Quilted Melania (*Tarebia granifera*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, July 2016
Revised, January 2017
Web Version, 3/30/2018

Photo: "*Tarebia granifera"* by H.G. Cheng. Licensed under Creative Commons BY-NC. Available: http://www.inaturalist.org/photos/1555419. (July 2017).

1 Native Range and Status in the United States

Native Range

From Madhyastha and Dutta (2012):

"The species has a widespread distribution in the Indo-Malayan and Oceania realms."

"Bangladesh; Bhutan; Cambodia; China (Guangdong, Hainan); Hong Kong; India (Andhra Pradesh, Bihar, Madhya Pradesh, Meghalaya, Orissa, Tripura, West Bengal); Indonesia (Papua, Sumatera); Japan; Malaysia (Peninsular Malaysia); Myanmar (Myanmar (mainland)); Nepal; Philippines; Singapore; Sri Lanka; Taiwan, Province of China; Thailand; and Viet Nam."

Status in the United States

From USGS (2017):

"Nonindigenous Occurrences: Florida, Hawaii, Idaho, Texas, Puerto Rico and US Virgin Islands."

From Fofonoff et al. (2003):

"*Tarebia granifera* occurs in Coral Gables and Miami, on the East Coast of Florida (Chaniotis et al. 1980b), but has not been reported from tidal waters."

"In 1947, it was collected in Lithia Springs, Hillsborough County, FL in headwaters of the Alafia River. It subsequently spread into tidal waters, where it can occur in high abundances in fresh-oligohaline tributaries (Poss 1999; Baker et al. 2004; Gulf States Marine Fisheries Commission 2009). It has been collected in interior springs and streams in nine Florida counties and in central Texas (Karatayev et al. 2009; Florida Museum of Natural History 2013; USGS Nonindigenous Aquatic Species Program 2013)."

"*Tarebia granifera* was collected in Maui in 1856, but it could have been introduced in Prehistoric times by Polynesian settlers as food or in the roots of cultivated Taro plants. It is now found in streams of all the major Hawaiian Islands (Cowie 1998; Carlton and Eldredge 2009). On Oahu, it is abundant in two brackish streams at 15 and 30 PSU (Englund et al. 2000)."

From Oglesby (1977):

"On 6 March 1976, many snails were observed by an aquatic biology class from Pomona College in Whitefield Creek, a brackish-water creek located in the headquarters area of the Salton Sea State Recreation Area, Riverside County [California], at an elevation of 68.6 m (225 ft) below sea level. […] Collected specimens were identified by Dwight W. Taylor, University of the Pacific, as *Thiara* (*Tarebia*) *granifera mauiensis* (Lea) […]"

Means of Introductions in the United States

From Abbot (1952):

"An aquatic-plant and fish dealer in Tampa related that he acquired specimens in 1937 while on a visit to California. Since that time, his plant vats have been stocked with this mollusk which, as an oddity, had been sold over a hundred times in a year as the "Philippine horn of plenty." It was his opinion that the snails were probably accidentally introduced to [Lithia Spring] around 1940, when improperly washed tubs were used to gather native plants."

From Oglesby (1977):

"[…] it seems likely that *T. granifera* was also introduced into Whitefield Creek [California] by aquarists or escapements from nearby tropical fish farms."

Remarks

From Fofonoff et al. (2003):

"Synonyms:
Melania granifera (Lamarck, 1822)
Tarebia lateritia. (Lea, 1850)
Thiara granifera (Lamarck, 1822)
Tarebia batana (Gould, 1843)
Tarebia broti (Reeve, 1859)
Tarebia celebensis (Quoy & Gaimard, 1834)
Tarebia chocolatum (Brot, 1860)
Tarebia coffea (Philippi, 1843)
Tarebia lineata (Gray in Wood, 1828)
Tarebia lirata (Menke, 1843)
Tarebia verrucosa (Hinds, 1844)"

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2016):

"Kingdom Animalia
  Subkingdom Bilateria
    Infrakingdom Protostomia
      Superphylum Lophozoa
        Phylum Mollusca
          Class Gastropoda
            Order Neotaenioglossa
              Family Thiaridae
                Genus *Tarebia*
                  Species *Tarebia granifera* (Lamarck, 1822) – quilted melania

"Taxonomic Status: valid"

Size, Weight, and Age Range

From Abbott (1952):

"*Thiara granifera* [see synonymy list under Remarks, above] is a relatively small gastropod, in which adults may vary in shell length from 6.0 to 40.0 mm., although the commonest size is approximately 25.0 mm. (one inch)."

