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A CHECKLIST OF THE HERPETOFAUNA OF THE PALAU ISLANDS (REPUBLIC OF BELAU), OCEANIA

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ABSTRACT: The Palau islands of western Micronesia comprise one of the most physiographically varied archipelagos in the Pacific. There are some 350 islands of volcanic and coralline origin that range from Babeldaob at 333 km^2 (about 80% of Palau's total land area) to others, unnamed, that are less than one hectare. A barrier reef encircles most of the archipelago creating a lagoon up to 20 km wide. The majority of the islands are uninhabited, accessible with difficulty only by boat at high tide, and are densely vegetated over steep, rocky terrain. Because of their proximity to the Philippines, New Guinea, the Moluccas, and Borneo, the Palau islands host a significantly richer herpetofauna with more unique taxa than is found on other Pacific islands to the east. As with most other Pacific island groups, however, the herpetofauna has been poorly documented. Since the earliest investigations that began in the nineteen century, Palau's herpetofauna has been uncovered piecemeal. No sustained field effort had been conducted until we began a systematic survey of the islands in 1992. Since then we have collected in Palau every month of the year at least once.

This checklist of 46 species of reptiles and amphibians includes almost twice as many taxa as were known from Palau (Owen, 1977) at the beginning of our study. Among these are new species or Palauan records of *Gehyra, Hemiphyllodactylus, Lepidodactylus, Nactus, Perochirus, Emoia* and *Sphenomorphus.* Because of the difficulties in surveying so many islands we believe that additional taxa and distributional records await discovery; even the smallest island in Palau can turn up surprises. Nonetheless, it is appropriate to consolidate what is now known about this intriguing fauna and environment. We provide an historical summary of previous collecting efforts, an overview of the islands' geology and habitats, and for each species account we include distributional information, taxonomic and systematic discussion, natural history observations, and a comprehensive bibliography.

Key words: Micronesia, Palau Islands, Amphibians, Reptiles

PERHAPS THE MOST zoogeographically significant yet poorly known archipelago in the Oceanic realm is the Palau Island group (now the independent Republic of Belau) in western Micronesia. The earliest herpetological investigations of this area by the Germans in the mid-1800's revealed new taxa in genera (*Hypsilurus, Sphenomorphus,* and others) otherwise unknown from the oceanic islands of the Pacific Plate, and the few subsequent field studies continued to yield additional novelties. Although these early collections suggested a diverse fauna with unexpectedly high levels of endemism, they were insufficient for addressing the numerous systematic and zoogeographic problems of this region.

Because many other islands in the Pacific have relatively depauperate extant vertebrate faunas but much larger lists of recently extinct taxa (e.g., Steadman, 1995), Palau provides an ideal opportunity to see if this pattern also obtains on an island group with a more diverse extant fauna that is closer to potential source areas. Therefore, in 1992 we began extensive surveys of the extant and extinct vertebrates of Palau. Although we have accumulated significant collections and data in our field work to date, each additional trip yields important (and often surprising) new specimens and distributional information. Nevertheless, given the considerable recent increase of interest in Micronesian biology and conservation (e.g., Rodda et al., 1991), we feel it is appropriate to present our working list.

Modern summaries of the Palauan herpetofauna (e.g., Cassell et al., 1992; Otobed and Maiava, 1994) have had to rely on the incomplete and taxonomically outdated list of Owen (1977). Despite the admitted shortcomings of the data, our list reflects current herpetological taxonomy (to August 1998) and it contains nearly twice as many species as listed by Owen

(1977), with many systematic problems duly noted. It is our intention to resolve some of these problems with future field work and collections. The strong zoogeographic affinities between Palau and the Papuan region, and additional influences from the Philippines, Borneo, and Oceania, further complicate systematic studies. This is especially so with respect to the logistics of obtaining pertinent comparative material from such a broad area that includes several political entities not known for expansive cooperation with scientific endeavours. We hope that our accumulated specimens and data-base for Palau are such that future studies involving this area will be facilitated.

The taxonomic aspect of our list is comprehensive, but we particularly want to stress the incomplete nature of the distributional data we present. Although we list all island records currently available for each species, the results of earlier surveys plus our own field work have sampled only a small fraction of the multitude of islands in Palau, with varying degrees of rigor. The logistics of even briefly sampling islands spread across nearly six degrees of latitude are daunting and expensive; the survey work itself is grueling and often dangerous. The Rock Islands in particular are often very difficult to land on, much less to survey adequately for cryptic and elusive amphibians and reptiles. Even the smallest and seemingly insignificant islands should not be ignored, as demonstrated by the recent discoveries of *Lepidodactylus paurolepis* (Ota et al., 1995), *Emoia impar, Lepidodactylus* sp. nov., and *Nactus* sp. (this paper). Our distributional data are intended to convey only the most general patterns, many of which will undoubtedly be modified with additional field work.

We but hope that the data presented here are not used to generate or justify counterproductive "conservation" efforts that will hinder or prevent the much-needed continuing data collection that is necessary to make sense of the Palauan herpetofauna. In short, we emphasize that these data are presented for general use, with the major caveat that they are not the "last word" in Palauan herpetology. We think that the following list adequately documents that the discovery phase is far from over.

Geography and Ecology

Spelling of Place Names

The inconsistent spelling of Palauan place names is attributable to idiosyncratic useage by four separate foreign administrations over the past one hundred years. These administrators made a limited attempt at using native names, and often misinterpreted their meaning when they did. Moreover, none of these languages (Spanish, German, Japanese, English) is adequate to fully capture the phonics of the Palauan tongue, such as the clipped nasal-quality *ng*. Even within Palau it is common to see the same name spelled two or three different ways. There are, for example, some 15 spellings for Palau itself, with the most common alternate being "Belau". The population center, both the island and the town, called "Koror" by practically everybody who lives there is spelled "Oreor" on many maps. For all place names we follow the spelling found on the USGS Topographic Maps of the Palau Islands (1983–1984), which are the most detailed available and are used by most governmental agencies. We note, however, that some of the spellings on these topographic sheets are at odds with local or casual useage, or are not followed in older (e.g., Anon., 1957; Brigham, 1900; Bryan, 1971) or recent (Karolle, 1993; Motteler, 1986) literature. Finally, most of Palau's smaller islands are unnamed.

The following is a list of our island localities and their common alternate spellings. Coordinates are for the center of the island/group (Lat. 0.000 N, Long. 000.000 E)

Babeldaob (Babelthuap, Babeldaop)	7.5	134.5
Bablomekang	7.14	134.316
Beliliou (Peleliu)	7.0	134.25
Chemoi Island Group	7.19	134.38
Euidelchol (Ashakasengu)	7.19	134.36
Ioulomekang	7.134	134.304
Kmekumer Islands (island 46 from Wiles and Conry, 1990)	7.19	134.24
Malakal (Ngemelachel)	7.33	134.45
Mecherchar (Eil Malk)	7.15	134.36

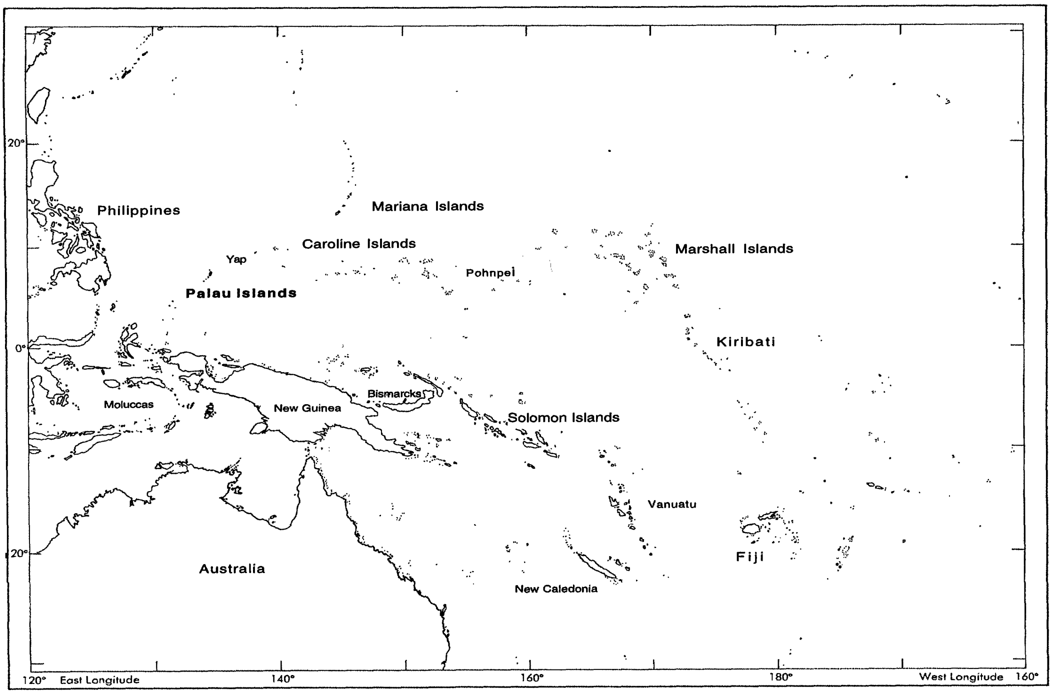

FIG. 1.—The islands of Micronesia and the southwest Pacific.

Ngcheangel Atoll (Kayangel, Ngerebelas, Ngeriungs, Orak)	8.07	134.7
Ngeanges (Necos)	7.206	134.370
Ngeaur (Angaur)	6.9	134.15
Ngebad (Ngabad)	7.019	134.270
Ngebedangel (Ngobasangl)	7.27	134.33
Ngedbus (Ngesebus)	7.06	134.26
Ngelsibel	7.187	134.344
Ngemlis Islands (Bailechesengel, Iilblau, Ngemlis)	7.12	134.25
Ngercheu (Ngergoi; Carp)	7.09	134.28
Ngerdis (Kobasang)	7.35	134.439
Ngerduais (Nardueis)	7.355	134.582
Ngerechong	7.11	134.36
Ngerechur	7.750	134.620
Ngerekebesang (Arakabesan)	7.35	134.45
Ngermalk	7.335	134.459
Ngeruchubtang (Ngerugelbtang)	7.083	134.327
Ngerukeuid Islands (Seventy Islands; islands 4, 12, 13, 16, 24, 34 of Wiles and Conry, 1990)	7.17	134.26
Ngeruktabel (Urukthapel)	7.25	134.4
Ngerur	7.365	134.429
Ngesbokel (Gechbokul)	7.508	134.488
Ngetmeduch	7.357	134.496
Oreor (Koror)	7.34	134.49
Pkulaklim (Orrak)	7.347	134.565
Toiracholodochoel	7.339	134.455
Uchulameradel	7.507	134.491
Uchulangas	7.340	134.460
Ulebsechel (Auluptagel)	7.31	134.47
Ulong (Aulong) Island Group	7.28	134.29

Southwest Islands:

Fana	5.36	132.22
Helen	3.0	131.8
Merir	4.29	132.31
Pulo Anna (Palo Anna)	4.66	132.95
Sonsorol	5.31	132.22
Tobi	3.01	131.18

Physical Description

The thousands of islands and atolls in Micronesia have a total land area of only about 3,227 km^2, roughly 0.03% of the surface area between 0°–20° N latitude and 135°–170° E longitude. The four major archipelagos of Micronesia, from east to west, are the Gilberts (Kiribati), Marshalls, Carolines, and Marianas (Fig. 1). Palau is the westernmost group of the Caroline Islands, centered near 7°20′ N latitude and 134° E longitude. The island of Mindanao in the southern Philippines is about 800 km west of Palau, whereas Irian Jaya and the Moluccas are, respectively, to the south and southwest about that same distance; Borneo is an additional 700 km. All of the Gilberts and Marshalls are coral atolls or low islands. The Carolines include both volcanic and coralline islands. Cartographically, Palau is included in the Caroline Islands, but the western Carolines (Palau and Yap), as well as the Marianas, are exposed peaks of undersea ridges stretching between Japan and New Guinea and are not located on the Pacific Plate.

The Palau islands originated on the now dormant southern section of the Palau-Kyushu Ridge, which formed by about 43 million years ago (mya) in a complex series of rifting and boundary shifts of the Pacific Plate margin during formation of the Philippine Basin (Kroenke, 1984; Seno and Maruyama, 1984). Volcanism along the Palau-Kyushu Ridge ceased in the earliest Miocene about 29 mya. Subsequently, the Palau-Kyushu ridge fractured and the eastern segment ultimately developed into the West Mariana Ridge. Back-arc spreading between the the two submerged ridges (Palau-Kyushu and West Mariana) widened the Philippine basin to the east, and for the last 17 mya the basin has been moving northwest with respect to Eurasia. Thus, Palau, Yap and the Mariana Islands rest on the eastern margin of the Philippine Plate where it contacts the western edge of the Pacific Plate. The Palau, Yap and Mariana Trenches that mark the subduction zone at plate contact are some of the deepest waters on earth. When the islands that are now Palau first emerged above sea level is uncertain. The oldest organic limestones are early Miocene (ca. 25 mya), which suggests that the volcanics were emergent sometime before that, perhaps by late Oligocene (ca. 30 mya).

The eastern Caroline Islands, by contrast, are comparatively young and originated on the Pacific Plate. From Kosrae in the east to Woleai (Ulithi Atoll) in the west, the eastern Carolines stretch across the Pacific for 2100 km. The Truk (Chuuk) Islands are estimated to have originated at ca. 12–14 mya, whereas Kosrae is much

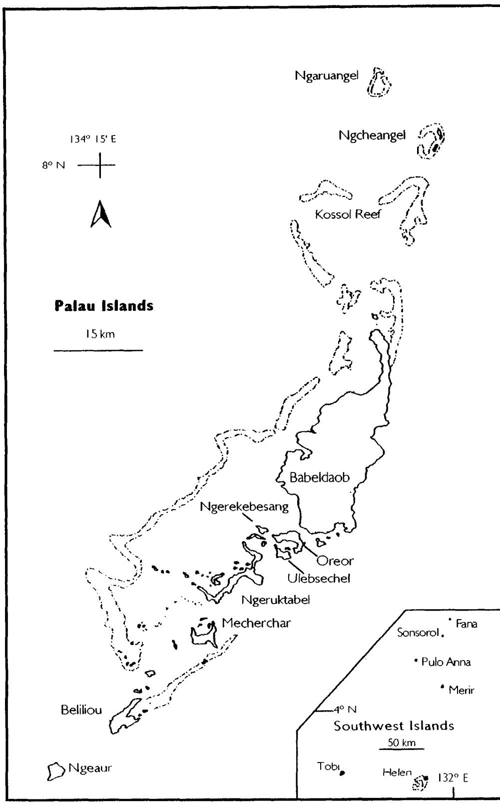

FIG. 2.—The main islands of the Palau archipelago.

younger at ca. 4 mya (Springer, 1982). The Carolines are being carried westward toward the Philippine Plate margin.

The Republic of Belau includes the Palau Islands proper and a cluster of remote outliers 320 to 480 km to the southwest (Fig. 2). Each of the latter (Tobi, Sonsorol, Fana, Merir, Pulo Anna and Helen) are separated from one another by from 130 to 280 km of open ocean. Few people outside of Palau are aware of them, and no one in the west has ever bothered to give them a collective name other than the Southwest Islands. The Palau islands themselves are arranged in a 160 km curving chain from Ngeruangel reef in the north to Ngeaur Island in the southwest. The total land area (including mangrove) is approximately 415 km^2. Most of Palau's 350 islands are enclosed in a reef: barrier to the west and fringing on the east. Only Ngeaur in the southwest and Ngcheangel Atoll and Ngeruangel reef in the north are

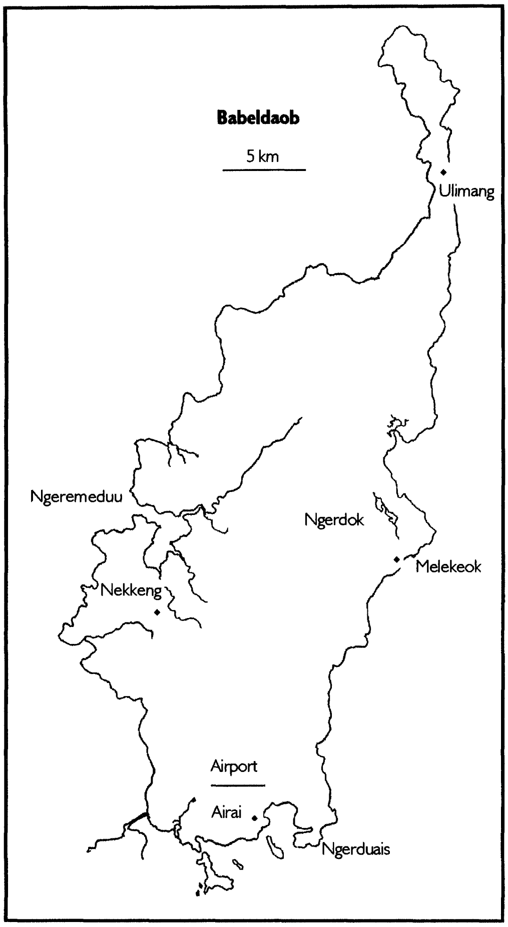

FIG. 3.—The island of Babeldaob, Republic of Palau.

outside the lagoon. The lagoon is approximately 20 km at its widest, covers about 1450 km^2, and varies in depth from barely a meter to over 20 m in a few places. Outside the reef ocean depths drop hundreds of meters almost immediately.

Babeldaob (Fig. 3) is the largest island at 333 km^2, accounting for about 80% of Palau's total land area. The next largest islands are Ngeruktabel (20.2 km^2), Beliliou (12.4 km^2), Ngeaur (8.3 km^2), Mecherchar (8 km^2), Oreor (7.5 km^2), Ulebsechel (4.3 km^2) and Ngerekebesang (2.3 km^2). Most of the other islands are less than 1 km^2 and many are no more than a few hectares. About two-thirds of Palau's 15,500 inhabitants live on Oreor, and practically all of the other residents live in the vicinity, either on southern Babeldaob, Ngerekebesang or Malakal, each of which is connected to Oreor by a causeway.

The islands are of four geological types: 1) volcanic, 2) high limestone, 3) low limestone, reef or atoll, or 4) a combination of volcanics and limestone. The *Military Geology of Palau* compiled by the U.S. Army of Corps of Engineers (1956) remains the most thorough description of Palau's geological features. The following summary is based on that compendium. Volcanic islands include Babeldaob, western Oreor, Ngerekebesang, Malakal, and numerous tiny islets in the northern end of the lagoon. Contours of the larger volcanic islands are generally rolling hills punctuated by steep irregular outcrops or other prominent landmarks. Palau's highest point, 242 m Ngerchelchuus in northwest Babeldaob, is one such feature. The largest evident volcanic center is Ngeremeduu Bay on the west coast of Babeldaob. The original cone collapsed leaving an eroded caldera which is now the bay. Poor exposures elsewhere on the volcanic islands obscure most former eruption centers, a possible exception being the volcanic breccias and the inclinations of pyroclastic rock on Ngerekebesang. Coastlines of the volcanic islands are irregular, sometimes steep, and often form small bays. Approximately 125 km of Babeldaob's 157 km coastline is bound by mangrove. The extent of calcareous beach sand on the volcanic islands is very limited, and mainly confined to Babeldaob's northeast and east coast. Each of the larger volcanic islands is dissected by streams, but the only perennial flows are on Babeldaob. On Oreor and Ngerekebesang the radial drainages slow to a trickle when rain ceases for more than a week or so. The major streams and rivers of Babeldaob are more or less aligned with the north-south axis of the island, but are linked irregularly with connecting tributaries. The largest river, Ngermeskang, flows for about 16 km into Ngeremeduu Bay from the northeast. The largest body of standing freshwater is Lake Ngerdok (approximately 30 hectares) located about 2 km from the east-central coast of Babeldaob.

The high limestone islands number more then 300, but comprise only about

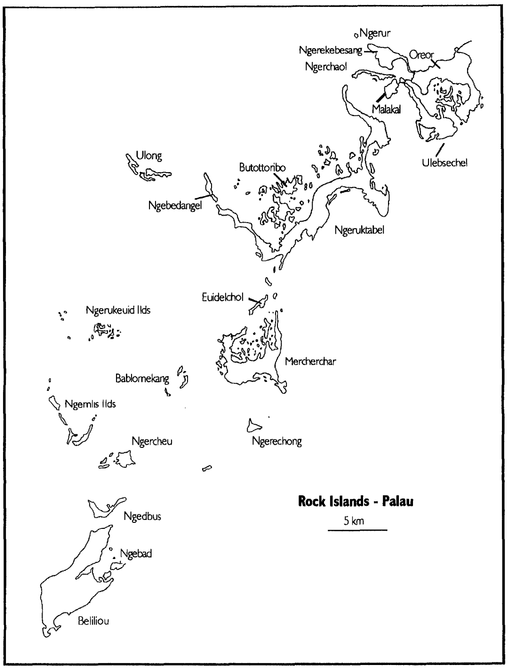

FIG. 4.—The Rock Islands of the Palau lagoon.

