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Variation in the Scincid Lizard *Lipinia noctua* and Notes on Other *Lipinia* from the New Guinea Region

RICHARD G. ZWEIFEL¹

ABSTRACT

Variation of color pattern and scutellation of *Lipinia noctua* (Lesson) is described, with emphasis on populations of the New Guinea region. The considerable individual and geographic variation seen in *L. noctua* and the less extensive, partly nonconcordant variation in scutellation are not readily resolved into a pattern of geographic subspecies. Hence, *L. noctua* is considered to be a monotypic species.

Lipinia miota (Boulenger) and *L. rouxi* (Hediger) are referred to the synonymy of *L. noctua*. Attention is directed to 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. A key to the five species of *Lipinia* in New Guinea is included together with notes on distribution and ecology.

INTRODUCTION

The initial objective of this study was to investigate the specific status of *Lipinia miota*, a species that the describer (Boulenger, 1895a) recognized "strikingly resembles *L. noctua*," and whose validity was soon questioned (Méhely, 1898; Andersson, 1913). The early doubts notwithstanding, later workers continued to recognize *miota* as a species (Loveridge, 1948; Mittleman, 1952; Greer, 1974). As my investigation progressed, it became evident that the *miota* problem should not be isolated from the more general question of variation in *L. noctua*, and this in turn led to a brief consideration of the other nominal species of *Lipinia* in the New Guinea region. The results of the study, presented here, include a description of variation in *L. noctua* and a discussion of the

taxonomic implications thereof, notes on the other five species of *Lipinia* in the New Guinea region, and a key to the species of that area.

In common with other lygosomine skinks, *Lipinia miota* (Boulenger) and *Lipinia noctua* (Lesson) have been shuffled about among several genera. Most authors assigned them jointly to *Lygosoma* or *Leiopisma*, though Mittleman (1952) used the combinations *Lipinia noctua* and *Scincella miota*. I follow Greer (1974), who assigned both names to the genus *Lipinia*.

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Specimens from the New Guinea region pertinent to this study are relatively few in number and widely scattered among collections. I am grateful to the following persons who made

¹Chairman and Curator, Department of Herpetology, American Museum of Natural History.

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MATERIALS AND METHODS

I have examined in detail specimens from New Guinea and nearby islands, including the Moluccas, Admiralty Islands, Bismarck Archipelago, and Bougainville Island. I have also studied less intensively specimens from the range of *L. noctua* throughout the Pacific region. *Lipinia noctua* and *L. miota* have been distinguished largely on a single key character—frontoparietal scale single or divided. My approach was to investigate variation in scutellation and color pattern in samples from different localities disregarding whether individuals in a given sample possessed the principal key character of one or the other nominal species. If indeed more than one taxon should be recognized, this should become evident.

Size of specimens is expressed as length from snout to vent, abbreviated SV. Methods of making scale counts and standards for color pattern descriptions are presented in the appropriate places in the text.

VARIATION IN *LIPINIA NOCTUA*

SCUTELLATION

I examined five characters: number of frontoparietals; number of lamellae beneath the

fourth toe; number of scale rows around mid-body; number of scales in a paravertebral row from occiput (including enlarged nuchals) to a line connecting the posterior edges of the hind limbs; and number of enlarged nuchals. The first of these is important because *L. miota* has been distinguished by having a single frontoparietal, whereas *L. noctua* has paired scales. This is the only trenchant character separating the taxa. The other characters are very often useful in distinguishing among species of skinks; hence, they may serve as independent checks bearing on the systematic status of the populations sampled.

FRONTOPARIETALS: It is convenient to recognize three states: two completely independent scales; a single scale partially cleft by a suture; and a single scale. In the case of partial division, the suture invariably commences at the posterior edge of the scale at or near its midpoint. The distribution of the character states in my samples from the Papuan region (augmented by literature records) is shown in figure 1.

The relatively large sample from Morotai Island includes one individual with a partly divided scale and 16 with paired scales. Among 35 specimens from localities widely scattered from the western tip of New Guinea to Astrolabe Bay all three states are found. The paired condition dominates, being found in 24 individuals compared to five intermediates and six with single scales. No geographic trend is evident in this admittedly meager sample, but the two extreme conditions occur together in samples from three widely separated localities. In contrast, all 13 specimens from farther east in New Guinea (Huon Peninsula to Milne Bay, including Fergusson Island, the type locality of *miota*), have a single frontoparietal. Kinghorn (1928, p. 176) found only single scales in 37 specimens from Kiriwina Island, and I examined an additional specimen that also has a single frontoparietal.

Three specimens from Manus Island and one from an adjacent islet include all three stages. Four from New Ireland have paired scales, whereas three from Tabar Island (off the north coast of New Ireland) have partly divided scales. All three states are seen among eight lizards from New Britain, with the five from

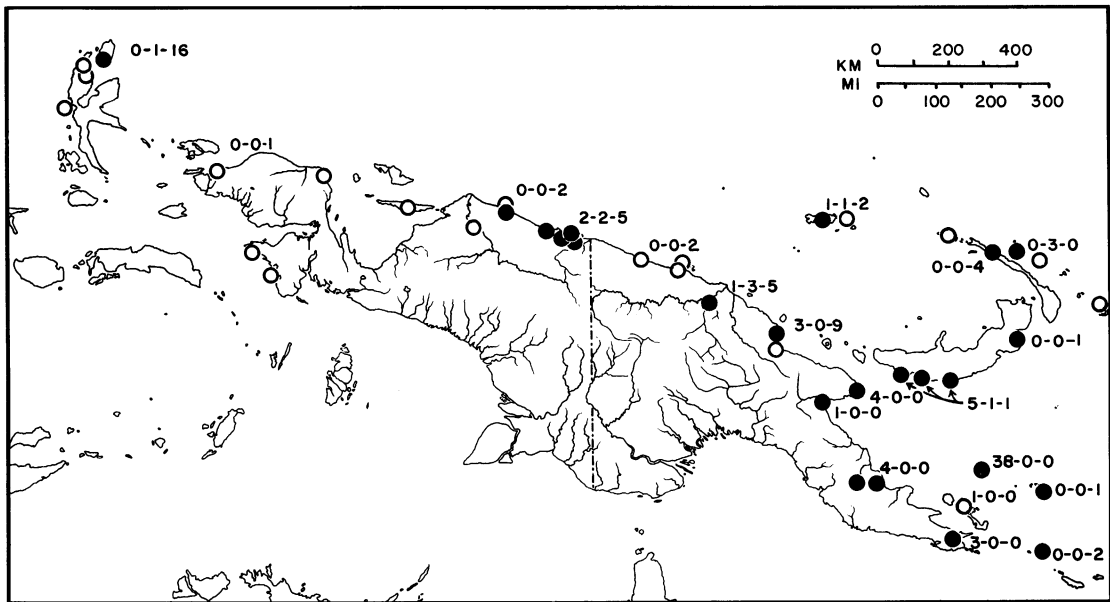


FIG. 1. Distribution of *Lipinia noctua* on New Guinea and adjacent islands, and variation in state of frontoparietal scale: open circles indicate literature records, closed circles specimens examined; numbers indicate (left to right) number of specimens with single frontoparietals, with partly divided frontoparietals, and with paired frontoparietals. For the total distribution of *L. noctua*, see figure 8.

closest to New Guinea having single scales. Twenty-five specimens from Bougainville Island (not shown on figure 1) have paired frontoparietals.

TOE LAMELLAE: The number of lamellae beneath the fourth toe ranges from 17 to 26 in specimens from the New Guinea region. Burt and Burt (1932, p. 540) recorded a range of 17 to 25 lamellae among 528 *L. noctua* from the Pacific Islands. Among 25 specimens from the New Guinea mainland the range is 17 to 22, mean 19.8 ± 0.22 . No geographic variation is evident in the limited samples available: 10 specimens from Toem to the vicinity of Jayapura (Hollandia) on the north coast average 20.4 ± 0.37 (18-22); a sample of 10 from several hundred kilometers to the southeast—Finschhafen to Popondetta—has a similar mean and identical range, 19.7 ± 0.34 (18-22).

Some insular samples differ from those on the mainland. Fifteen specimens from Morotai have a high average, 23.1 ± 0.39 (20-25), all four from New Ireland have the maximum number of 26, and three from Tabar Island have 24, 24, and 26. In contrast, seven lizards

from New Britain (range 18-21, mean 19.9) and four from Manus (range 19-23, mean 21.0) differ from the mainland samples little if at all.

The situation on Bougainville Island requires special attention. The range for the entire sample of 25 specimens is 19-24, mean 21.5 ± 0.23 . The span of variation is the same as seen in other samples of moderate size. But there is reason for subdividing this sample on the basis of color pattern (see subsequent discussion). When this is done, we have sample A mean 22.0 ± 0.33 (20-24) $N = 14$, and sample B mean 20.6 ± 0.31 (19-22) $N = 11$. Comparison of the means yields $t = 3.244$, $P < .01$. Thus, there is a significant difference in mean number of toe lamellae paralleling a color pattern difference.