Environment

From Lachner et al. (1970):

"This small snail prefers the shallow riffles of fast-flowing freshwater streams."

From Appleton et al. (2009):

"In common with other Thiaridae, *T. granifera* is primarily a benthic species and in South Africa has been collected on a variety of substrata in both natural and artificial waterbodies, *e.g*. sand, mud, rock, concrete bridge foundations and the concrete walls and bottoms of reservoirs, irrigation canals and ornamental ponds. Many of these habitats were vegetated and the associated vegetation included many types of emergent monocotyledons [. . .] Where densities are high, *T. granifera* may also occur on marginal, trailing vegetation and the floating *Eichhornia crassipes* (Mart.) Solms as well. It favours turbulent water and tolerates current speeds up to $1.2 m.s^{-1}$ and possibly greater."

From Miranda et al. (2010):

"In South Africa, *T. granifera* was first recorded in an estuarine environment in the St Lucia Estuary. […] this snail survives high salinity for a relatively long time, as LS_{50} (lethal salinity for 50% of the population) was reached at 30 psu over 65–75 days. However, higher salinity adversely affected the *T. granifera* population. Snails acclimated to freshwater conditions and suddenly transferred to 30 psu experienced 100% mortality within 48 h. Snail activity also declined with increasing salinity."

From Fofonoff et al. (2003):

"This snail, though aquatic, is quite tolerant of desiccation – individuals survived 2-3 days of air exposure at 25-30°C at 76-92% relative humidity (Chaniotis et al. 1980a)."

Climate/Range

From Miranda et al. (2010):

"*T. granifera* can tolerate temperatures between 0 ºC and 47.5 ºC, allowing it to survive high temperature extremes. The species may also survive cold snaps and invade higher altitude areas."

Distribution Outside the United States

Native

From Madhyastha and Dutta (2012):

"The species has a widespread distribution in the Indo-Malayan and Oceania realms."

"Native: Bangladesh; Bhutan; Cambodia; China (Guangdong, Hainan); Hong Kong; India (Andhra Pradesh, Bihar, Madhya Pradesh, Meghalaya, Orissa, Tripura, West Bengal); Indonesia

(Papua, Sumatera); Japan; Malaysia (Peninsular Malaysia); Myanmar (Myanmar (mainland)); Nepal; Philippines; Singapore; Sri Lanka; Taiwan, Province of China; Thailand; Viet Nam"

Introduced

From Fofonoff et al. (2003):

"*Tarebia granifera* was first found in Puerto Rico in 1945 (Chaniotis et al. 1980b) and is now widespread (USGS Nonindigenous Aquatic Species Program 2013). It also occurs in Cuba, Jamaica (by 1988), the Virgin Islands (by 1987), Martinique (in 1991), Haiti (by 1979), the Dominican Republic (in 1968), Trinidad (by 1944), the Gulf Coast of Mexico (by 2007), and the Caribbean coast of Guatemala and Venezuela (in 1975) (Chanitois 1980b; Pointier et al. 1994; Pointier 2001; López-López et al. 2010; Florida Museum of Natural History 2013). In two Mexican rivers, its range extends to the upper estuarine zone (López-López 2010)."

"*Tarebia granifera* was discovered near Durban, South Africa, in a freshwater reservoir in 1996 (Appleton and Nadasan 2002). It has now colonized freshwater drainages, lagoons, and estuaries along ~330 km of coastline, from Durban, nearly to the border with Mozambique (Appleton et al. 2009). In 2005, it was found in a freshwater stream flowing into the St. Lucie estuary in Kruger National Park, and soon established dense populations at salinities of 10-20 PSU (Appleton et al. 2009; Miranda et al. 2010). In 2004, *T. granifera* was found at several sites along the Jordan River estuary (Ben-Ami 2008)."