10% of Palau's land area. They include practically all of the islands in the lagoon. Those in the central and southern part of the lagoon are referred to locally as the Rock Islands (Fig. 4). Ngeruktabel and Mecherchar are the largest. The Rock Islands are formed in the Palau Limestone which consists of light-colored, poorly bedded, porous to very dense raised reef and lagoonal coralline deposits laid down in shallow warm water. The age of the Palau Limestone ranges from Miocene in the northern part of the Lagoon and parts of Beliliou (Bloody Nose Ridge) to Pleistocene elsewhere. The larger islands are characterized by steep, arcuate ridges flanked by descending skirts of parallel and/or tangential ridges that once marked exposed, successive reef fronts. The smaller rock islands probably derived from scattered, irregular deposits in the lagoon. The limestone islands were raised to their present extent by asymmetrical upwarping following the Neogene rifting and faulting that was associated with the tectonic and volcanic activities in the area. Uplift to as much as 200 m elevation occurs on an axis from southwestern Babeldaob to Beliliou. West of this line there is slight westward tilting. Although there are occasional coves and narrow beaches, the shorelines of the limestone islands are often nearly vertical, and almost everywhere are undercut by solution notches forming horizontal overhangs 1–5 m deep. Undercutting of the smaller islands gives them the appearance of mushrooms. Ashore, solution features of sharp, jagged pinnacles, pits and rubble make for exceedingly treacherous footing. Springs occur on some of the high limestone islands but there is no surface drainage. Caves, sinks, and other subsurface solution features are abundant in this highly karstified terrain. On several of the larger Rock Islands numerous interior depressions extend below sea level to form saline lakes.

The reef islands and atolls of Palau result from minor uplift of reef rocks and wave building accumulations. The largest and best developed of Palau's atolls is Ngcheangel (Kayangel), located about 3 km beyond the north end of the Palau reef. It is more or less oval, about 7 × 3.5 km, and embraces four small islands (beach deposits) on its east side.

Several of Palau's islands are a combination of the preceding geological types. High limestone ridges are present on the south end of Babeldaob. In a zone south and southwest of Babeldaob volcanic and high limestone islands occur adjacently or combined. The two volcanic islands, Ngerekebesang and Malakal, are separated by the high limestone island of Ngerchaol. Western Oreor is underlain by volcanics, whereas the southeast part is a high limestone ridge. The two larger islands at the southwest end of the Palau group, Beliliou and Ngeaur, consist of high limestone ridges, low platforms, and beach deposits.

Today, the Palau islands exist along a continuum of coastal morphologies determined by eustatic changes in sea level during the Pleistocene. During the last glacial maximum (18,000 years ago), when sea levels may have depressed as much as 120 m, the entire lagoon and most of the archipelago's 350 islands would have formed a single island of approximately 2250 km^2, more than five times the present area of emergent land. During periods of higher-than-present sea level, for instance in the mid-Holocene (e.g., Allen, 1997), Palau was more fragmented than it is today. The effect of these oscillations on the terrestrial biota was undoubtedly considerable. Indeed, the present distributions of Pacific island amphibians and reptiles in general must be considered in view of these sea level fluctuations (e.g., Gibbons, 1985; Gibbons and Clunie, 1986; see also Allison, 1996).

Habitat and Land Vertebrates

Palau's climate is tropical and rainy. Mean annual temperature is 27.2 C (81°F) and mean daily temperature varies no more than 1 degree throughout the year. On average the islands receive 355 cm (140″) annual rainfall with the wetter months (July and August) receiving 25–50 cm, the drier (February to April) 15–20 cm. A survey of vegetation and timber resources of Palau was drafted by the U.S. Forest Service (Cole et al., 1987; MacLean et al., 1988), and some of the vascular plants were listed by Fosberg et al. (1980). A soil survey of Palau by Smith (1983) includes 1:10,000 scale aerial photo maps of Babeldaob, Oreor and the causeway islands, Beleliou, and Ngeaur. Cole et al. (1987) estimated that three-fourths of Babeldaob and the other volcanic islands are covered in native upland forest, in which *Calophyllum, Ficus, Elaeocarpus* and *Campnosperma* are common genera. In the past few decades native upland forest has been greatly reduced, and most of the remaining area, especially on Babeldaob, is covered by coarse grasses burned annually, along with scattered pandanus and ferns. Mangrove (especially *Rhizophora* sp.) accounts for about 11% of Palau's vegetation cover, practically all of which is found around Babeldaob, Oreor, Malakal, Ngerekebesang, and Beleliou. The luxurient limestone forests of the Rock Islands form impressive, dense stands with canopies reaching 20 m or more on the larger islands. Freshwater swamps and marshes in Palau comprise about 5% of the area. Cultivated lands comprise about 3–4% and yield such crops as bananas, cassava, coconut, papaya, mango, pineapple, and betel nut. Urban areas occupy about 1% (Otobed and Maiava, 1994). Our impressions would put the percentage of agricultural and urban land considerably higher.

Besides amphibians and reptiles, the vertebrates of Palau include a fair diversity of freshwater fishes and birds, but a depauperate mammal fauna. The resident freshwater and land birds consist of widespread oceanic species, species confined to Micronesia, species found elsewhere only in Indonesia or the Philippines, endemic species, and a few introductions. Palau's modern avifauna has received much more attention than its herpetofauna (Baker, 1951; Engbring, 1983, 1988; Engbring and Pratt, 1985; Pratt et al., 1980), although it would be surprising if these islands have not experienced extinctions of native bird species similar to what has been discovered elsewhere in Oceania (Steadman, 1995), including the nearby Marianas (Steadman, 1999). The endemic land mammals known from Palau are the Palau Sheath-tailed Bat, *Emballonura semicaudata palauensis,* the "Marianas" Fruit Bat, *Pteropus marianus pelewensis,* and the larger Palau Fruit Bat *Pteropus pilosus.* The Palau Fruit Bat has not been seen since the 19th century and is presumed to be extinct (Wiles et al., 1997). Introduced taxa include rodents *Rattus* spp. and *Mus musculus* (see below), as well as the Asiatic musk shrew *Suncus murinus,* confined to Ngeaur (see Ruedi et al., 1996 for *Suncus* zoogeography). The introduced Crab-eating Macaque, *Macaca fascicularis,* is most common on Ngeaur, and a few individuals also occur on Babeldaob.

A review of Palau's freshwater fishes was compiled by Bright and June (1981), but very few of Babeldaob's rivers and streams (particularly in the eastern sectors) have been sampled, much less properly surveyed. Undoubtedly endemic, undescribed species await discovery (e.g., Parenti and Maciolek, 1993).

Human impact is most obvious in and around Palau's main habitation centers (Oreor, Ngerekebesang, Malakal, Airai) and surrounding settlements and plantations. Much of Babeldaob has been deforested, especially the southern half. Although Palau's present human population is relatively small (about 15,500), estimates of around 40,000 native Palauans were believed to be present at the time of first Western contact (Johannes, 1981; Osborne, 1966). There is some dispute of that figure, which is based on accounts of the early traders to the islands (Johannes, 1981). Nonetheless, ancient agricultural terraces and other archaeological indicators suggest that the population was significantly greater than it is today (Craib, 1983; Osborne, 1966). During this century population highs were in the early 1940's when 25,000 Japanese residents and native Palauans lived in the islands (U.S. Army, 1956; see also Bailey, 1991).

WWII brought substantial devastation to parts of Palau. Beliliou, the site of one of the bloodiest battles in the Pacific (Hough, 1990; Ross, 1991), was burned over most of its area. The island has generated dense second growth forest over the past 50 years. Ngeaur, Oreor, and southern Babeldaob were also heavily bombed by American forces, but of these only Ngeaur was invaded. Despite the impact of human occupation and WWII, Palau still claims some pristine habitat, or that which is but moderately disturbed. The Rock Islands are practically all primary forest due to their steep slopes and brutal topography (Johnson, 1972). Yet even there one of the most odious measures of human disturbance is conspicuous—introduced Black Rats (*Rattus rattus*). Our campsite on uninhabited Ulong was overrun by hundreds of rats one night in January 1995. During the same month in 1993 we trapped along a 200 m forest transect in Ngaraard State (northern Babeldaob) and had a capture rate of about 73% (19 of 26 traps) in one hour. Rats can also be seen commonly in Koror town by day. The effect of *R. rattus* as a predator on Palau's herpetofauna and birds has not been documented, but we suspect that it is substantial.

Rapidly growing economic interests in Palau probably will adversely affect the native fauna in the next few decades (Anon., 1998; Cassell et al., 1992). The human population is likely to double in 5–10 years (Maiva and BNRD, 1994), and at least one major road is under construction to the north end of Babeldaob where none presently exists. Erosion and siltation of some Babeldaob water courses are already evident. Tourism is burgeoning, and numerous hotels are planned or being built in Oreor, southern and eastern Babeldaob, Malakal, and on the Rock Islands. The government of Palau has proudly and justifiably promoted its marine resources as a tourist attraction. We hope that this does not come to the detriment of its terrestrial ecosystems.

Historical Summary

The Spaniards were the first Europeans to land on Palau, claiming the islands for the King of Spain in 1710. Their presence was uneventful, particularly biologically except perhaps for the first introduction of rats. Several European ships were wrecked in the treacherous waters around Palau in the 18th and 19th Century and stories of the interactions between the marooned sailors and Palauans have been amply chronicled (Keate, 1802, 1808; Martin, 1980). Not surprising, the early Pacific exploratory expeditions usually avoided Palauan waters in favor of the better harbors on Guam, Yap, and Kosrae, so their naturalists and collectors had little or no opportunity to sample the Palauan fauna. The French ships Astrolabe and Zelee briefly contacted the residents of Beliliou in January 1838 (Rosenman, 1992:162), but we have found no herpetological specimens that were collected at that time. The French did, however, make the most significant early contribution to Micronesian herpetology during the voyage of the Coquille, 1822–1825. Many of the most common and widespread Pacific lizards were described from the island of Oualan (now Kosrae in the eastern Carolines), four of which also occur in Palau (*Gehyra oceanica, Emoia atrocostata, Lamprolepis smaragdina, Lipinia noctua*).

Lessons's (1830) zoological report of the Coquil expedition generated confusion on several levels, however. Brygoo (1986) pointed out that the Atlas of plates from the Expedition appeared in 1826 but the text not until 1830, so Lesson's taxa must date from the Atlas. The types of several of the species are no longer extant (Brygoo, 1986) and Barbour (1911) suggested that Lesson's type locality (Oualan, now Kosrae in the eastern Carolines) was suspect. Loveridge (1948) disagreed and criticized Barbour's interpretation but we feel that Barbour's suspicion was justified for at least some of the taxa. The situation is complex and a lengthy discussion is not appropriate here since it has no direct impact on Palau, although we hope to provide clarification in a future paper.

Serious herpetological research in Palau began only after the Germans suceeded Spain in 1899. Unlike the Spanish, German merchants and diplomats were actually resident in Palau. Particularly notable among them was Carl Semper, who wrote an interesting book on his Palau experiences (Semper, 1925, English translation Semper and Craig, 1982). Semper was an experienced field naturalist who had made important collections in the Philippines and elsewhere in Asia. His Palau herpetological material was studied by Wilhelm Peters in Berlin, who described many new taxa (Peters, 1867*a,b*, 1874, 1877, 1879). Most of the Berlin specimens have no locality data other than the island group, variously rendered as "Pelew", "Pelew-Inseln" or "Palaos". Additional Palau material (mostly from Angau = Ngeaur) in the Senckenberg Museum, Frankfurt, was reported by Sternfeld (1914, 1920), who (1920:385) mentioned that, "another new lizard from Palau" was present in the Senckenberg collection and that it would "also be described here." However, no new Palauan lizards were described in the 1920 paper or any subsequent publications by Sternfeld before he was executed by the Nazis in 1943, nor are there type specimens of any Palauan lizards in the Senckenberg collection (Mertens, 1967). The material of this new species alluded to by Sternfeld was not located during a visit to Senckenberg by RIC in May of 1986, and we are unsure which of the still undescribed Palauan lizards Sternfeld referred to.

The Japanese period (1914–1944) produced relatively little herpetological research, as summarized in Utinomi's *Bibliographica Micronesica* (Fisher, 1947). No new herpetological taxa were described, and most of the information was published in obscure, generally unavailable journals. Messel and King (1991), in summarizing the crocodilian literature, mentioned two significant papers by Motoda (1937, 1938). However, we have been unable to locate any extant herpetological collections that were made by the Japanese during their 30-year occupation of Palau.

U.S. influence in Palauan herpetology began with personnel of the Naval Medical Research Unit (NAMRU II), who were active in Palau soon after the islands were secured from the Japanese. Biological material was collected from November 1944 until about September 1945 (Baker, 1951; USNM catalogue records). Although collecting efforts centered on Beliliou and offshore islands, the team also obtained herpetological material from Ngeaur, Ngercheu, and Ngcheangel Atoll. The NAMRU collections provided the first meaningful distributional data (island and specific localities) for Palau amphibians and reptiles. Although most of the NAMRU material was deposited in USNM, one member of the team, William Lewellen, contributed most of his Ngeaur specimens (CM 29085–29103, collected between 19 November 1944 and 13 January 1945) to the Carnegie Museum.

Until recently, the most extensive and important Palauan herpetological collection was made by H. Adair Fehlmann during his ichthyological surveys in the mid 1950's (Fehlmann, 1960). Most of the fish data remain unpublished but his discovery of the remarkable endemic skink *Lipinia leptosoma* appeared early (Brown and Fehlmann, 1958). Fehlmann's herpetological specimens were deposited in the Stanford University collection (now housed at CAS) and they represent important baseline data on distributions before extensive development on Palau.

The earliest natural history observations on the endemic Palauan frog (*Platymantis pelewensis*) was by a Palauan, Kenji Atoda (1950). Palauan citizens and residents have continued to contribute meaningfully to herpetology ever since. Although he was severely criticized by Messel and King (1991) for encouraging exploitation and even extermination of crocodiles in Palau, Robert Owen was the entomologist and Chief Conservation Officer of Palau for many years, and was unfailingly helpful to visiting researchers. He provided data and specimens to many individuals (including us), and meaningfully aided projects involving the Palauan flora and fauna during his tenure there. Owen's successors, particularly Demei Otobed and Kammen (Taktai) Chin, have continued this fine tradition of cooperation and have made significant contributions of their own (e.g., Cassell et al., 1992; Fosberg et al., 1980; Otobed and Maiava, 1994).

Zoogeography

Although it is premature to discuss Palauan zoogeography in any detail before the relationships of many species are understood, summary papers on SW Pacific biogeography continue to appear (Allison, 1996; Brown, 1997; Holloway, 1997 among others), some of which are hampered by the lack of recent data on Palau. A brief summary is justified. We are confident that analysis of the data in hand will confirm that Palau is an important zoogeographic crossroads, with faunal influences from all four major source areas. Our preliminary data do not confirm any species with unequivocal Bornean relationships, but the Oceanic (*Gehyra oceanica, Lepidodactylus* sp. nov., *Perochirus* sp.) and Philippine (*Lepidodactylus moestus, Mabuya* sp.) affinities are more certain. Without question, the greatest influence on the Palauan herpetofauna is the Greater Papuan region (New Guinea + the Solomons and Moluccas, East Wallacea of Brown, 1997 and others). At least 13 Palauan species are derivatives of this area, and several of the 13 or 14 others of uncertain origin will likely be added to that total with additional research.

Critically missing from the puzzle are sufficient data from the Southwest Islands. This chain of islands provides a potential stepping stone pathway between Palau proper and the Greater Papuan region, particularly during periods of lower sea level. The few extant herpetological records from the islands provide many surprises, as much for the species that have not been collected as those that have. Donaldson's (1996) discussion on the striking diversity and complexity of relationships in the fish fauna convinces us that the terrestrial fauna will be equally significant.

Species Accounts

Forty-six species of amphibians and reptiles (39 terrestrial and 7 marine) are treated in the following section (Table 1). Three species are twentieth-century introductions, eight species are certain endemics, and ten others are probably endemic. The latter include several species represented by only one or a few specimens and their status cannot yet be determined. Other species are known under existing names but for reasons discussed we believe are distinct species. For each species, the localities listed under *Distribution* are those islands in Palau where we have collected voucher specimens and/or verified existing museum records. Almost all of the island records derive from, or are verified by, our field work through 1998. Appendix I is a checklist of species by island.

AMPHIBIA: ANURA

Bufonidae

Bufo marinus (Linnaeus, 1758)

This large toad is very widely distributed, both in its natural range of the Neotropics (Zug and Zug, 1979) and in many other parts of the world via introduction (Easteal, 1981; Honegger, 1970). Details of exactly when and whence *Bufo marinus* was first introduced into Palau are unknown (Easteal, 1981:102) but the first museum specimens were collected in the early 1950's. Although the NAMRU 2 teams did not collect any *Bufo* during their stay on Beliliou in 1945, it is likely that toads were introduced during U.S. military activity in Palau in the post-war years, pos-

TABLE 1.—Amphibians and reptiles of the Palau Islands. Those marked by an asterisk (*) have not been reported previously.

FROGS
Bufonidae
Bufo marinus (introduced)
Ranidae
Platymantis pelewensis (endemic)
LIZARDS
Agamidae
Hypsilurus godeffroyi (status uncertain)
Gekkonidae
Gehyra sp.*
Gehyra brevipalmata (endemic)
Gehyra mutilata
Gehyra oceanica
Gekko sp. (endemic)*
Hemidactylus frenatus
Hemiphyllodactylus cf. *H. typus**
Lepidodactylus sp. nov.*
Lepidodactylus lugubris
Lepidodactylus moestus
Lepidodactylus paurolepis (endemic)
Nactus sp. (endemic)*
Nactus cf. *N. pelagicus**
Perochirus sp.*
Polychrotidae
Anolis carolinensis (introduced)
Scincidae
Carlia cf. *C. fusca* (introduced)*
Cryptoblepharus sp. (probable endemic)*
Emoia atrocostata
Emoia caeruleocauda
*Emoia impar**
Emoia jakati
Eugongylus sp. (endemic)
Lamprolepis smaragdina
Lipinia leptosoma (endemic)
Lipinia cf. *L. noctua**
Mabuya sp. (endemic)
Sphenomorphus sp. nov. (endemic)*
Sphenomorphus scutatus (endemic)
Varanidae
Varanus cf. *V. indicus*
SNAKES
Boidae
Candoia cf. *C. carinata*
Colubridae
Cerberus rynchops
Dendrelaphis sp.
Hydrophiidae
Pelamis platurus
Laticaudidae
Laticauda colubrina
Typhlopidae
Ramphotyphlops acuticaudus (endemic)
Ramphotyphlops braminus
TURTLES
Chelidae
Gen. & sp. indet.*
Bataguridae (?)
cf. *Chinemys reevesii**

TABLE 1.—Continued.

Cheloniidae
Chelonia mydas
Eretmochelys imbricata
Dermochelys coriacea
Lepidochelys olivacea
CROCODILES
Crocodylidae
Crocodylus porosus

sibly from Guam, New Guinea and/or Australia where *Bufo* has been well established since the 1930's. Gressitt (1952) visited Kayangel Atoll in July–November 1951 and the toads were well established by then. The hypothesis of a post-war (i.e., mid-1940's) introduction into Palau is further supported by USNM 123909, collected in July 1946 on nearby Yap. The field notes of the collector state that, "On Yap (the toad) does not reach the size it does on Guam and other islands . . ." but that it was "very common" around Yaptown (now Colonia) at that time. Fisher (1948) did not mention toads from Palau, but he confirmed that they were common on Ponape and all the islands of Yap during his visits there, at some unspecified time before 1948.

Although Easteal (1981:117) found museum vouchers for only three islands in Palau—Arakabesan (= Ngerekebesang), Kayangel (= Ngcheangel Atoll), and Kerrar (= Koror, now Oreor)—*Bufo marinus* is widely distributed in the archipelago. It is most abundant on the causeway-connected islands where agriculture (particularly taro patches) and other human activities provide abundant breeding places. The species is not found on most of the Rock Islands where standing water rapidly percolates through the steep, porous limestone, thus eliminating potential breeding places. We have sight records from Ulong in January 1995, when the toads were quite common, but several subsequent visits to collect vouchers were unsuccessful. Rat density was also startlingly reduced and we initially suspected that a rat poisoning project might also have extirpated the toads. An El Nino-associated drought in late 1997–early 1998 killed off much of the undergrowth in the disturbed area around the beach that it is unlikely any toads survived this exceedingly dry period on Ulong.

Our one vouchered Rock Island record is USNM 531973 from Pkulaklim, a high island just off the Airai Dock area of southeastern Babeldaob. The toad was active by day in low undergrowth adjacent to a low swampy area just behind a small beach on the west side. Taro had recently been planted in the swamp and the toad(s) may have been intentionally brought in with the agriculture.

Distribution.—Babeldaob, Beliliou, Malakal, Ngcheangel Atoll (Ngcheangel), Ngeaur, Ngerekebesang, Oreor, Pkulaklim.

Ranidae

Platymantis pelewensis Peters, 1867:33

Wilhelm Peters (1867*a*:33) described *Platymantis pliciferus pelewensis* from the "Pelewinseln", based on a single specimen collected by Dr. C. Semper. The holotype (ZMB5699) was listed as "not located" in Frost (1985:469) and Peters' extremely brief description provided no morphological information, merely indicating that the Palau specimen was nearly identical with the Philippine *Platymantis plicifera* Günther, differing only in the coloration of the side of the head (all black in *plicifera,* upper and lower lips flecked with white in *pelewensis*). The name was overlooked in subsequent reviews of ranids (Boulenger, 1882, 1918), but it reappeared as a valid species in the more recent literature (Gorham, 1965; Frost, 1985). Although Ota and Matsui (1995) and Kuramoto (1997) recently presented some data on the relationships of the species, no historical review has ever been published. We will fill in some of the "lost years".