SCALE ROWS AROUND MIDBODY: Among specimens from the New Guinea region, including the mainland and all islands except Bougainville, the modal number of scales is 26 (55% of 67 specimens), with 24 rows occurring next most frequently (25%). Other counts include 22 (2%), 23 (2%), 25 (10%), and 28 (6%). There is no evidence of geographic vari-

ation among the subsamples where these are large enough to be meaningful.

In contrast to the situation elsewhere, the lizards from Bougainville Island show a reversal of modal frequencies. This sample of 25 specimens has 24 rows occurring most frequently (64%) and 26 rows next (24%). As seen in the fourth toe lamellae (see above), a difference between subsamples A and B is indicated: each has 24 rows as the dominant mode, whereas only one of 11 of pattern B has 26 rows, five of 14 with pattern A have this count. The range of variation is 22 to 26 rows.

Burt and Burt (1932, p. 540) recorded a range of 23 to 27 rows in their Pacific Islands sample of 528 specimens.

SCALES IN PARAVERTEBRAL ROW: Burt and Burt (1932, p. 540) gave a range of 47 to 60 scales for more than 500 specimens from the Pacific Islands. In my total sample from New Guinea and all other associated islands the range is displaced slightly downwards—44 to 57—but there is no indication of geographic variation between most samples. Means, standard errors, and ranges for some subsamples are: mainland New Guinea, 50.8 ± 0.54 (44-57) $N = 29$; Morotai Island, 50.6 ± 0.80 (45-55) $N = 15$; New Britain, 51.0 ± 0.93 (48-55) $N = 7$. The entire Bougainville sample ($N = 25$) has a mean of 50.8 ± 0.58 (46-57). Subsamples A and B differ slightly but not significantly: A, 51.8 ± 0.87 (47-57) $N = 14$; B, 49.6 ± 0.58 (48-53) $N = 11$. Comparison of the means yields $t = 1.98$, $p < .1$.

ENLARGED NUCHAL SCALES: Data are available for 66 specimens from the New Guinea region. One specimen (from New Britain) lacks enlarged nuchals, whereas the maximum of four pairs enlarged is seen in two individuals from mainland New Guinea. In most areas the modal count is 3/3. Exceptions include the lower Sepik River locality (nine specimens), where two is the mode and one is more frequent than three, and the sample from New Britain (seven specimens), where specimens with two enlarged nuchals on one or both sides are slightly more frequent than those with three. Burt and Burt did not tabulate this character for the Pacific Islands.

COLOR PATTERN

The basic color pattern of the body appears to be striped, as it is in many skinks. Therefore, although some populations deviate somewhat from the striped condition, variation is best discussed in terms of longitudinal fields that may be distinct stripes or may be variously modified. The lizards illustrated in figures 2A and 2B exemplify the basic pattern described here. The light-colored vertebral field commences in the frontal or parietal region and occupies part of each of the paravertebral scale rows, here termed row one. Often the anterior end of the vertebral stripe pinches off, or is conspicuously more brightly colored, forming a discrete occipital spot. The dark paravertebral field occupies part of row one and most of row two. The light dorsolateral field begins on the supraoculars and centers on row three, overlapping onto rows two and four. The dark lateral field covers rows five, six, and seven and part of row four.

MOROTAI ISLAND, MOLUCCAS: This sample, from the westernmost area known to be inhabited by this species, comprises 17 specimens. Two are juveniles of 24-26 mm. SV, whereas the others range from 32 to 47 mm. In all specimens, even the largest adults, the vertebral stripe is pale and distinct on the anterior part of the body, and in most it is recognizable to or almost to the base of the tail (fig. 2). The edges of the stripe are relatively sharply defined and little invaded by dark pigmentation from the paravertebral field. The dorsolateral stripe is also quite distinct anteriorly and persists to the tail base. Its borders, especially posteriorly, tend to be somewhat less well defined than those of the vertebral stripe, but it retains its integrity. The paravertebral field is unbroken dark brown in the neck region of all specimens. In the smallest individuals, and also in some larger ones, this field is essentially completely dark to the rump (fig. 2A, 2B). More often, however, it breaks into large squarish blotches at about midbody (fig. 2C). The lateral field, even in the juveniles, is pigmented in large, squarish dark blotches separated by narrow light interspaces. Only one individual has a

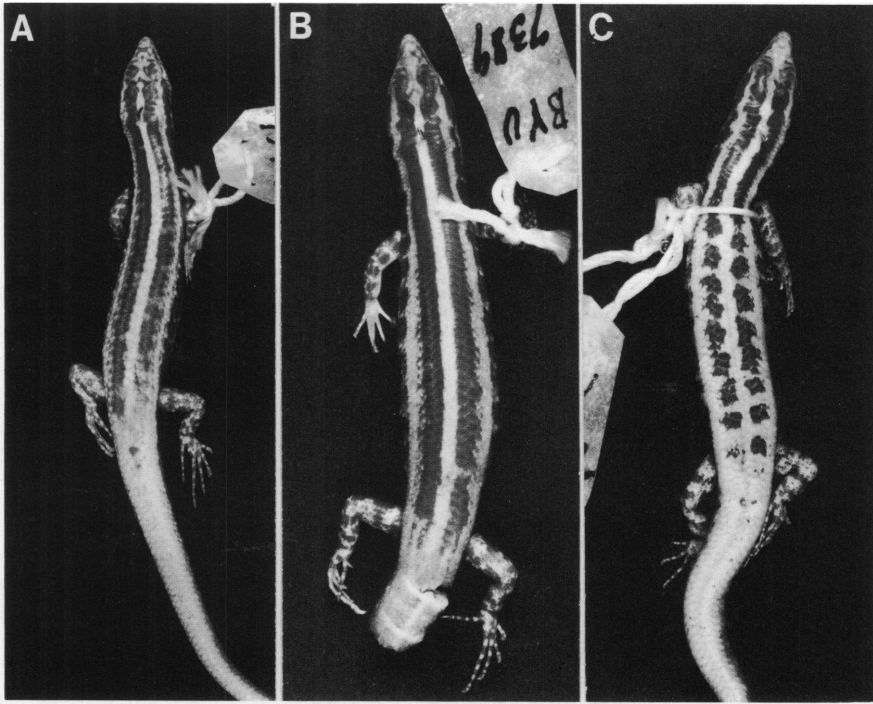


FIG. 2. *Lipinia noctua* from Morotai Island, Moluccas. A. BYU 7325, SV 37 mm. B. BYU 7389, SV 44 mm. C. BYU 7632, SV 46 mm.

largely dark lateral field with a few light spots along its edges.

NEW GUINEA MAINLAND: I have data from 18 specimens collected over a distance of 600 km. between the lower Sepik River on the east in Papua New Guinea and Toem in Irian Jaya. The westernmost specimens—one from Toem and two from Doromena—have a striped aspect, but much less distinctly than those from the Moluccas. The vertebral stripe is ragged-edged, even in the neck region, due to spreading of the irregular blotches of the paravertebral fields. The occipital spot is fairly distinct and paler than the vertebral stripe. The paravertebral fields are not broken into large, discrete blotches but rather into smaller ones that tend to be joined together. The dorsolateral stripe is distinct to the base of the tail and not sharply defined because of the ragged edges of the adjacent fields. The lateral field is dark with occasional light spots. The smallest of these

specimens, SV 34 mm., has the most regular pattern of the three.

The remaining specimens—five from the vicinity of Lake Sentani near Jayapura (fig. 3A) and nine from Kamberamba on the lower Sepik River (fig. 3B)—look quite different from the western lizards. The striped aspect of the pattern is suppressed in all. Even juveniles show only an indistinct vertebral stripe with edges that fade into the ground color between relatively small, dark markings of the paravertebral fields. Both juveniles and adults have the occipital spot well marked, being outlined in dark pigment and much paler than the vertebral field. Dark markings of the paravertebral fields are not well developed, and in the larger lizards, especially posteriorly, the distinction between the paravertebral and dorsolateral fields tends to become obscure. A contributing factor is the development of tiny dark spots in the dorsolateral field. The dark lateral field main-

