Recent Records of Alien Anurans on the Pacific Island of Guam[1]

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Abstract: Eight anuran species were recorded for the first time in Guam in the period May 2003–December 2005, all apparently the result of arrivals to the island since 2000. Three of the eight species (*Rana guentheri*, *Polypedates megacephalus*, and *Eleutherodactylus planirostris*) had well-established breeding populations by 2005. A further three (*Fejervarya* cf. *limnocharis*, *Fejervarya cancrivora*, and *Microhyla pulchra*) were recorded from a number of individuals, but it is not known whether these species have established breeding populations. Two species (*Kaloula pulchra* and *Eleutherodactylus coqui*) appear to be incidental transportations to the island that have not established. Before 2003, five anuran species, all introductions, had been recorded from Guam. Three of these, *Polypedates leucomystax*, *Pseudacris regilla*, and *Kaloula picta*, were detected on Guam in incoming cargo but destroyed. Two species established: *Bufo marinus* was deliberately introduced and the Australian hylid *Litoria fallax* was probably an accidental introduction. Successful establishment of anurans on Guam has increased the risk of frog introductions to nearby islands. By providing additional food sources for the brown tree snake (*Boiga irregularis*), anuran introductions have increased the chance that *B. irregularis* might substantially increase in numbers and in turn increase the risk of the snake being accidentally transported to other islands.

Invasive organisms impact recipient communities in a number of ways, perhaps the most important being the modification of the trophic structure within the community (e.g., Fritts and Rodda 1998, Short et al. 2002, Moore et al. 2004). Island endemics that have evolved in the absence of certain alien predators may be particularly vulnerable because they lack the necessary defenses to impede their predation (Case and Bolger 1991, Dickman 1996, Fritts and Rodda 1998). Alternatively, the influx and successful establishment of nonindigenous prey may increase food availability for a number of species already present (e.g., Pimm 1987, Rodda and Fritts 1992, Burnett 1997, Poulin et al. 2001). If there is a lack of niche differentiation in environments where invasive and native species share common resources, the resultant competitive exclusion of the weaker species may cause extirpation of endemics (Rosenzweig and MacArthur 1963, Rosenzweig 1981, Cadi and Joly 2003). Invasive species can destroy or modify crucial habitat, leading to elevated levels of exposure of endemics to

[1] Funding for this project was provided by the Department of the Interior's Office of Insular Affairs and Fish and Wildlife Service. Manuscript accepted 19 October 2006.

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Pacific Science (2007), vol. 61, no. 4:469–483

predators, competition for food resources, or removal of important refuge attributes (Costin and Moore 1960, Paulay 1994, Priddel and Carlile 1998). Pest animals are also often vectors for the spread of pathogens and disease (Geering et al. 1995, Dickman 1996). Furthermore, if predator control methods are established, the resulting effect on native nontarget species can be considerable (Belcher 1998, Eason et al. 1999, Marks et al. 2000).

Guam, situated in the western Pacific Ocean (13° 25′ N, 144° 45′ E), is renowned for the introduction of a number of nonindigenous vertebrate species over the past century, including the brown tree snake (*Boiga irregularis*) (Savidge 1984, 1987, Fritts and Rodda 1998). McCoid (1993) listed 17 extralimital species of reptiles and amphibians, of which nine are known to have established populations, and later estimated that 43% of Guam's nonmarine herpetofauna were nonindigenous (McCoid 1999). Wiles (2000) documented an additional six reptile and one amphibian species, all of which were single specimens and unlikely to have established populations.

Of the five anuran species known to have been introduced to Guam before 2003, only two established breeding populations (Eldredge 1988, McCoid 1993, McCoid and Kleberg 1995, Wiles 2000). The marine toad (*Bufo marinus*) was intentionally imported as a biocontrol agent for insects and the black slug (*Veronicella leydigi*) in 1937 (Anon. 1940, Chernin 1979), and the eastern dwarf tree frog (*Litoria fallax*) was introduced from Australia around 1968 via an unknown vector (Eldredge 1988). The three species that failed to establish appear to be introductions of one or two individuals in cargo: *Kaloula picta* from the deck of a ship (McCoid 1993), *Polypedates leucomystax* in an aircraft (Wiles 2000), and *Pseudacris regilla* on imported Christmas trees (McCoid 1993) and more recently (2005) on produce originating from the mainland United States (Guam Division of Aquatic and Wildlife Resources, unpubl. data). By 2005, an additional eight anuran species were identified on Guam, of which at least three are recognized as established. Here we document these new introductions and discuss their potential impacts to Guam and neighboring islands.

MATERIALS AND METHODS

Occurrence records of the new nonindigenous frog species on Guam were obtained from reports and specimens brought in by the public and wildlife personnel, opportunistic field collection, and targeted field surveys carried out by U.S. Geological Survey, Colorado State University, and U.S. Department of Agriculture, Wildlife Services staff between 2003 and 2005.

