

Notes on the Herpetofauna of Tinian, Mariana Islands

GARY J. WILES

Division of Aquatic and Wildlife Resources, P.O. Box 2950, Agana, Guam 96910

A. BINION AMERSON, JR.

4020 Brookhaven Club Drive #1520, Dallas, Texas 75244

ROBERT E. BECK, JR.

Division of Aquatic and Wildlife Resources, P.O. Box 2950, Agana, Guam 96910

Abstract—Sixteen species of reptiles and amphibians are known from Tinian, Mariana Islands and include *Bufo marinus*, *Chelonia mydas*, *Eretmochelys imbricata*, *Gehyra oceanica*, *G. mutilata*, *Perochirus ateles*, *Hemidactylus frenatus*, *Lepidodactylus lugubris*, *Nactus pelagicus*, *Carlia fusca*, *Emoia caeruleocauda*, *E. slevini*, *Cryptoblepharus poecilopleurus*, *Lamprolepis smaragdina*, *Varanus indicus*, and *Ramphotyphlops braminus*. Twelve of these species were found during a field survey in 1984 and 1985. Historic evidence indicates that at least six species have been introduced to the island.

Introduction

The herpetofauna of the Mariana Islands is poorly described in published accounts. Although a useful checklist of amphibians and reptiles for each island in the Marianas is being compiled (R. I. Crombie, unpubl.), data on species abundance and ecology are lacking for almost all islands. It is particularly important to have a better understanding of the herpetofauna of the large southern islands of the archipelago, from Guam to Saipan, where increasing development and the possible introduction of the brown tree snake (*Boiga irregularis*) threaten existing wildlife populations. *B. irregularis* has become a serious predator on lizards and most native vertebrates on Guam since its introduction after World War II (Savidge, 1987; Fritts, 1988).

This short survey was part of a study to describe the wildlife and flora of Tinian (Hawaiian Agronomics, Inc., 1985) and documents the current status of the island's reptiles and amphibians, with notes on habitat use and natural history. All data were collected from the northern two-thirds of Tinian, which is known as the Military Retention Area (MRA), and from the vicinity of San Jose village (Figure 1). We have also summarized historical information on the island's herpetofauna.

Study Area

Tinian (15°N, 145°38'E) is 102 km² in size, being approximately 20 km long and 9 km wide. The nearest islands are Saipan, which is 4.5 km to the northeast, and Aguijan, which is 9 km to the southwest. Tinian is a relatively low and level island composed al-

