of *B. gracilis* a specimen in the British Museum (Natural History): [BM(NH) 1962770]. Earlier, however, Baker (1964) had designated a specimen in the collection of the Academy of Natural Sciences of Philadelphia (ANSP 22474a) as the lectotype of this species, thus preempting Kay's action. Kay's type designation was noted by Johnson (1994, 1996) and Cowie *et al*. (1995), who were also unaware of Baker's action.

CONCLUSION

Coastal wetlands similar to the archaeological sites yielding recent finds of *Blauneria* are

now much-reduced in area in the Hawaiian Islands as a result of urbanization and other changes in land use, especially on O‘ahu (Van Rees & Reid 2014). The adverse impact on *Blauneria* is demonstrated by the destruction in the late 19th and early 20th centuries of each of the three O‘ahu sites where the former occurrence of *Blauneria* has been demonstrated archaeologically. *Blauneria* may survive, however, in some of those coastal wetlands that remain. Biological surveys of such sites more recent than Pease’s time have not encountered *B. gracilis* (*e.g.*, Maciolek & Brock 1974; Brock & Kam 1997; Englund *et al.* 2000; Hoover & Gold 2006; Tango *et al.* 2012), but it is unsurprising that this minute snail would be overlooked by those unaware of its potential presence. Furthermore, non-Hawaiian studies show that mangrove swamps are a preferred habitat for *Blauneria*. Mangroves are not native to the Hawaiian Islands, but in the early 1900s several species were intentionally introduced for various purposes and are now well-established throughout the state, particularly on O‘ahu and Moloka‘i (Wester 1981; Allen 1998). Their spread has created new potential habitat for this rare snail. A recent collection of a specimen in beach drift (Severns 2011) indicates that living populations of *Blauneria* do survive in the Hawaiian Islands, notwithstanding the destruction of many coastal wetlands; and those conducting future biological surveys of such areas should be alert to its possible presence, especially in sedge marshes and mangrove swamps.

ACKNOWLEDGMENTS

The author thanks Kimberly Lactaoen for photographs of *Blauneria gracilis* shells and is grateful to the archaeological consulting firms of Cultural Surveys Hawai‘i, Inc., International Archaeological Research Institute, Inc., and Paul H. Rosendahl, Inc., for including analysis of nonmarine mollusks in their cultural resources management activities.

LITERATURE CITED

Allen, **J**.**A**. 1998. Mangroves as aliens: the case of Hawaii. *Global Ecology and Biogeography Letters* **7**: 61–71.

Andrade, **J**.**T**.**M**., **Palhano**, **N**.**B**., **Tagliaro**, **C**.**H**. **& Beasley**, **C**.**R**. 2014. Spatial and temporal variation in the abundance and taxonomic composition of estuarine and terrestrial macrofaunal associated with mangrove logs. *Journal of the Marine Biological Association of the United Kingdom* **94**: 35–42.

Athens, **J**.**S**., **Erkelens**, **C**., **Ward**, **J**.**V**., **Cowie**, **R**.**H**. **& Pietrusewsky**, **M**. 1994. The archaeological investigation of inadvertently discovered human remains at the Pi‘ikoi and Kapiolani intersection, Kewalo, Waikiki, O‘ahu, Hawai‘i. Unpublished report prepared for Hawaiian Dredging and Construction Co. by International Archaeological Research Institute, Inc. vi + 56 pp. + appendix.

Backeljau, **T**., **Jannsens**, **L**. **& Jocqué**, **R**. 1987. Faunistics of some Ellobiidae (Mollusca, Pulmonata) of the Comores. *Revue de Zoologie Africaine* **101**: 275–279.

Baker, **H**.**B**. 1964. Type land snails in the Academy of Natural Sciences of Philadelphia. Part III. Limnophile and thalassophile Pulmonata. Part IV. Land and fresh-water Prosobranchia. *Proceedings of the Academy of Natural Sciences of Philadelphia* **116**: 149–193.