From Madhyastha and Dutta (2012):

"Introduced: […] French Polynesia (Society Is.) […]"

"Present - origin uncertain: Madagascar; Papua New Guinea (Papua New Guinea (main island group))"

Means of Introduction Outside the United States

From Fofonoff et al. (2003):

"The aquarium industry is probably the primary vector of introduction, but some of its later spread in the Caribbean region has resulted from its use for biocontrol of the native snail *Biomphalaria glabrata*, a host of the disease-causing trematode *Schistosoma mansoni* (blood-fluke) (Pointier et al. 1994; Pointier 2001)."

From Appleton et al. (2009):

"It is probable that dispersal of *T. granifera* from one waterbody or river catchment to another occurs passively via birds, notably waterfowl, which eat them and void them later, perhaps in another habitat. Evidence for this comes from the finding of many small *T. granifera* 5-7 mm in height and still containing the soft parts in unidentified bird droppings from the bank of the Mhlali River. […] Passive dispersal may also occur via weed on boats and boat trailers and via water pumped from one waterbody to another for industrial and irrigation purposes. In the Nseleni River juvenile *T. granifera* were commonly found with another invasive snail, *Lymnaea* *columella* Say, 1817, on floating clumps of water hyacinth *Eichhornia crassipes* which provide a vehicle for rapid downstream dispersal."

Short Description

From Abbott (1952):

"The shell is rather elongate with a straight-sided, pointed spire and is sculptured with several spiral rows of beads or blunt tubercles. The aperture of the shell is obliquely ovate, and the apertural lip is sharp. The color of the shell and its thin periostracal covering is generally a light brown to yellowish brown, which sometimes is flecked with small, dark, red-brown color spots. The operculum is about two-thirds the size of the aperture, opaque, and colored a dark blackish brown. The animal and operculum may be withdrawn into the shell completely from view. When fully extended the head and foot are, together, about one-fourth the length of the shell. The foot is relatively small and square to oblong. The proboscis is rather large and flattened. The two tentacles are round and slender and extend slightly beyond the anterior limits of the proboscis. The mantle, which lines the interior of the last shell whorl, is bordered by several prominent, fleshy papillae, which may be seen projecting beyond the shell lip on the left (or outer lip) side. In mature and gravid specimens a brood pouch is present on the back of the animal just behind the head. In some individuals the shells of the small, living young may be seen through the thin dorsal wall of the pouch."

Biology

From Oglesby (1977):

"Observations in the field and laboratory indicate that *T. granifera* feeds on microscopic algae, other micro-organisms, and small particles of organic matter."

From Fofonoff et al. (2003):

"This snail has separate sexes, but reproduces primarily by parthenogenetic reproduction (without fertilization), with only occasional sexual reproduction, resulting in populations that are largely or completely clonal. Males are rare or absent (Abbott 1952; Myers et al. 2000; Miranda et al. 2010). Reproduction is ovoviviparous, with eggs being incubated in the female's brood pouch in the last (largest) whorl of the shell and hatching out as small snails, 2.0 - mm in length with 4-5 shell whorls. Estimated annual fecundity is 213 embryos per year (Keller et al. 2007). The snails reach maturity at about 6 mm shell length in 3-6 months (Abbott 1952; Chaniotis et al. 1980b)."

"It is eaten by crabs, fishes, and birds […]"

From Appleton et al. (2009):

"In Florida Tucker Abbott (1952) recorded an 'extraordinary' *T. granifera* density of 4444 m^{-2} which falls within the range of densities measured with a Van Veen grab in a number of sites in northern KwaZulu-Natal […] Typically half or more of these snails were buried in the sediments and were not visible from the surface."

Human Uses

From Fofonoff et al. (2003):

"It is a popular aquarium species […]"

"[…] *T. granifera* came to be regarded as a parasite fighter in the Caribbean, against the Blood Fluke *Schistosoma mansoni*, by competition with the native host snail *Biomphalaria glabrata*. It has been introduced to many streams as a biocontrol agent (Perez et al. 1991; Pointier et al. 1994)."