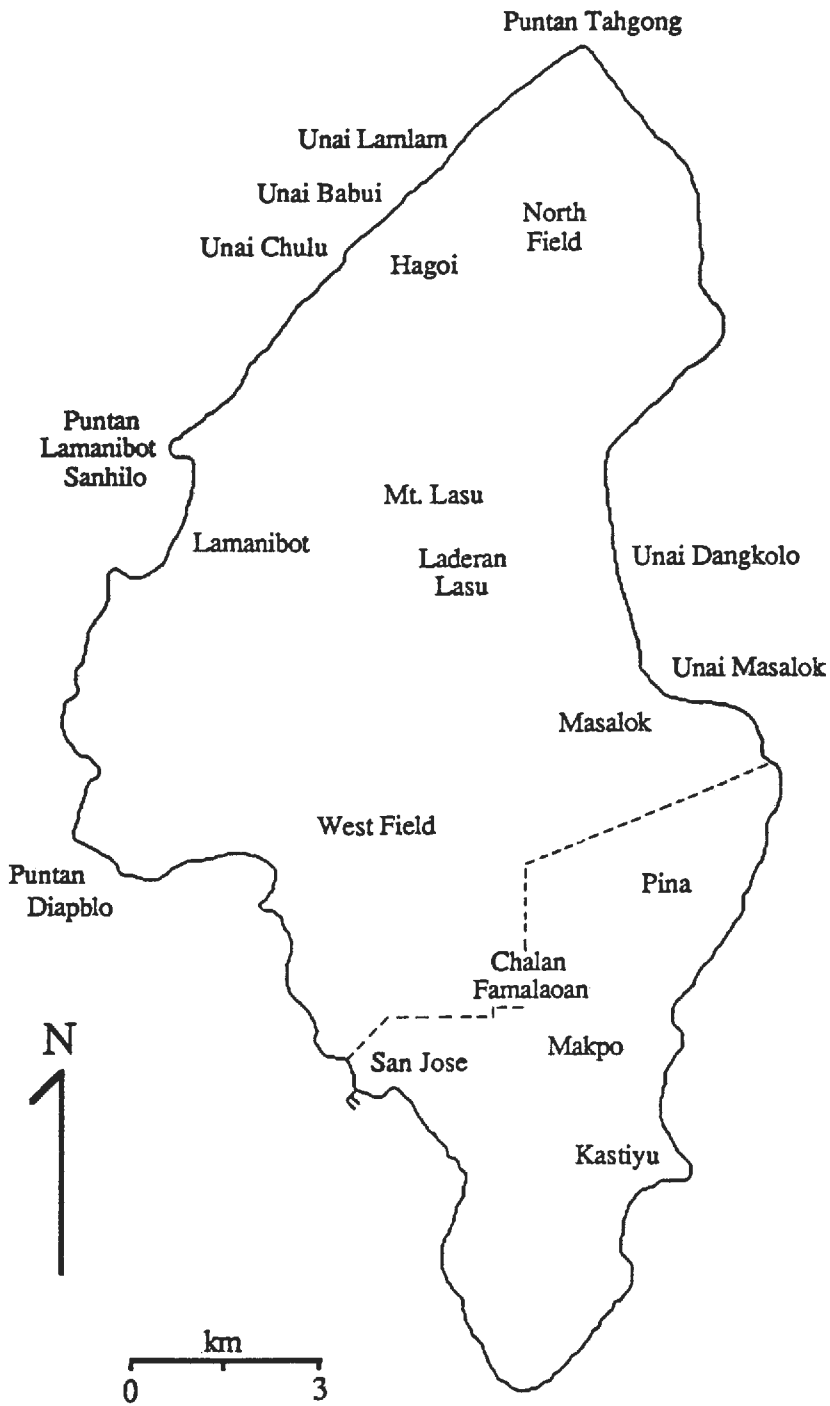


Figure 1. Map of Tinian, Mariana Islands, with names of locations used in the text. The Military Retention Area lies north of the dashed line.

most entirely of limestone terraces. The highest elevations are 178 m at Kastiyu and 166 m at Mt. Lasu (Mt. Lasso). The island's climate is tropical and temperatures remain warm and fairly uniform during the year (Eldredge, 1983), ranging from 20–32°C. Annual rainfall averages about 2,000 mm, with the wettest months being July to November. A dry season occurs from January to April.

Tinian's vegetation has been severely altered by humans and livestock, and is largely characterized by secondary growth and numerous introduced species. Fosberg (1960) believed that much of the island's vegetation was originally modified by a large indigenous Chamorro population prior to European contact. Other major impacts on plant life have been extensive grazing by feral and domestic ungulates during the last 300–400 years, the clearing of most of the island for sugar cane cultivation in the 1920s and 1930s by the Japanese (Fosberg, 1960), and military construction during World War II. Descriptions of Tinian's plant communities are given by Fosberg (1960), Hawaiian Agronomics, Inc. (1985), and Engbring et al. (1986). Tangantangan (*Leucaena leucocephala*) forest and open fields of grass or low herbaceous growth are the two most predominant habitats, covering 38.3% and 30.9% of the island, respectively (Engbring et al., 1986). Other vegetation types include secondary forest (19.2%), native forest (4.9%), strand vegetation (3.6%), cultivated fields (1.9%), urban areas (0.8%), and marshland (0.1%) (Engbring et al., 1986). Tinian's human population numbers about 1,000 residents, most of whom live in the town of San Jose on the southwest side of the island.

Methods

Visits to Tinian were made on 21–25 November 1984, 5–12 January 1985, 10–14 May 1985, and 11–15 October 1985. The October trip was devoted entirely to collecting information on reptiles. During the other visits, most data were gathered incidental to bird and mammal field studies. A total of 40 man-hours during the day and 18 man-hours at night was spent searching for reptiles and amphibians.