Brock, **R**.**E**. **& Kam**, **A**.**K**.**H**. 1997. Biological and water quality characteristics of anchialine resources in Kaloko-Honokohau National Historical Park. Cooperative National Park Resources Studies Unit Technical Report 112. University of Hawai‘i at

Mānoa, Department of Botany, Honolulu. iv + 110 pp. Available at https://scholarspace.manoa.hawaii.edu/bitstream/10125/7396/1/112.pdf (Accessed 4 April 2018).

Christensen, **C**.**C**. 2013. Analysis of nonmarine mollusks. Pp. 355-368 *in* Hammatt, H.H., Final archaeological inventory survey report for the City Center (Section 4) of the Honolulu High-Capacity Transit Corridor Project, Kalihi, Kapālama, Honolulu, and Waikīkī Ahupua'a, Honolulu (Kona) District, Island of O'ahu TMK [1] 1-2, 1-5, 1-7, 2-1, 2-3 (various plats and parcels). Volume V: Lab results. Unpublished report prepared by Cultural Surveys Hawai'i, Inc., for the City and County of Honolulu and the Federal Transit Administration on behalf of PB Americas, Inc. Available at http://hartdocs.honolulu.gov/docushare/dsweb/Get/Document-17689/20132608-CC-AISR-Vol-5-Sec-6.pdf (Accessed 30 March 2018).

Christensen, **C**.**C**. 2017. Analysis of Nonmarine Mollusks from Archaeological Excavations at Loko Kaipuni, Site 50-80-14-4573, Hawai'i State Inventory of Historic Places, Fort DeRussy Military Reservation, Waikīkī, Honolulu, O'ahu (TMK: [1] 2-6-005:001). Unpublished report prepared for Cultural Surveys Hawai'i, Inc. 12 pp. + 17 pp. (Appendix).

Cowie, **R**.**H**., **R**.**H**., **Evenhuis**, **N**.**L**. **& Christensen**, **C**.**C**. 1995. *Catalog of the native land and freshwater molluscs of the Hawaiian Islands*. Backhuys Publishers, Leiden. vi + 248 pp.

Crosse, **H**. 1872a. Diagnoses molluscorum Novae Caledoniae incolarum. *Journal de Conchyliologie* **20**: 69–75.

Crosse, **H**. 1872b. Description d'espèces inédites provenant de la Nouvelle-Calédonie. *Journal de Conchyliologie* **20**: 349–359, pl. 16.

Cummings, **L**.**S**. 2013. Pollen analysis of samples from the Honolulu High-Capacity Transit Corridor Projec, pp. 495–518. *In*: Hammatt, H.H., Final archaeological inventory survey report for the City Center (Section 4) of the Honolulu High-Capacity Transit Corridor Project, Kalihi, Kapālama, Honolulu, and Waikīkī Ahupua'a, Honolulu (Kona) District, Island of O'ahu TMK [1] 1-2, 1-5, 1-7, 2-1, 2-3 (various plats and parcels). Volume V: Lab results. Unpublished report prepared by Cultural Surveys Hawai'i, Inc., for the City and County of Honolulu and the Federal Transit Administration on behalf of PB Americas, Inc. Available at http://hartdocs.honolulu.gov/docushare/dsweb/Get/r_Document-17692/unknown. (Accessed 31 March 2018).

Englund, **R**. **A**., **Preston**, **D**. **J**., **Wolff**, **R**., **Coles**, **S**. **L**., **Eldredge**, **L**. **G**. **& Arakaki**, **K**. 2000. Biodiversity of freshwater and estuarine communities in Lower Pearl Harbor, Oahu, Hawaii with observations on introduced species. *Bishop Museum Technical Report* 16. x + 167 pp. Available at http://hbs.bishopmuseum.org/pdf/tr-16.pdf (Accessed 4 April 2018).

Grasset, **J**.**-P**.**-A**. 1884. *Index testaceorum viventium quoe in collectione J.-P.-A. Grasset.* Imprimerie Casablanca, Alger. 324 pp.