From Oglesby (1977):

"These snails are used by tropical fish aquarists to keep down algal growth and to prevent accumulation of organic debris in aquaria."

Diseases

From Fofonoff et al. (2003):

"Many trematode species and many more undescribed larval forms have been reported from this snail (Abbott 1952; Appleton et al. 2009)."

From Abbott (1952):

"Family HETEROPHYIDAE
1. *HAPLORCHIS TAICHUI* (Nishieorl. 1924).
2. *DIORCHITREMA FORMOSANUM* Kataata. 1932.
3. *METAGONIMUS YOKOGAWAI* Katsorada, 1912."

"Gastropod mollusks serve as the obligatory first intermediate host of all digenetic trematodes or flukes. While in several cases the relationship between the parasitic fluke and the host snail is restricted to one species in certain areas, on the whole there does not appear to be any set pattern for certain snails to serve as hosts to any particular species or even genus of trematode."

"In all likelihood *Thiara granifera* may be considered a potential host of the American *Paragonimus kellicottii* on epidemiological and ecological grounds."

From Appleton et al. (2009):

"*Tarebia granifera* serves as the first intermediate host for a variety of trematodes in its native south east Asia. Amongst these are several species of the family Heterophyidae some of which have been reported as opportunistic infections in people (Watson, 1960), and another, *Centrocestus formosanus* (Nishigori, 1924), is an important gill parasite of fish. […] *T. granifera* also serves as intermediate host for the philopthalmid eyefluke *Philopthalmus gralli* Mathis & Ledger, 1910 which has recently been reported affecting ostriches on farms in Zimbabwe (Mukaratirwa et al., 2005). The snail host implicated in this outbreak was *Melanoides* *tuberculata* (Müller, 1774) but the rapid spread and high population densities achieved by *T. granifera*, which appears to be replacing *M. tuberculata* in South Africa, may exacerbate the problem in the future. For many years *T. granifera* was believed to be an intermediate host for the Asian lungfluke *Paragonimus westermani* (Kerbert, 1878), but Michelson showed in 1992 that this was erroneous."

Threat to Humans

From Lachner et al. (1970):

"*Thiara granifera* serves as an intermediate host of numerous trematodes, three of which are known, in their adult stages, to parasitize man (Abbott: 1952:108). A second intermediate host, such as a freshwater crayfish or crab, is a necessary part of the life cycle of the fluke, and there is only a potential menace of human infection, for these crustaceans must be eaten raw if the fluke is to infest man."

From Appleton et al. (2009):

"In addition to its role as intermediate host for several economically important trematode species, *T. granifera* has colonized reservoirs, dams and ponds on the premises of three large industrial plants in northern KwaZulu-Natal and been pumped out of at least one of them, blocking pipes and damaging equipment. This generally happens when snail densities are high and the damage is due to individuals being crushed so that pieces of shell and soft tissue are carried into machinery. Details of the nature and extent of this damage and the costs incurred are not available. It is not possible to say how the snails reached these reservoirs but there is no doubt that *T. granifera* is able to pass unharmed through pumps, probably as juveniles. The snail has also interfered with the circulation of water through the ponds at a fish hatchery in the region by blocking pipes and pumps."

3 Impacts of Introductions

From Appleton et al. (2009):

"*T. granifera* has colonized reservoirs, dams and ponds on the premises of three large industrial plants in northern KwaZulu-Natal and been pumped out of at least one of them, blocking pipes and damaging equipment. […] The snail has also interfered with the circulation of water through the ponds at a fish hatchery in the region by blocking pipes and pumps."

From Gómez Pérez et al. (1991):

"After a study of the population dynamics of *Biomphalaria glabrata* snails in several breeding places in the Dominican Republic, the snail *Thiara granifera* was introduced in some *B. glabrata* habitats. *T. granifera* became established in one point in one habitat in the town of Quisqueya, in the east of the country. […] After 14 months of observations, the results showed that *T. granifera* was competing with and displacing *B. glabrata*. This competition does not seem to be competition for food or vital space. Rather, *B. glabrata* avoids the presence of *T. granifera* and moves away to new areas, and this is possibly due to a chemical substance(s) secreted by *T. granifera* or by physical contact with the large number of individuals of *T. granifera*."