Study sites were selected around the island to provide wide geographic coverage and to cover a variety of common or unique natural habitats (Fig. 1). One to three observers searched for reptiles and toads at each site. Most surveys took place between 0900–1700 and 1930–2130 hours. Animals were collected or closely examined visually to obtain accurate identifications. Skinks were captured by shooting them with a heavy rubber band; geckos were caught by hand. Specimens were deposited in the B. P. Bishop Museum (BPBM). Scientific names of amphibians and reptiles in this paper follow those used by Crombie (unpubl.).

Species Accounts

BUFONIDAE

Bufo marinus

Previous Records: Marine toads were first introduced to the Marianas on Guam in 1937 to control invertebrate agricultural pests (Anon., 1937; Esteal, 1981). Subsequent

Table 1. Known (+) and suspected (?) occurrence of terrestrial reptiles and *Bufo marinus* in different habitats on Tinian.

Species	Tangantangan forest	Open fields	Secondary vegetation	Inland and coastal forest	Strand vegetation	Cultivated land	Urban	Marshes and stock ponds
<i>Bufo marinus</i>	+	+	+	+	+	+	+	+
<i>Gehyra oceanica</i>	+		+	+	+			
<i>Gehyra mutilata</i>	+		+	+	+			
<i>Perochirus ateles</i>				?				
<i>Hemidactylus frenatus</i>		+			+		+	
<i>Lepidodactylus lugubris</i>	+	+	+	?	?		+	
<i>Nactus pelagicus</i>			?	?				
<i>Carlia fusca</i>	+	+	+	+	+	?	+	
<i>Emoia caeruleocauda</i>	+			+				
<i>Emoia slevini</i>				?				
<i>Cryptoblepharus poecilopleurus</i>	+				?			
<i>Lamprolepis smaragdina</i>	+		+				?	
<i>Varanus indicus</i>	+	+	+	+	+			
<i>Ramphotyphlops braminus</i>	+							

releases of toads took place on Tinian, Saipan, and Rota between then and 1944 (Townes, 1946).

Stohler and Cooling (1945) published the first record of *B. marinus* from Tinian. They reported that toads were abundant in cisterns and lily ponds in San Jose village in 1944. Downs (1948) also noted that this species was abundant on the island in 1945, especially in the vicinity of the marsh at Hagoi. He recorded toads at all elevations. Nearly 30 years later, Owen (1974) described *B. marinus* as still "fairly common". He also observed that toads were most numerous near sources of standing water such as Hagoi and a small forested wetland at Makpo.

Present Survey: Toads were locally common and were noted throughout the MRA in all habitats (Table 1). They were most easily seen at night on the island's roads. As previous authors have noted, *B. marinus* was most abundant in the vicinity of water sources such as the marsh at Hagoi, stock ponds, and roadside pools. The availability of water for egg laying is undoubtedly an important limiting factor of toads on predominantly limestone islands such as Tinian. Tadpoles were present in Hagoi and probably occur at most other sites with permanent or semi-permanent water. Tadpoles were recorded on the October and November trips.

CHELONIIDAE

Chelonia mydas

Previous Records: There are no previously published records of *C. mydas* from Tinian.

Present Survey: Green sea turtles are reported to occur in offshore waters around the entire island (A. Borja, pers. comm.). On several days in May and October, we observed two to seven turtles, which we presumed to be green sea turtles, swimming in the cove on the south side of Puntan Lamanibot Sanhilo. Both large and small individuals were present.

Beaches at Unai Masalok and Unai Dangkolo are still used occasionally for nesting by this species. Four nests are known to have been dug at these sites in 1984, however, at least two of them were robbed by egg collectors (A. Borja, pers. comm.). Other beaches on Tinian, such as those at Unai Lamlam, Unai Babui, Unai Chulu, and southeast of Puntan Diablo (Figure 1), appear to be suitable for nesting but there are no records to verify their use.

As of 1985, green sea turtles could still be legally hunted in the Commonwealth of the Northern Mariana Islands (CNMI) by residents with licenses, although this activity is not believed to be widely practiced on Tinian (A. Borja, pers. comm.). Few licenses were sold in 1984 and only one turtle was known to be killed legally on the island. The amount of illegal hunting is probably much greater.

Eretmochelys imbricata

Previous Records: There are no previous records of *E. imbricata* for Tinian.