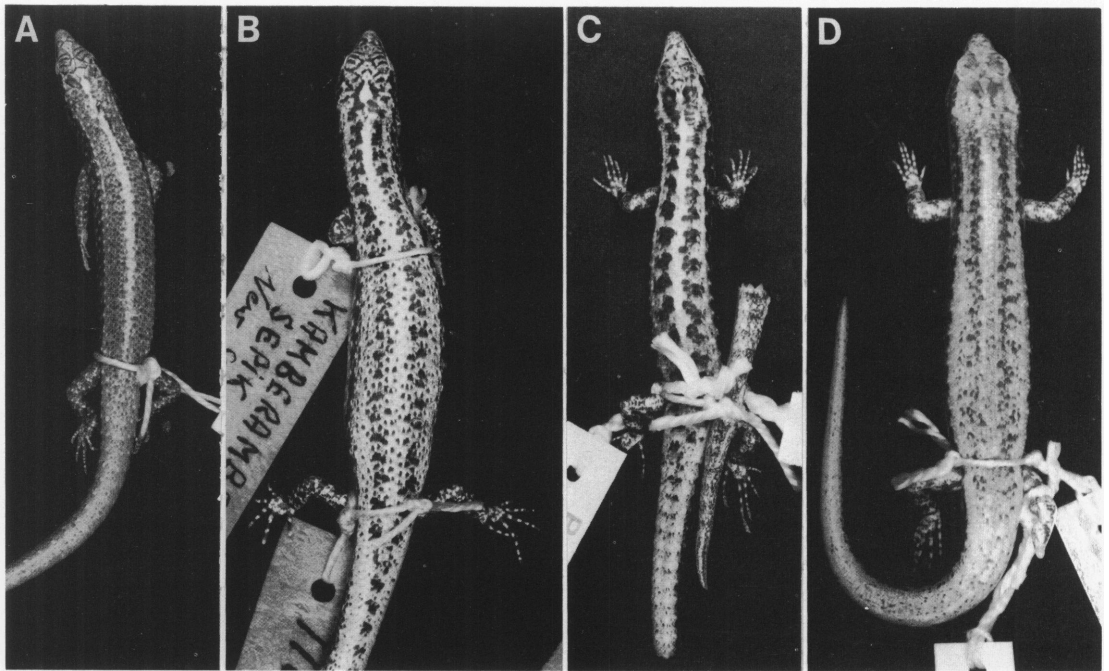


FIG. 3. *Lipinia noctua* from mainland New Guinea. A. NHMB 9297, SV 40 mm., vicinity of Lake Sentani, Irian Jaya. B. NHMB 11642, SV 51 mm., Kamberamba, lower Sepik River, East Sepik Province, Papua New Guinea. C. AMNH 105535, SV 37 mm., vicinity of Bostrem Bay, Madang Province, Papua New Guinea. D. AMNH 95374, SV 43 mm., Kokoda, Northern Province, Papua New Guinea.

tains its distinctiveness better, and resembles that of the lizards from Toem and Doromena in bearing numerous small light spots.

Lizards from farther east in New Guinea tend to retain more of a striped pattern than do those from the Sentani and Sepik regions, though the pattern has less contrast than seen in lizards from Morotai and some other islands. The vertebral field is pale and visible to the base of the tail though slightly ragged-edged in some instances. Two of nine specimens at hand have distinct occipital spots. The paravertebral field varies, being mainly dark in three small individuals (SV 32, 34, and 35 mm.) from Madang and Milne Bay, broken into distinct dark blotches in two from the Huon Peninsula (35 and 42 mm.), one from Madang (27 mm.) and one from near Alexishafen (37 mm., fig. 3C), and composed of rather diffuse dark spots in one from Kokoda (43 mm., fig. 3D), and another from Embi Lakes (39 mm.). The light

dorsolateral field is distinct in all, especially clear and sharp-edged in the smaller specimens. The dark lateral field is broken only by small light spots.

MISIMA, WOODLARK, AND TROBRIAND ISLANDS: Two large lizards (SV 45 and 46 mm.) from Misima Island are striped. The vertebral stripe is sharp-edged and slightly broader than usual, occupying all but the tips of the paravertebral scale rows. No occipital spot is evident. The paravertebral field, somewhat narrowed by the expansion of the vertebral stripe, is mostly dark. Although somewhat uneven, it is not broken into discrete spots. The dorsolateral stripe is distinct and the dark lateral field has light spots. The lizard from Woodlark Island (SV 40 mm.) presents much less of a striped aspect. The color pattern is obscure posteriorly, with the light vertebral stripe almost indistinguishable and the dorsolateral stripes faint and uneven. A specimen from the Trobriand

Islands (SV 31 mm.) has a very faded appearance, not unlike the specimens illustrated in figure 3A. The vertebral field is pale and distinct to the base of the tail. The paravertebral fields are only slightly darker and have few and small dark markings. The dorsolateral fields are pale and sharp-edged, and the lateral fields dark with light spots.

ADMIRALTY ISLANDS AND BISMARCK ARCHIPELAGO: I have examined four specimens from Manus Island and adjacent N'Drova Island. A juvenile (SV 29 mm., fig. 4A) and two adult individuals (46 and 39 mm.) from Manus have closely similar patterns: vertebral, paravertebral, and dorsolateral fields are contrasting dark and light stripes, lateral fields bear only a few tiny light spots, and an occipital spot is present. The specimen from N'Drova (fig. 4B, SV 40 mm.) resembles the others, but the paravertebral dark fields are broken into irregular spots.

Three specimens from Tabar Island off the north coast of New Ireland are of adult size

(SV 39, 41, and 44 mm.). All have an occipital spot and all stripes are well developed in the neck region. The vertebral stripe is distinct to the rump of the smallest specimen and almost so in the intermediate specimen (fig. 4C), whereas in the largest individual it loses its distinctness by midbody. The paravertebral field is broken posteriorly into dark blotches in the small lizard and is pale, uniform light brown in the others. The dorsolateral stripes are present to the rump in all three, and the lateral field is continuously dark, broken only by a few light spots in the largest lizard.

Four specimens from New Ireland, the holotype (fig. 5), and three paratypes of *Leiolepisma rouxi* Hediger, measure 32 to 38 mm. SV. All lack an occipital spot. The vertebral stripe is broad and reaches to the rump, occupying almost all of its two scale rows. The paravertebral field is divided between two longitudinal components of essentially the same width: a dark stripe edging the vertebral stripe and slightly interrupted posteriorly, and a

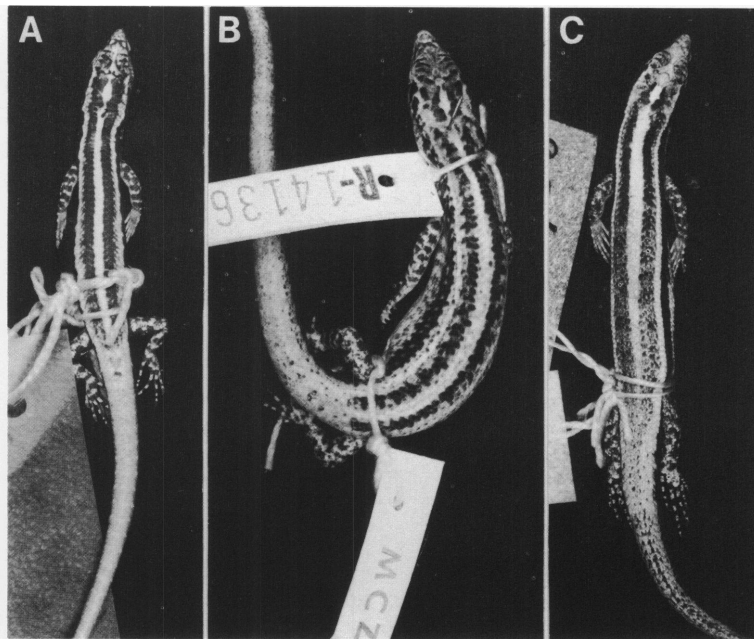


FIG. 4. *Lipinia noctua* from the Admiralty Islands and Bismarck Archipelago. A. NHMB 11802, SV 29 mm., Iriu, Manus Island, Manus Province. B. MCZ 141369, SV 40 mm., N'Drova Island, Manus Province. C. NHMB 10955, SV 41 mm., Tabar Island, New Ireland Province.

lighter brown stripe lateral to it. The light dorsolateral stripe is narrow and somewhat broken

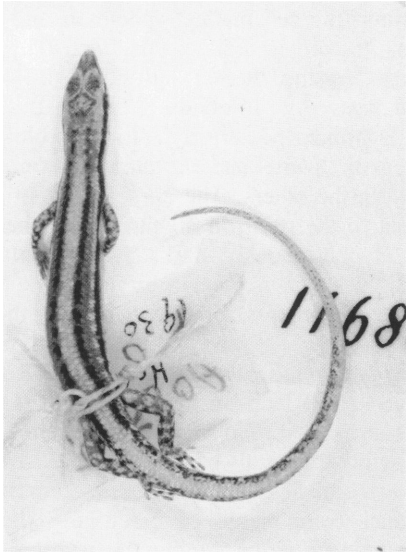


FIG. 5. *Lipinia noctua* from Fissoa, New Ireland, New Ireland Province, NHMB 11685, SV 36 mm. (paratype of *L. rouxi*).

up posteriorly. The lateral band is dark and continuous.

Eight specimens from New Britain are strongly striped. None has the occipital spot completely cut off from the vertebral stripe and in two large individuals (47 and 51 mm. SV) it is not distinguished by paler, brighter pigmentation (fig. 6A). All specimens (24 to 51 mm. SV) have a distinct, sharp-edged vertebral stripe. One small specimen (fig. 6B, SV 30 mm.) has a paravertebral field pigmented somewhat like that of the lizards from New Ireland—a black edge along the vertebral stripe bordered by a paler stripe—but without the unusually wide vertebral field as in the New Ireland lizards. This pattern is duplicated in lizards on Bougainville Island (see following). In the other specimens, including the smallest, this field is unevenly pigmented but is not clearly divided among the two longitudinal components nor broken into distinct dark blotches. The light dorsolateral stripe is distinct in all specimens as is the dark lateral stripe. The latter is continuous and bears light spots. All stripes extend to the rear of the body.