From Prentice (1983):

"In four field trials [in St. Lucia], *B. glabrata* was apparently eliminated from marshes and streams six to 22 months after the introduction of *T. granifera*."

From Fofonoff et al. (2003):

"Habitat Change: *Tarebia granifera* has a generalist diet, but feeds mostly on filamentous microlalgae (Miranda and Perissinotto 2012). In Trinidad streams, the snail was much more abundant (2-8 X) in open areas, with direct sunlight and denser algal populations, compared with forested areas. The high snail abundance and intense grazing led to a 3-9-fold increase in nitrogen export, contributing to eutrophication downstream (Moslemi et al. 2012). An unusual habitat effect was found at the mouth of streams in Tobago, where abundant shells of *M. tuberculata* (Red-Rim Melania) and *Tarebia granifera* were washed down streams into coastal waters during storms, providing a new empty-shell resource for hermit crabs (*Clibanarius tricolor* and *C. vittatus*) and drastically changing the patterns of shell use (van Oosterhout et al. 2013)."

4 Global Distribution

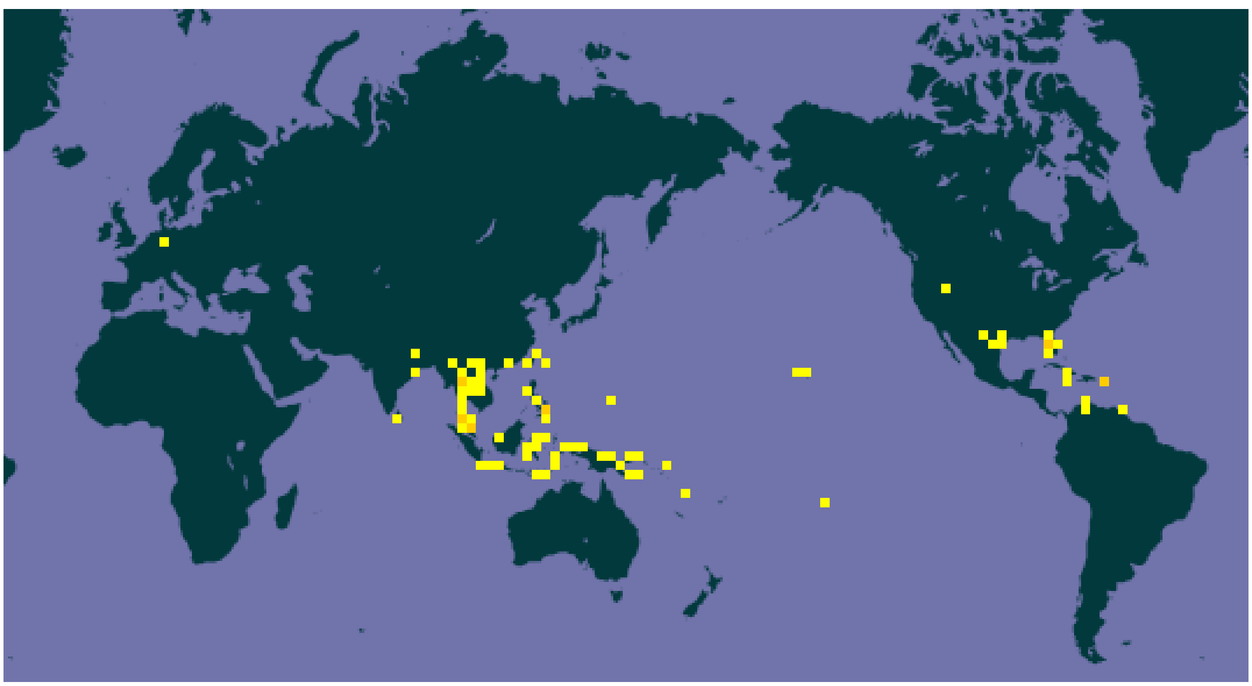

Figure 1. Known global established populations of *Tarebia granifera*. Points located in Idaho and Europe were excluded from climate matching as they do not represent established populations (see Status in the United States, and Distribution Outside the United States, above). Map from GBIF (2016).