RESULTS

Established Species

Eleutherodactylus planirostris Cope, 1862 (Family Leptodactylidae), Greenhouse Frog

This species was first detected at St. John's School, Tumon (21 October 2003), when reports were made of numerous "small frogs" on the school grounds. Surveys (22–29 October 2003) to delimit the population confirmed a well-established population in Tumon (Figures 1 and 2*A*), with juveniles and calling adults recorded. The species has since been found in Tamuning, Mangilao, and Manengon. The direct development of frogs from eggs laid under damp vegetation or debris (Schwartz 1974) makes detection of eggs of this species difficult, and they have yet to be found on Guam.

Originally from the Caribbean islands of Cuba, the Bahamas, and the Caymans, the greenhouse frog has been introduced to Florida, Louisiana, Hawai'i, and Jamaica (Kraus et al. 1999, Kraus and Campbell 2002). Hawai'i is the suspected source of the Guam population, because the areas first colonized were supplied with ornamental plants from Hawai'i.

Polypedates megacephalus Hallowell, 1861 (Family Rhacophoridae), Hong Kong Whipping Frog

The species was initially detected as a breeding population in ponds north of Dan-

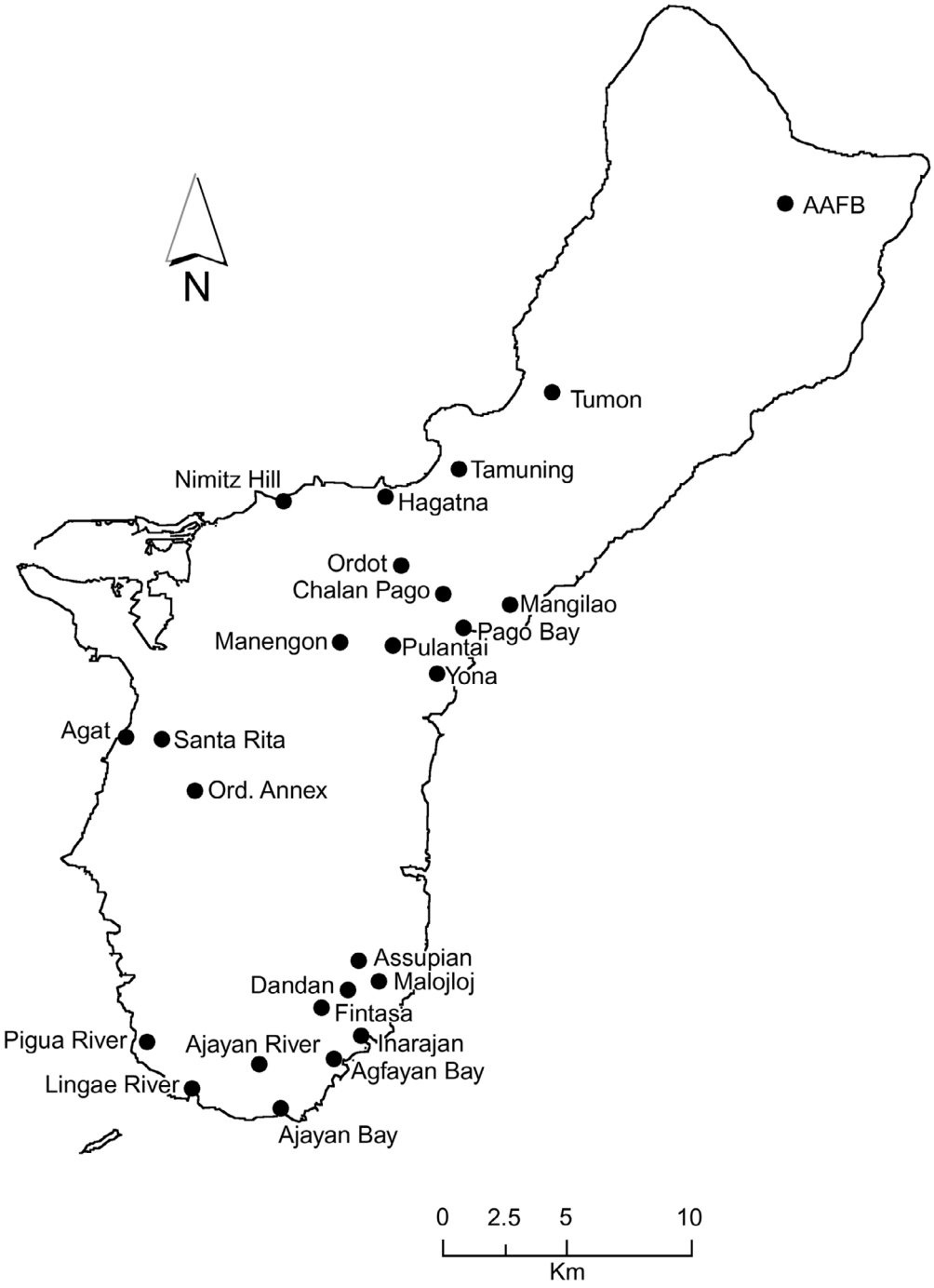

FIGURE 1. Map of Guam showing locations mentioned in the text. AAFB, Andersen Air Force Base; Ord. Annex, COMNAVMAR Ordnance Annex.