Kampen (1923:190) transferred *plicifera* to the genus *Rana* (but maintained *Platymantis* as a subgenus), where the species name became a homonym. He provided the unnecessary replacement name *Rana rugata* and regarded *pelewensis* as a strict synonym of it. Loveridge (1948:407) criticized Kampen's arrangement, regarded Philippine and New Guinea *Platymantis* as subspecifically related, and pointed out that the name *corrugatus* had priority over *plicifera.* He also commented, "... whether *Platymantis plicifera pelewensis* Peters, 1867, from the Pelew Islands, is a recognizable race, scarcely concerns us here."

Brown (1952:51) and Inger (1954:351) concluded that the Philippine and New Guinea "*corrugatus*" were not only specifically distinct, but quite unrelated to one another. Inger (1954:355–356) correctly pointed out that both *pelewensis* and *papuensis* were more similar to the Philippine *Cornufer meyeri* (= *Platymantis dorsalis,* Brown and Inger, 1964) than to *P. corrugatus* (see also Tyler, 1979). He regarded the three taxa as distinct species and provided some data on *pelewensis* (size, dorsal and ventral skin texture, digital and vocal sac morphology, ova dimensions).

Atoda (1950) published an excellent embryological study of direct development in the Palauan frog but used no scientific name, speculating that it was, "... probably a new species of *Rana.*" Alcala (1961: 721) referred Atoda's material to *Cornufer pelewensis* (see Zweifel, 1969 for use of the name *Platymantis* rather than *Cornufer*). Gorham (1965:410–411) confirmed that *pelewensis* was a valid species and provided the first illustrations of it (sketches of the lateral head, ventral view of the hand and a photo of an entire specimen (1965:432, Figs. 3A,B)). Brown (1965:2–3) summarized the known species of "*Cornufer*", also listing *pelewensis* as a valid species. The validity of the Palauan *Platymantis* has remained unchallenged since Brown and Tyler (1968). [Tyler's (1979:82, Fig. 6) mention of one species of *Rana* in Palau is incorrect. This is either a lapsus or perhaps a reference to Atoda's (1950) erroneous remark that *P. pelewensis* as "an undescribed species of *Rana*", but Atoda's paper is not cited.]

Most recently, Ota and Matsui (1995) described the karyotype and Kuramoto (1997) analysed morphological, karyological, and acoustic information on *P. pelewensis* to clarify its relationships. All data unequivocally confirmed that *pelewensis* is very closely related to *P. papuensis* from New Guinea (e.g., Menzies, 1982*a,b*) and quite distant from the Philippine *P. dorsalis.* We have collected several hundred more *P. pelewensis* than our Japanese colleagues, material that includes call recordings, skeletons, and frozen tissue, but we concur completely with their conclusions. Our larger sample sizes negate the size differences between *pelewensis* and *papuensis* noted by Kuramoto (1997) and greatly expand the limited pattern polymorphism he reported.

Platymantis pelewensis is ubiquitous in Palau, at least from Kayangel to Ngeaur, but Owen (1977) stated that frogs were *not* found in the Southwest Islands. This species is abundant in backyards in Koror town and in undisturbed forest on the Rock Islands. Although Kuramoto (1997: 183) characterized the Palau frog as being "found among leaf litter on the forest floor," it is most assuredly not a forest obligate. In fact, based on call records it may be most abundant in patches of thick grass in disturbed areas, where dozens of males can be heard vocalizing among the impenetrable, moisture-retaining roots. Call records also confirm the presence of frogs on many of the Rock Islands, even very small pinnacles. We suspect *P. pelewensis* may be salt tolerant as well, since we have heard and collected the species at the edges of mangrove swamps and other haline areas.

Details on the natural history of the Palau frog have been minimal since Atoda's (1950) description of the development of the clutch he discovered. Unfortunately, he did not provide information on where the eggs were found, if there was an attendant frog, or other important details on direct-developing species. No other clutch has ever been found, despite our intense field efforts. We suspect, however, that males call from and defend a calling/nest chamber and attend the clutch. We base this on the fact that calling males are often nearly impossible to find, particularly during dry periods. On rainy evenings males may call from exposed sites but in general they are well concealed and several have been collected from calling chambers, under detritus but not subterranean.

One of our more startling discoveries involved the ecology of female *P. pelewensis.* Collections made from the forest floor (e.g., Kuramoto, 1997) are usually strongly skewed towards males and subadults, but we found that females congregate, often in incredible numbers, in the multitude of natural caves and Japanese-made bunkers that are omnipresent in Palau. These bunkers usually retain moisture and many have an abundance of trash on the floor or crevices in the wall, so we initially suspected they may have been an important egg deposition area. However, after thoroughly searching dozens of bunkers (some repeatedly throughout much of the year) we have yet to find any indication that reproduction occurs there. The bunker frogs are 90+% female, many of them larger than maximum previously reported size, and we initially suspected that they might be a second species. However, the few males found in samples from more than 12 "caves" were all immature; calling males have been heard near the mouths of the caves (but never inside) and the calls were all typical *pelewensis.* Apparently large females use the bunkers as diurnal retreats and venture into the forest at night for reproduction, presumably at the male calling site. The bunkers remain consistently moist even during the driest spells, and provide an abundance of food (cave crickets are particularly abundant). On several occasions we have also found juvenile *P. pelewensis* in the guts of large females from bunkers.

Distribution.—ENDEMIC. Babeldaob, Bailechesengel (Ngemlis Islands; call only), Beliliou, Malakal, Ngcheangel Atoll (Ngcheangel, Ngeriungs), Ngeaur, Ngercheu, Ngerechur, Ngerekebesang, Ngerukeuid (island 24), Ngeruktabel, Ngetmeduch, Oreor, Ulebsechel, Ulong.

REPTILIA: SAURIA

Agamidae

Hypsilurus godeffroyi Peters, 1867

Originally described from two specimens as *Lophura* (*Hypsilurus*) *Godeffroyi* from the "Pelew-Inseln" (Peters 1867*b*: 707, Fig. 1; lectotype ZMB 5891), this species has never been collected again anywhere in Oceania. Boulenger (1885:295–296) first associated the species name with populations from the Papuan region. In fact, he did not even include Palau in the distribution of the species, listing only "New Ireland, New Britain, Solomon and Fiji Islands, Northern Queensland". Cogger (1975:222) discounted the Australian records (and deleted the species from subsequent editions of his book) and listed the distribution as "Widely distributed . . . from the Solomon Islands to the Philippines." However, the species (and the genus) has never actually been reported from the Philippines and Cogger (personal communication 1997) confirms that "Philippines" was probably a lapsus for Palau. Zug (1991:7–8) regarded the Fijian locality as erroneous.

The status of this lizard in Palau is problematic. Palauans are utterly unfamiliar with photographs of this large and distinctive species. However, McCoy (1980:14) emphasized that, in the Solomons at least, *H. godeffroyi* can be amazingly cryptic, even where it is common. The only recent evidence of the lizard's presence in Palau comes from a collection of skeletal remains found in a cave(s)/gravel pit (now flooded) on Ngeaur by Tom Iliffe in March, 1985, and sent to us for examination. The bones are clearly those of an agamid, and represent a minimum of 11 individuals ranging in approximate snout–vent length of 70–110 mm; McCoy gives an average SVL of 120 mm for Solomon Island *godeffroyi*. Iliffe recovered the bones along with mollusk shells while sampling for archaeological artifacts. The bones show no evidence of deterioration, and appear much like macerated skeletons, suggesting that they were deposited not too long before they were collected. We think it probable that this species still exists in Palau and it awaits rediscovery in some forested area. If and when additional material from Palau is collected, we believe it equally probable that the lizard will prove not to be conspecific with the populations in the Solomons and New Guinea.

Other possibilities are that the type locality is erroneous. Peters' types were received from the Godeffroy collection, without a specific locality or collector. The Germans were also active in the New Guinea-Solomons area during this period and the specimens could have been mislabelled, or Palau may have been where the specimens were shipped to Europe and the shipping port was erroneously interpreted as a collecting locality. However, this scenario seems less plausible in view of the bones collected from Ngeaur.

Conceivably the species is a recent (i.e., post-European) extinction. It may have been exterminated by rat predation, perhaps coupled with habitat loss in the wake of deforestation, particularly during the Japanese period.

Distribution.—unknown (Ngeaur?), probably endemic.

Gekkonidae
Gehyra sp.

On first inspection, the large Palauan *Gehyra* seem simple taxonomically, i.e., the dark, velvety *G. brevipalmata* with divided terminal lamellae and yellow or orange ventral color, versus the pale, ghostly gray *G. oceanica* with transverse, undivided lamellae and a gray (occasionally yellow) belly. The reality is considerably more complex. Although the two species are usually easily identifiable in the field, even in areas of absolute syntopy (Ngaraard State, Babeldaob), some small island populations are more equivocal. One of us (RIC) misidentified the Ngerur population of *oceanica* as *brevipalmata* on his first visit, despite considerable experience with both species in the field.

Judging from the number of misidentified specimens in museum collections, preserved material is more confusing still. The terminal lamellae can appear divided in poorly preserved or dessicated specimens of *G. oceanica.* This apparently caused the misidentification of Saipan *oceanica* as *Peropus papuanus* in Dryden and Taylor (1969).

Although we are *reasonably* confident that the *Gehyra* with transverse lamellae from the core islands of Palau are all *oceanica* (sensu lato), we are much less sure about the specimens from the Southwest Islands. We have no experience in these islands, so no ecological or color data are available. The few specimens known (USNM 348770 from Fana; 348762–63 from Pulo Anna; 348781–82 from Sonsorol; 348788 from Tobi) have unquestionably undivided lamellae, but somewhat more emarginate than is typical for *oceanica* (this may be an artifact of preservation as noted above). The males also have longer preanal-femoral pore series, extending to mid thigh (restricted to the preanal area in Palauan *oceanica*). King and Horner (1989) described south-coast Papua New Guinea *"oceanica"* as *Gehyra membranacruralis* but the Southwest Islands specimens lack the extensive femoral membrane of that species. Perhaps the most pertinent comparisons are with *Gehyra* from the Moluccas (the most proximate landmass to the Southwest Islands), whence Rooij (1915) records both *G. oceanica* and *marginata*. *Gehyra marginata* is a large species with undivided (but slightly emarginate) digital lamellae, well distinguished from *oceanica* by the extensive skin folds along the thighs and the venterolateral body. We have seen no actual *Gehyra oceanica* from the Moluccas but a series (USNM 237578–83) of *oceanica*-sized *Gehyra* from Halmahera has strongly divided digital lamellae, unlike any species previously reported from the Moluccas and equally distinct from the Southwest Islands taxon.

Clearly the *Gehyra "oceanica"* from the southwest Pacific are in need of revision. Rather than refer the Southwest Islands material to this catch-all species, we prefer to call it *Gehyra* sp. to emphasize our impressions of its distinctiveness from *"oceanica"* on the core islands of Palau.

Distribution.—Fana, Pulo Anna, Sonsorol, Tobi.

Gehyra brevipalmata (Peters, 1874:159)

The relationships of this distinctive Palauan endemic [*Hemidactylus* (*Peropus*) *brevipalmata* Peters, 1874; Holotype ZMB7927] are not clear, but we suspect it may be close to some of the poorly known New Guinea species with divided lamellae (e.g., *papuana, lampei, interstitialis, baliola* (Rooij, 1915:38; Bauer, 1994)). Dryden and Taylor (1969) reported *Peropus papuanus* (= *Gehyra papuana*) from Palau based on one specimen from Ngeaur (EHT-HMS = FMNH 6699), citing Brongersma's (1934) notes on the holotype of *G. papuana* as justification for their identification. Brongersma (1934:174) stated that only the basal and terminal lamellae were entire, the rest divided, and that the tail was, "... much depressed ... with a sharp lateral edge." We have reexamined Dryden and Taylor's specimen, which is dessicated and tailless so Brongersma's characters are difficult or impossible to apply (see also comments under *Gehyra* sp.). However, several of the proximal lamellae (not just the basal ones) appear to be undivided, similar to the digital structure of *G. brevipalmata*. King and Horner (1989) characterized *G. papuana* as a medium-sized species (less than 80 mm SVL) restricted to New Guinea. We have collected extensively on Ngeaur, finding only *G. brevipalmata* and *G. mutilata*. We are confident that Dryden and Taylor's specimen is a misidentified *brevipalmata* (a species they did not mention), as suggested by Bauer (1994:100).

Gehyra brevipalmata is likely one of the "old" Palauan species. It occurs widely throughout the archipelago including forest on Rock Islands to buildings in disturbed areas. Its rich, dark, velvety skin is remarkably fragile and undamaged specimens are rare. When grasped, *G. brevipalmata* spins and *any* restraint causes the skin to peel back from the subdermal fascia and a completely skinless specimen can result.

Gehyra brevipalmata is particularly fond of crevices and the species is found commonly on banyan trees, in *Pandanus* axils, under bamboo sheaths, and in man-made crevices around buildings (under shutters, behind drain pipes, in corrugated tin roofs). In captivity, the species eats fruit readily and in the wild we have seen it licking at sweets (tree sap, open soft drink cans and bottles). Crombie and Steadman (1987) reported that the stomachs of several *Gehyra oceanica* from the Cook Islands were "packed with small seeds" similar to fig, and fruit eating has

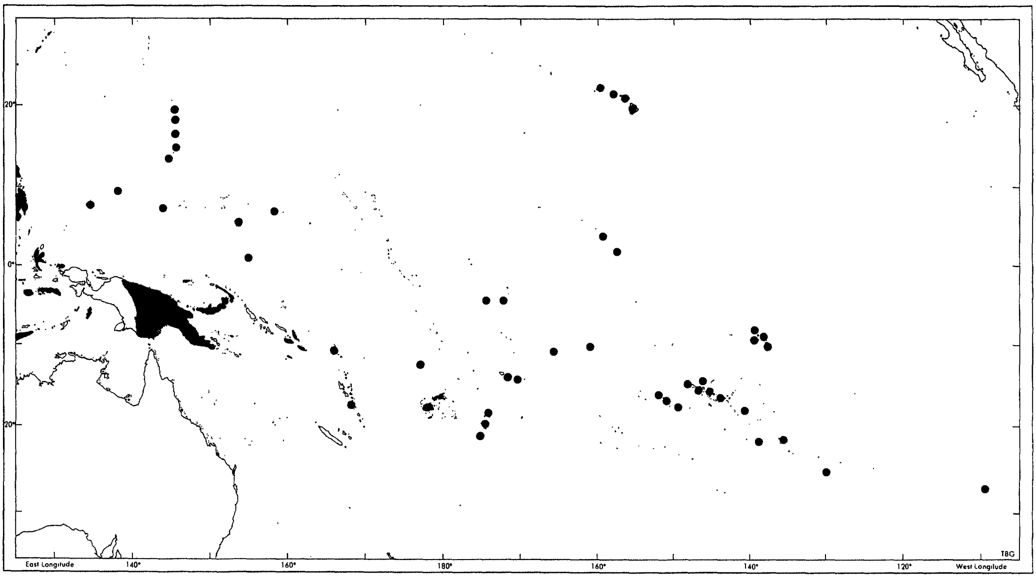

FIG. 5.—The distribution of *Gehyra mutilata* in Oceania. (Also occurs in India, Sri Lanka, Indochina, Philippines, Japan, Madacasgar; after Bauer, 1994).

been reported for several other species of *Gehyra* (see Burnett and Nolen, 1996).

Distribution.—ENDEMIC. Babeldaob, Bablomekang, Beliliou, Euidelchol, Iiblau (Ngemlis Islands) Kmekumer Islands, Malakal, Ngeaur, Ngercheu, Ngerduais, Ngerekebesang, Ngeruktabel, Oreor, Pkulaklim, Ulebsechel, Ulong.

Gehyra mutilata (Wiegmann, 1834)

This gecko is very widely distributed in mainland south and southeast Asia, and numerous island groups including Madagascar and other Indian Ocean groups, the Indoaustralian Archipelago, the Philippines, and most of Oceania (Fig. 5; Bauer, 1994:92, map 24). Its broad distribution is usually attributed to human transport. Some populations (the Neotropics, New Zealand) are clearly post-European introductions, but the species probably dispersed easily with indigenous peoples through much of Oceania.

Peters (1867*a*) discussed a "variety" of *Gehyra mutilata* based on a single 60 mm specimen collected in the "Pelew-Inseln" by C. Semper which he distinguished from typical *mutilata* by the more extensive digital webbing and the small outer postmental scales. This was a subadult of what he later described as *Gehyra brevipalmata* (Peters, 1874).

This species is ubiquitous in Palau and is found in a wide variety of habitats. In the absence of *Hemidactylus frenatus* it is often the commonest house lizard, but it is also found in more natural habitats including undisturbed forest.

Distribution.—Babeldaob, Ioulomekang, Malakal, Ngcheangel Atoll (Ngcheangel), Ngeaur, Ngerechong, Ngerekebesang, Ngetmeduch, Oreor, Tobi (Southwest Islands).

Gehyra oceanica (Lesson, 1826)

Although King and Horner (1989) found Oceanic populations (Fig. 6) of *Gehyra oceanica* to be homogeneous both morphologically and karyologically, Beckon (1992) was able to distinguish morphologically Micronesian from Polynesian *oceanica.* Biochemical data confirm the differences between the two populations (R. Fisher, 1997), although no one has yet attempted to sort out the confusing synonymy of *oceanica* to determine which names apply to the two species.

Gehyra oceanica has been recorded from Oreor (CAS-SU 23747, 23753, CAS 122393), but we have collected it only in

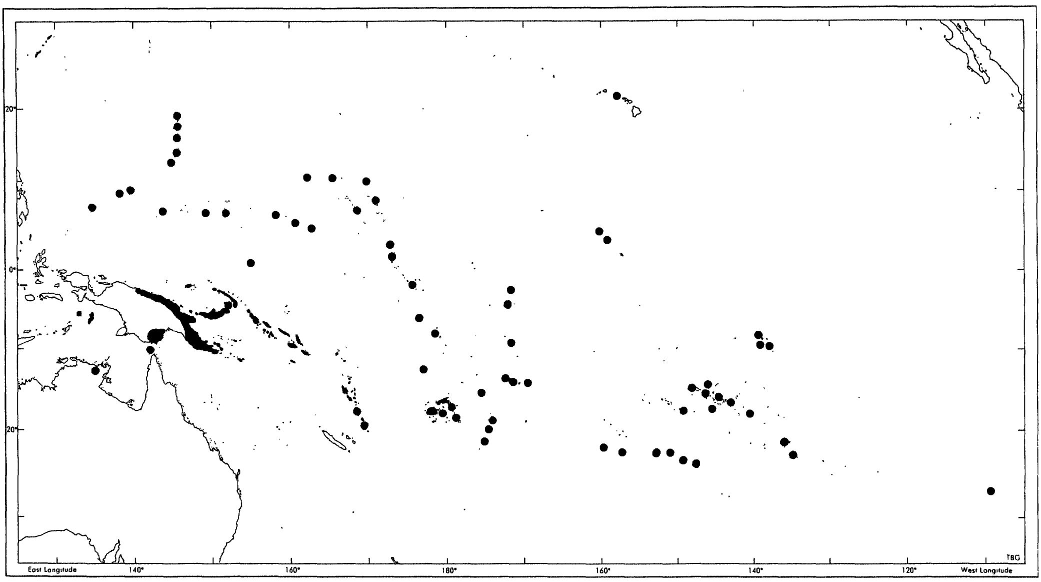

FIG. 6.—The distribution of *Gehyra oceanica* (after Bauer, 1994).

the extreme north of Babeldaob and on peripheral small islands (e.g., Ngerur). We have not verified its presence on Oreor despite intensive effort. In Nagaraard State (northern Babeldaob) it occurs syntopically (often on adjacent trees) with *Gehyra brevipalmata* in Ulimang Village, but *brevipalmata* seems to be slightly more abundant.

Distribution.—Babeldaob, Chemoi, Ngcheangel Atoll (all islands), Ngeanges, Ngerechur, Ngerur, Oreor.

Gekko sp.

This large, attenuate gekkonid is an undescribed endemic species. It is related to *Gekko vittatus* of New Guinea and the Indoaustralian Archipelago, and it is frequently identified as *vittatus* in the literature and in museum collections. New Guinea/Indonesian *Gekko vittatus* are extremely variable and more than one species is certainly included in *vittatus* as currently defined. The nomenclatural history of *vittatus* and its synonyms is plagued by erroneous type localities, missing type specimens, and other problems that preclude resolution with currently available data and specimens. A brief summary as it relates to the Palau *Gekko* is warranted. Basically, *Gekko vittatus* (in New Guinea and the Solomons at least, data for the Indonesian populations are almost totally lacking) is dimorphic in color pattern, but *not* sexually correlated (McCoy, 1980: plate 7a,b illustrates both forms). The most common morph has a vivid light vertebral stripe outlined in black, and a distinctly banded tail. A more unicolor, obscurely striped lizard is often called *Gekko vittatus bivittatus* (e.g., Boulenger, 1885), but Mertens (1926) pointed out that both morphs occurred at several places in the New Guinea region, and he referred to *bivittatus* as a "Mutation" rather than a recognizable taxon.