Present Survey: Hawksbill sea turtles occur in Tinian's offshore waters but are less

common than *C. mydas* (A. Borja, pers. comm.). None was observed in this study. Hawksbills are not known to nest on the island and are reportedly rarely taken by turtle poachers because of their less desirable meat (A. Borja, pers. comm.). This turtle is fully protected under CNMI law.

GEKKONIDAE

Gehyra oceanica

Previous Records: Downs (1948) collected a single *G. oceanica* on a papaya tree at Hagoi in 1945.

Present Survey: This species (BPBM 11268) was common and widely distributed in the MRA. *Gehyra oceanica* inhabited tangantangan, inland, and secondary forests, strand vegetation, and abandoned concrete structures in forested locations (Table 1). Within these habitats, animals made use of surfaces such as building walls, rock walls inside caves, the trunks of large trees such as *Cocos* and *Pisonia*, and the leaves of a banana tree. The use of such substrates is probably related to this gecko's large size. A number of individuals were seen during the day inside small limestone caves, indicating that caves are a common diurnal hiding site. One such cave at Laderan Lasu that was closely examined held at least five *G. oceanica*.

Gehyra mutilata

Previous Records: Cagle (1946a) and Downs (1948) encountered few *G. mutilata* during their studies in 1945.

Present Survey: *Gehyra mutilata* (BPBM 11259, 11261–11265, 11267) was common in the MRA and found at a number of widely dispersed locations. Habitats used included several kinds of forest, strand vegetation, and deserted remote buildings made of concrete (Table 1). Daytime retreats included sites beneath the bark of trees, under piles of rocks, and crevices in concrete walls.

Perochirus ateles

Previous Records: A single individual (U.S. National Museum of Natural History [USNM] 123748) was collected at Mt. Lasu in 1946 by H. K. Townes (R. I. Crombie, pers. comm.). No other specimens are known from Tinian. *Perochirus ateles* is a forest-dwelling gecko (Sabath, 1981), and it is likely that Townes' specimen was captured in a narrow strip of inland forest that was growing on the hillside below Mt. Lasu. At present, this stand of forest is surrounded by tangantangan and small open fields, but in 1946, these adjoining sites probably held abandoned sugar cane fields, a habitat that is unlikely to have been used by *P. ateles*. Extensive agricultural clearing by the Japanese probably resulted in greatly reduced abundances and distributions of forest-dependent lizards on the island.

Present Survey: This gecko was not recorded during this survey.

Hemidactylus frenatus

Previous Records: This species is a well-known commensal with man (McCoy, 1980; Sabath, 1981) and has been widely introduced in the tropical Pacific. On Tinian, Cagle (1946a) and Downs (1948) reported *H. frenatus* (almost certainly misidentified by Cagle as *H. garnotii* [Dryden and Taylor, 1969; Crombie, unpubl.]) to be the most common gecko in their studies. They found this species on the walls and ceilings of buildings and in the wreckage of destroyed dwellings. Owen (1974) observed a single species of gecko, which occurred only in houses. Although he did not collect any specimens for identification, these were probably *H. frenatus*.

Present Survey: This species (BPBM 11255, 11266) was found at locations scattered throughout the MRA but was usually in association with various types of man-made structures. *Hemidactylus frenatus* was most numerous on lighted buildings in San Jose village and Chalan Famalaoan, and at the slaughterhouse west of Masalok. It was the most common gecko at each of these sites, far outnumbering other species. *Hemidactylus frenatus* was also collected at small isolated concrete structures that were unlighted at Puntan Tah-gong and Unai Chulu, on cement and wooden fence posts along a roadside running through pastureland west of Masalok, and on the trunks of coconut trees at a beach in San Jose. They were absent from the ruins of the former Japanese airport control tower at North Field.

Lepidodactylus lugubris

Previous Records: Cagle (1946a) found *L. lugubris* to be abundant on tree trunks and shrubs in a village destroyed during the war, but it was rare along the right-of-way of a nearby railroad. Its status on the remainder of the island was not reported.

Present Survey: *Lepidodactylus lugubris* (BPBM 11260) was common throughout the MRA in a variety of natural and man-made sites. During the day, they were found hiding under loose bark or inside hollow tangantangan trunks. At night, *L. lugubris* was caught on coconut trunks and fronds, the foliage of small trees, and on a wooden telephone pole in the center of a grassy field. They were observed on a variety of lit and unlit buildings and structures, but were much rarer than *H. frenatus* at most sites.