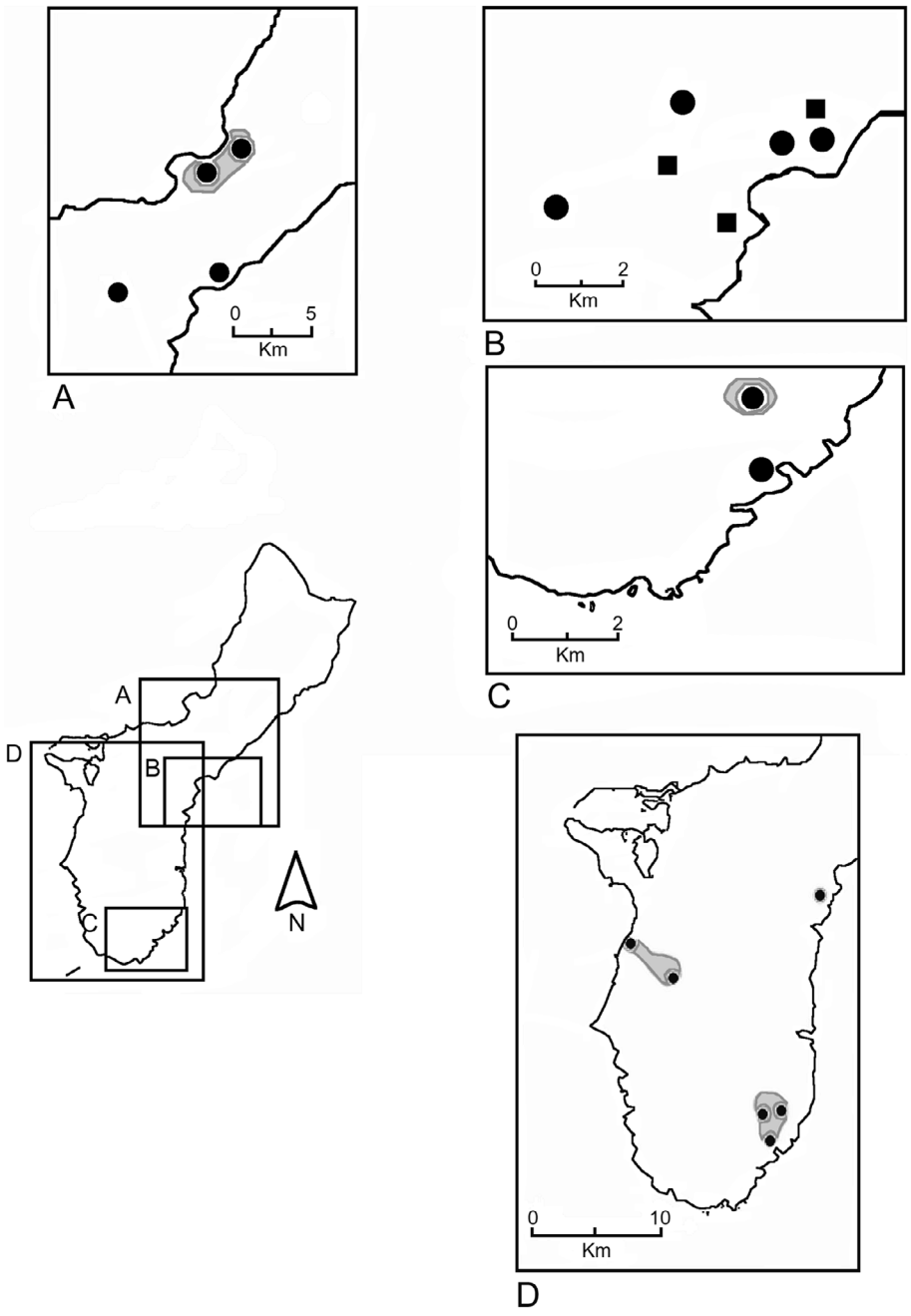

FIGURE 2. Map showing the known locations of five of the eight frog species discovered on Guam to December 2005: *A*, *Eleutherodactylus planirostris*; *B*, *Fejervarya cancrivora* (●) and *F.* cf. *limnocharis* (■); *C*, *Microhyla pulchra*; and *D*, *Polypedates megacephalus*. Solid symbols represent collection locations and shaded areas illustrate the current range of the species based on these and additional observations. Specimens with unknown collection location are not included.

dan (22 January 2004). Foam nests containing 300–400 eggs each were found in shallow, still water, typically attached to emergent vegetation. The species has since been collected or reported breeding from Agat, Malojloj, Inarajan, Yona, and COMNAVMAR (Commander Naval Forces Marianas) Ordnance Annex (Figures 1 and 2*D*). The Guam population has both forms of anterior dorsal surface coloration and pattern (x-shaped marking and four longitudinal stripes) that are typical within-population variation in *P. megacephalus* (H. Ota, University of the Ryukyus, pers. comm.).