Probably because it is obscurely striped, the Palau *Gekko* has occasionally been referred to *G. vittatus bivittatus* (Boulenger, 1885; Dryden and Taylor, 1969). However, there are significant meristic and molecular (C. Austin; H. Ota; R. Fisher, personal communication) differences between the unstriped *Gekko* from Palau and those from the New Guinea region.

Although common in Palau, *Gekko* sp. is secretive and easily overlooked. It does inhabit houses, even in Koror town itself, but it usually haunts the darkest areas, rather than foraging around lights as many

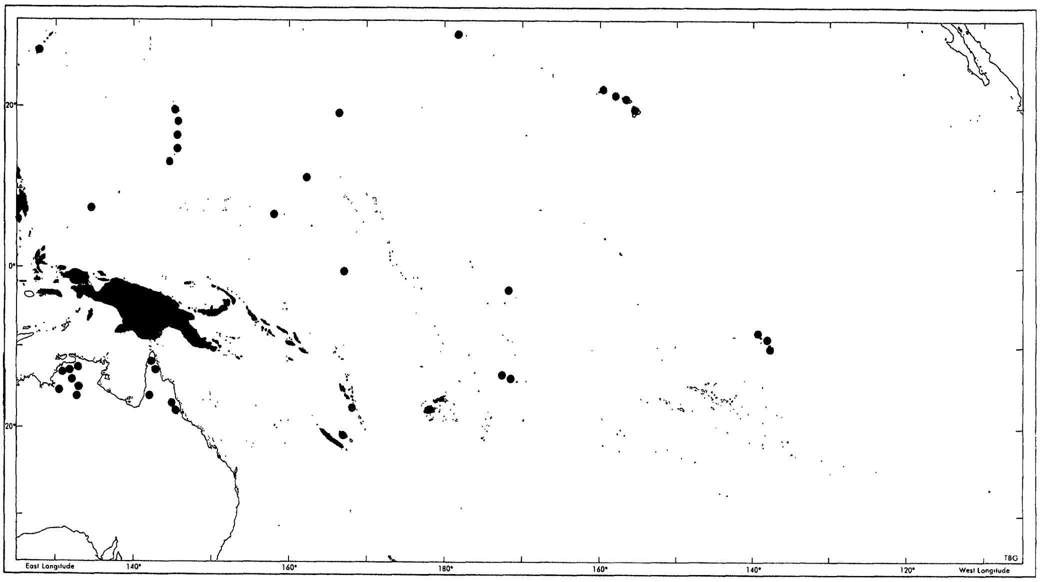

FIG. 7.—The distribution of *Hemidactylus frenatus* in Oceania (after Bauer, 1994).

of the smaller species of gekkonids do. More commonly it occurs on tree trunks and leaves, with little preference other than vegetation that provides crevices for diurnal retreats. Palms, *Pandanus*, banyans, and banana (wild or cultivated) are favored. Adults are found after dark on leaves, fronds, trunks or branches, apparently awaiting insect or vertebrate prey. Eggs are adherent, laid in crevices, and the clutch size is two. Palm, *Pandanus*, or banana axils are common deposition sites but cracks in masonry and other man-made sites are also used. Incubation time is about 90 days and hatchlings are as obscurely striped as adults.

We suspect that *Gekko* sp. is a major nocturnal predator in Palau, feeding on arthropod prey and small vertebrates. Their jaws are quite powerful, capable of inflicting a painful bite on human fingers often accompanied by a twisting motion that causes bloody lacerations. Subduing even sizable vertebrate prey would be well within their abilities. Captive individuals are highly territorial and aggressive; males will brutalize non-reproductive females and cannibalize juveniles. Fruit is also readily eaten in captivity. These behavioral characteristics are strikingly different from our experience with Papuan *G. vittatus*, which frequently are found in communal groups in the field and live well together in captivity.

Distribution.—ENDEMIC. Babeldaob, Bablomekang, Beliliou, Kmekumer Islands (island 46), Malakal, Ngeaur, Ngercheu, Ngerduais, Ngerechur, Ngerekebesang, Ngerukeuid Islands (island 24), Oreor, Ulebsechel, Ulong.

Hemidactylus frenatus Dumeril and Bibron, 1836

This widespread Southeast Asian weed species, a quintessential "house lizard" (sensu Mertens 1928), is apparently a recent introduction to Palau (Fig. 7). None of the earlier collections included this highly visible human commensal, and the earliest record is a single specimen (CAS-SU 23728) collected near the Conservation/Entomology Lab on Koror by Fehlmann in July 1955. Dryden and Taylor (1969) next reported it from Ngeaur.

When introduced into established communities of other gekkonids (native or introduced) *H. frenatus* is often successful in displacing other species from disturbed (lighted) habitats (Case et al., 1994; McCoid, 1996; Petren et al., 1993; Petren

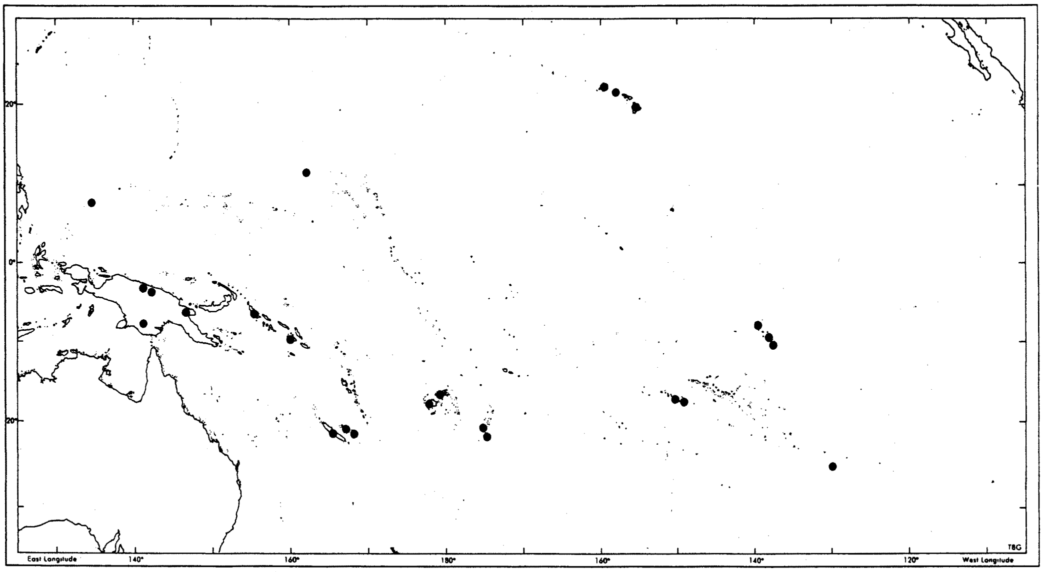

FIG. 8.—The distribution of *Hemiphyllodactylus typus* in Oceania. (Also occurs in the Mascarenes, throughout southeast Asia including India, Indonesia, and Philippines; after Bauer, 1994.)

and Case, 1996). In Palau *H. frenatus* has not completely displaced *Lepidodactylus* and *Gehyra* from buildings. On the National Museum building in Koror, *Gehyra mutilata* and two species of *Lepidodactylus* were collected in the mid-1990's, although *H. frenatus* was by far the most common lizard. Perhaps even more instructive is the situation in Ulimang Village, Ngaraard State, in a section of northern Babeldaob that is not yet connected by road to the southern causeway-connected islands. During the time of our field work, *Hemidactylus frenatus* was almost completely confined to the Evangelical Church, where it was slightly more common than *Gehyra mutilata* around the light at night. Despite our extensive field work in and around this community, we found only one other individual of *H. frenatus,* a single male that vocalized frequently in the rafters of a recently constructed house about one km south of the village. Although we often heard this individual over a span of several years, we never saw it in the characteristic *frenatus* foraging area around the lights of the house, which were occupied exclusively by *Lepidodactylus moestus* and occasionally *Gehyra brevipalmata.* We finally caught several fleeting glimpses of him in shadowy parts of the house. Although the house was largely constructed from local material, some lumber was brought in from Koror and we suspect this one male came with it. The other population around the church has not dispersed far enough to provide him a mate.

Distribution.—Babeldaob, Beliliou, Malakal, Ngeaur, Ngercheu, Ngerekebesang, Ngermalk, Oreor, Uchulangas.

Hemiphyllodactylus cf. *H. typus* Bleeker, 1860

This cryptic, easily-overlooked small species was previously unreported from Palau other than Bauer's (1994:131, map 29) inclusion of Palau in the distribution of *H. typus* (Fig. 8). The only other Micronesian record (Lamberson, 1987 from Enewetak, Marshall Islands; also mapped in Bauer, 1994) is based on a misidentification (USNM 205534–35 = *Lepidodactylus* sp.). Although all other Oceanic populations are all-female, males are present in Palau. This complex of species is under study by G. R. Zug and we defer any taxonomic conclusions pending completion of his analysis.

Hemiphyllodactylus is not a "house lizard" (sensu Mertens, 1928), but it has been found *near* houses in more sparsely populated areas. When active after dark, the species has been collected on attenuate leaves of shrubs (including palm fronds), on small and large trees, and on debris around houses. We also collected it in primary forest (Ngeruktabel).

Distribution.—Babeldaob, Ngeanges, Ngeaur, Ngerekebesang, Ngeruktabel, Oreor, Ulebsechel.

Lepidodactylus sp.

Bisexual, possibly parental species of the widespread parthenospecies *Lepidodactylus lugubris* are known from Micronesia. One distinctively patterned bisexual species (Radtkey et al., 1995: plate 1) is known from Takapoto in the Tuamotus and Arno Atoll in the Marshalls, but it has never been reported from Palau. We collected one male (USNM 531970, preserved with everted hemipenes) low on a palm trunk at the high tide line on Ulong that is similar to the illustration in Radtkey et al. (1995). However, two other specimens (USNM 531971–72) collected subsequently demonstrate to us that it is not conspecific with the Takapoto/Arno populations.

Distribution.—Iilblau (Ngemlis Islands), Ngeruktabel, Ulong.

Lepidodactylus lugubris (Dumeril and Bibron, 1836)

This widespread, all-female, parthenogenetic species has been intensively studied (Bolger and Case, 1994; Ineich, 1988; Ineich and Ota, 1992; Radkey et al., 1995, 1996) and several distinct species are certainly included under this name. The species seems to be a relatively recent arrival in Palau, regardless of the name applied to it. It occupies the most disturbed areas, often syntopic with *L. moestus*, with which it may hybridize, producing puzzlingly intermediate specimens (Ota et al., 1995).

As noted in the account of *Hemidactylus frenatus*, this species continues to share the building habitat with *frenatus* in many areas of Palau.

Distribution.—Babeldaob, Beliliou, Ioulomekang, Kmekumer Islands, Malakal, Ngeanges, Ngeaur, Ngercheu, Ngerdis, Ngerekebesang, Ngermalk, Ngerur, Ngesbokel, Ngetmeduch, Oreor, Pulo Anna, Uchulangas.

Lepidodactylus moestus (Peters, 1867:13)

Long mired in the synonymy of the catch-all *Lepidodactylus lugubris*, this species (*Gecko moestus* Peters, 1867; ZMB5610) was recently resurrected by Ota et al. (1995). It is undoubtedly a native species in Palau, but it also occurs in Micronesia as far east as Arno Atoll in the Marshalls (Fig. 9). *Lepidodactylus moestus* is very widely distributed in Palau including both disturbed and natural areas. It does quite well even in downtown Koror, surviving on buildings despite the abundance of *Hemidactylus frenatus.* It also coexists with *L. lugubris* and the two species are almost equally common on the picnic pavillion on the Museum grounds. In severely disturbed areas (e.g., Klouklubed village on Beliliou), *lugubris* may be more abundant but we have found only a few instances where this is so. Accumulating evidence (e.g., Radtkey et al., 1995, 1996) strongly suggests that *moestus* is one of the sexual species that gave rise to the parthenogenetic *lugubris. Lepidodactylus moestus* is an adaptable, aggressive, and vocal species that can survive in some surprisingly harsh environments. We have collected the species on the smallest (unnamed) island at the mouth of Ngeremeduu Bay (Ngatpang State, western Babeldaob), a pinnacle barely 4 m^2 that supported one *Pandanus* tree. One adult *moestus* (USNM531969) and a clutch of viable eggs were found in the *Pandanus* axil.

Radtkey et al. (1995) illustrated the two distinct morphs of *moestus:* plain and striped. Robert Fisher (personal communication) insists that these morphs are genetically identical.

Distribution.—Babeldaob, Kmekumer Islands (island 46), Malakal, Ngcheangel Atoll (all islands), Neanges, Ngeaur, Ngercheu, Ngerduais, Ngerechur, Ngerekebesang, Ngermalk, Ngerukeuid Islands (island 4), Ngeruktabel, Ngerur, Ngesbokel, Nget-

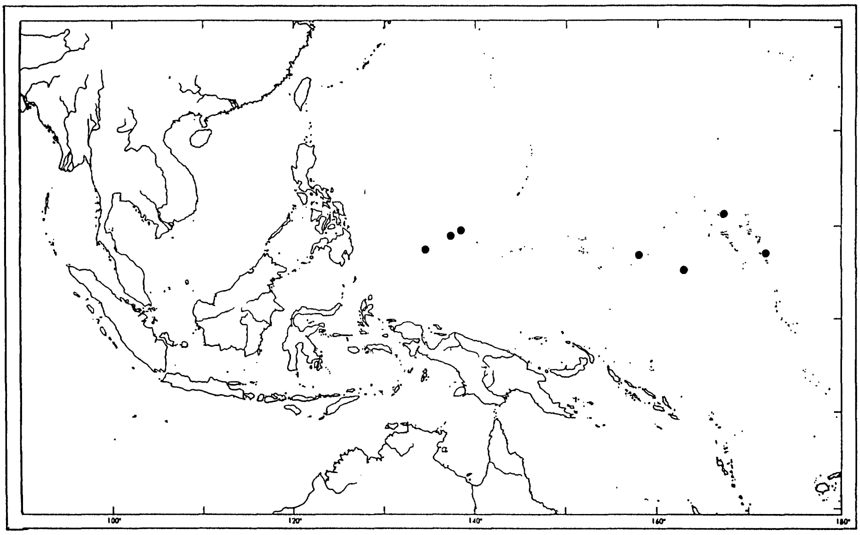

FIG. 9.—The distribution of *Lepidodactyus moestus.*

meduch, Oreor, Pulo Anna, Uchulameradel, Uchulangas.

Lepidodactylus paurolepis Ota et al., 1995

This recently described species remains known only from the small type series collected in the Ngerukeuid Islands. Although it is a very distinctive gecko, it would be most surprising if it was indeed restricted to this isolated cluster of small islands. We suspect it will be found on other islands in the Palau lagoon.

Distribution.—ENDEMIC. Ngerukeuid Islands (islands 16, 34)

Nactus sp.

Prior to our field work the apparent absence of *Nactus* from Palau was enigmatic because the genus is widespread in the Papuan region and southwest Oceania (see map 40 in Bauer 1994:169). This absence was simply an artifact of inadequate collecting. Two species are present in the archipelago (see also *Nactus* cf. *N. pelagicus*).

Nactus sp. is a bisexual gecko that we found only on Ulong (one adult male) and Ulebsechel (two hatchlings), but we suspect that its distribution is more extensive. Unlike members of the *Nactus pelagicus* complex, which are often abundant in beach habitats, this species is very cryptic and secretive. The adult male was found on a tree in scrubby forest just behind the beach, and adjacent to a limestone cliff. No other individuals were seen in 4 hours of collecting that evening, and ca. 30 hours (day and night) subsequently. The two hatchlings from Ulebsechel were found beneath ground litter, one near the beach and the other at the base of a limestone ridge inland.

Resolution of the systematics of the *Nactus pelagicus* complex is still in the preliminary stages (see summary in Bauer, 1994:168; Zug, 1998; Zug and Moon, 1995), and this species appears to be undescribed (G. R. Zug, personal communication). More specimens and data are needed to confirm the status and distribution of the species in Palau.

Distribution.—Ulebsechel, Ulong.

Nactus cf. *N. pelagicus* (Girard, 1858)

A single specimen (USNM 348780) from Merir in the Southwest Island Group was referred to *N.* cf. *pelagicus* by G. R. Zug (personal communication). The *pelagicus* group (Fig. 10) is a complex of bisexual and unisexual, parthenogenetic species (see summary in Bauer, 1994:169) but the alpha taxonomy is not yet stabilized. Zug and Moon (1995) recently resurrected *N.*

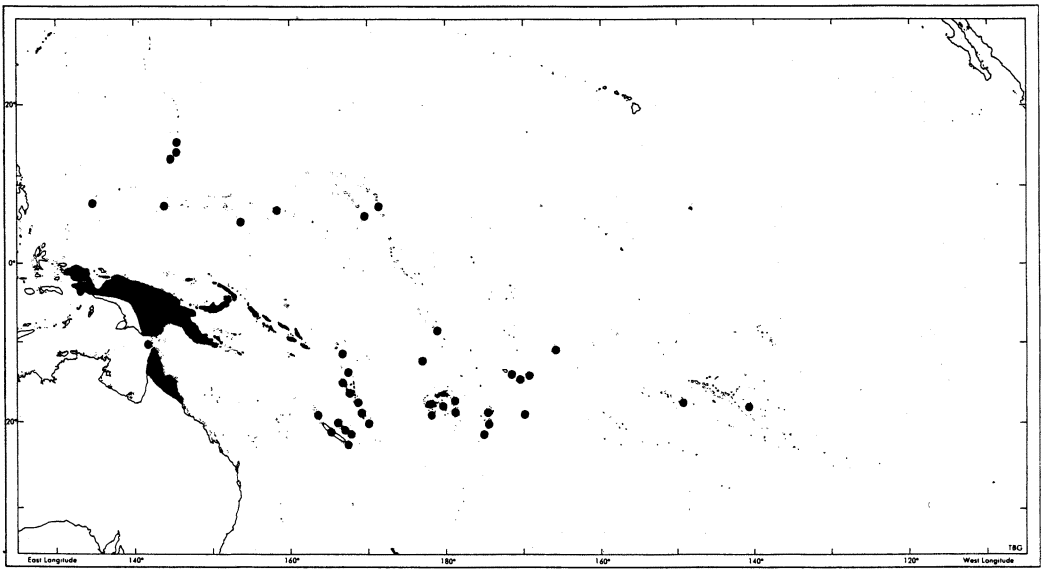

FIG. 10.—The distribution of the *Nactus pelagicus* species group (after Bauer, 1994).

multicarinatus for the bisexual species of Vanuatu and the southern Solomons, but the situation on New Guinea itself is much more complex. Larger sample sizes from the Southwest Islands are needed to determine if they are indeed conspecific with the unisexual *pelagicus*. The Merir specimen is a female.

Distribution.—Merir.

Perochirus sp.

The genus *Perochirus* is a Pacific insular endemic, consisting of three species from scattered island groups in Micronesia and Vanuatu (Brown, 1976), and an extinct form from 'Eua, Tonga (Pregill, 1993). The most widespread species, *Perochirus ateles*, occurs close to Palau in the Carolines, Marianas, and Marshalls (Bauer, 1994: 208, map 49). Although Bauer (1994:283) recorded *Perochirus ateles* from Palau with a question mark, there are no documented records of this species from Palau.

A recent collection from the Southwest Islands contains two specimens (USNM 348771–72) of a large *Perochirus* from Fana. Their proportions and scalation invite comparison with *Perochirus scutellatus*. Until recently, *Perochirus scutellatus* was a very poorly known species represented by only a few older specimens from Kapingamarangi Atoll, located more than 2000 km SSE of Palau. In the summer of 1996, Donald W. Buden collected a large series of *scutellatus* from Kapingamarangi (Buden, 1998*a,b*). We have not yet had the opportunity to examine these specimens in detail, and the limited material from Palau may be inadequate to demonstrate conspecificity in any case. If the Palau specimens are *scutellatus* the enormous distributional hiatus could be explained as the relictual distribution of an old radiation created by local extinctions on the intervening islands.

Both specimens of *Perochirus* from Fana were collected on trees. Interestingly, no *Gekko* were collected from any of the Southwest Islands. *Gekko* is normally a conspicuous species where it occurs, and *Perochirus* may replace it ecologically in the Southwest Islands.

Distribution.—Fana.

Polychrotidae

Anolis carolinensis Voigt, 1832

This species has been introduced in several areas of the Pacific, but historical information on the introductions is lacking. Some authors have suggested that the

Oceanic *Anolis* are Cuban in origin (*Anolis porcatus* or *Anolis carolinensis porcatus*; Oliver and Shaw, 1953; Vance, 1987) but we agree with McKeown (1996) that Pacific populations (including Palau) are typical of *A. carolinensis* of the southeastern United States.

Although *Anolis carolinensis* has been in Palau for at least 30 years (Owen, 1977), it has not dispersed far from the presumed place of entry, the Port of Palau on Malakal. Robert Owen (personal communication to RIC in 1980) said that the lizards were restricted to the immediate vicinity of the Port and adjacent docks at that time, and their distribution has changed little since then. Our field work 15 years later indicates that the species is now found 50–100 meters east and west of the Port along the road, but it is not abundant. No obvious dispersal barriers confront this species on Malakal, and there is abundant disturbed habitat all over Malakal and adjacent Oreor. Our herpetological surveys and transects have covered Malakal from the top of the hill to sea level in several places from 1993–1997, but yielded no specimens or even sight records of *Anolis* from anywhere other than the narrow coastal area on the west side of the island. Then in July 1996, Chris Austin and RIC collected an adult male in thick, scrubby vegetation in the agricultural area on "Radio Tower Hill", just below the band of forest around the peak, a site we had sampled frequently before. The species was also abundant around the newly constructed Coral Reef Research Foundation building at the Malakal end of the causeway across to Koror, and in August 1998 RIC found the anole on the edge of Koror town itself. After a long sedentary period, *Anolis* may finally be dispersing in Palau; it will be interesting to watch its progress.