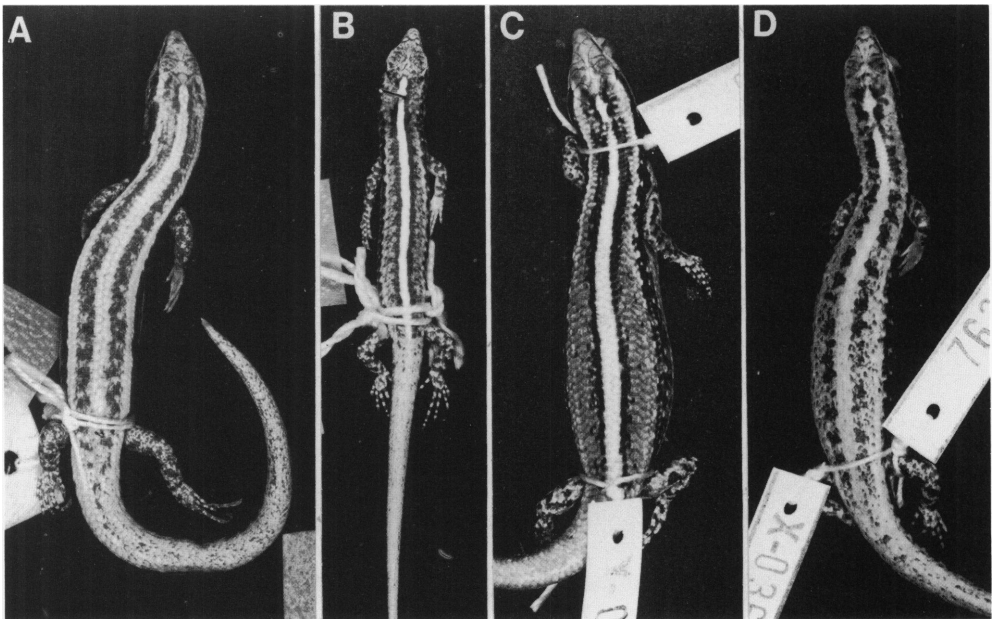


FIG. 6. *Lipinia noctua* from New Britain and Bougainville Island. A. NHMB 11637, SV 47 mm., Arawe, West New Britain Province. B. NHMB 11636, SV 30 mm., Jacquinot Bay, East New Britain Province. C. MCZ 93823, SV 47 mm., Melilup, Bougainville Province. D. MCZ 76273, SV 46 mm., Kunua, Bougainville Province.

BOUGAINVILLE ISLAND: The sample of 27 specimens from this island includes two pattern types that I designate type A (fig. 6C) and type B (fig. 6D). In type A the vertebral stripe is distinct to the tail base and is edged by a narrow, continuous dark border. The dorsolateral light field is broad and relatively unmarked. The labials have indistinct dark bars or none. Type B lizards have a less well-defined vertebral field, and the paravertebral fields are broken into irregular spots much broader than the homologous narrow dark line in type A lizards. The dorsolateral light field is narrower than in type A and more spotted. The lips bear strong, vertically oriented dark bars. In both forms the lateral dark field is continuous and lightly spotted.

In view of the variation seen elsewhere, such variation would not be particularly noteworthy except that on Bougainville the pattern types appear to be geographically segregated. Most of the type A lizards (12 of 14 specimens) come from elevations above 600 m. (perhaps as high as 1200 m.) in the southern (Turiboiru, Matsiugu), central (Guara area near Kieta), and northern (Mutahi, Melilup) parts of Bougainville. Two, however, come from close to sea level in the vicinity of Kieta, a station on the east coast. The type A pattern is duplicated in a lizard from the south coast of New Britain (fig. 6B). The 13 type B lizards are from Kunua, a low-elevation station on the northwest coast.

Most of the specimens of types A and B are of adult size, so the extent of ontogenetic change, if any, is not known. The smallest specimens of each (A, 33.2 mm.; B, 30.5 mm. SV) have typical patterns. The specimens were not sexed, but the geographic segregation of the pattern types makes sexual dimorphism a very unlikely explanation of the differences.

OCEANIC ISLANDS: A survey of pattern variation in *Lipinia noctua* throughout its vast distribution in the Pacific is outside the scope of this study, but I have examined specimens from many parts of the range. (See Burt and Burt, 1932, for localities of many specimens in the American Museum of Natural History.) My impression is that variation across the Pacific is much less than is seen in the smaller New Guinea region. Nowhere did I see lizards so extremely different from each other as those

from Morotai, New Ireland, and Milne Bay. Typically, adult lizards from the Pacific Islands have a distinct occipital spot and a persistent light vertebral stripe. The spot is brighter than the vertebral stripe, if not actually separated from it (fig. 7). There seldom are distinct paravertebral and dorsolateral fields; rather, the dark spots of the paravertebral field tend to fade in larger lizards and the light brown of the ground color carries across to the edge of the dark lateral field. This last field may be broken into large dark blotches or may persist as a dark field with small light spots. Among the lizards from the Papuan region, those from the Lake Sentani and lower Sepik areas on the north coast of New Guinea most closely resemble the Oceanic populations.

TAXONOMIC CONSIDERATIONS

The principal character that has been utilized to diagnose *Lipinia miota* is the presence of a single frontoparietal scale. Indeed, this character has been given weight in generic (Mittleman, 1952) and infrageneric (Smith, 1937) classifications. Among the samples I studied, no other scale character shows variation concordant with that seen in the frontoparietals. In fact, the only scale character in which one mainland New Guinea population differs much from any other is the number of nuchals. The lower Sepik sample (N = 8), with fewer nuchals than most, has all three conditions of the frontoparietal and shows no correlation between number of nuchals and state of frontoparietal. Thus, there is no support among scale characters for the proposition that lizards with a single frontoparietal are a species distinct from those with paired scales.

Variation in color pattern is considerably greater than in scutellation, but still no correlation with scutellation emerges that would support specific status for *miota*. For example, lizards from the Huon Peninsula are closely similar in pattern to some from the northwest coast, where lizards from one locality (Doromena) having patterns essentially identical with those of eastern lizards show both single and paired scales.

Boulenger (1895a) diagnosed *miota* on the basis of, in addition to its single frontoparietal,

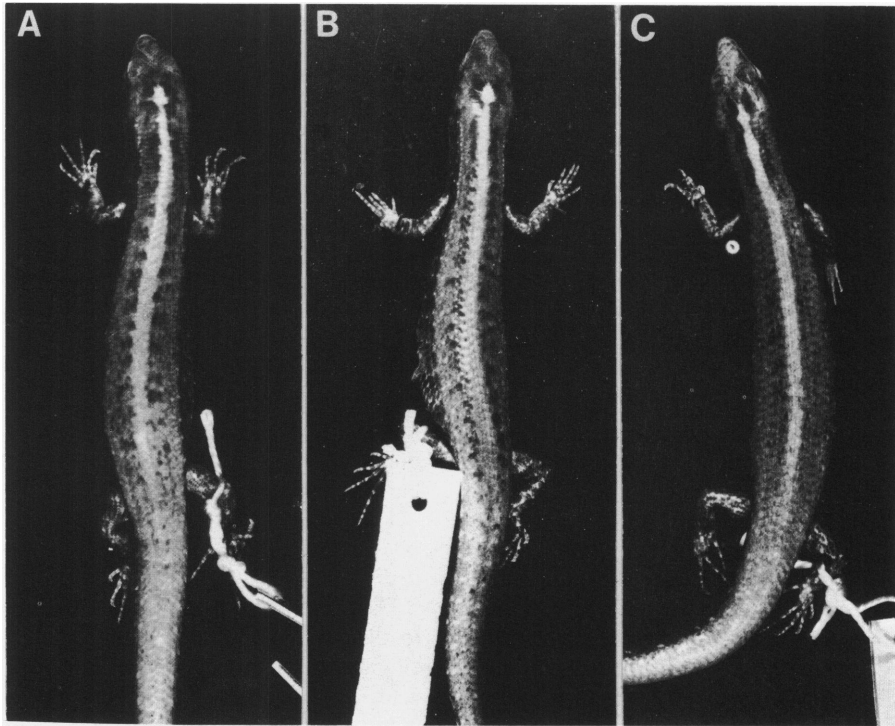


FIG. 7. *Lipinia noctua* from Pacific Islands. A. AMNH 60170, SV 43 mm., Erromanga, New Hebrides. B. AMNH 113272, SV 41 mm., Nukuhiva, Marquesas Islands. C. AMNH 66571, SV 45 mm., Runit Atoll, Eniwetok, Marshall Islands.

a broader internasal and much smaller ear opening. I have not studied the second character and have given only cursory attention to the third. I note in passing that the smaller of two specimens with single frontoparietals (fig. 3C) has a larger ear opening than the larger (fig. 3D), suggesting considerable variation in this character.

I conclude that *Lipinia miota* cannot be distinguished on a specific level from *Lipinia noctua*.

Although *miota* and *noctua* cannot be verified as different species, some populations of *noctua* are distinctive in color pattern, in one or more aspects of scutellation, or in both color and scutellation. Thus, the recognition of subspecies within *L. noctua* requires discussion.