Polypedates megacephalus is distributed in southern China, Taiwan, Tibet, and northern India (Zhao and Adler 1993).

Rana guentheri Boulenger, 1882 (Family Ranidae), Günther's Amoy Frog

An established population was detected in Inarajan (Figure 1) by the owner of an aquaculture farm (6 May 2003). Two adults were collected on a riverbank adjacent to the fish farm ponds, and tadpoles were collected from the fish ponds. Subsequently, a large number of frogs was hand captured and eggs and larvae removed from nearby ponds at Dandan, at the same location *Microhyla pulchra* and *P. megacephalus* were first detected. However, opportunistic observations by one of the authors (M.P.W.) suggest that the species has been present in the area since at least 2001, and reports by residents indicate that it was present for several years before being detected at the Inarajan fish farm. Residents have reported hearing small choruses initially from ponds around Malojloj, Ajayan Bay, and Agfayan Bay in June 2001, and over a much wider area following Supertyphoon Pongsona in December 2002. Near the Lingae River a resident noted choruses in November 2003, and by March 2004 a population was established in the area. By December 2005 this species was also detected in Santa Rita, Agat, COMNAVMAR Ordnance Annex, Assupian, Fintasa Falls, the Ajayan River, and the Pigua River, and there are unconfirmed reports of it being present at Chalan Pago, Ordot, Mangilao, and Hagåtña. Dry land dispersal to high points distant from water, such as Mount Alutom (near Nimitz Hill), has also been observed. *Rana guentheri*'s range has expanded rapidly (Figure 3), and it now appears to be established broadly over southern Guam north to Pago Bay and Nimitz Hill. The species is locally known as the "barking frog" because of its distinctive call and was the first of the recent frog introductions to be detected.

Rana guentheri is distributed throughout southern China north to Hong Kong and the Yangtze River. It is also common in Hainan, Taiwan, and central Vietnam (Frost 2004), and populations exist in Laos (Orlov et al. 2002).

Species of Questionable Status

Fejervarya cancrivora Gravenhorst, 1829 (Family Ranidae), Crab-Eating Frog

The species was first recorded from a specimen collected at the University of Guam's Marine Laboratory (5 November 2003), within 500 m of the university's aquaculture facility at Fadian Point, near Mangilao (Figure 1). It was presented to Guam Division of Aquatic and Wildlife Resources. A second specimen was brought to Guam Division of Aquatic and Wildlife Resources almost a year later (13 September 2004); no collection information for the specimen was available except that it was found in "southern Guam." These first two specimens were initially identified as belonging to the *Rana nigromaculata* complex. A third specimen, also from "southern Guam," was collected on 27 January 2005, and it was at this point that the correct identity of the previous two specimens of *F. cancrivora* was determined. Over the next 10 months the species was located at an additional four sites (Figure 2*B*)—Mangilao: two specimens collected, one behind the Ordot School (9 May 2005) and one in a damp swale (12 May 2005); Pulantat, near Yona: a single individual (10 November 2005) caught in a damp swale (J. Cepeda, pers. obs.); Manengon: a single individual (13 November 2005) found in a roadside puddle approximately 400 m from a golf course. The breeding status and range of the species is unclear.

Fejervarya cancrivora is native to Southeast Asia, including the southeastern part of