We suspect that *Lamprolepis smaragdina* may be somewhat of a controlling agent in the spread of *Anolis carolinensis*. The two species often occupy the same habitat, and Palauan *A. carolinensis* is uncharacteristically secretive compared to other natural and introduced anole populations we have seen. We have only one direct observation of interactions between *Lamprolepis* and *Anolis,* which involved a subadult *Anolis* we were pursuing in a viney tangle near the Port. The anole attempted to escape by leaping to the ground but had barely taken a few steps before an adult male *Lamprolepis* dashed down the trunk of a nearby sapling and seized it.

Distribution.—Malakal, Oreor.

Scincidae

Carlia cf. *C. fusca* (Gray, 1845)

Despite its abundance in most disturbed areas in Palau, *Carlia* seems to be a very recent introduction to the islands. The origin and taxonomic status of the propagule remains unclear. *Carlia* has never been recorded in the literature from Palau and the earliest known specimens were collected by Tom Fritts in 1988, but we are confident that the species was introduced before then.

Both the Marianas and Palauan populations of *Carlia* are clearly members of the widespread and taxonomically unresolved *fusca* group, and the logical assumption would be that the two areas were synchronously colonized from the same source. However, females and juveniles in Palau often have strong dorsolateral striping, which is rare or nonexistent in the Marianas population. Our impression is that Palau and Marianas *Carlia* had different origins and may be different species, neither of which is true "*fusca*".

Carlia is the dominant terrestrial skink on the causeway-connected islands of Palau, occurring in very high densities in all the disturbed areas of southern Babeldaob, Oreor, and the associated smaller islands, but they are not (yet) on any of the adjacent Rock Islands. The more distant islands of Ngeaur and Beliliou have healthy populations of *Carlia,* but here also the lizards do not penetrate forested areas and are restricted to open grassland or the vicinity of human habitation. The parts of northern Babeldaob not connected by road to the south may be *Carlia*-free (at least at the moment). Our extensive experience in the Ulimang-Ngesang area yielded a few "possible" *Carlia* sightings in 1994 and again in 1997, but no vouchers.

Juvenile *Mabuya* are superficially similar to striped female and juvenile *Carlia* and difficult to distinguish when they are on the move. Extensive sticky-trapping (40+ trap-hours) in and around Ulimang village in August 1998 yielded many *Mabuya* but no *Carlia*.

Distribution.—Babeldaob, Beliliou, Malakal, Ngeaur, Ngerekebesang, Ngermalk, Ngetmeduch, Oreor, Uchulangas.

Cryptoblepharus sp.

Mertens (1931, 1933, 1934b, 1964) regarded *Ablepharus* (= *Cryptoblepharus*) *boutonii* as a polytypic species with more than 40 subspecies ranging from the Indian Ocean coast of Africa to the eastern limits of the Pacific. Crombie and Steadman (1987) cited accumulating evidence that many of these "subspecies" are valid species, and they suggested that the name *Cryptoblepharus poecilopleurus* was applicable to most of the Oceanic populations. Fiji, Vanuatu, and New Caledonia all have distinct species of *Cryptoblepharus* (Sadlier, 1986; Zug, 1991 and personal communication) but the other Pacific Rim populations have not yet been studied in detail. Peters (1879:37) described the Palauan *Cryptoblepharus* as *Ablepharus rutilus* (holotype ZMB 7926) and we suspect that it may be a valid species. Both George Zug and Paul Horner are examining variation in *Cryptoblepharus* and we have made our material available to them to be analysed and compared with broader geographic samples.

In many parts of its range *Cryptoblepharus* is a beach species, occurring on rocks and wrack in the supratidal zone (e.g., McCoid et al., 1995). Palauan *Cryptoblepharus* are much more arboreal, often found well away from the beach on tree trunks, vines and lianas (e.g., USNM 531953–56 from central Oreor). The species does occur as well in beach situations, frequently on large trees hiding behind exfoliating bark. On northern Babeldaob more strongly striped (*poecilopleurus*-like) *Cryptoblepharus* were seen, but not collected, on aerial roots of mangroves. This particular locality has since been destroyed by dredging. More than one species of *Cryptoblepharus* may be present in Palau but presently available material is inadequate for a determination.

Distribution.—Babeldaob, Beliliou, Iilblau (Ngemlis Islands), Kmekumer Islands (island 46), Ngeaur, Ngebad, Ngerekebesang, Ngetmeduch, Oreor.

Emoia atrocostata (Lesson, 1826)

This variable "superspecies" (sensu Brown, 1991) occurs from Taiwan and the Ryukyus to New Guinea, the Moluccas, and the southern Malay Peninsula including Christmas Island in the Indian Ocean, and western Micronesia (Fig. 11). Brown (1991) recognized subspecies from Cape York, Australia (*australis*) and the Solomons/Vanuatu area (*freycineti*). We agree with Brown that several taxa are probably included in his nominate *atrocostata,* and that the Micronesian populations are reasonably distinctive.

Throughout its broad distribution, *Emoia atrocostata* invariably inhabits rocky beaches and mangrove swamps as reported by Alcala and Brown (1967) in the Philippines. Some populations are associated with one habitat over the other, but it is currently unclear if this is merely sampling bias or an ecological preference with systematic implications.

In Palau, *Emoia atrocostata* seems to have a spotty distribution but we are confident that this reflects the difficulty of collecting individuals amid the multitude of refuges on rocky beaches and in mangrove swamps, rather than actual rarity or a restricted distribution. For example, we have seen *atrocostata* commonly on beach boulders near the KB Bridge on Oreor but we have not yet been successful in collecting them there. In other cases something more complex is involved. Near the northern tip of Babeldaob in Ngaraard State, the species is abundant and easily observed in mangrove swamp near the dock west of Ngebuked on the west side of the peninsula. However, in similar swamps south of Ulimang on the east side (less than 3 km airline) not a single *atrocostata* has been seen in more than 40 person/hours of searching. The species does occur on the east side of Babeldaob. A single

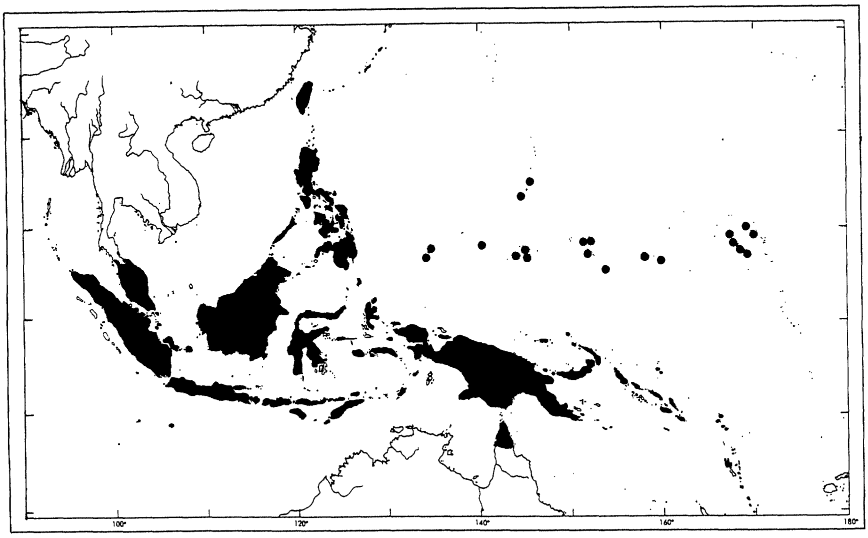

FIG. 11.—The distribution of *Emoia atrocostata.*

subadult (USNM 531952) was collected under beach wrack at the high tide line directly in front of our base of operations at Ulimang in February 1996. Six other individuals (USNM 495091–95) also were obtained at Melekeok by Gordon Rodda and Tom Fritts. Although usually characterized as a coastal species, *Emoia atrocostata* can extend well inland along riverine mangroves, as documented by USNM 495090 from the Tabecheding River at Nekkeng, Aimeliik State, Babeldaob.

Distribution.—Babeldaob, Beliliou, Malakal, Ngeaur, Ngebad, Ngerdis, Ngerekebesang, Ngetmeduch, Oreor, Uchulangas, Ulebsechel.

Emoia caeruleocauda (De Vis, 1892)

Brown (1991) did not fully analyze variation in the "superspecies" *Emoia caeruleocauda.* However, many Palau specimens in museum collections are identified as *Emoia* "pelewensis", apparently an early Brown manuscript name that was never published. Given the broad distribution (Fig. 12) and extensive variation of *caeruleocauda,* it is not surprising that Brown (1991) deferred in trying to resolve all the taxonomic problems of this taxon.

Palauan *caeruleocauda* are distinctive in a number of ways. The unicolor ("bronze" morph of Crombie and Steadman, 1987) males in Palau have a profusion of turquoise or yellow lateral flecks that are lacking in other populations of *caeruleocauda* that we are familiar with. We feel that Brown's earlier impression was correct, and that additional analysis will demonstrate that Palauan *E. caeruleocauda* are indeed specifically distinct.

Although this species is easily displaced by *Carlia* in disturbed habitats, it persists in backyard garden plots and other shaded, moist areas even in Koror town itself. The lizard is primarily terrestrial, but juveniles and subadults in particular frequently ascend low vegetation.

Distribution.—Babeldaob, Beliliou, Euidelchol, Iilblau (Ngemlis Islands) Ioulomekang, Malakal, Mecherchar, Ngcheangel Atoll (Ngcheangel, Ngerebelas, Orak), Ngeanges, Ngeaur, Ngebad, Ngebedangel, Ngercheu, Ngerechur, Ngerekebesang, Ngeruchubtang, Ngeruktabel, Ngerur, Ngetmeduch, Oreor, Pkulaklim, Ulebsechel, Ulong.

Emoia impar (Werner, 1898)

Originally described from 12 specimens collected on Ralum and Mioko Islands in the Bismarck Archipelago, this species was long considered a synonym of *Emoia cyanura* (e.g., Brown, 1991). It is now clear that *impar* is a distinct species (Ineich and

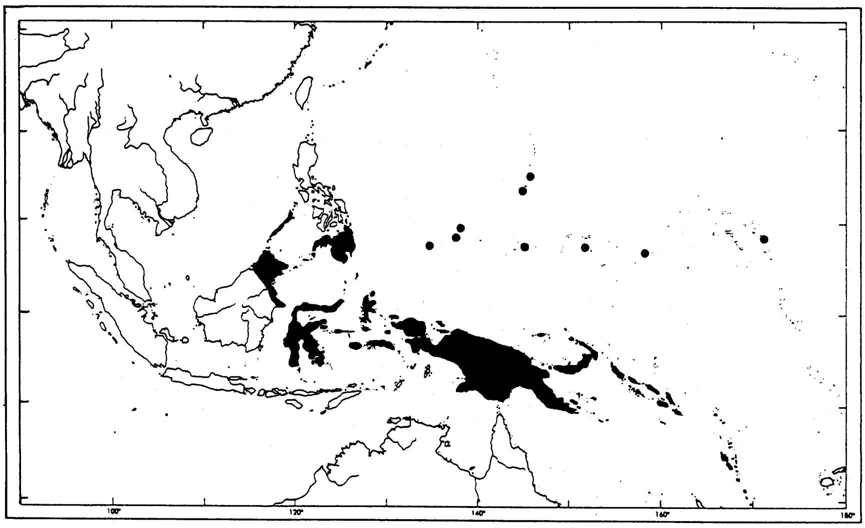

FIG. 12.—The distribution of *Emoia caeruleocauda* "superspecies".

Zug, 1991; Guillaume et al., 1994) and some data indicate that even more cryptic sibling species may be recognizable within the broad Pacific distributions of both *cyanura* and *impar* (Bruna et al., 1996).

The apparent absence of the ubiquitous *cyanura* superspecies (sensu Brown, 1991) from the Palau Group was puzzling. However, at least *E. impar* is present in Palau, albeit with a strange distribution, paralleling in some ways that of *E. jakati.* Why this odd, disjunct distribution appears in two distinct lineages of *Emoia* is perplexing, but we suspect that both *impar* and *jakati* are relatively recent adventives to Palau, probably via natural dispersal or accidental transport by Micronesians rather than as post-European introductions.

The Palau populations of *Emoia impar* were apparently restricted to small and peripheral islands at the northern (Ngcheangel Atoll) and southern (Southwest Islands) extremes of the Republic. The species had never been found between those two points (a distance of more than 400 km) until 1996, when Chris Austin and RIC collected a small series on Ngesbokel, the largest of 4–5 tiny islets at the mouth of Ngeremeduu Bay, Ngatpang State, western Babeldaob. Some of these islands were barely emergent at high tide but connected by broad tidal flats at low tide. Ngesbokel has a few hectares of flat plateau 2–3 m above the high tide line. The vegetation is a mixture of thick grasses, stunted shrubs and scattered *Pandanus.* Although we saw a few striped skinks on the plateau, we were unable to verify their identity in the thick vegetation. However, in the wrack above the high tide line in a shaded cove that provides the only access to the plateau, we found *Emoia impar* to be abundant at low tide, veritably swarming over driftwood and escaping into the low vegetation on the slope leading up to the plateau. We estimated there were at least a dozen individuals in the small area. On some of the Rock Islands we have found *Emoia caeruleocauda* in very similar situations.

Emoia impar is peripheral on Ngcheangel Atoll as well, occurring only on the two smallest islands, sympatric with *E. caeruleocauda* on Ngerebelas and Orak. The Southwest Islands have been only incidentally collected so nothing can be said other than to note that the species occurs on three of the islands.

Distribution.—Ngcheangel Atoll (Ngerebelas, Orak), Ngesbokel, Merir, Pulo Anna, Sonsorol.

Emoia jakati (Kopstein, 1926)

Although this species is widespread in the Carolines (Fig. 13), often occurring

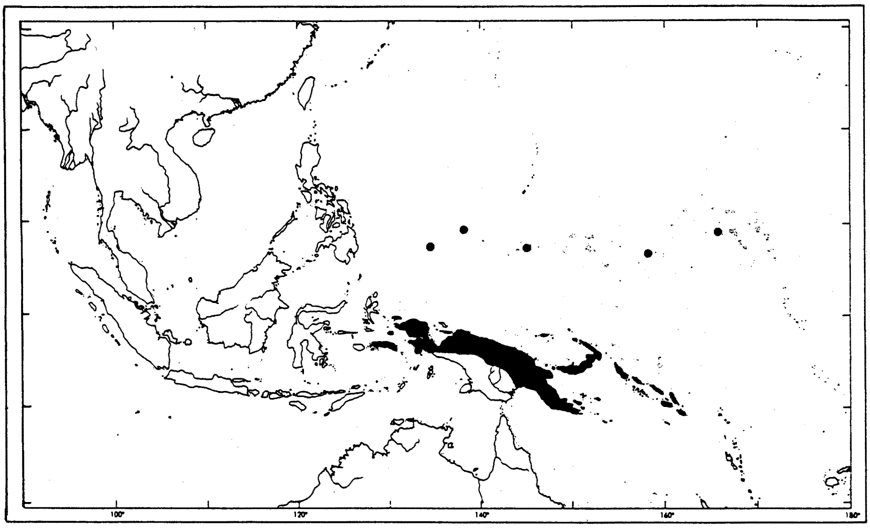

FIG. 13.—The distribution of *Emoia jakati.*

sympatrically with members of the *Emoia caeruleocauda* and *cyanura* "superspecies" (sensu Brown, 1991), its distribution in Palau is decidedly strange. Brown's (1991) treatment of *jakati* does not lend confidence that all populations he referred to that taxon are indeed conspecific. In fact, when Loveridge (1945) examined museum collections for his "Reptiles of the Pacific World" he left many specimens identified with the (still unpublished) manuscript name *Emoia mivarti "fuscolineata,"* indicating that he regarded the Oceanic populations as distinct from New Guinea *"mivarti,"* a name misapplied to *jakati* until Brown's revision.

Like *Emoia impar, E. jakati* was previously known only from Ngcheangel Atoll and the Southwest Islands, but nowhere in between. However, in 1996 Chris Austin and RIC found the species abundant on Ngerechur, the northernmost of two small islands off the northern tip of Babeldaob. At low tide the channel between Ngerechur and Ngerkeklau is wadable and that between Ngerkeklau and the Babeldaob coast (about 0.5 km) is even shallower. The coastal areas of extreme northern Babeldaob have never been collected herpetologically, nor has Ngerkeklau, and *E. jakati* may indeed occur at either or both, but currently the only record for the species within the fringing reef of Palau is Ngerechur.

Based on our experience elsewhere in Micronesia (Pohnpei and surrounding islands), *Emoia jakati* is an inhabitant of the most disturbed and marginal habitats, including around human habitation. The Ngerechur population confirms this impression since the species is extremely abundant around an abandoned house at the south end of the island, an area of mixed strand vegetation and tall *Cocos.* The northern end of the island is higher, boulder-strewn and well forested, with much evidence of substantial Japanese occupation during WWII. We did not see *E. jakati* anywhere in the forest. Picknickers and overnight visitors often use the house on the southern end, but there are no permanent residents at this time.

Distribution.—Ncheangel Atoll (Ngcheangel), Helen, Ngerechur, Tobi.

Eugongylus sp.

Dryden and Taylor (1969) first recorded this large scincid from Palau based on a single specimen from Ngeaur. They referred it to *Eugongylus mentovarius,* a poorly known species previously reported only from the Moluccas. Based on our preliminary comparisons of Palauan *Eugongylus* with one Moluccan *E. mentovarius*

(USNM 237428), we do not consider them conspecific. However, the systematic relationships and content of the genus *Eugongylus* are so chaotic that we defer a decision at this time, but offer the following taxonomic summary of the genus as it currently exists.

Despite the contributions of Böhme (1976) and Greer (1974), species limits, relationships, and even the number of species in *Eugongylus* (including the "genera" *Phoboscincus* and *Tachygyia*) remain largely unresolved. For example, Böhme (1976) did not even mention *mentovarius* in his list of the recognized species in the genus. He did, however, include *sulaensis* (Kopstein, 1927) which was distinguished from *mentovarius* only in lacking the characteristic throat markings and in having a shorter tail. Most recently, Sadlier (1986) tacitly redefined *Eugongylus* by describing a new genus for *haraldmeieri* (*Geoscincus*) and recognizing two species of *Phoboscincus*. In so doing, he inferred that *Tachygyia* is also a valid taxon.

Eugongylus has been infrequently collected in Palau but it seems to be a common, if cryptic, terrestrial skink in a wide variety of habitats. Specimens have been taken in primary forest and mature second growth on rock islands (Wiles and Conry, 1990; our surveys), in backyard gardens in Koror town, and in scrubby forest adjacent to mangrove swamps (our surveys). We found three individuals actively foraging and most of the sticky-trapped individuals (see below) were obviously also active. One specimen (USNM531958) was moving swiftly and silently with an almost serpentine motion through thick ground cover on the Museum grounds (Koror town) at 0915 h. Two others (USNM 531961–62) from Ulong were collected in the leaf litter in forest on the first terrace at 1415 h, and near the buttress of a large tree near the beach at 0710 h during torrential rain. Inactive individuals were found from 1430–1510 h under logs and in moist piles of coconut husks in beach forest on Babeldaob (Ngesang and Ulimang, Ngaraard State).

The secretive habits of *Eugongylus* give the impression of rarity, but sticky traps are an effective collecting technique that yields specimens even in areas where the species has not been recorded in visual surveys. Wiles and Conry (1990) first noted this and our collections amply confirm their observations. *Eugongylus* are so effective at avoiding detection that most Palauans are incredulous that such a sizable, unfamiliar lizard was collected in their backyard. Sticky traps also yield some interesting natural history information on *Eugongylus*. On at least three occasions we have trapped *Eugongylus* that clearly had been attracted to smaller skinks (*Carlia* and *Emoia caeruleocauda*) stuck in the trap. Two *Emoia* and one *Carlia* stuck near the edge of the trap were neatly sawed off just above the adherent part of their bodies, and in another instance a *Eugongylus* that became stuck trying to reach a *Carlia* in the center of the trap regurgitated the missing pieces of smaller skinks when he was being removed from the trap. Another *Eugongylus* was completely stuck along the long axis of the trap with an *Emoia* at the far end still in his jaws, thoroughly masticated at midbody. When *Eugongylus* are partially stuck they tend to spin, crocodile-like, causing the entire trap to wrap around them burrito-fashion.

On at least three other occasions we observed *Eugongylus* that did not get stuck trying to pull adherent *Emoia* or *Carlia* off the trap, often escaping with a tail or piece of body. We think these data clearly point to *Eugongylus* being an active, primary predator in the leaf litter community, probably feeding on a wide variety of invertebrates and smaller vertebrates. We would not be surprised if *Platymantis, Sphenomorphus,* typhlopid snakes, and even juvenile *Candoia* and *Dendrelaphis* are included in the diet.