The first use of a trinomial in this group was Peters and Doria's (1878) *Lygosoma (Mocoo) noctua* var. *ternatensis*, a combination that

seems generally to have been ignored. Loveridge (1948) was the first recent author to use trinomials for populations of *L. noctua*. He referred to specimens from New Guinea as *Lygosoma (Leiolopisma) noctua noctua* in his text (1948, p. 357); in a list (p. 318) he used the combination *Lygosoma (Leiolopisma) noctua rouxi* for the form described from New Britain by Hediger (1934) as *Leiolepisma rouxi*, but did not document the assignment of *rouxi* to subspecific status. In the same publication Loveridge recognized *miota* as a distinct species. Subsequently, Tanner (1950, 1952) referred to specimens from the Moluccas, Tahiti, and the Marquesas as *Lygosoma (Leiolopisma) noctua noctua*, and Oliver and Shaw (1953), Hunsaker and Breese (1967), and McMorris (1970) used the same trinomial for the Hawaiian population.

Lizards from Morotai in the Moluccas (fig.

2) are distinctive in the persistent striping of adults, in the contrast between dark and light fields, and in having the lateral field broken into large, squarish blotches. They differ from lizards from the New Guinea mainland in having a higher mean number of lamellae under the fourth toe, but small samples from other islands (Tabar, New Ireland) have even more scales. Possibly the name *ternatensis* could apply to this population, but I have seen no specimens from Ternate (or from islands in the Moluccas other than Morotai) and do not know if the features seen in the lizards from Morotai are also characteristic of other populations in the Moluccas.

A similarly distinctive population is the one from New Ireland (fig. 5) named *rouxi* by Hediger (1934). These lizards also are persistently striped, but the lateral band is continuous rather than broken and the paravertebral field is resolved into dark and light longitudinal components rather than into dark and light spots. These lizards have even more fourth toe lamellae than occur in the sample from Morotai. Hediger (1934, p. 464) compared *rouxi* to *Lipinia longiceps* (Boulenger), but I think that Loveridge (1948) was more nearly correct in treating *rouxi* as a subspecies of *noctua*. The snout shape of *rouxi* is that of *noctua* rather than the elongate snout of *longiceps*, and the body pattern is more readily derived from the general *noctua* type.

The distribution of characters of color pattern and scutellation among samples from New Guinea does not resolve into a geographic pattern of concordant variation that would support separation into subspecies. As discussed above, the sample from eastern New Guinea ("*miota*") is distinctive in the 100 percent incidence of the single frontoparietal scale (fig. 1), but in color pattern the lizards resemble those from part of the north coast of New Guinea where the incidence of single frontoparietals appears to be low. Lizards from a locality on the lower Sepik River are distinctive in color pattern from most other New Guinea specimens and differ somewhat from other Papuan samples in having fewer enlarged nuchal scales, but (at least as preserved specimens) they do not differ greatly in pattern from specimens from the region of

Lake Sentani, 300 km. to the west, where nuchals are normal.

Considering the samples from the New Guinea region as a whole, I can see no great advantage in according subspecific recognition to any population. Some populations could be singled out and adequately diagnosed, with those of Morotai Island and New Ireland being the best candidates, and a case could even be made for recognizing two subspecies on Bougainville Island. Yet this would leave a majority of populations either as *L. noctua* ssp. or in a meaningless catchall, *L. n. noctua*. Perhaps the acquisition of larger series of specimens from more localities will reveal patterns of character distribution that will make for geographically meaningful subspecies, but for the present I feel that recognition of subspecies is not warranted. The following synonymy expresses my taxonomic conclusions.

Lipinia noctua (Lesson)

- Scincus noctua* Lesson, 1830, p. 48 (type locality, "Oualan," given as "Qualan" by Loveridge [1948] and as "Ualan" by Burt and Burt [1932], both of whom identify it as Kusaie Island in the Carolines).
- Lygosoma vertebrale* Hallowell, 1860, p. 487 (type locality, "Sandwich Islands" [Hawaiian Islands]).
- Euprepes Novarae* Steindachner, 1869, p. 47 (type locality, "Taiti; Samoa-Inseln").
- Lygosoma (Lipinia) aurea* Meyer, 1874, p. 132 (type locality, "Jobi" [Japen Island, Geelvink Bay, Irian Jaya]; the original description is sparse to the point of being useless, but Boulenger [1887, p. 256] examined the type specimen and cited *aurea* as a synonym of *noctua*).
- Lygosoma (Mocoa) noctua* var. *ternatensis* Peters and Doria, 1878, p. 347 (type locality, "Ternate" [Moluccas]).
- Lygosoma miotis* Boulenger, 1895a, p. 29 (type locality, "Ferguson [Fergusson] Island," d'Entrecasteaux Islands, Milne Bay Province, Papua New Guinea).
- Lygosoma (Leiolepisma) subnitens* Boettger, 1896, p. 2 (type locality, "Bongu, Astrolabe Bai, New Guinea," [Madang Province, Papua New Guinea]).
- Leiolepisma rouxi* Hediger, 1934, p. 462 (type locality, "Fissoa (Neu Irland)," New Ireland Province, Papua New Guinea).

ECOLOGY AND DISTRIBUTION

What little is on record for *Lipinia noctua* indicates both terrestrial and arboreal habits. The only specimen I captured was on the wall of a shelter built of wood and palm fronds. Loveridge (1948) recorded one caught under similar circumstances and another under loose bark on a root buttress; Tanner (1950) mentioned one taken from a palm tree. Fred Parker (*in litt.*) mentioned exposed tree trunks as the habitat of *noctua* on Bougainville Island. Hediger (1934) referred to *noctua* as a "moderately good climber," but also recorded individuals found on a horizontal tree trunk and under bark on a fallen branch. Oliver and Shaw (1953) found *noctua* "a common ground inhabitant of the herbaceous vegetation along the beach dunes" of Runit Island, Eniwetok. McMorris (1970) found a Hawaiian specimen "in the leaf litter under a large Banyan tree." I infer from these anecdotal observations and from its morphology that *L. noctua* is somewhat of a generalist, able to function in both terrestrial and arboreal microhabitats but possibly not highly adapted to either.

Lipinia noctua is widespread among islands of the Pacific Ocean, from the Moluccas west of New Guinea to the Hawaiian Islands and to Pitcairn Island at the southeastern edge of the Tuamotu Archipelago (fig. 8). The distribution appears to be spotty, with some island groups well represented by specimens and others seemingly uninhabited. Records are abundant in the southern part of this range from the New Hebrides to the Marquesas and Tuamotus. The species was thought exterminated on the Hawaiian Islands (Oliver and Shaw, 1953), but it persists at least on Oahu (Hunsaker and Breese, 1967; McMorris, 1970). I find no records in the Gilbert Islands, only Eniwetok (AMNH 66571-72 + 4) in the Marshall Islands, and four widely scattered among the Caroline Islands: Yap and Fais (Sternfeld, 1920); Palau (Brown and Fehlmann, 1958); and Kusaie (type locality). There are no records for the Loyalty Islands or New Caledonia, and few for the Solomon Islands except for Bougainville (Tanner, 1951).

In the New Guinea region (fig. 1), *L. noctua*

occurs on the northern islands of the Moluccas, along the entire north coast of New Guinea (but on the south coast evidently only at the western end of the island), on islands of the Admiralties and Bismarck Archipelago, and on several islands off the eastern end of New Guinea. The distribution on New Guinea proper appears to be almost wholly coastal. The only locality much removed from the immediate coastal region is Kokoda, elevation 370 m.

In the following list of locality records in the New Guinea region, I cite literature references only for localities from which I did not examine specimens. Abbreviations: AMNH, the American Museum of Natural History, New York; BMNH, British Museum (Natural History), London; BYU, Brigham Young University, Provo, Utah; FMNH, Field Museum of Natural History, Chicago; MCZ, Museum of Comparative Zoology, Harvard University; NHMB, Naturhistorisches Museum Basel, Switzerland; RMNH, Rijksmuseum van Natuurlijke Historie, Leiden; USNM, National Museum of Natural History, Washington; ZMA, Zoölogisch Museum, Amsterdam.

INDONESIA: Moluccas: Morotai Island, south end, within 3 miles of Pitu airfield (BYU 7325, 7358, 7359, 7388, 7389, 7404, 7597, 7632-7640, 7772); Halmahera Island, Soah Konorah and Tobelo (Boettger, 1900); Ternate Island (Peters and Doria, 1878; Boettger, 1900). Irian Jaya (West New Guinea): Sorong (Barbour, 1912); Mansinam Island (Peters and Doria, 1878); Dorei (= Manokwari, Peters and Doria, 1878); Tangion Bair (Peters and Doria, 1878); Pulo Faor (Poelau Faer, Peters and Doria, 1878); Fak Fak (de Rooij, 1915); Japen (Jobi) Island (Meyer, 1874, as *Lygosoma aurea*); Pionierbivak, Mamberambo River (de Jong, 1927); Liki Island (Loveridge, 1948); Toem (USNM 124639); Tawarin River (RMNH 4869); Lower Sermowai (ZMA 11287); Doromena (FMNH 43186, 43187); Lake Sentani region (NHMB 9294-9298).