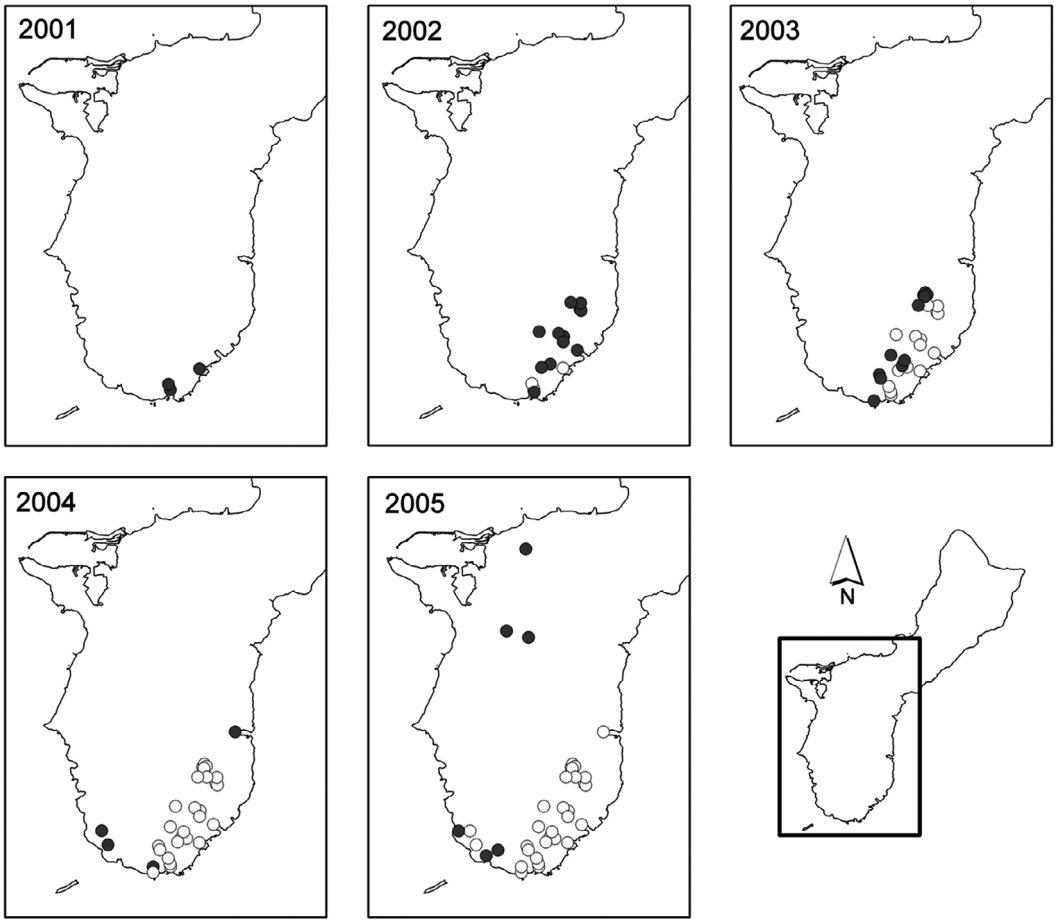

FIGURE 3. Distribution and range expansion on Guam of *Rana guentheri* since its discovery in June 2001 to December 2005. Each map shows the total cumulative number of localities from 2001 to that year. ●, locations discovered for the first time in that year; ○, locations discovered in previous years. *Rana guentheri* was first found at two aquaculture facilities in southern Guam.

China, Indonesia, Malaysia, Myanmar, Singapore, Thailand, and Vietnam (Dubois and Ohler 2002, Sumida et al. 2002). Introduced populations of the species are present in New Guinea (Menzies 1996) and perhaps the Philippines (Brown and Alcala 1970).

Fejervarya limnocharis sensu lato Gravenhorst, 1829 (Family Ranidae), Rice Frog

A second *Fejervarya* species, *Fejervarya limnocharis* sensu lato was recorded from three sites within 5 km of each other along the east coast of central Guam. Initially a single specimen was collected from Yona (Figure 1) at a plant nursery (3 November 2003). An unsubstantiated report from the nursery owner stated that it had been unintentionally transported to that location from another plant nursery in Inarajan. The specimen was photographed but accidentally destroyed during preservation. At the second site, Pulantat, a pair was observed in amplexus (24 January 2004), and at Mangilao (5 June 2005) an individual was found calling in an aquaculture pond used to stock tilapia (*Oreochromis* sp.) for a period of 5 yr before being abandoned

in 2002 (Figure 2*B*). The owner of the pond reported the "same species" calling each rainy season for at least 3 yr (2003–2005). A subsequent inspection of the ponds confirmed the presence of a number of individuals, but no tadpoles were found.

Fejervaria limnocharis sensu lato is known to be a composite of several morphologically similar but genetically distinct species (e.g., Dubois 1987, Toda et al. 1998, Dubois and Ohler 2002). It is widespread throughout the Asian region, ranging from China to Nepal, Pakistan, India, Sri Lanka through to Japan, Taiwan, Philippines, Indonesia, Cambodia, Thailand, and Malaysia (Toda et al. 1997, Sumida et al. 2002, Frost 2004). A member of this species complex is currently well established on some islands of the Ryukyus, including a few oceanic islands (Ota et al. 2004).

To determine the specific identity and origin of the Guam samples, genetic investigations are essential.

Microhyla pulchra Hallowell, 1861 (Family Microhylidae), Marbled Pigmy Frog

This species was initially recorded from Dandan (Figure 1), where three individuals were observed around the periphery of a pond (22 March 2004), two of which were collected. It was then located at Inarajan (26 March 2004 [Figure 2*C*]), approximately 5 km distant, where a single individual was observed in a mud depression made by ungulates at the pond's edge. It has not since been recorded at any other location, either as adults or tadpoles.

Microhyla pulchra is found throughout India and Sri Lanka, and Southeast Asia including Indochina and southern China (Dubois 1987, Frost 2004).