Griffiths, **O**.**L**. **& Florens**, **V**.**F**.**B**. 2006. *A field guide to the non-marine molluscs of the Mascarene Islands (Mauritius, Rodrigues and Réunion) and the Northern Dependencies of Mauritius*. Bioculture Press, Mauritius. xv + 185 pp.

Habe, **T**. 1980. Second locality of *Blauneria quadrasi* Möllendorff. *Venus* **38**: 278.

Hammatt, **H**.**H**. 2013. Final archaeological inventory survey report for the City Center (Section 4) of the Honolulu High-Capacity Transit Corridor Project, Kalihi, Kapālama, Honolulu, and Waikīkī Ahupua'a, Honolulu (Kona) District, Island of O'ahu TMK [1]

1-2, 1-5, 1-7, 2-1, 2-3 (various plats and parcels). Volume IVD: Excavation results: Zone 9 East Kaka‘ako (Test Excavations 198 through 197); Zone 10 Kālia (Test Excavations 198 through 225); Zone 11 Kaka‘ako Makai (Test Excavations 226 through 232A). Unpublished report prepared by Cultural Surveys Hawai’i, Inc., for the City and County of Honolulu and the Federal Transit Administration on behalf of PB Americas, Inc. vii + 521 pp. Available at http://hartdocs.honolulu.gov/docushare/dsweb/Get/Document-17677/20132608-CC-AISR-Vol-4D-Sec-3-Part-2.pdf (Accessed 30 March 2018).

Hedley, **C**. 1901. Studies on Australian Mollusca III. *Proceedings of the Linnean Society of New South Wales* **25**: 721–732, pl. 48.

Hoover, **D**. **& Gold**, **C**. 2006. Assessment of coastal water resources and watershed conditions at Pu‘uhonua O Honaunau National Historical Park, Hawai‘i. National Park Service, U.S. Department of the Interior, Technical Report NPS/NRWRD/NRTR-2006/352. ix + 153 pp. Available at http://www.botany.hawaii.edu/basch/uhnpscesu/pdfs/hooveretal6a.pdf (Accessed 4 April 2018).

Johnson, **R**.**I**. 1994. Types of shelled Indo-Pacific mollusks described by William Harper Pease (1824-71). *Bulletin of the Museum of Comparative Zoology* **154**: 1-61.

Johnson, **R**.**I**. 1996. Types of land and freshwater mollusks from the Hawaiian Islands in the Museum of Comparative Zoology. *Bulletin of the Museum of Comparative Zoology* **155**: 159–214.

Kay, **E.A**. 1965. Marine mollusks in the Cuming collection, British Museum (Natural History) described by William Harper Pease. *Bulletin of the British Museum (Natural History) Zoology Supplement* **1**, 96 pp., 14 pls.

Kay, **E**.**A**. 1979. *Hawaiian marine shells*. Bishop Museum Press, Honolulu. xiii + 653 pp.

Maciolek, **J**.**A**. **& Brock**, **R**.**E**. 1974. Aquatic survey of the Kona Coast ponds, Hawaii Island. Sea Grant Advisory Rept., UNIHI-SEAGRANT-AR-74-04. v + 73 pp. Available at http://www.botany.hawaii.edu/basch/uhnpscesu/pdfs/maciolek74.pdf (Accessed 4 April 2018).

Marcus, **E**. **& Marcus**, **E**. 1965. On two Ellobiidae from southern Brazil. *Boletim da Faculdade de Filosofia, Ciências e Letras de São Paulo, Zoologia* **25**: 425-453, 5 pls.

Martins, **A**.**M**. **de F**. 1996. Anatomy and systematics of the eastern Atlantic Ellobiidae (Gastropoda: Pulmonata). *Malacologia* **37**: 163–332.

Moellendorff, **O**.**F**. **von**. 1900. The land shells of the Caroline Islands. *Journal of Malacology* **7**: 101-126.