Distribution.—Babeldaob, Beliliou, Kmekumer Islands (island 46), Ngcheangel Atoll (Ngcheangel), Ngeaur, Ngercheu, Ngerukeuid Islands (islands 16, 24), Ngeruktabel, Oreor, Ulebsechel, Ulong.

Lamprolepis smaragdina (Lesson, 1826)

This widespread western Pacific species was divided into 8 subspecies by Mertens (1929), reflecting the extensive variation

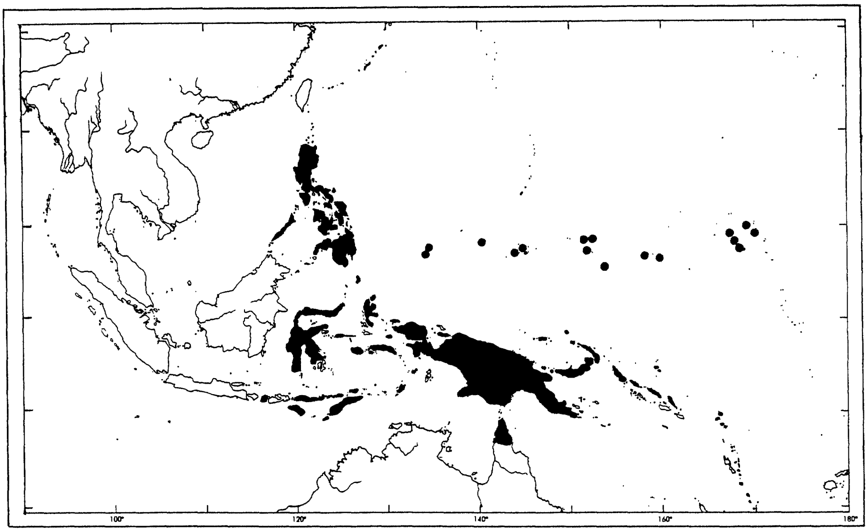

FIG. 14.—The distribution of *Lamprolepis smaragdina.*

throughout its range (Fig. 14). Dryden and Taylor (1969) referred Palauan specimens to the subspecies *viridipunctum,* but we prefer to retain the binomial pending a more rigorous analysis of variation in the species. Mertens' subspecific arrangement does not accurately reflect the inter- and intra-island variation in Oceania and we suspect that several recognizable species may be subsumed in Mertens' concept of "*smaragdina*".

The large, green tree skink may be the most familiar reptile in Palau, as it often perches conspicuously during the day on large backyard trees, even in Koror town. It is a remarkably adaptable species that also occurs in forest, but we have only a few records from true forest habitat. Perhaps the species is simply more difficult to observe in forest, or it may truly be less abundant there. Our impression is that *Lamprolepis* is an "edge" species, most suited to the tangle of vegetation at the forest margin. There is considerable variation in habitat preference within the "species", however. Some populations or subspecies (e.g., the Philippine *philippinica*) are more forest-adapted and cryptically colored (brown body and dull green head) versus small island Oceanic *smaragdina,* which are unmarked, almost electric green, and highly prominent on exposed *Cocos* trunks.

Palauan *Lamprolepis* are usually bright green with varying amounts of enamel black on the dorsal scale edges. Additionally, there is what we have called the "mustard morph" which is most abundant in (or possibly restricted to) northern Babeldaob. As the name suggests, "mustard morph" individuals are dull yellow-brown above and lemon yellow below, without a hint of the usual greens. Normal green specimens have been found on trees adjacent to "mustard" perch sites and the morph is not sexually correlated (males, females, and juveniles with this coloration have been collected).

We suspect that *Lamprolepis* is a major predator on small organisms in Palau. It has a broad activity period, forages from the ground to the canopy, and occurs in every habitat that supports trees, even low, scrubby *Pandanus* on tiny islets. It feeds on a wide variety of invertebrates and on any vertebrate it can subdue, including geckos and skinks (see also *Anolis* account). Fruit and other sweets are also consumed. We observed *Lamprolepis* on Ngeaur gorging on ripe papaya. In Ulimang, northern Babeldaob, which supports a particularly dense population, *Lamprolepis* regularly came onto the porch of our house to lick residual soft-drink from the lips of cans. Manthey (1985), working mostly with Philippine individuals in captivity, confirmed the species' fondness for sweets and he even reported egg-eating.

Reproduction also reflects the broad ecological tolerance of *Lamprolepis.* Although two elongate, leathery eggs are invariable (at least in Palau), we have found clutches under rocks, inside dead logs, and in the duff of palm axils 3–4 m above the ground.

Another aspect of *Lamprolepis* biology that has received very little attention are the sexually dimorphic heel scales, greatly enlarged in males and often more brightly colored than the plantar surface. Gandolfi (1907) first discussed this structure in *Lamprolepis* and provided illustrations of sections through the scale, but neither he nor anyone since has suggested a function for them. The field notes of William H. Stickel described MCZ 49312 from Toem, Irian Jaya, New Guinea as, "Heel scale orange, which is unusual." (Loveridge 1948: 340–341). Manthey (1985:8) provided a color photo of the plantar surfaces of a live male and female from the Philippines in which the enlarged scale in the male is only slightly more yellowish than the dead-white ventral color. By comparison the scale is usually highly contrasting in the greener populations, described in our notes as "lemon yellow", "yellow-orange" or even bright orange, against the usually yellow-green plantar color.

Distribution.—Babeldaob, Bablomekang, Beliliou, Fana, Kmekumer Islands, Malakal, Merir, Ngcheangel Atoll (all islands), Ngeaur, Ngebad, Ngebedangel, Ngercheu, Ngerdis, Ngerechur, Ngerekebesang, Ngermalk, Ngerukeuid Islands (islands 12, 16, 24), Ngeruktabel, Ngerur, Ngesbokel, Ngetmeduch, Oreor, Pkulaklim, Pulo Anna, Sonsorol, Tobi, Ulebsechel, Ulong.

Lipinia leptosoma (Brown and Fehlmann, 1958)

Originally described as an endemic genus (*Aulacoplax*) from Palau, *leptosoma* was referred to *Lipinia* by Greer (1974). Austin (1995, 1998) confirmed this generic allocation, but he found the relationships of *leptosoma* relative to several Papuan species equivocal.

Brown and Fehlmann (1958) claimed that this species was an obligate dweller in the leaf axils of a single species of *Pandanus,* and they reported specimens from Babeldaob, Oreor, and "Toiracholodochoel." The latter is supposedly "a small island at the north end of Malakal" (Brown and Fehlmann, 1958:5), but it does not exist on our maps. Gordon Rodda (personal communication) offered that according to Demei Otobed "Toiracholodochoel" is actually the name of a pass between the two islands, the smaller of which (Ngermalk?) is apparently the one to which Brown and Fehlmann (1958) referred. In any case, there is no longer any suitable *Pandanus* in this area. There are additional museum specimens (CM 29101–03) from Ngeaur collected as long ago as 1944, and we recently verified that the species does indeed occur there. Most of the recent Ngeaur specimens were collected from *Pandanus* near the south end of the island, but several individuals were seen and collected (e.g., USNM531945, SAM R4800) from palm axils near the northern tip of the island.

Distribution.—ENDEMIC. Babeldaob, Ngeaur, Oreor, "Toiracholodochoel".

Lipinia cf. *L. noctua* (Lesson, 1826)

Zweifel (1979:1) noted "the relative uniformity of color pattern and scutellation of *L. noctua* over the Pacific islands, in contrast to the diversity in the much smaller New Guinea region." He did not list the non-New Guinea material he examined but the AMNH collections have *noctua* from a broad area of Oceania. Our field experience with *noctua* in Oceania are at odds with Zweifel's suggestion. Although scutellation is indeed conservative, we have noted significant differences in coloration, body form, and ecology between Polynesian and Micronesian *noctua.* Polynesian *noctua* tend to be heavier-bodied, short-legged terrestrial or semi-arboreal skinks with a prominent, light occipital spot and a distinct broad vertebral stripe. By contrast, Micronesian *noctua* are more gracile, strongly arboreal skinks (possibly even obligate palm axil dwellers), often with a poorly developed occipital spot and vertebral stripe, but more distinct dorsolateral striping. This pattern is very similar to Palauan *Cryptoblepharus*.

In Palau, *Lipinia noctua* is found almost exclusively in or very near the axils of palms, and usually uncovered by peeling dead fronds and fabric from low trees. We have seen a few individuals apparently active (or at least visible) outside axils but they generally slip back into concealment as soon as they are detected. One exception was a near-neonate that was active on a large dead tree near the beach just south of Ngaramasch, western Ngeaur. The tree had abundant loose bark which provided refuge for numerous (10+) active *Cryptoblepharus*, and the *Lipinia* was mistaken for a juvenile of the former until we examined the specimen more closely when preserving it. Two other adults were collected from beneath casuarina bark on northern Ngeaur. We suspect Palauan *Lipinia* (and other Micronesian populations) may also occupy the axils of tall palms, similar to the Philippine *L. auriculata* group (Brown and Alcala, 1980; RIC, personal observation), but we have found no way to sample taller Palauan palms as yet.

The preference for palms departs from the preferred habitat of Polynesian *L. noctua*, which are frequently found under rocks and logs (McKeown, 1996; personal observation) or active on a variety of low vegetation, but rarely palms (Crombie and Steadman, 1987). From our limited data on pregnant females, Micronesian *noctua* usually produce a single offspring, as opposed to the usual litter of 2 (but with a range of 1–4) in Hawaii (McKeown, 1996). Data from the Cook Islands suggested litter sizes of 1 or 2 (Crombie and Steadman, 1987).

Christopher C. Austin is currently reviewing morphological and molecular variation in the genus *Lipinia* with significant samples from Oceania. His recent (Austin, 1999) mtDNA analysis of the widespread "*noctua*" suggests a monophyletic eastern and central Polynesian population of human-mediated origin. Micronesian "*noctua*" are genetically diverse and probably represent pre-human colonization of the islands. Although Lesson's type locality (Oualan, now Kosrae in the Carolines) would seem to restrict the name *noctua* (sensu stricto) to the Micronesian populations, the possible unreliability of the locality and the lack of a type specimen (Brygoo, 1986:75) further complicate nomenclatural resolution of the problem. However, because Lesson's text (1830) gives ecological information (on a building in a sugar cane field) for the type(s) of *noctua*, perhaps the locality is accurate for this species.

Distribution.—Babeldaob, Malakal, Ngeaur, Ngercheu, Ngerekebesang, Oreor, Pulo Anna, Ulong.

Mabuya sp.

Sternfeld (1920:395) first reported *Mabuia multicarinata* from Palau. He discussed in detail seven specimens from Feis (= Fais) and one from Mogomay, Ulit (= Ulithi) Atoll, in the western Carolines just north of Palau, and concluded by saying that the Senckenberg Museum also had two specimens from Palau, but no locality or other details were provided. The material from the Carolines included juveniles, indicating that the species was established and reproducing at that time.

Sternfeld (1920:395) summarized the distribution of *M. multicarinata* as Borneo and the Philippines. Brown and Alcala (1980) studied Philippine material of "*multicarinata*" and described two smaller species, *M. cumingi* and *indeprensa*, that had long been confused with it. They also found north-south variation in *multicarinata* itself, and named the northern Philippine populations *M. multicarinata borealis*. Ota (1991) extended the northern distributional limits of *M. m. borealis* to Lanyu Island, off the southeastern coast of Taiwan, noting that it was *not* found on the main island of Taiwan. However, neither the Bornean nor the Palau/Carolines populations have been studied in light of Brown and Alcala's (1980) revision of the group, primarily due to limited samples from these areas.

The Palau/Carolines *Mabuya* represent the eastern distributional limit of the *multicarinata* group and possibly the eastern limit of the Asian members of the genus. *Mabuya multifasciata* is found in the Moluccas and western New Guinea but its distribution in this area is poorly documented; Ingram (1987) concluded that *multifasciata* was restricted to the western (Irian Jaya) area of New Guinea and that the northern Australian record was based on erroneous locality data or an introduction. Some museum material from Palau and the Carolines has been misidentified as *multifasciata.*

Many of the disjunct populations of Philippine or Papuan vertebrate species in Oceania (e.g., *Varanus, Crocodylus, Suncus, Macaca*) are often attributed to introductions by the Japanese during their pre-World War II occupation of Micronesia and much of the rest of insular East Asia. *Mabuya,* however, clearly pre-dates the period of Japanese occupation, and the Oceanic populations may represent natural dispersal from the Philippines and/or Borneo. Preliminary data from our material support this proposal, since Palau/Carolines *Mabuya* have the large body size typical of *multicarinata* but scale counts intermediate between *multicarinata* and *indeprensa.* We suspect that these populations represent at least one undescribed species. The problem is currently being studied by Hidetoshi Ota and RIC.

Distribution.—Babeldaob, Beliliou, Ngcheangel Atoll (Ngcheangel), Ngercheu, Oreor, Pulo Anna, Sonsorol.

Sphenomorphus sp. nov.

This moderate-sized skink has only been found on Koror, Ngermalk, southern Babeldaob, and Ngeruktabel, usually in or near moist wooded areas. It is superficially similar to some members of the *Sphenomorphus variegatus* group, which includes more than 50 named species that do not fit conveniently into other groups. The Palauan species has several distinctive characters, including bifurcate hemipenes with long and attenuate terminal elements. We only tentatively refer it to *Sphenomorphus* pending further study.

Interestingly, Tiedemann and Haupl (1980:42) listed 5 "Syntypes" [NMW 14855 (2), and 16638 (3)] of *Lygosoma (Hinulia) jagorii* Peters from "Palaos", collected by Semper in 1874. Quite aside from the fact that these specimens were supposedly collected 10 years *after* Peters described the species (1864:54), Peters clearly stated that the types of *jagorii* were collected by Jagor at "Borongan, . . . Samar" and "Tacloban, . . . Leyte". Brown and Alcala (1980:209) list ZMB 4975 and 4610 as syntypes of *Sphenomorphus jagorii.* We know of no Philippine locality called "Palaos," but that name is another old permutation for Palau, in which case the above "syntypes" collected by Semper are possibly this species of *Sphenomorphus.* The Palauan species *vaguely* resembles some *jagorii,* which is a poorly resolved composite of several to many species throughout the Philippine archipelago (Brown and Alcala, 1980:211; RIC, unpublished data). However, most of the problematical Philippine populations are in the eastern arc of islands and the far north (greater Luzon landmass and associated island groups) rather than the area most proximate to Palau (Mindanao), which is occupied by the fairly well defined *S. jagorii grandis.* Thinking that the NMW specimens might actually be types, but of a species other than *jagorii* (meaning that there might be an available name for the Palau species), we carefully examined all of Wilhelm Peters' papers (Bauer et al., 1995) and could find no scincid described from "Palaos" or any permutation thereof.

We characterize this species as a denizen of moist woodland, but this requires some comment. The "woodland" need not be primary forest. Most of our specimens have come from the small park adjacent to the National Museum, which barely qualifies as woodland. We also collected one specimen (USNM 531965) under a rock in a roadside ditch at the Mechang dock area (Oreor). The ditch was adjacent to the lawn and driveway of a new house and the only "woodland" in the area was a small patch of dry scrub about 10 m away. On the other extreme, the southern Babeldaob specimens (SAM R47736, BPBM 13046) were collected under a sodden banana spathe in a swampy patch of *Pandanus*.

We also have a single juvenile from Ngermalk (USNM 531966), collected by Kurt Auffenberg in nearly undisturbed vegetation on the top of the small (north of the causeway) part of this rock island that is crossed by the Koror-Malakal causeway. Although this individual and some of our Babeldaob specimens have a more complex pattern than others, they do not differ in scalation. The pattern differences may be individual or ontogenetic variation.

Our only Rock Island record (USNM 531974 from Ngeruktabel) was collected under a log on the trail to German Lighthouse at the southern end of the island. This trail ascends through lush limestone forest to the lighthouse ruins on the ridge crest. The Japanese had a shore battery and a support base in this area and the ruins are prominent landmarks along the trail. The specimens was collected about halfway between the battery (marked by the enormous gun barrel along the trail) and the ruins of the support base. The Japanese surely cleared some of this forest for fields of fire but it is hard to tell now as the trees are huge and the canopy is high, more typical of undisturbed primary forest.

Distribution.—ENDEMIC. Babeldaob, Ngermalk, Ngeruktabel, Oreor.

Sphenomorphus scutatus (Peters, 1867)

This Palauan endemic [*Lygosoma* (*Hinulia*) *scutatum* Peters, 1867; syntypes (2) ZMB5893] is closely related to the small Papuan species of the *solomonis* subgroup of the *S. fasciatus* group (Greer and Parker, 1974). Although *S. scutatus* and the preceding species are strikingly different in size and scalation, both have the unusual, attenuate, bifurcate hemipenes (discussed under *Sphenomorphus* sp.). Unfortunately, hemipenial morphology is unknown for virtually all of the multitude of species currently assigned to *Sphenomorphus*. The two Palauan species are currently assigned to two different (unrelated) species groups, but we think it equally plausible that they may represent a Palauan radiation of closely related species.

Although previously rare in museum collections (Greer and Parker, 1974, found only four specimens), *S. scutatus* is actually a common leaf-litter skink on most islands. During the rainy season this skink is often active in the leaf litter by day, but during the dry season it is usually encountered under rocks and logs in shaded areas. It is found both in forest and in disturbed areas, including downtown Koror.

Distribution.—ENDEMIC. Babeldaob, Malakal, Ngcheangel Atoll (Ngcheangel), Ngeaur, Ngermalk, Ngeruktabel, Ngerur, Oreor, Ulebsechel, Ulong.

Varanidae

Varanus cf. *V. indicus* (Daudin, 1802)

The systematics of the *Varanus indicus* group (Fig. 15) are still quite chaotic despite recent research in the Papuan area that has produced two new species, subspecies elevated to species status, and a drastically revised taxonomy of the group (Böhme et al., 1994; Harvey and Barker, 1998; Sprackland, 1993). None of the revisions have included Oceanic material, probably because these populations are generally assumed to be introductions by the Japanese before or during WWII (e.g., Owen, 1977). Our experience with *Varanus* in Oceania suggests that the situation may not be so simplistic. Uchida (1969) noted that there were museum specimens from Micronesia that long antedated the Japanese occupation, and he concluded that they must have been a German introduction. Historical accounts suggest that the Western Caroline (Yap, Ulithi) and Palau populations might be native but that the eastern Caroline (Ifalik, Kosrae, Pohnpei), Marshall (not represented by any voucher specimens we have located), and Mariana monitors could be recent introductions. One of the earliest zoological reports on Micronesia (Chamisso, 1821) mentioned monitors from both Yap and Palau, and commented on their totem status in local cultures. On the other hand, in

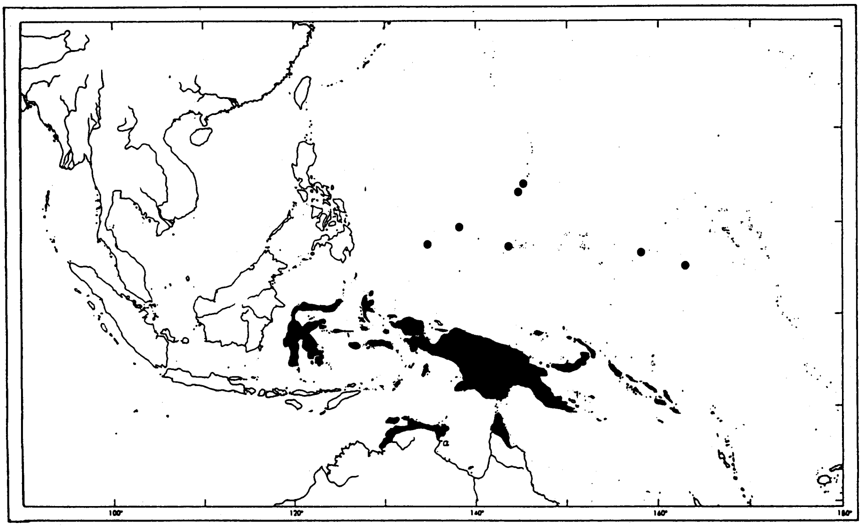

FIG. 15.—The distribution of *Varanus indicus*.

the Northern Marianas Pregill (1998) found *Varanus* only in recent (post-European) strata.

We are impressed with the morphological dissimilarity of Micronesian monitors. The "*indicus*" on Guam are smaller, paler, and more gracile than Palauan specimens. The common name "mangrove monitor" used for Greater Papuan *indicus* reflects its arboreality, but the Palauan populations are decidedly terrestrial. They take refuge in trees when pursued but only when terrestrial retreats are unavailable. In coloration and pattern, Palauan *Varanus* are black with prominent yellow dorsal rosettes and other irregular markings, with a vivid peach-colored throat in both adults and juveniles. They are both longer and bulkier than monitors on Guam. We have seen a reliable photo of an individual collected (and eaten) by Filipinos near Ulimang, northern Babeldaob. It was laid out next to a tape measure that was a bit longer than 6 feet total length. We have seen individuals approaching this length on Ngeaur.

Available data on the Marianas/Carolines populations suggest that they are usually associated with the most disturbed habitats (Bates and Abbott, 1958; Dryden, 1965). There is no comparable information for Yap and Ulithi, but in Palau *Varanus* is most definitely not a human commensal. In Palau, we have been unable to verify the earlier Koror records (AMNH 70652, CAS 152219), and have only one sight record from the island, and that from the rugged limestone Ngermeuangel Peninsula. On Babeldaob we have never seen monitors in the southern part of the island, nor have we received any reports from the area by the Filipinos who work the rural farms. Monitors (bayawok in Tagalog) are a favored food item among Filipinos and if they occurred in southern Babeldaob we are confident we would have confirming information and/or specimens from this valuable source. In sparsely populated northern Babeldaob we have seen but been unable to collect *Varanus* in the Ulimang/Ngesang area of Ngaraard State.