Clutches of *L. lugubris* usually contain two eggs that adhere to each other and the substrate (Cagle, 1946a; Schwaner, 1980; Sabath, 1981). Eggs are sometimes laid at communal nest sites (Cagle, 1946a; McCoy, 1980). We noted similar egg-laying behavior in this study and, based on the descriptions of the above authors, assumed these eggs to be those of *L. lugubris*. Several pairs of eggs were discovered glued together under loose bark of tangantangan. Three communal egg-laying sites were located on the walls of old concrete buildings and in a culvert, with all groups of eggs protected by overhangs. Two of the sites contained more than one group of eggs. Individual clusters held 4–50 eggs, but most had 15–30 eggs. Shell fragments glued to the walls were all that remained of most eggs.

Nactus pelagicus

Previous Records: One individual (BPBM 1374) was captured at an unidentified forested site in 1924 by H. G. Hornbostel. This appears to be the only record of this species from Tinian.

Present Survey: This gecko was not observed during the study.

SCINCIDAE

Carlia fusca

Previous Records: A native of New Guinea, northern Australia, and the Solomon Islands (McCoy, 1980), *C. fusca* was apparently introduced to the Marianas sometime between the end of World War II and the early 1960s. Specimens were first collected on Saipan in 1964 (Dryden and Taylor, 1969) and Guam in 1968 (G. R. Zug, pers. comm. to L. G. Eldredge). Owen (1974) described the presence of a "golden brown skink" that was common throughout Tinian. Although he collected no specimens, it seems likely that these skinks were *C. fusca*, and that this species was introduced to the island sometime prior to the early 1970s.

Present Records: Our specimens (BPBM 11252–11254, 11257–11258) represent the first verified record of this skink from Tinian. An active terrestrial lizard, *C. fusca* is the most abundant skink on Tinian and was recorded throughout the MRA. It was common in nearly all habitats, but was less numerous in native forests (Table 1). Animals typically foraged in forest leaf litter or among grasses and below dense herbaceous growth in open fields.

Emoia caeruleocauda

Previous Records: Downs (1948) described *E. caeruleocauda* as the most abundant lizard on Tinian in 1945. He found them throughout much of the island, especially near Hagoi. Owen (1974) also stated that an unidentified type of blue-tailed skink was common islandwide.

Present Survey: *Emoia caeruleocauda* (BPBM 11256) appears to now be rare on the island. Only eight animals were recorded during the survey, with these being found in tangantangan and both types of native forests. Sightings occurred at Masalok, Hagoi, Laderan Lasu, and a coastal site 1 km south of West Field. All of these skinks were found on the ground or in low vegetation. This skink has obviously decreased in abundance since the visits of Downs (1948) and Owen (1974). Competition from the introduced *C. fusca* may have caused its decline. *Carlia fusca* has also been observed to prey on juvenile *E. caeruleocauda* on Guam (J. Engbring, pers. comm.).

Emoia slevini

Previous Records: One specimen (USNM 128028) of this poorly known species has been collected from the island. It was taken by H. K. Townes at Mt. Lasu in 1946 (Brown

and Falanruw, 1972). As noted for *P. ateles*, it is likely that Townes caught this specimen in inland forest growing on a steep hillside at this location. In contrast to this habitat, literature records (Brown and Falanruw, 1972) and data from specimen labels indicate that all other *E. slevini* from the southern Marianas have been collected from locations along or near coasts.

Present Survey: *Emoia slevini* was not recorded during this survey.

Cryptoblepharus poecilopleurus

Previous Records: This skink is widely distributed in the Mariana Islands (Crombie, unpubl.), but has not been previously reported from Tinian.

Present Survey: We did not observe *C. poecilopleurus* during the survey, but in August 1985, N. J. Scott and H. Muna collected three individuals from tangantangan trees near the small shrine at the tip of Puntan Tahgong. *Cryptoblepharus poecilopleurus* was not observed during a follow-up visit to this site in October. On Rota, we have since noted that *C. poecilopleurus* appears to live mainly in clumps of *Pemphis acidula* in coastal strand (Wiles, unpub. data). Additional searches of this habitat on Tinian may reveal this lizard as common.