Unsuccessfully Established Species

Eleutherodactylus coqui Thomas, 1966 (Family Leptodactylidae), Coquí Frog

This species was first reported (November 2003) from calls heard by a member of the public at Tumon (Figure 1), less than 50 m from a plant nursery. A single call was heard periodically over several weeks, but no specimen was caught. The reporter recognized the call as the same as those heard in Puerto Rico. In 2004, two specimens were collected in central Guam by the Guam Division of Agriculture and Wildlife Resources (DAWR, unpubl. data).

Eleutherodactylus coqui is native only to Puerto Rico but has been introduced to Florida (Meshaka et al. 2004) and from there to Hawai'i in the mid- to late 1990s (Kraus et al. 1999, Kraus and Campbell 2002). Hawai'i is the suspected origin of the individuals found on Guam.

Kaloula pulchra Gray, 1831 (Family Microhylidae), Malayan Narrow-Mouthed Toad

A single individual was discovered by military personnel in a cargo plane arriving from Thailand at Andersen Air Force Base (Figure 1) on 3 October 2003. The species has not been recorded on the island since.

Kaloula pulchra is found throughout Southeast Asia including Cambodia, Indonesia, Laos, Malaysia, Myanmar, Singapore, Thailand, and Vietnam, as well as China, Nepal, and northeastern India (Naik and Vinod 1996, Frost 2004). Flower (1896, 1899) suggested that the Singapore population is introduced. The species seems also to have been introduced to Borneo and Sulawesi (Parker 1934, Matsui 1979, Inger and Stuebing 1997) and recently to Taiwan (Lue et al. 1999).

DISCUSSION

Vertebrate species have been introduced to Guam from a variety of locations around the globe including North America, Micronesia, New Guinea, the Philippines, other parts of Asia, Australia, and Hawai'i (Chernin 1979, Eldredge 1988, Rodda et al. 1992, Fritts and Rodda 1998) (Table 1). Before western settlement, 13 species of reptiles but no amphibians were found on the island (Rodda and Fritts 1992). *Bufo marinus* was the first frog to be introduced, in 1937 (Chernin 1979), followed by *Litoria fallax* in 1968 (Eldredge 1988). With the addition of the species newly reported herein, the number of breeding frog species on Guam has risen to at least five. Except for *B. marinus*, all introductions (suc-

TABLE 1

Herpetological Introductions to Guam (1800–2005)

Taxa	Year Detected	Release	Status[a]	Probable Origin	References
Frogs and Toads					
Bufo marinus (marine toad)	1937	Intentional	Established	Hawai'i	Anon. (1940), Townes (1946), Chernin (1979), Easteal (1981)
Eleutherodactylus coqui (coquí frog)	2003	Accidental	Absent	Hawai'i	DAWR, unpubl. data
Eleutherodactylus planirostris (greenhouse frog)	2003	Unknown	Established	Hawai'i	This study
Fejervarya cancrivora (crab-eating frog)	2005	Unknown	Present	SE Asia	This study
Fejervarya limnocharis sensu lato (Indian rice frog)	2003	Unknown	Present	SE Asia	This study
Kaloula picta[b] (painted narrow-mouthed frog)	1990	Accidental	No colonization resulted	Philippines	McCoid (1993)
Kaloula pulchra[b] (Malayan narrow-mouthed frog)	2003	Accidental	No colonization resulted	SE Asia	This study
Litoria fallax (eastern dwarf treefrog)	1968	Unknown	Established	Australia	Falanruw (1976), Eldredge (1988)
Microhyla pulchra (marbled pigmy frog)	2004	Unknown	Present	SE Asia	This study
Polypedates leucomystax[b] (whipping frog)	1993	Unknown	No colonization resulted	Thailand	Wiles (2000)
Polypedates megacephalus (Hong Kong whipping frog)	2004	Unknown	Established	SE Asia	This study
Pseudacris regilla[b] (pacific treefrog)	1989, 2005	Accidental	No colonization resulted	NW USA	McCoid (1993); DAWR, unpubl. data
Rana guentheri (Günther's amoy frog)	2001	Accidental	Established	E Asia	This study
Reptiles					
Anolis carolinensis (green anole)	1950s	Intentional	Established	SE USA	Moore (1977), Eldredge (1988), Mayer and Lazell (1992)
Boiga irregularis (brown tree snake)	1950	Accidental	Established	Admiralty Islands	Savidge (1987), Fritts (1988), Rodda et al. (1992)
Carlia ailanpalai (curious skink)	1968	Unknown	Established	Admiralty Islands	Rodda et al. (1991), Zug (2004)
Chelydra serpentina (common snapping turtle)	1997	Unknown	Unknown	USA	Leberer (2003)
Chinemys reevesii (Chinese three-keeled pond turtle)	Early 1990s	Unknown	Unknown	E Asia	Leberer (2003)
Chrysemys picta[b] (painted turtle)	1990	Accidental	No colonization resulted	USA	McCoid (1993)
Gekko gecko[b] (tokay gecko)	1983	Accidental	No colonization resulted	Philippines	McCoid (1993)
Iguana iguana[b] (green iguana)	1983 or 1984	Accidental	No colonization resulted	Unknown	McCoid (1993)
Kinosternon sp. (mud turtle)	1970s	Unknown	No colonization resulted	Americas	Leberer (2003)
Lamprolepis smaragdina (green tree skink)	1960s	Intentional	Absent	Yap	Eldredge (1988)