Gressitt (1952, 1953) made notes on *Varanus* on Ngcheangel Atoll. Tom Fritts and Gordon Rodda verified that the species was still present in January 1993, but only on the two larger islands where they were moderately abundant. The only other place *Varanus* is truly common is Ngeaur, where 20 or more can usually be seen in a few hours walk along the road that circles the island. They do occur in and near Ngaramasch village, but they are most abundant in the rugged limestone of the

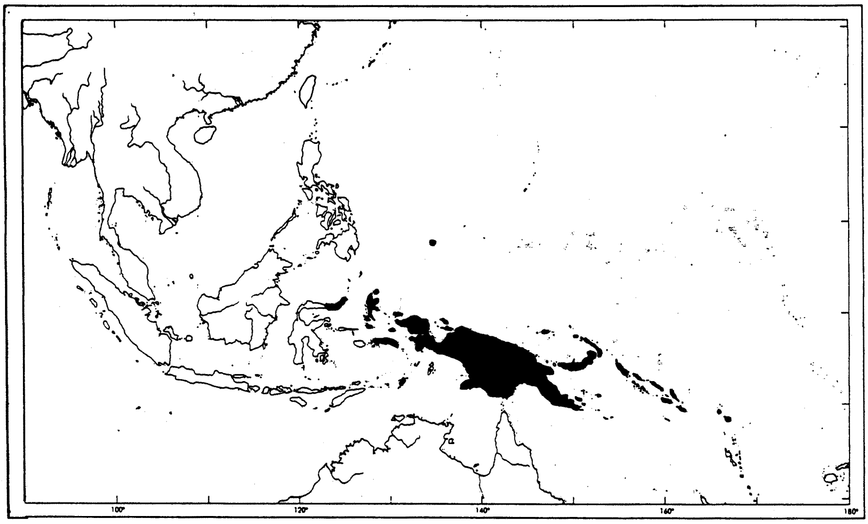

FIG. 16.—The distribution of *Candoia carinata.*

interior where they have multitudes of refuges and are extremely difficult to catch.

Clearly, the status of Oceanic *Varanus* needs additional study but collection of pertinent material is hampered by the CITES status of all varanids. Tissue samples from the Oceanic islands would help resolve the status of these important, primary predators, and clarify which populations are introduced versus those that are native (and possibly endemic) species.

Distribution.—Babeldaob, Ngcheangel Atoll (Ngcheangel, Ngeriungs), Ngeaur, Oreor.

SERPENTES

Boidae

Candoia carinata (Schneider, 1801)

Günther (1863) described *Candoia superciliosa* from Palau, but the taxon was quickly relegated to the synonymy of the widespread and variable *C. carinata* (e.g., Boulenger, 1893:107). Our first field impressions of Palauan *Candoia* was how subjectively "different" they were from New Guinea/Solomons *carinata.* McDowell (1979) examined a small sample of Palauan *Candoia* in his survey of New Guinea boids and found them to be an interesting mix of his normally allopatric "long tailed" and "short tailed" morphs. Böhme et al., (1998) recently described the rediscovered lectotype in the Zoologisches Forschungsinstitut und Museum Alexander Koenig (ZFMK 35503), and reported that the type locality, previously unknown, was Ambon Island ("Amboina" on the specimen label) in the southern Moluccas. They examined over 300 specimens from throughout the species' range (Fig. 16), and found morphological uniformity in the populations from the southern Moluccas, Irian Jaya, northern Papua New Guinea, New Britain and New Ireland, all of which they regarded as "typical" *C. carinata.* Their Palau specimens (n = 29) conformed with these in most respects, but showed several average differences in some scale counts and tail length ratios. Hobart M. Smith has recently taken data on a great many *Candoia* from throughout the distribution of the genus (including many of our recent Palauan specimens) and has concluded that the Palauan populations are quite distinct, but most closely related to "true" *carinata* from the Moluccas (personal communication to RIC, June 1998). We expect him to formally recognize Günther's *superciliosa* for this species.

Wynn and Zug (1985) detected some reproductive differences between Palauan *Candoia* and their larger sample from New Guinea, which they suggested were

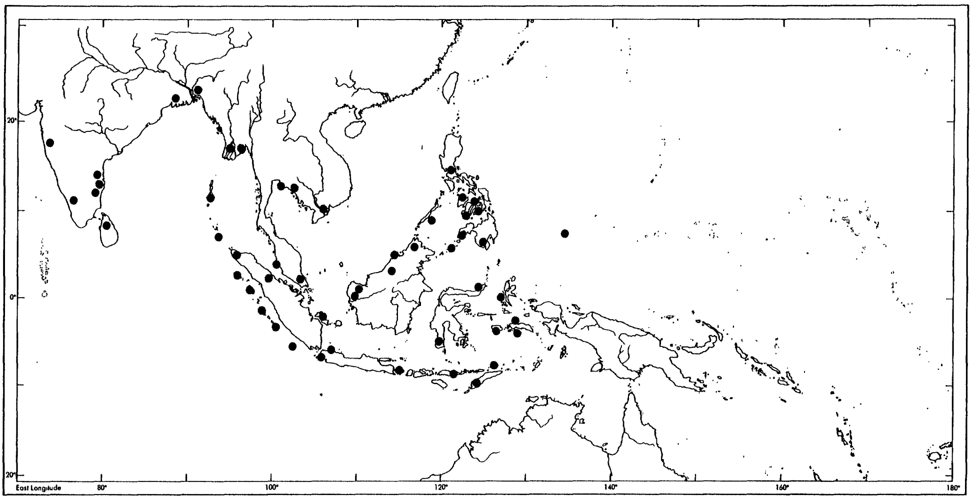

FIG. 17.—Locality records for *Cerberus rynchops* (after Gyi, 1970).

correlated with latitude. Harlow and Shine (1992) amplified Wynn and Zug's reproductive information and added dietary data based on dissection of museum material and published observations on captive specimens. They further noted that virtually all natural history data on *Candoia* were derived from preserved museum material, captive specimens, and very few actual field observations, all from the New Guinea region.

Candoia is common and widely distributed in Palau and it is found in both disturbed habitats (even in Koror town and on Malakal) and in forest. The species is usually reported to be arboreal and nocturnal, and indeed most of our specimens were so found. Still, several juveniles were found active on the ground in the early morning near the beach in northern Babeldaob. An adult also was found sunning on a limestone ledge at 1130 h on Ngerduais (a small island separated from the southeast coast of Babeldaob by mangrove and a stream).

Distribution.—Babeldaob, Beliliou, Malakal, Ngeaur, Ngercheu, Ngerduais, Ngerechur, Ngerekebesang, Ngerukeuid Islands (island 13) Ngeruktabel, Ngetmeduch, Oreor, Pkulaklim.

Colubridae

Cerberus rynchops (Schneider, 1799)

The most recent review of this widespread species (Fig. 17) was by Gyi (1970), who characterized it as "usually found in the brackish water of tidal rivers, creeks, and estuaries, but is equally at home in the upper reaches of rivers, and in salt waters along the coasts."

Although he apparently did not examine any material from Palau, Gyi included Palau as the eastern distributional limit of the nominate subspecies. He recognized the subspecies *novaeguineae* based on four specimens from Merauke in the Irian Jaya portion of New Guinea.

Cerberus is common in Palau, but often difficult to collect since it is nocturnal and the mangrove swamps it prefers are inhospitable after dark. The species is occasionally found in the open ocean or along beaches, particularly near river or stream mouths. One specimen (USNM 507563) from northern Babeldaob was found crawling across strand vegetation between the beach and an inland mangrove swamp at 0710 h.

Reproduction in Philippine *Cerberus rynchlops* was described by Gorman et al., (1981). For the Palauan population we have data on a single neonate with an umbilical scar (USNM 531967, SVL 232 mm, Tail 62 mm, live weight 11.3 gm) collected 29 Jan 1995. This individual emerged from a crevice in the mud bank of a mangrove swamp on Oreor when one of us (RIC) stepped and sank into the ooze. We thought that there might be an underwater entrance, but further manipulation of the area produced no further neonates, although other juveniles were seen in adjacent pools of the swamp.

Distribution.—Babeldaob, Ngerekebesang, Oreor.

Dendrelaphis sp.

Peters (1867*a*) described *Dendrophis striolatus* (ZMB 5450) that was collected from an unspecified locality on Palau; he suggested the new species was most closely related to the Australian *D. punctulatus*. Boulenger (1894:87) synonymized *striolatus* with *lineolatus* and his arrangement was followed by Dryden and Taylor (1969) in their discussion of three specimens (two from Ngeaur, one from Oreor). Meise and Hennig (1932) retained *striolatus* as a valid subspecies of *lineolatus* but Mertens (1934*a*) referred to the Palau species as *D. punctulatus striolatus*. McDowell (1984:6) also called the Palau snakes *Dendrelaphis punctulatus* (with *lineolatus* as a synonym but no mention of *striolatus*), based on a very small sample size.

Despite McDowell's careful analysis of the New Guinea material, we are not convinced that his placement of the Palauan populations is correct. Our collections contain two distinct forms of *Dendrelaphis:* the common, greenish, striped variety with a yellow belly occurs in the southern part of the archipelago, but a larger, unmarked blue form with a pale blue venter is found in northern Babeldaob. Our samples do not demonstrate any meristic differences between the two morphs.

Occasional "blue" individuals are found among the Philippine *Dendrelaphis caudolineatus* (RIC, personal observation), but there does not seem to be any geographic correlation in the variant. The "melanistic" *Dendrelaphis salomonis* from Misima Island (McDowell, 1984) may be a similar situation.

Palauan *Dendrelaphis* are very ecologically tolerant, surviving quite well in Koror town as well as in primary forest on the Rock Islands. They are diurnal and primarily terrestrial, but usually sleep on fences, low bushes, or (especially in the blue populations) even 3–5 m above ground on palm fronds or in the axils.

Distribution.—Babeldaob, Beliliou, Malakal, Ngeanges, Ngeaur, Ngemlis Islands (sight record, Bailechesengel), Ngercheu, Ngerduais, Ngerekebesang, Ngerukeuid Islands (island 24), Ngeruktabel, Oreor, Ulebsechel, Ulong.

Hydrophiidae

Pelamis platurus (Linnaeus, 1766)

This pan-tropical, pelagic species probably rarely if ever enters the waters inside the Palau reef. The only known specimen from the Palau area (CAS 122587) was collected "ca. 2 miles off SW side of Anguar (sic) Id.," outside the reef. *Pelamis* gives birth to live young while swimming at sea so, unlike *Laticauda,* does not need to make landfall to lay eggs. Owen (1977) reported that *Pelamis* shows up occasionally in Palauan waters after storms.

Distribution.—Ngeaur?

Laticaudidae

Laticauda colubrina (Schneider, 1799)

This is the common sea snake in Palau, although some other species could be expected as occasional vagrants. *Laticauda colubrina* is very common inside the reef and is often seen by divers in a variety of shallow and deep-water situations. Juveniles are often trapped in tidal pools at low tide, where we have observed reef herons (*Egretta sacra*) feeding on them. All of our *Laticauda* vouchers were collected onshore.

As the name implies, sea kraits are not as tied to the ocean as the true sea snakes. *Laticauda* must come ashore to lay eggs (unlike the live-bearing sea snakes) and they often spend enough time on land to accumulate ticks (Booth et al., 1997; Das, 1992; Pernetta, 1977). Although sea caves and uninhabited, precipitous rocky islands are favoured reproductive areas where large aggregations of snakes may be found (Saint Girons, 1964; Stuebing, 1988; Stuebing et al., 1990), individuals may come ashore singly and climb into beach wrack to shed, rest, and perhaps even bask. Shed skins and inactive individuals have been found in exposed root masses of undercut beach trees in Ngaraard State, northern Babeldaob. In this same area, a large male (USNM 507503) was found actively moving through strand vegetation 10 m from the sea at 2035 h. At this site (just south of Ulimang Village), there is only a narrow strip of "dry land" between the beach and an inland mangrove swamp. *Laticauda* has not been found in mangrove swamps in Palau, although, we collected a DOR subadult adjacent to mangrove (USNM 531992; 350 mm SVL) in north Oreor just south of the causeway to Ngetmeduch and the KB Bridge. Mangrove is extensive to the east of the road, and the specimen was collected on that side of the road; to the west mangrove is scattered, and opens to the shallows of the lagoon.

Distribution.—Babeldaob, Beliliou, Malakal, Ngelsibel, Ngerduais, Ngerechur, Ngerukeuid Islands (islands 13, 24), Oreor, Pkulaklim, Ulong.

Typhlopidae
Ramphotyphlops acuticaudus (Peters, 1877:416)

This species (*Typhlops acuticaudus* Peters, 1877; ZMB9127) is endemic to Palau but it is very close in coloration and external morphology to the Papuan *R. flaviventer* (McDowell, 1974). In fact, one museum specimen from Ngeaur (CM 29087) was identified as *flaviventer* by Neil D. Richmond, a specialist in typhlopid snakes, in 1967. Addison H. Wynn has examined most of our recent Palauan typhlopid material and he confirms the lack of diagnostic characters separating *acuticaudatus* from *flaviventer.* Van Wallach (personal communication) also dissected and examined the everted hemipenes of one of our *acuticaudus* specimens (SDSNH 68437) and feels that the species is distinct from *flaviventer.* However, he (Wallach, 1996) did not discuss *acuticaudus* in his recent review of the *flaviventer* group of *Ramphotyphlops.* We retain *acuticaudus* as a valid species, related to *flaviventer,* pending the results of future studies.

Although *Ramphotyphlops acuticaudus* seems to require slightly more mesic conditions than *R. braminus, R. acuticaudus* is certainly not a forest obligate. In fact, we have never collected it in primary forest, or the more forested parts of the larger islands. We have collected it at the forest edge at Nekkeng, Babeldaob, sympatrically with *R. braminus.* The two species were collected microsyntopically in sawdust piles on the grounds of the Museum in Koror town (R. Owen, personal communication, based on the following specimens: *acuticaudus*—USNM 207022, 207024, 207026–28; *braminus*—USNM 207023, 207025) and we have collected the two species under adjacent rocks in the same area. Unlike Owen's series, *braminus* is now much more abundant everywhere than *acuticaudus.*

Although we have never found this species on any of the many Rock Islands surveyed, Ota's record (KUZ 20006–07) for Ngercheu is undeniable. It is possible that this population was accidentally transported there in construction material for the Carp Island Resort.

Distribution.—ENDEMIC. Babeldaob, Ngeaur, Ngercheu, Oreor.

Ramphotyphlops braminus (Daudin, 1803)

This polyploid, unisexual, parthenogenetic species (Wynn et al., 1987) is the most successful disperser in the snake world, and its broad distribution in the IndoPacific rivals (and parallels in some ways) that of some of the house geckos. Unlike some frogs (e.g., *Bufo marinus, Rana catesbeiana*) that were intentionally introduced in new places for insect control, *Ramphotyphlops braminus* is apparently a passive disperser, albeit likely with human assistance. The most probable mechanism is in the root balls of ornamental (more recently) or food (historically) plants transported by humans. Although the natural range of *braminus* is unknown, it occurs from the Indian subcontinent to most of mainland Southeast Asia (Hahn, 1980:40). Presumably the species originated somewhere in this area. The salinity tolerance of *braminus* has never been tested, but nonetheless it is a superb island colonizer. It occurs on many Indian Ocean islands and has even reached the coasts of Africa. It is ubiquitous on the close-in East Asian archipelagos (Indonesia, Philippines), and it presumably dispersed from there to the Pacific islands and even to the coast of Mexico. The species' distribution in Oceania is spotty and it did not reach the Neotropics by "island hopping" across the entire Pacific. Until very recently, the Mexican distribution centered around Acapulco, Guerrero (and associated trade routes inland), which was the eastern terminus of the "Manila Galleon" route that transported goods from the Philippines to the New World colonies during 18th and 19th Century Spanish occupation (Dixon and Hendricks, 1979). The species continues to disperse in Mexico (Mancilla-Moreno and Ramirez-Bautista, 1998). It has even turned up recently in the Caribbean (Censky and Hodge, 1997) and additional range expansion is inevitable.

Natural dispersal from the mainland to closer island groups is not out of the question. Much has been made of "arboreal" behavior in the normally fossorial leptotyphlopid and typhlopid snakes, but common sense would indicate that these obligate ant and termite feeders should be able to utilize above-ground "soil" in the arboreal nests and runways of their prey. Our field observations and anecdotal literature reports provide preliminary data that this "arboreality" may be much more common than previously expected (Das and Wallach, 1998; Gaulke, 1995). Taylor (1922:59–64) suggested that some of the larger endemic Philippine species of *Typhlops* may occur exclusively in the extensive root masses of aerial ferns (*Asplenium*), which can provide substantial "fossorial" habitat in the forest canopy. On several occasions we have found *Ramphotyphlops braminus* climbing a meter or more above the ground on live coconut trees (after dark). We have also found several other species of leptotyphlopid and typhlopid snakes (including *R. braminus*) 2 m or more above the ground in dead, usually ant- or termite-ridden trees.

The punky interior of dead coconut trees knocked into the ocean by storms is an obvious dispersal mechanism. There is insulation from the dehydrating effects of salinity, as well as abundant insect prey for a small snake like *R. braminus*. Assisted by high-energy storm tracks, a propagule (= a single individual of a parthenogenetic species) could easily cross the 800 km from Mindanao to Palau. In fact, late Holocene fossil remains from the Marianas (Pregill, 1988) indicate the likely pre-human (and certainly pre-European) presence of a *braminus*-like blindsnake. Although Dryden and Taylor (1969) described *Typhlops pseudosaurus* [retained as a valid species of *Typhlina* (= *Ramphotyphlops*) by Hahn, 1980] from Harmon Village, Guam, RIC examined the holotype of *T. pseudosaurus* (FMNH 189357) and considers it to be *R. braminus*. The specimen was preserved as it was preparing to shed, and having aberrant head sutures on one side accounted for Dryden and Taylor's (1969) supposed diagnostic characters.

In Palau, the limited historical and ecological evidence suggest that *Ramphotyphlops braminus* is a recent arrival, and *R. acuticaudus* is a much older autochthon. The earliest records for Palauan *braminus* are Fehlmann's (mid-1950's), who found the species commonly on Oreor (25 specimens) but nowhere else, despite the fact that he spent far more time on Babeldaob, where he only collected *R. acuticaudus*. He collected both species on Oreor, including one locality where both were found syntopically (1 *acuticaudus* and 11 *braminus*). *Ramphotyphlops braminus* is now widespread in Palau and is particularly common in disturbed areas on the causeway-connected islands. Still, we have collected it from the northern end of Babeldaob (not connected to the south by road in the 1990's), Ngcheangel Atoll, and Ngeaur. There are no records from the Rock Islands or Beliliou, but there is one specimen from the Beliliou satellite of Ngedbus, collected in 1955 by Robert Owen (CAS-SU 19077).

Distribution.—Babeldaob, Malakal, Ngcheangel Atoll (Ngcheangel), Ngeaur, Ngedbus, Ngetmeduch, Oreor.

REPTILIA: TESTUDINES

Chelidae, gen. and sp. indet.

Aoki (1977) first reported a freshwater turtle from Palau, but his photograph was not adequate to confidently identify it to genus or species and no voucher specimens are known to exist.

Apparently this turtle is (or was) a recent introduction from New Guinea, probably a species of *Elseya* or *Emydura* as suggested by Aoki (1977). Nothing is known of the distribution or status of the species on Palau and most Palauans are unaware of its existence. Residents of Ngerekebesang, however, indicated that turtles could be found "commonly" in taro patches on the eastern end of the island.

Until a voucher specimen is available to verify the identification, it would be speculative to suggest what impact (if any) this introduction might have if the turtles are indeed established and reproducing. However, since turtles are often top predators in aquatic ecosystems the species could affect native aquatic vegetation, invertebrates, or fishes.

Distribution.—unknown.

Bataguridae
cf. *Chinemys reevesii*

Etpison (1997:211) published photographs of another freshwater turtle from an unspecified locality in Palau. George R. Zug and Carl H. Ernst examined the photograph and they are reasonably sure that it is an Asian batagurid (formerly a subfamily of Emydidae). Hidetoshi Ota (personal communication) suggested that it could be *Chinemys reevesii,* and we so refer it on that basis. Without a voucher specimen no further conclusions can be made.

It is unclear if either of the freshwater turtles (see previous account) are established in Palau, and origin of the introductions is likewise unknown. In Hawaii, several Asian turtles were imported and released by the Chinese community as a food source, and at least two of them are now established and breeding (McKeown, 1996). Palau has a significant Chinese community and there has been a sizeable recent influx of people and economic support from Taiwan. This seems a plausible possible source of the Etpison (1997) turtle. Turtle herpetoculture is not practiced in Palau (but it is a major cause of exotic introductions elsewhere). As noted in the chelid account, exotic turtles are a potentially serious threat to the poorly documented endemic freshwater fish and invertebrate fauna, and serious effort should be made to document the status of these turtles in Palau. Further import should be prohibited, and extant populations (if any) identified and eradicated while control is still possible.