Lamprolepis smaragdina

Previous Records: *Lamprolepis smaragdina* is widely distributed through southern Micronesia, eastern Malesia, and the Philippines (McCoy, 1980). Its disjunct presence on Tinian and Saipan suggests that it was introduced to these two islands. Eldredge (1988) speculated that *L. smaragdina* was an early arrival to these islands, perhaps reaching them on sailing canoes originating from the Carolines. However, specimens were not collected on Saipan until 1979 (R. I. Crombie, pers. comm.), which strongly suggests that *L. smaragdina* has appeared in the Marianas much more recently. On Tinian, neither Downs (1948) nor Owen (1974) mentioned the presence of this conspicuous bright green skink, indicating that it was probably absent at the time of their studies and was introduced after 1974.

Present Survey: This species was uncommon on Tinian and does not yet appear to have spread islandwide. All sightings occurred in central Tinian between San Jose, West Field, and Pina except for one animal seen at Lamanibot.

Lamprolepis smaragdina was recorded only in secondary and tangantangan forests. This species is highly arboreal (McCoy, 1980) and was seen only in trees and vines at heights greater than 1 m above the ground. In nine of 17 sightings, animals foraged on the smooth trunks of *Delonix regia*. Other individuals were observed in tangantangan (four occasions), on small branches in the crowns of *D. regia* (twice), on a 1-m-high *Operculina* vine (once), and on a coconut palm frond (once). In May and October, individuals were seen feeding on honey bees at the entrance to a hive located in the trunk of a large *D. regia* on the outskirts of San Jose.

VARANIDAE

Varanus indicus

Previous Records: Monitor lizards are believed to have been originally brought to the Marianas by colonizing islanders (L. G. Eldredge, pers. comm.). De la Corte, who referred to *V. indicus* by the local name of "iguana", recorded this species on Tinian in the mid-1800s (Anon., 1927). Interestingly, monitor lizards were apparently rare on the island between 1900 and 1945. Both Fritz (1901) and Hornbostel (1921–1924) failed to sight them although Hornbostel was told by a resident that they were still present. Fritz (1901) contrasted the apparent absence of *V. indicus* on Tinian with its abundance on nearby Saipan. Downs (1948) did not include this species in his account, a possible indication that it was still rare at the end of World War II. Owen (1974) observed several monitor lizards in 1974 and presumed them to be common.

Present Survey: Monitor lizards were judged to be uncommon with zero to three sightings made per day. Observations occurred throughout the MRA. These lizards used a variety of terrestrial habitats, but were seen most often in tangantangan forest and weedy fields and openings. Farmers on Tinian consider monitor lizards to be a serious pest because they prey on domestic fowl (Owen, 1974).

TYPHLOPIDAE

Ramphotyphlops braminus

Previous Records: *Ramphotyphlops braminus* has been introduced to many tropical and subtropical areas of the world including Oceania (McCoy, 1980; Nussbaum, 1984; Gibbons, 1985; Crombie, unpubl.). Blind snakes have been on Guam since at least around 1900 (Safford, 1905). The first known record of this species from Tinian was an individual (BPBM 1376) collected by H. G. Hornbostel in 1924. Cagle (1946b) and Downs (1948) found *R. braminus* under rocks and pieces of wood at low elevations; both considered it to be uncommon.

Present Survey: Little effort was extended toward searching for this species and we are unable to describe its current status and distribution on Tinian. One blind snake was observed in this study. It was found on the ground beneath a piece of concrete in tangantangan forest near the Japanese shrine at Mt. Lasu.

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poecilopleurus. We also thank T. H. Fritts, L. Raulerson, M. J. McCoid, R. I. Crombie, J. D. Reichel, and G. H. Rodda for reviewing the manuscript.