Mabuya multifasciata[b] (many-lined sun skink)	1999	Accidental	No colonization resulted	Philippines	Wiles (2000)
Mabuya sp.[b]	1970	Accidental	No colonization resulted	Caroline Islands	Wiles (2000)
Ocadia sinensis (Chinese striped-neck turtle)	Early 1990s	Unknown	Unknown	E Asia	Leberer (2003)
Pelodiscus sinensis (Chinese softshell turtle)	1970s	Intentional	Established	E Asia	McCoid (1993), Leberer (2003)
Perochirus ateles[b,c] (Micronesian gecko)	1991	Accidental	No colonization resulted	Chuuk	Wiles (2000)
Sceloporus occidentalis[b] (western fence lizard)	1992	Accidental	No colonization resulted	California	Wiles (2000)
Terrapene carolina triunguis (three-toed box turtle)	1992	Accidental	Present	E USA	McCoid (1993), Leberer (2003)
Thamnophis sp.[b]	1996	Accidental	No colonization resulted	NW USA	Wiles (2000)
Trachemys scripta elegans (red-eared slider)	1950s	Unknown	Present	SE USA	McCoid (1993, 1999)

[a] Status is that for wild stocks on Guam (2005) to the best of the authors' knowledge. Species are listed as "present" if the population's recruitment is unknown or inadequately documented.

[b] Introduced individuals that were intercepted and destroyed in cargo or on board cargo vessels.

[c] This species is native to Guam but had been extirpated from the island (Rodda et al. 1991) by the time of this introduction.

cessful and unsuccessful) were most likely accidental.

The recently introduced anurans arrived on Guam without most of their native associates, including predators, competitors, or parasites. There are no native amphibian species on Guam, so an obvious ecological consequence of their invasion is a reduction in invertebrate abundance and diversity (Stewart and Woolbright 1996, Beard et al. 2003). If the incursion of anurans causes unnaturally high predation pressure on especially vulnerable native species such as tree snails (*Partula gibba* and *Partula radiolata*), recovery of those populations may not be possible (e.g., Cowie 1992, 2001, Hadfield et al. 1993).

Just as invasive anurans can be predators in Guam's ecosystem, so too they can be prey. Following the extirpation of the majority of Guam's endotherms, *B. irregularis* must now depend more heavily on diurnal, terrestrial species of lizards that are comparatively reclusive at night (Fritts and Rodda 1998, Boyarski 2005). With the addition of palatable nocturnal anurans (e.g., Minton and Dunson 1978, Greene 1989, Shine 1991), accessibility to substantial active prey during the snakes' primary foraging period could greatly increase. On Guam, the snake has consumed *E. planirostris* in captivity (C.L.T., unpubl. data) and has been observed preying on unidentified *Rana* sp. in the wild (G. Acosta, Guam Department of Agriculture, unpubl. data). Further, a number of prey sizes attractive to *B. irregularis* are now represented by the new frog species, each filling a portion of the void in the prey size continuum created by the extirpation of most of Guam's birds. Ontogenetic shifts in consumption based on prey size and type in *B. irregularis* are well documented; juvenile snakes prey on small ectotherms such as lizards, and mature snakes prey on larger endotherms such as birds and rats (Savidge 1988, Greene 1989). Through the incursion of anurans covering sizes from 2 to 10 g (*E. planirostris*, *E. coqui*, and *L. fallax*), 10 to 30 g (*P. megacephalus*, *M. pulchra*), and greater than 30 g (*F. limnocharis* sensu lato, *F. cancrivora*, and *R. guentheri*), all prey sizes, particularly those crucial for small snakes, are potentially available. Although some introduced frogs are relatively small, they can be locally common and their reproductive potential high enough to withstand strong predation pressure (Kraus et al. 1999). Such abundant populations are a key food source sufficient to supply increasing snake population densities. Moreover, *E. planirostris* and *E. coqui*'s direct development will allow them to potentially colonize a large proportion of the island, including the north, because they do not require standing water to breed. The pond species, however, will remain limited to the southern half of the island, where surface water provides breeding sites. Thus, anuran prey for small snakes would likely be available islandwide and in most habitats.