Nevill, **G**. 1878. *Hand list of Mollusca in the Indian Museum, Calcutta. Part I. Gastropoda. Pulmonata and Prosobranchia-Neurobranchia*. Office of Superintendent of Government Printing: Calcutta. xv + 338 pp.

Pease, **W**.**H**. 1860. Descriptions of new species of Mollusca from the Sandwich Islands. *Proceedings of the Zoological Society of London* **28**: 141–148.

Pease, **W**.**H**. 1869. Descriptions of the animals of certain genera of Auriculidae. *Proceedings of the Zoological Society, London* **37**: 59–61.

Quadras, **J**.**F**. **& Moellendorff**, **O**.**F**. **von**. 1895. Diagnoses specierum novarum ex insulis Philippinis. *Nachrichtsblatt der Deutschen Malakozoologischen Gesellschaft* **27**: 73–88.

Raven H. **& Vermeulen J**.**J**. 2007. Notes on molluscs from NW Borneo and Singapore. 2. A synopsis of the Ellobiidae (Gastropoda, Pulmonata). *Vita Malacologica* **4**: 29–62.

Romero, **P**.**E**., **Pfenninger**, **M**., **Kano**, **Y**. **& Klussmann-Kolb**, **A**. 2016. Molecular phylogeny of the Ellobiidae (Gastropoda: Panpulmonata) supports independent terrestrial invasions. *Molecular Phylogenetics and Evolution* **97**: 43–54.

Rosendahl, **P**.**H**. 1982. Archaeological reconnaissance survey, single-family dwelling site, Kupeke, Island of Molokai (TMK: 2-5-7-6:11). Unpublished report prepared for Mr. LeRoy E. Austin, Molokai Construction, Inc. 7 pp.

Severns, **M**. 2011. *Shells of the Hawaiian Islands: The sea shells*. Conchbooks: Hackenheim. 564 pp.

Tan, **S**.**K**. **& Woo**, **H**.**P**.**M**. 2010. A preliminary checklist of the molluscs of Singapore. Raffles Museum of Biodiversity Research, Singapore. 78 pp. Available at https://www.researchgate.net/publication/267852804_A_PRELIMINARY_CHECKLIST_OF_THE_MOLLUSCS_OF_SINGAPORE (Accessed 1 April 2018).

Tango, **L**.**K**., **Foote**, **D**., **Magnacca**, **K**.**N**., **Foltz**, **S**.**J**. **& Cutler**, **K**. 2012. Biological inventory of anchialine pool invertebrates at Pu‘uhonua o Honaunau National Historical Park and Pu‘ukohola Heiau National Historic Site, Hawai‘i Island. *The Hawai‘i-Pacific Islands Cooperative Ecosystem Studies Unit & Pacific Cooperative Studies Unit, University of Hawai’i at Manoa. Technical Report* **181**, ii + 24 pp. Available at https://scholarspace.manoa.hawaii.edu/bitstream/10125/34112/1/ v181.pdf (Accessed 4 April 2018).

Thomas, **W**.**S**. 1979. A biography of Andrew Garrett, early naturalist of Polynesia: Part 1. *The Nautilus* **93**: 15–28.

Van Rees, **C**.**B**. **& Reed**, **J**.**M**. 2014. Wetland loss in Hawai‘i since human settlement. *Wetlands* **34**: 335–350.

Vermeulen, **J**.**J**. **& Maassen**, **W**.**J**.**M**. 2003. The non-marine mollusk fauna of the Pu Luong, Cuc Phuong, Phu Ly, and Ha Long regions in northern Vietnam. Survey report for the Vietnam Programme of FFI (Flora and Fauna International). 35 pp. Available at https://classdat.appstate.edu/aas/bio/vandevenderr/Vietnam2016/PuLuong-Cuc Phuong-HaLong%20snails.pdf (Accessed 1 April 2018).

Wester, **L**. 1981. Introduction and spread of mangroves in the Hawaiian Islands. *Association of Pacific Coast Geographers Yearbook* **43**: 125–137.