5 Distribution Within the United States

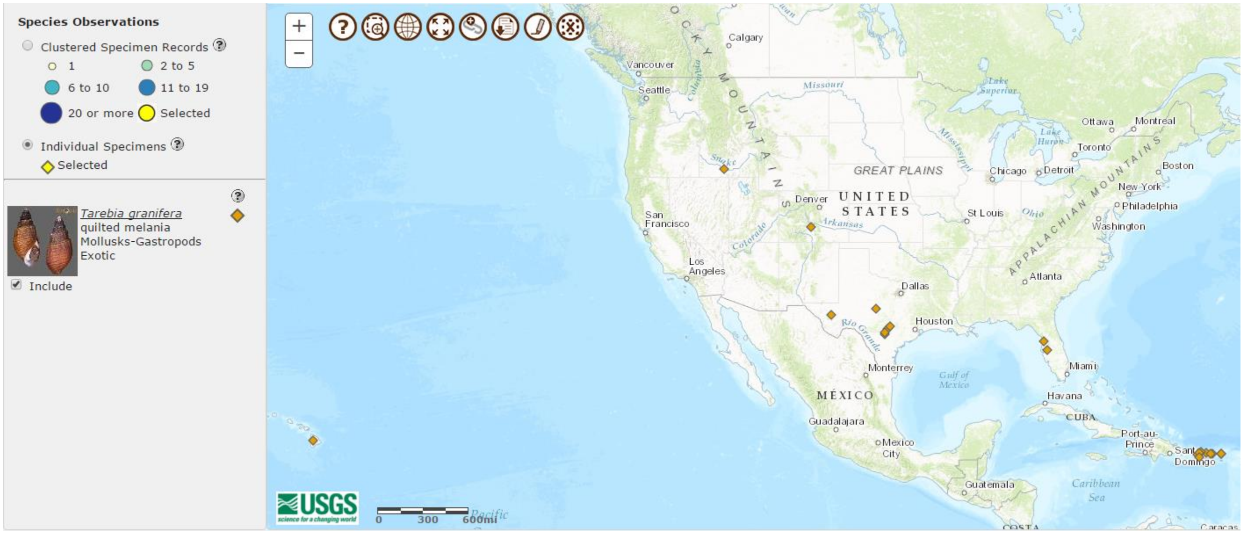

Figure 2. Known established locations of *Tarebia granifera* in the United States. Map from USGS (2017). Point in Idaho does not represent an established location and was excluded from climate matching. Point in Colorado occurs at a hot spring that is not representative of the local climate and was excluded from climate matching.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) was high across Florida, Texas, coastal Georgia and South Carolina, and southeastern New Mexico. The climate match was medium in much of the remainder of the south-central and southwestern U.S and up into the Mid-Atlantic states. The northern contiguous U.S. showed a low climate match. Climate 6 proportion indicated that the contiguous U.S. showed a high climate match overall. High climate matches are associated with proportions >0.103; the Climate 6 proportion for *Tarebia granifera* was 0.212.