PAPUA NEW GUINEA: West Sepik Province: Aitape (Loveridge, 1948). East Sepik Province: Valise Island (= Walis Island, Vogt, 1912); But (Vogt, 1912); Kamberamba, lower Sepik River (NHMB 11642-11650). Madang Province: vicinity of Bostrem Bay (AMNH

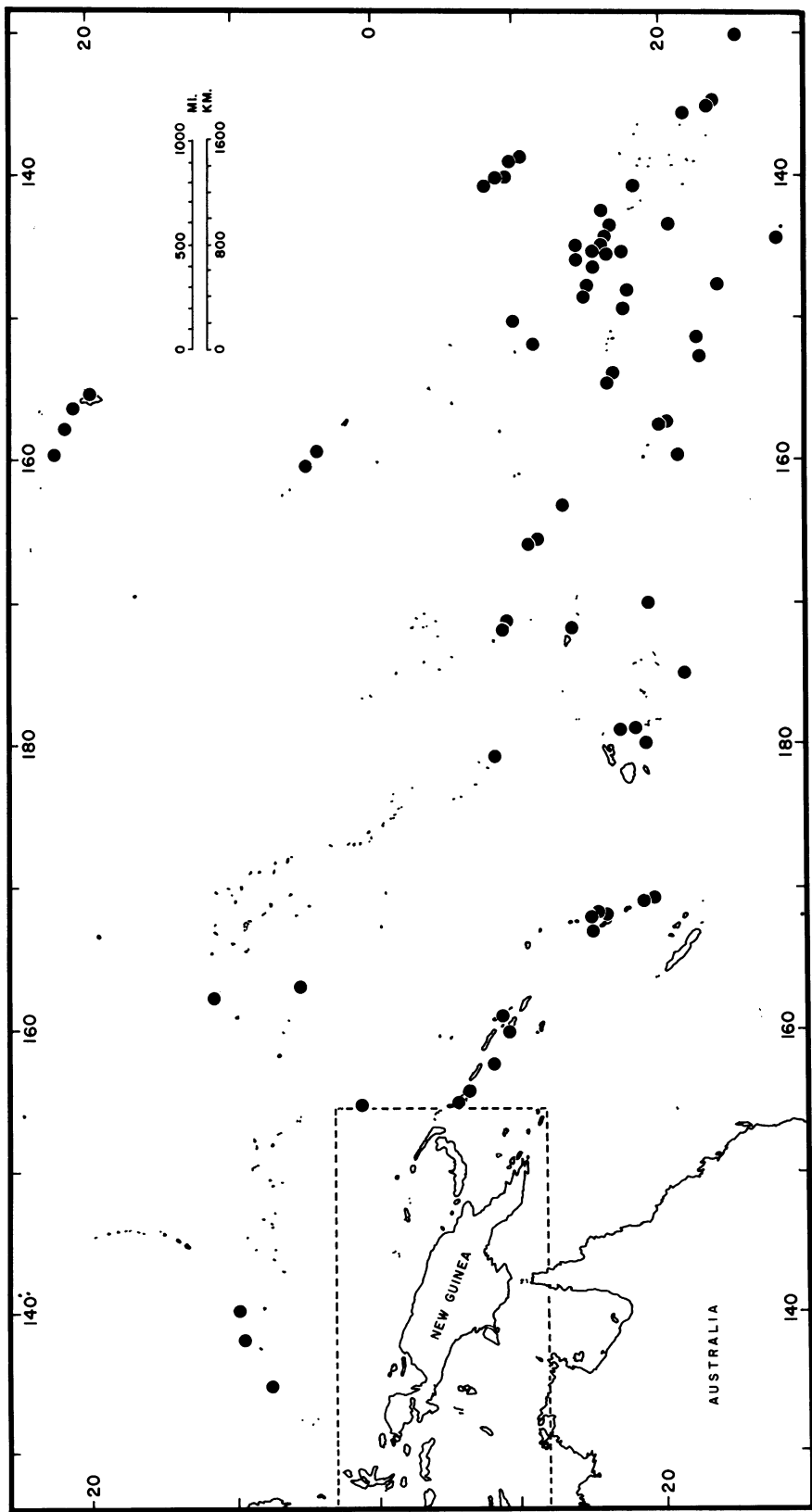


FIG. 8. Distribution of *Lipinia noctua* based on specimens examined and literature records. For localities in the area within the broken line, see figure 1.

105535); Madang (MCZ 130874, 130875); Bongu, Astrolabe Bay (Boettger, 1896, as *Lygosoma subnitens*); Bogadjim, Astrolabe Bay (Andersson, 1913, as *Lygosoma miotis*); Erima, Astrolabe Bay (Méhely, 1898). Morobe Province: Finschhafen (AMNH 95802; MCZ 49347-49349); Gusiko (USNM 119355); Lae (BYU 7862). Northern Province: Kokoda (AMNH 95374; BMNH 1935.5.10.116-117; Embi Lakes (MCZ 135430). Milne Bay Province: Milne Bay (BMNH 1903.4.30.20; USNM 119182, 119183); Fergusson Island (Boulenger, 1895a, as *Lygosoma miotis*); Woodlark Island (AMNH 76810); Misima Island (AMNH 76825, 76826); Kiriwina Island (Kinghorn, 1928); Trobriand Islands (MCZ 146032). Manus Province: Iriau, Manus Island (NHMB 11802); Lorengau, Manus Island (MCZ 139524, 139525); Pak Island (Vogt, 1912); N'Drova Island (MCZ 141369). New Ireland Province: Fisoa, New Ireland (NHMB 11685, 11686, 11689 [paratypes], 11690 [holotype of *Leiolepisma rouxi*]); Tabar Island (NHMB 10953-10955); Masaket and Malie Islands, Lihir Group (Sternfeld, 1920); New Hanover (Werner, 1899). West New Britain Province: Movehafen (NHMB 11635); Arawe (NHMB 11637-11641). East New Britain Province: Jacquinot Bay (NHMB 11636); Gasmata (NHMB 11634). Bougainville Province: Pinipel, Green Islands (Sternfeld, 1920); Bougainville Island, Kieta and vicinity (MCZ 64221, 65544, 65872); Bougainville Island, Kunua and vicinity (MCZ 67750, 67751, 72534, 76004-76008, 76271-76273, 76921, 76922); Turiboiru (MCZ 88494, 93827, 93828); Mutahi, 670-975 m. (MCZ 91464, 93824-93826); Melilup, 900 - 1200 m. (MCZ 93822, 93823, 98783); Matsiogu, 640 m. (MCZ 97318).

NOTES ON OTHER NEW GUINEAN SPECIES OF *LIPINIA*

Greer (1974, p. 11) included 20 species in the genus *Lipinia*. I have referred *miota* and *rouxi* to the synonymy of *L. noctua*. Five of the remaining 18 species are known to inhabit New Guinea: *cheesmanae*, *longiceps*, *noctua*, *pulchra*, and *venemai*. I have examined specimens of all but the last species. The only published key (de Rooij, 1915, pp. 227-229)

antedates the descriptions of two of the species, so I provide here a new key, illustrations, distribution maps, and some notes on the New Guinean species other than *noctua*.

Lipinia cheesmanae (Parker) 1940

Figure 9A

Three specimens of this species (AMNH 62461, 62464, 62465) were taken by the 1938-1939 Archbold New Guinea Expedition (Archbold, Rand and Brass, 1942) at 4 km. southwest of Bernhard Camp, 850 m., on the Idenburg River of Irian Jaya, located 190 km. southwest of the type and the only other known locality for the species, Sabron, Cyclops Mountains (fig. 10).

The specimens agree well with the original description except that in one of the two intact specimens the prefrontal scales are not in contact (the skull was removed from the third specimen). As Parker stated, this species appears to be closely allied to *L. longiceps*. In the degree of modification of the feet for arboreal habits, it stands between *longiceps* and the less highly adapted species *noctua* and *pulchra*. The basal toe lamellae are notably broader than the compressed distal lamellae, but the difference is less extreme than in *longiceps*. The fourth toe is longer than the third (virtually equal in *longiceps*) but is relatively shorter than in *noctua* and *pulchra*.