References

- Anon. 1927. Memoirs of Don Felipe de la Corte's eleven years as Governor of Guam, 1855–1866. *Guam Recorder* 3: 270–271, 282–283.
- Anon. 1937. Department of Agriculture notes. *Guam Recorder* 14(5): 21.
- Brown, W. C. and M. V. C. Falanruw. 1972. A new lizard of the genus *Emoia* (Scincidae) from the Marianas Islands. *Proc. Calif. Acad. Sci.* 39: 105–110.
- Cagle, F. R. 1946a. A lizard population on Tinian. *Copeia* 1946: 4–9.
- Cagle, F. R. 1946b. *Typhlops braminus* in the Marianas Islands. *Copeia* 1946: 101.
- Downs, T. 1948. Amphibians and reptiles of Tinian Island. *Trans. Kansas Acad. Sci.* 51: 112–116.
- Dryden, G. L. and E. H. Taylor. 1969. Reptiles from the Mariana and Caroline Islands. *Univ. Kansas Sci. Bull.* 48: 269–279.
- Eldredge, L. G. 1983. Summary of environmental and fishing information on Guam and the Commonwealth of the Northern Mariana Islands: historical background, description of the islands, and review of the climate, oceanography, and submarine topography. *Natl. Oceanic Atmospheric Admin. Tech. Mem. NMFS-SWFC-40*.
- Eldredge, L. G. 1988. Case studies of the impacts of introduced animal species on renewable resources in the U.S.-affiliated Pacific islands. In B. D. Smith (ed.), *Topic reviews in insular resource development and management in the Pacific U.S.-affiliated islands*. Univ. Guam Marine Lab. Tech. Rep. 88. pp. 118–146.
- Engbring, J., F. L. Ramsey, and V. J. Wildman. 1986. Micronesian forest bird surveys, 1982: Saipan, Tinian, Aguiguan, and Rota. U.S. Fish Wildl. Serv., Honolulu. Unpublished report.
- Estel, S. 1981. The history of introductions of *Bufo marinus* (Amphibia: Anura); a natural experiment in evolution. *Biol. J. Linnean Soc.* 16: 93–113.
- Fritz, G. 1901. Die Insel Tinian (Marianan). *Deutschen Kolonialbl.* 12: 150–154.
- Fosberg, F. R. 1960. The vegetation of Micronesia. *Bull. Am. Mus. Nat. Hist.* 119: 1–75.
- Fritts, T. H. 1988. The brown tree snake, *Boiga irregularis*, a threat to Pacific islands. U.S. Fish Wildl. Serv., Biol. Rep. 88(31): 1–36.
- Gibbons, J. R. H. 1985. The biogeography and evolution of Pacific island reptiles and amphibians. In G. Grigg, R. Shine, and H. Ehmann (eds), *Biology of Australasian Frogs and Reptiles*, pp. 125–142. Royal Zool. Soc. New South Wales, Sydney.
- Hawaiian Agronomics, Inc. 1985. Final report for flora and fauna survey on Tinian, Northern Mariana Islands. Honolulu, Hawaii. Unpublished report.
- Hornbostel, H. G. 1921–1924. Unpublished field notes: Guam, Rota, Saipan, and Rota. Ms. on file, B. P. Bishop Museum, Honolulu. Unpublished report.
- McCoy, M. 1980. Reptiles of the Solomon Islands. *Wau Ecology Inst. Handbook No. 7*: 1–80.
- Nussbaum, R. A. 1984. Snakes of the Seychelles. In D. R. Stoddart (ed.), *Biogeography and Ecology of the Seychelles Islands*, pp. 361–377, Junk Publ., The Hague.

- Owen, R. P. 1974. Environmental impact study on the terrestrial fauna and flora with respect to the proposed establishment of a U.S. military base on that island. Trust Territory of the Pacific Islands, Biol. Lab., Koror, Palau. Unpublished.
- Sabath, M. D. 1981. Gekkonid lizards of Guam, Mariana Islands: reproduction and habitat preference. *J. Herpetol.* 15: 71–75.
- Safford, W. E. 1905. The useful plants of the island of Guam. *Contrib. U.S. Natl. Mus.* 9: 1–416.
- Savidge, J. A. 1987. Extinction of an island forest avifauna by an introduced snake. *Ecology* 68: 660–668.
- Schwaner, T. D. 1980. Reproductive biology of lizards on the American Samoan islands. *Occas. Papers Mus. Nat. Hist., Univ. Kansas* 86: 1–53.
- Stohler, R. and A. G. Cooling. 1945. Toads in the Marianas. *Science* 101: 678.
- Townes, H. K. 1946. Entomology. Part I. Non-agricultural plants. *Economic Survey of Micronesia, Vol. 12.* U.S. Commercial Company, Honolulu. Unpublished report.