The threat that invasion poses to Guam's ecosystem also threatens the island's socioeconomic interests in a number of ways. Guam's primary industry is tourism, which accounts for approximately 60% of its economy (Whitman 2003). *Eleutherodactylus coqui* is known for its piercing chirp, and choruses have been recorded to exceed 70 decibels (Kraus et al. 1999). Residents and tourists of areas of Hawai'i plagued with the species experience disturbance and sleep problems as a direct result of deafening choruses (Kraus and Campbell 2002). If populations of *E. coqui* become established on Guam, the economic repercussions to the tourism industry could be substantial, as has been the case in Hawai'i (Kraus et al. 1999, Kraus and Campbell 2002). In addition to the impact upon tourism, nonindigenous frogs could negatively impact freshwater fisheries production and the horticulture industry by forcing the implementation of stricter quarantine measures that could decrease imports to Guam.

The number of individuals in each introduction and the overall frequency of introductions have been found to affect the probability of a species establishing (Veltman 1996, Kolar and Lodge 2001). For example, the rapid expansion of the Guam population of *R. guentheri* may have been facilitated by multiple introductions over time that increased reproductive output. It stands to rea-

son that high frog densities on Guam could increase the probability of their transport to Guam's trading partners, such as the Northern Mariana Islands, Federated States of Micronesia, and Hawai'i. If these frogs provide a substantial increase in available prey, and this in turn leads to higher densities of *B. irregularis* on Guam, then there will be a greater probability of snakes successfully entering cargo and being transported to new locations. Once in these new locations, *B. irregularis* is likely to proliferate if the right-sized prey, such as frogs, are abundant. It is therefore important both to reduce the risk of introduction and reintroduction of anurans to Guam and neighboring Pacific islands, and to control the spread and reduce the numbers of established anuran populations on Guam.

Control, containment, and future prevention of anuran introductions are important issues that are beginning to be addressed on Guam. Recently, the Guam Department of Agriculture established a Plant Inspection Station that has decreased the risk of alien flora and fauna entering Guam through live plant shipments. Restrictions on cargo originating from Hawai'i have helped reduce the entry of *Eleutherodactylus* via plant material. Temporary containment of imported plants, inspection of cargo, the use of alternative treatments such as citric acid sprays and hot water for foliage and soil, the trade of bare-rooted rather than soil-rooted plants, and tighter phytosanitary certificate conditions associated with high-risk cargo are all examples of a multifaceted quarantine and containment initiative undertaken by local government agencies. In addition, Guam Division of Aquatic and Wildlife Resources launched a communication and outreach program in March 2005 aimed at educating the public in detecting and reporting the occurrence of frogs, especially *E. coqui*.

VOUCHER MATERIALS EXAMINED

USNM (Smithsonian National Museum of Natural History), BPBM (Bernice Pauahi Bishop Museum), KUZ (Kyoto University Museum), BSFS (U.S. Geological Survey/Colorado State University Brown Tree Snake Project).

Eleutherodactylus coqui: (Tumon) BSFS 9321; (Manengon) BSFS 9323.

Kaloula pulchra: (Andersen Air Force Base) USNM 561142.

Pseudacris regilla: ("Guam") BSFS 9352.

Fejervarya cancrivora: (Fadian Point, near Mangilao) BSFS 9304; ("southern Guam") BPBM 21288; ("southern Guam") KUZ R57996; (Ordot School, Mangilao) KUZ R57995 and USNM 563050; (Mangilao) BPBM 21336.

Fejervarya cf. *limnocharis:* (Pulantat) USNM 563051.

Microhyla pulchra: (Dandan) BSFS 9324 and BSFS 9325.

Eleutherodactylus planirostris: (Tumon) USNM 561138–561141, BPBM 18229–18234, and BSFS 9253–9258.

Polypedates megacephalus: (Dandan) USNM 563052, BPBM 21284–21285, BSFS 9262–9274, BSFS 9276–9282.

Rana guentheri: (Inarajan) USNM 561143, USNM 563049 and metamorphs BSFS 9228, BSFS 9230, BSFS 9235–9237, USNM 561144–561145, BPBM 18235; (Molojloj Village N of Dandan) BPBM 21286–21287.

ACKNOWLEDGMENTS

We thank Earl Campbell III, Jeff Cepeda, Brian Feeley, Dustin Janeke, Linda Laracuente, Jeffrey Quitugua, Haldre Rogers, Peter San Nicolas, and Rick Seidel for collection, information, and, in some cases, discovery of the frogs in Guam. We are grateful to Steve Gotte, Fred Kraus, Roy McDiarmid, Hidetoshi Ota, and George Zug for their invaluable contribution to species identification. The Bernice Pauahi Bishop Museum's Division of Natural Sciences, Smithsonian National Museum of Natural History's Division of Amphibians and Reptiles, Kyoto University Museum, and The U.S. Geological Survey/Colorado State University Brown Tree Snake Project archived specimens as indicated in the text. We thank Richard Bischof for his assistance in preparing some of the figures. Fred Kraus, Teri Kman, Bjorn Lardner, Ross Sadlier, Hidetoshi Ota, and an

anonymous reviewer suggested improvements to the manuscript.

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