Lipinia longiceps (Boulenger) 1895b

Figure 9B

The type locality is Trobriand Islands, north of the eastern tip of New Guinea. The species ranges from Misima Island (AMNH 76827) along the north coast of New Guinea at least to the vicinity of Humboldt Bay in Irian Jaya and from Etna Bay to the Lorentz River on the south coast of Irian Jaya (fig. 11). Localities in Papua New Guinea include Lae (AMNH 92326), Gusiko (AMNH 66697; Loveridge, 1948), Draeger Harbor and Aitape (Loveridge, 1948). In Irian Jaya there are several records for the vicinity of Humboldt Bay on the north coast and for localities on the south coast (summarized by de Rooij, 1915), and two inland but low-elevation records, Prauwenbivak on the

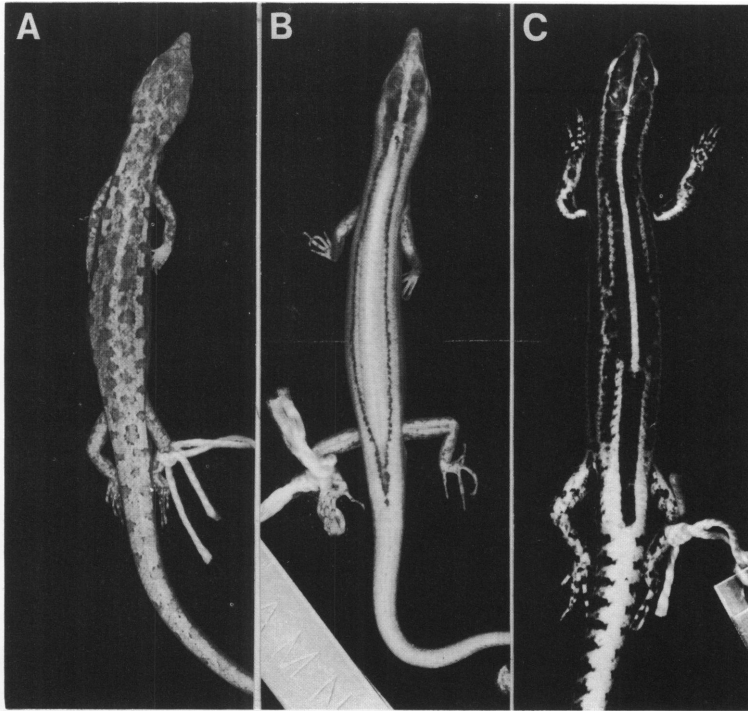


FIG. 9. A. *Lipinia cheesmanae*, AMNH 62465, SV 39 mm., 4 km. SW Bernhard Camp, Idenburg River, Irian Jaya. B. *Lipinia longiceps*, AMNH 66697, SV 38 mm., Gusiko, Morobe Province, Papua New Guinea. C. *Lipinia pulchra*, AMNH 66703, SV 41 mm., Lae, Morobe Province, Papua New Guinea.

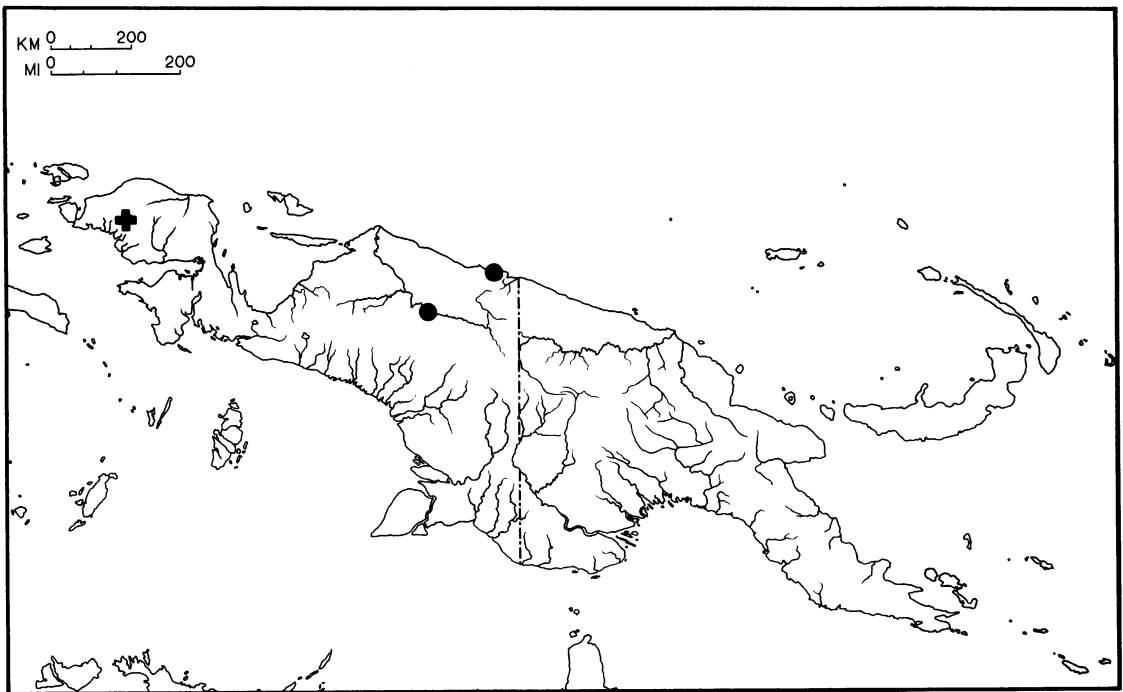


FIG. 10. Distribution of *Lipinia venemai* (cross) and *L. cheesmanae* (circles) in New Guinea.

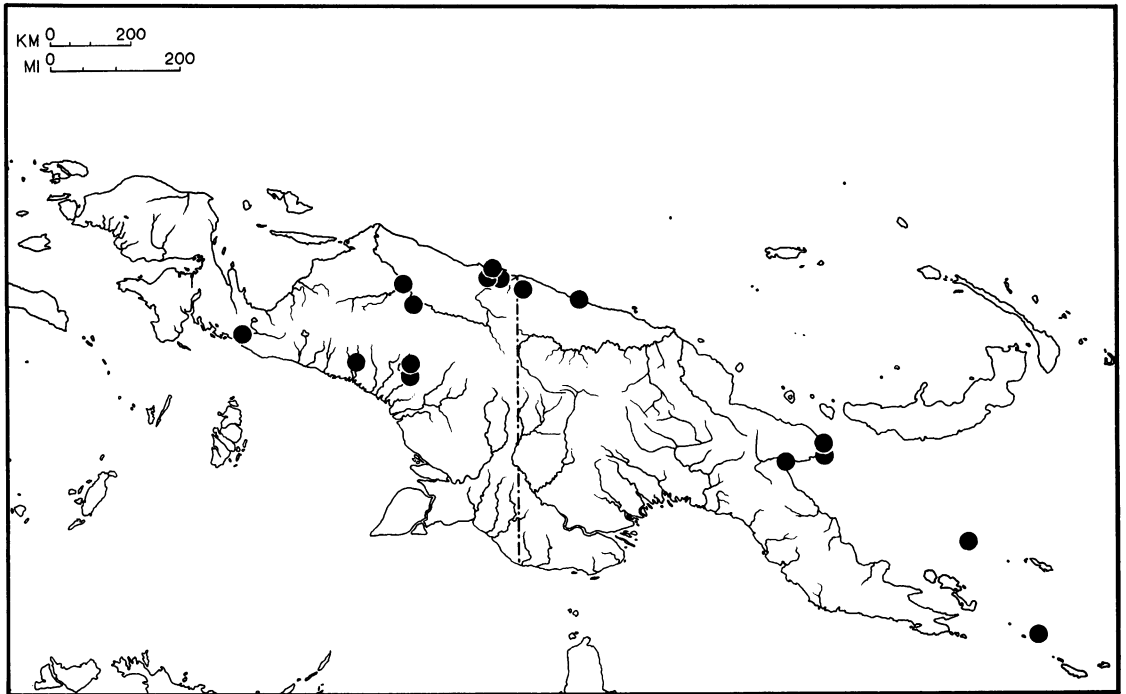


FIG. 11. Distribution of *Lipinia longiceps* in New Guinea.

Idenburg River (de Jong, 1927), and Mamberambo River, 50 m. (de Jong, 1930).

With its narrow, elongate snout and broadened basal digital lamellae, the distinctive *longiceps* is perhaps the most derived of the Papuan *Lipinia*. It is readily recognized by its color pattern (see Key). Melvin C. Kurtz, who collected the AMNH specimen from Gusiko, noted that it was captured on a tree trunk and had golden stripes. Loveridge (1948) provided more detailed color notes.

Lipinia pulchra (Boulenger) 1903
Figure 9C

This species is recorded from several localities in the northern drainage of Irian Jaya, including Prauwenbivak on the Idenburg River (de Jong, 1927) and localities in the general vicinity of Humboldt Bay (de Rooij, 1915). Records in Papua New Guinea include Aitape on the north coast (Loveridge, 1948), Lae

(AMNH 66703, 113175-113179), Popondetta (MCZ 137596, 137678), 8 miles east of Popondetta (MCZ 139523), and the type locality, "Albert Edward Ranges, 6000 feet" (Boulenger, 1903), on the southeastern tail of the island (fig. 12).

All locality records except the type locality are for coastal sites or low elevations, the highest being upper Sermowai River, ca. 400 m. I suspect that the elevation given for the type locality may be excessive. The collector ("H. S. Rohn" according to Boulenger, but probably the same as "R. H. Rohu" of Wichmann [1912]) also obtained specimens of six species of microhylid frogs with the same locality data: *Genyophryne thomsoni*, *Phrynomantis lateralis*, *Hylophorbus rufescens*, *Xenorhina doriae*, *Barygenys atra*, and *Copiula oxyrhina* (possibly *C. fistulans*). All are known from lowlands or foothills, but only one (*H. rufescens*) is known from as great an elevation as 6000 feet, if Rohu's specimens are excepted.