Distribution.—unknown.

Cheloniidae
Chelonia mydas (Linnaeus, 1758)
Eretmochelys imbricata (Linnaeus, 1766)

Green sea turtles (*Chelonia mydas*) and Hawksbills (*Eretmochelys imbricata*) are common in Palauan waters, and for centuries they were exploited by native residents for their meat, eggs, and shells (Johannes, 1981; McCoy, 1981). There are no current censuses of nesting sites within the lagoon. Sandy beaches are limited and nesting sites are restricted accordingly. Hawksbills nest in the Ngerukeuid group (Seventy Islands), and Greens utilize sites on some of the small islands surrounding Babeldaob, on Beliliou, and doubtless other isolated places within the lagoon. The most important nesting site for Greens are on Helen and Merir in the Southwest Islands (Pritchard, 1981; Wilson, 1969). Leatherbacks (*Dermochelys coriacea*) and Olive Ridley turtles (*Lepidochelys olivacea*) also occur in Palau but are uncommon compared to Greens and Hawksbills.

Distribution in Palau.—Scattered but probably throughout Palau including Southwest Islands.

REPTILIA: CROCODYLIA

Crocodylus sp.
Crocodylus porosus Schneider, 1801

Salt water crocodiles are native to Palau (Motoda, 1937, 1938), and supposedly were much more numerous 30 years ago than they are now (Kimura, 1968*a,b*; Wilson, 1964). They occur elsewhere in the Caroline Islands only as rare waifs. A 12-foot individual was caught on Pohnpei in 1971 after three pigs teathered near the beach mysteriously disappeared over a six-month period (Allen, 1974). In Palau, a non-fatal attack in 1964 and the subsequent capture of a crocodile nearly 15 feet long was followed by the death of a local spear fisherman in December, 1965 (Brown, 1971; Wilson, 1965). Subsequently, a crocodile eradication program was initiated, and during the next 15 years various parties of Japanese, Australians, and Palauans hunted and killed crocodiles. Unfortunately, records of kills were inadequately maintained, and there is no accurate figure of the number of crocodiles taken, nor were scientific vouchers saved. Estimates run from a few hundred to several thousand killed during the 1970's according to Messel and King (1991), who reviewed the history of crocodile populations in Palau and conducted the only systematic biological survey. Messel and King made their survey in June, 1991, and concluded that a generous estimate of Palau's total number of saltwater crocodiles was less than 150. At that time the majority of their actual sightings were made on Beliliou and various river systems on Babeldoab (tributaries feeding Ngeremeduu Bay, others along the east coast south to Airai) as well as Ngerdok Lake. Crocodiles are also known to occupy the various marine lakes in the Rock Islands, but Messel and King (1991) dismissed the likelihood that they breed there because of insufficient places to lay eggs, and the fact that larger breeding adults would have limited access to these lakes because of the narrow crevices and channels that connect them to the lagoon. Today, a crocodile farm in north Koror harbors about 40 individuals of various size classes of local *C. porosus*. Supposedly, this enterprise is in place to build a breeding stock for eventual release of adults into protected areas.

Messel and King (1991) also emphatically state that *C. porosus* is the only species of crocodile in Palau, despite rumors and opinions that have persisted for decades that another species, perhaps two, occur (Kimura, 1968*a,b*; Thyssen, 1988). *Crocodylus novaeguineae* and the Philippine *C. mindorensis* were imported during the 1930's for a farming venture, but by the end of WWII few if any of these remained alive. Escapees apparently are the source of the supposed other species in Palau. We would also like to point out that despite Messel and King's vehement denial of a native freshwater croc in Palau, it is hard to imagine that the islands would not have (or had) one on purely zoogeographic grounds. It has long been thought that *Crocodylus mindorensis* and *C. novaeguinea* are closely related, even conspecific by some authors (see discussion in Hall, 1989). Although palustrine crocodiles can (and do) cross freshwater barriers, most areas (especially islands, even large ones like Borneo) harbour only one freshwater *Crocodylus*. If in fact *C. mindorensis* and *C. novaeguinea* are sister taxa then only two plausible dispersal routes could explain the distribution: island-hopping through the islands west of New Guinea, or by a direct oversea route between the Philippines and New Guinea. The island-hopping route would have to bypass Borneo, which is inhabited by another freshwater species, *C. raninus* (Ross, 1992). On the oversea route the only major landfall between New Guinea and the Philippines is Palau. Given the strong Papuan influences (and lesser Philippine ones) in the Palauan herpetofauna, including species that have great difficulty in crossing marine barriers (e.g., frogs), we think that the presence of freshwater crocodiles in Palau is not as unthinkable as Messel and King insist. Note that we do not suggest that the species *is* there, merely that it is an intriguing possibility, particularly given the abundance of anecdotal reports and local lore. Unfortunately, it is a moot point since CITES restrictions prevent collection of specimens and data that would resolve the problem. Even more regrettable is that none of the crocodiles killed during the "control" period was saved for science.

We made no attempt to search actively for crocodiles, *C. porosus* or otherwise, but note that ample habitat exists in which crocodiles could breed. We photographed a two-foot juvenile that was brought into the Coral Reef Research Foundation on Malakal in January, 1995 that was taken from nearby Koror. Indeed, our experiences with *Crocodylus* in Palau are somewhat at odds with Messel and King's data. Without even particularly looking for them, we have seen hatchlings, juveniles, and large adults virtually everywhere we have traveled in Palau, even quite close to Koror Town itself. Messel and King (1991) recounted the difficulties in surveying for crocodiles, for example that tidal fluctuations limit survey time and that navigating through the slackwater of mangrove is perilous at night. We agree, but while we do not diminish the efforts of their survey, it would surprise us if the number of crocodiles in Palau was not significantly greater than 150.

Distribution.–Babeldaob, Beliliou, Oreor.

Acknowledgments.—This project would have been impossible without the cooperation and assistance of numerous Palauan citizens and residents. We have enjoyed more than the usual cordial welcome in Palau, and we owe a huge debt of gratitude to many people. Our governmental contacts in Palau were Robert Owen (early in the planning stages), Demei Otobed, the late David Idib, Noah Idechong, and most recently Kammen (Taktai) Chin, each of whom so greatly facilitated our activities that any success we have had must be credited to their enlightened policies and cooperation.

In attempting to locate and verify identifications on all earlier Palau collections, we received cooperation from a great many individuals and institutions. We are unable to acknowledge all of the collections responding to verify that they did *not* have Palauan material, but we appreciate the information nonetheless. The following collections and their staffs provided printouts or other lists, loaned specimens and/or made working space available for us (museum acronyms follow Leviton et al., 1978):

AMNH—R. Zweifel, J. Cole, C. Myers, D. Frost, L. Ford
ANSP—E. Malnate
BMNH—N. Arnold, C. McCarthy, B. Clambe
BPBM—A. Allison, C. Kishinami
BYU—W. Tanner
CM—J. McCoy, E. Censky
FMNH—H. Voris, A. Resetar, C. Redhead
KUZ—H. Ota
MCZ—E. E. Williams, J. Rosado, J. Cadle
MNHN—A. Dubois, R. Bour, E. Brygoo
MVZ—H. Greene, D. Wake
SAM—M. Hutchinson, C. Austin
SMF—K. Klemmer, G. Köhler
SMNS—A. Schluter, J. Hallermann
UMMZ—A. Kluge, G. Schneider

We have not yet had the oportunity to examine the important early Palau collections in Germany and Amsterdam, but Aaron Bauer and Rainer Günther provided us with a great deal of information on the ZMB collections, and Andreas Schluter provided a list of the Stuttgart holdings.

As the repository for the second largest Palauan herpetological collection, The California Academy of Science endured our frequent visits with surprising tolerence. Walter Brown, Bob Drewes, Jacques Gauthier, Al Leviton, Heidi Robeck and especially Jens Vindum came through with space, assistance and courtesies well above and beyond the call.

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APPENDIX I

Distributions by Island

(* = *island records NOT verified by RIC/GKP collections*)

BABELDAOB

Bufo marinus
Platymantis pelewensis
Gehyra brevipalmata
Gehyra mutilata
Gehyra oceanica
Gekko sp.
Hemidactylus frenatus
Hemiphyllodactylus cf. *typus*
Lepidodactylus lugubris
Lepidodactylus moestus
Carlia cf. *C. fusca*
Cryptoblepharus sp.
Emoia atrocostata
Emoia caeruleocauda
Eugongylus sp.
Lamprolepis smaragdina
Lipinia leptosoma
Lipinia cf. *L. noctua*
Mabuya sp.
**Sphenomorphus* sp. nov.
Sphenomorphus scutatus
**Varanus* cf. *v. indicus* (CAS 152219)
Candoia carinata
Cerberus rynchops
Dendrelaphis sp.
Laticauda colubrina
Ramphotyphlops acuticaudus
Ramphotyphlops braminus
**Eretmochelys imbricata* (CAS 154193)
**Crocodylus porosus*

BABLOMEKANG

(ca. 2.5 km W of Mecherchar)

Gehyra brevipalmata
Gekko sp.
Lamprolepis smaragdina

BELILIOU

Bufo marinus
Platymantis pelewensis
**Gehyra brevipalmata*
Gekko sp.
Hemidactylus frenatus
Lepidodactylus lugubris
Carlia cf. *C. fusca*
**Cryptoblepharus* sp.
**Emoia atrocostata*
**Emoia caeruleocauda*
**Eugongylus* sp. (CAS 122407–08)
Lamprolepis smaragdina
**Mabuya* sp. (CAS 122595–97)
**Candoia carinata*
**Dendrelaphis* sp.
**Laticauda colubrina*
**Crocodylus porosus*

CHEMOI GROUP

(ca. 0.5 km NW of Mecherchar)

Gehyra oceanica

EUIDELCHOL ISLAND

(ca. 0.5 km N of Mecherchar)

Emoia caeruleocauda
Gehyra brevipalmata

IOULOMEKANG

(ca. 0.8 km SSW of Bablomekang)

Gehyra mutilata
Lepidodactylus lugubris
Emoia caeruleocauda

KMEKUMER ISLAND GROUP

(ca. 2 km W of Ngerukeuid Group)

(*specimens from island "46" of Wiles and Conry, 1990)

Gehyra brevipalmata
**Gekko* sp.
Lepidodactylus lugubris
**Lepidodactylus moestus*
**Cryptoblepharus* sp.
**Eugongylus* sp.
Lamprolepis smaragdina

MALAKAL

Bufo marinus
Platymantis pelewensis
Gehyra brevipalmata
Gehyra mutilata
Gekko sp.
Hemidactylus frenatus
Lepidodactylus lugubris
Lepidodactylus moestus
Anolis carolinensis
Carlia cf. *C. fusca*
Emoia atrocostata
Emoia caeruleocauda
Lamprolepis smaragdina
Lipinia cf. *L. noctua.*
Sphenomorphus scutatus
Candoia carinata
Dendrelaphis sp.
Laticauda colubrina
Ramphotyphlops braminus

MECHERCHAR

Emoia caeruleocauda

NGCHEANGEL ATOLL

NGCHEANGEL ISLAND

**Bufo marinus*
**Platymantis pelewensis*
**Gehyra mutilata*
**Gehyra oceanica*
**Lepidodactylus moestus*
**Emoia caeruleocauda*
**Emoia jakati*

**Eugongylus* sp. (CAS 122409)
**Lamprolepis smaragdina*
**Mabuya* sp.
**Sphenomorphus scutatus*
**Varanus indicus*
**Ramphotyphlops braminus*

NGEREBELAS ISLAND

**Gehyra oceanica*
**Lepidodactylus moestus*
**Emoia caeruleocauda*
**Emoia impar*
**Lamprolepis smaragdina*

NGERIUNGS ISLAND

**Platymantis pelewensis*
**Gehyra oceanica*
**Lepidodactylus moestus*
**Lamprolepis smaragdina*
**Varanus* cf. *v. indicus*

ORAK ISLAND

Gehyra oceanica
Lepidodactylus moestus
Emoia caeruleocauda
Emoia impar
Lamprolepis smaragdina

NGEANGES

Gehyra oceanica
Hemiphyllodactylus cf. *H. typus*
Lepidodactylus lugubris
Lepidodactylus moestus
Emoia caeruleocauda
Dendrelaphis sp.

NGEAUR

Bufo marinus
Platymantis pelewensis
**Hypsilurus godeffroyi* (?)
Gehyra brevipalmata
Gehyra mutilata
Gekko sp.
Hemidactylus frenatus
Hemiphyllodactylus cf. *H. typus*
Lepidodactylus lugubris
Lepidodactylus moestus
Carlia cf. *C. fusca*
Cryptoblepharus sp.
Emoia atrocostata
Emoia caeruleocauda
**Eugongylus* sp.
Lamprolepis smaragdina
Lipinia leptosoma
Lipinia cf. *L. noctua*
Sphenomorphus scutatus
Varanus cf. *v. indicus*
Candoia carinata
Dendrelaphis sp.
**Pelamis platurus* (CAS 122587)
**Ramphotyphlops acuticaudus* (CM 29087)
Ramphotyphlops braminus

NGEBAD

**Cryptoblepharus* sp.
**Emoia atrocostata*
**Emoia caeruleocauda*
**Lamprolepis smaragdina*

NGEBEDANGEL

(0.1 km NW of Ngeruktabel)

Emoia caeruleocauda
Lamprolepis smaragdina

NGEDBUS

(0.6 km N of Beliliou)

**Ramphotyphlops braminus* CAS 19077

NGELSIBEL

(ca. 1 km N of Mecherchar)

Laticauda colubrina

NGEMLIS ISLANDS

BAILECHESENGEL

Platymantis pelewensis (calling 1/97)
Dendrelaphis sp. (sight record 1/97)

IILBLAU

Gehyra brevipalmata
Lepidodactylus sp.
Cryptoblepharus sp.
**Emoia caeruleocauda* (sight record 1/97)

NGERCHEU

(4 km N of Beliliou; all specimens KUZ)

**Platymantis pelewensis*
**Gehyra brevipalmata*
**Gekko* sp.
**Hemidactylus frenatus*
**Lepidodactylus lugubris*
**Lepidodactylus moestus*
**Emoia caeruleocauda*
**Eugongylus* sp.
**Lamprolepis smaragdina*
**Lipinia* cf. *L. noctua*
**Mabuya* sp.
**Candoia carinata*
**Dendrelaphis* sp.
**Ramphotyphlops acuticaudus*

NGERDIS

(off Palau Pacific Resort, Ngerekebesang; connected to mainland by jetty)

Lepidodactylus lugubris
**Emoia atrocostata* (CAS 184016)
**Lamprolepis smaragdina* (CAS 184017)

NGERDUAIS

(off SE Babeldaob, 100 m SW Garudawisei Point)

Gehyra brevipalmata
Lepidodactylus moestus
Gekko sp.
Candoia carinata
Dendrelaphis sp.
**Laticauda colubrina*

NGERECHONG

(2.3 km S of Mecherchar)

Gehyra mutilata

NGERECHUR

(ca. 2 km off N point Babeldaob)

Platymantis pelewensis
Gehyra oceanica
Gekko sp.
Lepidodactylus moestus
Emoia caeruleocauda
Emoia jakati
Lamprolepis smaragdina
Candoia carinata
Laticauda colubrina

NGEREKEBESANG

Bufo marinus
Platymantis pelewensis
Gehyra brevipalmata
Gehyra mutilata
Gekko sp.
Hemidactylus frenatus
Hemiphyllodactylus cf. *H. typus*
Lepidodactylus lugubris
Lepidodactylus moestus
Carlia cf. *C. fusca*
Cryptoblepharus sp.
Emoia atrocostata
Emoia caeruleocauda
Lamprolepis smaragdina
Lipinia cf. *L. noctua*
Candoia carinata
**Cerberus rynchops*
Dendrelaphis sp.

NGERMALK

(between Oreor and Malakal, connected by causeway)

Hemidactylus frenatus
Lepidodactylus lugubris
Lepidodactylus moestus
Carlia cf. *C. fusca*
Lamprolepis smaragdina
Sphenomorphus sp. nov.
Sphenomorphus scutatus

NGERUCHUBTANG

(4 km SSW of Ngerechong)

**Emoia caeruleocauda*

NGERUKEUID ISLAND GROUP

NGERUKEUID ISLAND (Island 24)

**Platymantis pelewensis*
**Gekko* sp.
**Eugongylus* sp.
**Lamprolepis smaragdina*
**Dendrelaphis* sp.
**Laticauda colubrina*

ISLAND 4

**Lepidodactylus moestus*

ISLAND 12

**Lamprolepis smaragdina*

ISLAND 13

**Candoia carinata*
**Laticauda colubrina*

ISLAND 16

**Lepidodactylus paurolepis*
**Eugongylus* sp.
**Lamprolepis smaragdina*

ISLAND 34

**Lepidodactylus paurolepis*

NGERUKTABEL

Platymantis pelewensis
Gehyra brevipalmata
Hemiphyllodactylus cf. *H. typus*
Lepidodactylus moestus
Lepidodactylus sp.
Emoia caeruleocauda
Eugongylus sp.
Lamprolepis smaragdina
Sphenomorphus scutatus
Sphenomorphus sp. nov.
Candoia carinata
Dendrelaphis sp.

NGERUR

(0.8 km W of Ngerekebesang)

Gehyra oceanica
Lepidodactylus lugubris
Lepidodactylus moestus
Emoia caeruleocauda
Lamprolepis smaragdina
Sphenomorphus scutatus

NGESBOKEL

(Ngeremeduu Bay, west coast of Babeldaob)

Lepidodactylus lugubris
Lepidodactylus moestus
Emoia impar
Lamprolepis smaragdina

NGETMEDUCH

(ca. 0.2 km north of Oreor, connected by causeway)

Platymantis pelewensis
Gehyra mutilata
Lepidodactylus lugubris
Lepidodactylus moestus
Carlia cf. *C. fusca*
Cryptoblepharus sp.
Emoia atrocostata
Emoia caeruleocauda
Lamprolepis smaragdina
Candoia carinata
Ramphotyphlops braminus

OREOR

Bufo marinus
Platymantis pelewensis

Gehyra brevipalmata
Gehyra mutilata
**Gehyra oceanica* (CAS-SU 23747, 122393)
Gekko sp.
Hemidactylus frenatus
Hemiphyllodactylus cf. *H. typus*
Lepidodactylus lugubris
Lepidodactylus moestus
Anolis carolinensis
Carlia cf. *C. fusca*
Cryptoblepharus sp.
Emoia atrocostata
Emoia caeruleocauda
Eugongylus sp.
Lamprolepis smaragdina
Lipinia cf. *L. noctua*
**Lipinia leptosoma*
Mabuya sp.
Sphenomorphus sp. nov.
Sphenomorphus scutatus
**Varanus* cf. *v. indicus* (CAS 154150)
Candoia carinata
Cerberus rynchops
Dendrelaphis sp.
Laticauda colubrina
Ramphotyphlops acuticaudus
Ramphotyphlops braminus
Crocodylus porosus
**Eretmochelys imbricata* (CAS 154194)

PKULAKLIM (ORRAK)
(ca. 0.6 km SW of Ngerduais)

Bufo marinus
Gehyra brevipalmata
Emoia caeruleocauda
Lamprolepis smaragdina
Candoia carinata
Laticauda colubrina

TOIRACHOLODOCHOEL
(island name from Brown and Fehlmann, 1958:5 as "a small island at the north end of Malakal")

**Lipinia leptosoma*

UCHULAMERADEL
(southernmost of eastern islands, mouth of Ngeremeduu Bay)

Lepidodactylus moestus

UCHULANGAS
(connected to Oreor and Ngermalk by causeway)

Hemidactylus frenatus
Lepidodactylus lugubris
Lepidodactylus moestus
Carlia cf. *C. fusca*
Emoia atrocostata

ULEBSECHEL

Platymantis pelewensis
Gehyra brevipalmata
Gekko sp.
Hemiphyllodactylus cf. *H. typus*
Nactus sp.
Emoia atrocostata
Emoia caeruleocauda
Eugongylus sp.
Lamprolepis smaragdina
Sphenomorphus scutatus
Dendrelaphis sp.

ULONG

Platymantis pelewensis
Gehyra brevipalmata
Gekko sp.
Lepidodactylus sp.
Nactus sp.
Emoia caeruleocauda
Eugongylus sp.
Lamprolepis smaragdina
Lipinia cf. *L. noctua*
Sphenomorphus scutatus
Dendrelaphis sp.
Laticauda colubrina

SOUTHWEST ISLANDS

FANA ISLAND

**Gehyra* sp.
**Perochirus* sp.
**Lamprolepis smaragdina*

HELEN (Helen Reef)

**Emoia jakati*

MERIR ISLAND

**Nactus* cf. *N. pelagicus*
**Emoia impar*
**Lamprolepis smaragdina*

PULO ANNA

**Gehyra* sp.
**Lepidodactylus lugubris*
**Lepidodactylus moestus*
**Emoia* sp.
**Emoia impar*
**Lamprolepis smaragdina*
**Lipinia* cf. *L. noctua*
**Mabuya* sp.

SONSOROL ISLAND

**Gehyra* sp.
**Emoia* sp.
**Emoia impar*
**Lamprolepis smaragdina*
**Mabuya* sp.

TOBI ISLAND

**Gehyra* sp.
**Gehyra mutilata*
**Emoia jakati*
**Lamprolepis smaragdina*