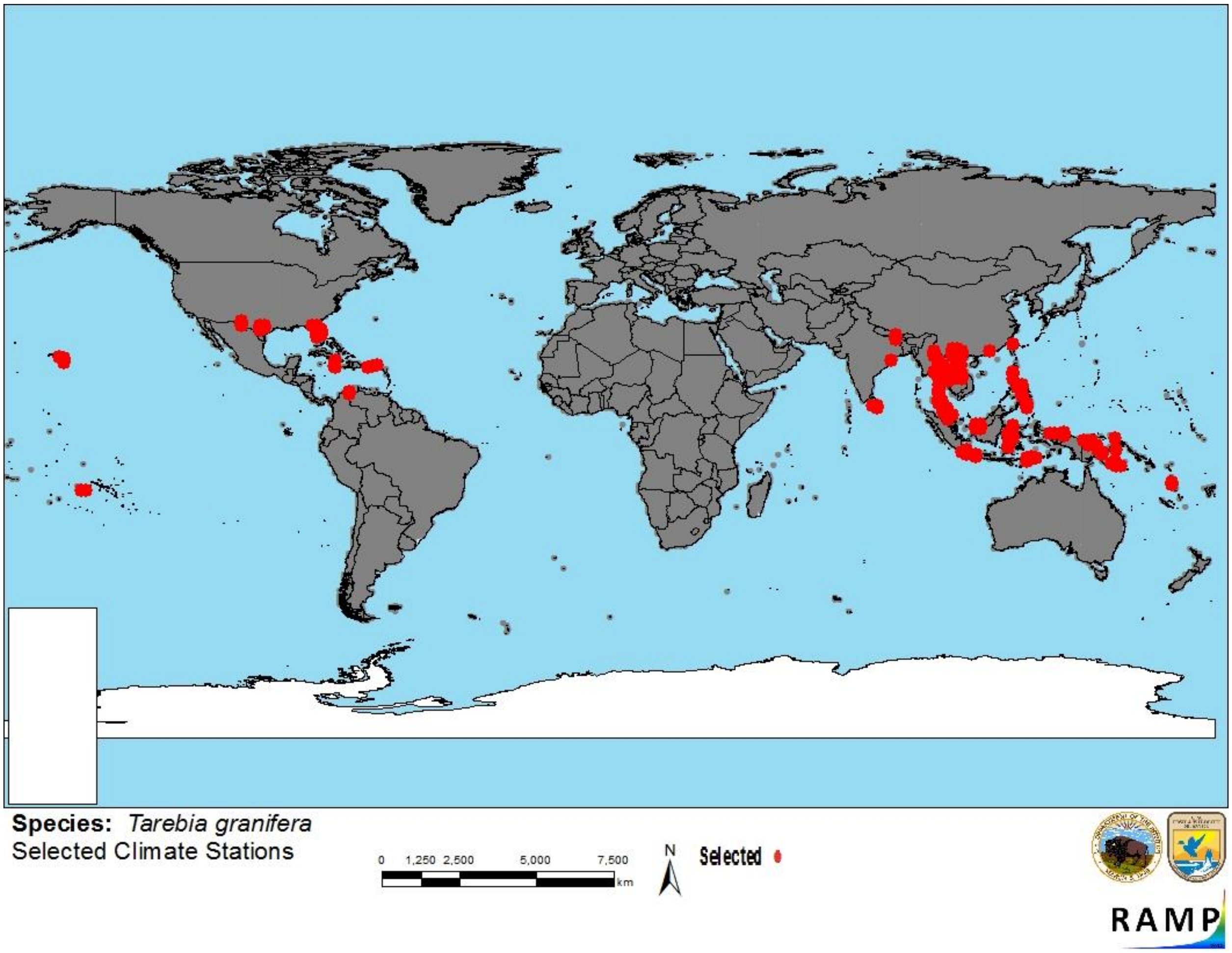

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *Tarebia granifera* climate matching. Source locations from GBIF (2016) and USGS (2017).