According to Wichman (1912), Rohu was the jailer and overseer at "Tamata-Station," which I infer was at or near the present Ioma Patrol Post in Northern Province on the coastal plain east of the Albert Edward Ranges. Wichmann indicated that on Rohu's one collecting trip to the Albert Edward Ranges he attained an elevation of 6000 feet. I think it likely that he obtained at least some of his specimens, including the holotype of *L. pulchra*, at elevations well below the highest attained.

Lipinia pulchra is close to *L. noctua* in head shape, narrowness of subdigital lamellae, and in having the fourth toe longer than the third. The two are quite distinct in color pattern (see Key). The frontoparietal is single in *pulchra*, so far as is known, but is paired in other Papuan *Lipinia* except for some *L. noctua*. The field notes of the collector of the AMNH specimens, Melvin C. Kurtz, provide information on habits and color in life. The lizards were sun-

ning on tree trunks in early morning and hid under dry, flaky bark when disturbed. The light stripes of the body were golden on a jet black background; the tail was vivid orange.

Lipinia venemai (Brongersma) 1953a

I am aware of no specimens of this species other than the male holotype and female paratype (+ 2 embryos) upon which Brongersma (1953a) based his description. A photograph of the holotype appears in Brongersma (1953b). The type locality, Ajamaroe, and only other locality, Djidmaoe, are 15 km. apart at an elevation of 260 m. in the center of the Vogelkop Peninsula of Irian Jaya (fig. 10).

KEY TO THE SPECIES OF *LIPINIA* ON NEW GUINEA AND NEARBY ISLANDS

For distinctions between *Lipinia* and other related Papuan genera, see Greer (1974); however, note that his character of "color pat-

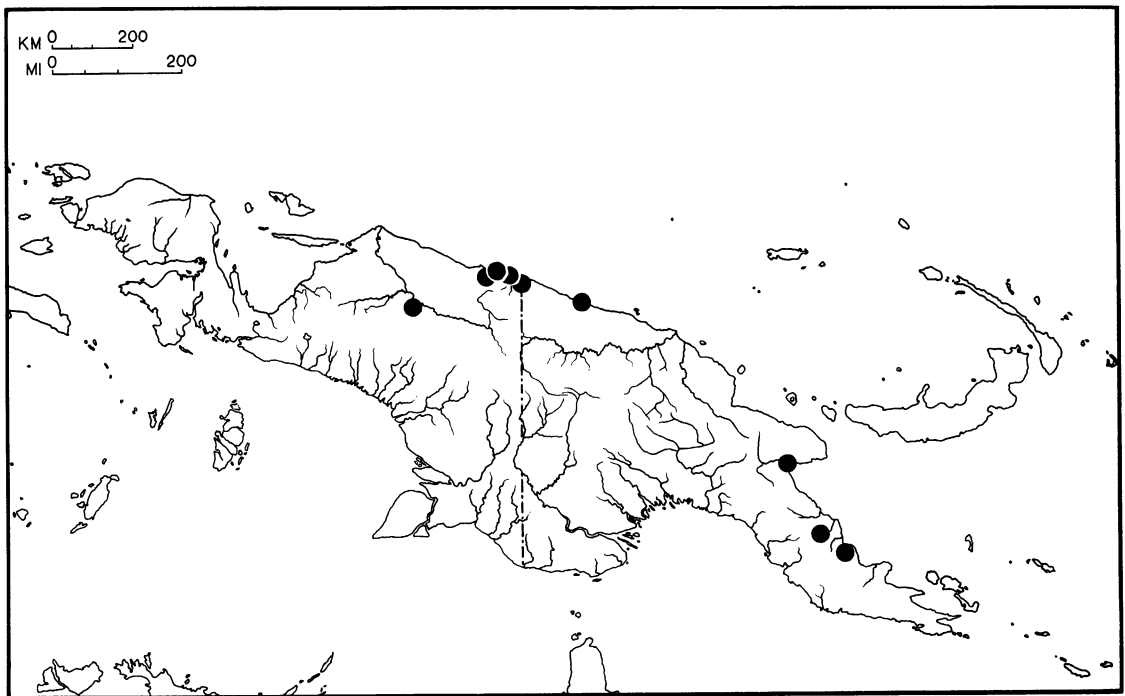


FIG. 12. Distribution of *Lipinia pulchra* in New Guinea.

tern of striking light and dark longitudinal stripes" does not hold for all *Lipinia* and in one species (*noctua*) varies intraspecifically. In many characters of scutellation often useful in discriminating species of skinks (e.g., scales around midbody, rows from occiput to rump, number of lamellae under the fourth toe), these *Lipinia* show few or no interspecific differences. Hence, characteristics of color pattern are emphasized in several couplets. Additional characteristics sometimes useful in determinations are included parenthetically.

1. Body pattern without a distinct striped component2
 Body pattern with a distinct striped component, which may be limited to a light vertebral stripe on neck and anterior trunk3
2. Snout elongate and depressed, narrow, with margins slightly concave when viewed from directly above (prefrontals in contact or narrowly separated; basal toe lamellae broadened; no light occipital spot) ... *cheesmanae*
 Snout shorter, not depressed, margins straight when viewed from above (prefrontals usually well separated; basal toe lamellae broader than distal; often a dark-bordered, light occipital spot) *noctua*
3. A pair of narrow dark lines, forming outer margins of paravertebral fields, converge abruptly at base of tail (snout narrow, elongate and depressed; prefrontals in broad contact; frontoparietals paired; basal toe lamellae broadened; fourth toe scarcely longer than third *longiceps*
 Pattern variable, but not as described (snout not notably narrow, elongate or depressed; prefrontals usually separated; frontoparietal single or paired; basal toe lamellae broadened or not; fourth toe distinctly longer than third 4
4. Neck and body with an uninterrupted dark lateral field bordered on its upper edge by a clear white stripe; no other stripes present, middorsal region unpatterned *venemai*
 Lateral region not as described or if so, then stripes, spots or other markings present in middorsal area 5
5. A narrow white stripe commences on tip of snout and terminates abruptly at midbody, replaced there by a broader dark brown stripe derived from the paravertebral stripes (frontoparietal single) *pulchra*
 Pattern variable but not as described; vertebral stripe, if present and terminating anterior to base of tail, fades out and is not replaced

abruptly by a broader dark stripe (frontoparietal single or paired) *noctua*

BIOGEOGRAPHY

The variation in color pattern of *Lipinia noctua* is peculiar in one respect; namely, the diversity seen on New Guinea and nearby islands, compared with the relative uniformity of populations scattered across thousands of miles of the Pacific Ocean. Conceivably, a more detailed study might alter this impression of relative uniformity, but I think it unlikely that the span of variation seen within the much smaller New Guinea region (Moluccas to Bougainville) will be approached. The biogeographic implications of this situation merit consideration.

New Guinea is thought to be a geological composite, formed when the northern edge of the northward-moving Australian Plate collided with an island arc in the Miocene (Jaques and Robinson, 1977, and references cited therein). The north coast ranges of New Guinea incorporate parts of this arc, with New Britain remaining insular, whereas the islands from Manus through New Ireland into the Solomons constitute a second arc (Curtis, 1973). Possibly islands of these arcs possessed vicariant populations of *Lipinia noctua* that had differentiated in color pattern and in some cases slightly in scutellation as well. Opportunities for dispersal and gene flow that opened with the amalgamation of some islands into the main mass of New Guinea could have led to the confusingly varied situation seen there today. Similar reasoning could be applied to the origin of the several species of *Lipinia* endemic to the New Guinea region, all of which have at least part of their distributions on land-locked remnants of the island arc. There is no fossil record of *Lipinia*, but within the Scincidae at least one Recent genus extends well back into the Tertiary: *Eumeces* is known from the middle Oligocene as well as from several Miocene localities (Estes, 1969). *Lipinia* could be similarly ancient.

The relatively slight variation seen over the vast area inhabited by Oceanic populations of *L. noctua* argues for more recent dispersal. I suggest that this has come about largely by human agency, with the lizards traveling as stowaways during inter-island voyages. This

implies that the "seeding" of Oceania was from a single source (not from a variety of differentiated populations of the New Guinea region), and that dispersal has been mainly within Oceania.

Somewhat comparable variation and distribution are seen in another skink of similar size, habitus and habits, *Cryptoblepharus boutonii* (Desjardin), which coexists with *L. noctua* over a broad area of the Pacific. Mertens (1931) recognized 36 subspecies of *C. boutonii* (some now considered distinct species). With this penchant for lending taxonomic recognition to geographic variation, he nevertheless assigned most Oceanic island populations to a single subspecies, *C. b. poecilopleurus* (Wiegmann).¹ The explanation advanced for the situation in *L. noctua* on the Pacific Islands can be applied here. On New Guinea itself the situation is somewhat different, with two allopatric subspecies of *boutonii* occupying the north coast and two forms of Australian affinity, one possibly a distinct species, found in southern New Guinea. The status of *Cryptoblepharus* in New Guinea is too poorly known to permit further comparisons.

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