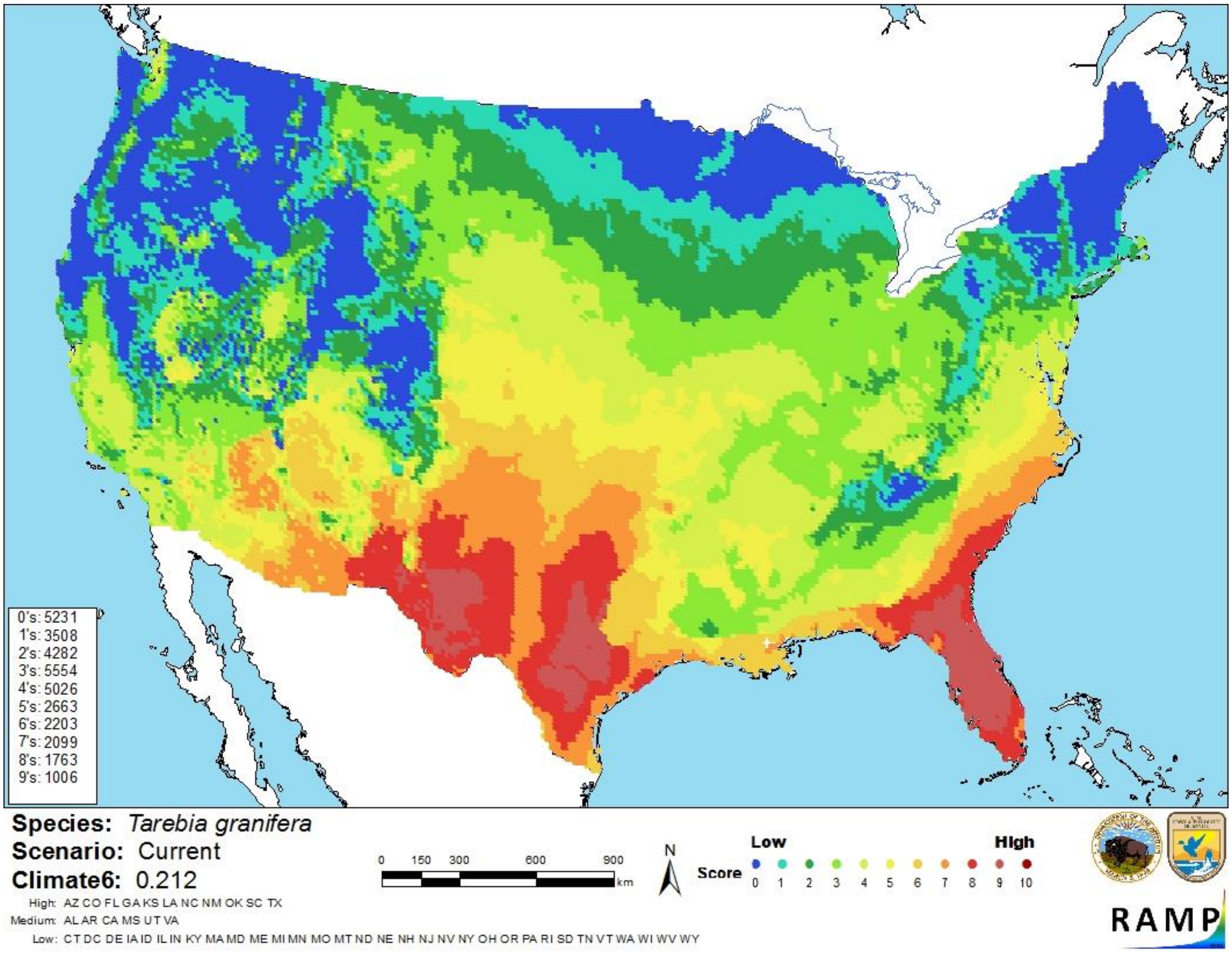

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Tarebia granifera* in the contiguous United States based on source locations reported by GBIF (2016) and USGS (2017). 0=Lowest match, 10=Highest match. Counts of climate match scores are tabulated on the left.

The "High", "Medium", and "Low" climate match categories are based on the following table:

Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)	Climate Match Category
$0.000 \leq X \leq 0.005$	Low
$0.005 < X < 0.103$	Medium
≥ 0.103	High

7 Certainty of Assessment

The biology and distribution of *Tarebia granifera* are well-documented in the scientific literature. The existence of impacts of *T. granifera* introduction is supported by multiple peer-reviewed studies. The certainty of this assessment is high.

8 Risk Assessment

Summary of Risk to the Contiguous United States

The Indo-Malayan and Oceanic mollusk *Tarebia granifera* has become established in Africa, North America, and South America. In the U.S., it is well-established in Florida, Texas, and Hawaii, with additional occurrences reported in Colorado, California, and Idaho. *T. granifera* is an intermediate host to trematodes that can infect humans as well as economically important fish and birds. It is capable of reproducing asexually and forming high densities that can interfere with industrial pipe function. *T. granifera* has displaced native gastropods in the Dominican Republic and St. Lucia, and high abundances of *T. granifera* have contributed to stream eutrophication in Trinidad. Climate match to the contiguous U.S. is high. Overall risk assessment for this species is high.

Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): High**
- **Overall Risk Assessment Category: High**

9 References

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

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10 References Quoted But Not Accessed

Note: The following references are cited within quoted text within this ERSS, but were not accessed for its preparation. They are included here to provide the reader with more information.

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