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Notes on a Collection of Squamate Reptiles from Eastern Mindanao, Philippine Islands Part 1: Lacertilia

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Abstract. -In 1982, I spent six months collecting the herpetofauna of several areas in eastern Mindanao, Philippine Islands. I present species accounts for all lizards collected at these sites, and draw conclusions about the biodiversity of second-growth and primary forest habitats. I found second-growth habitats to be depauparate compared to primary forest habitats. Species which may depend on primary forest habitat and also species apparently restricted to such habitats are detailed. The importance of primary forest reserves, selective logging, and a mosaic of successional habitats within primary forest reserves is discussed.

Key words: Reptilia, Squamata, Lacertilia, Philippines, taxonomy, ecology, biodiversity

Introduction

Little is known of the ecology, distribution, and life history of Philippine lizards. Taylor (1922a, b, c; 1923; 1925) investigated the systematics and zoogeography of the Philippine herpetofauna and provided some ecological information. Brown and Alcala (1961, 1964, 1978, 1980) undertook ecological and systematic studies on some islands, Alcala (1986) recently reviewed the herpetofauna, and Auffenberg (1988) has detailed the ecology of the Gray's monitor, *Varanus olivaceus*. However, many islands remain poorly known. This and a subsequent paper provide information on the natural history of squamate reptiles collected in eastern Mindanao, Philippine Islands, during a collecting trip to the area made in 1982. I also comment on squamate assemblages occurring in primary and second-growth dipterocarp forest in an effort to pinpoint species of special concern should primary forest continue to be lost to logging and agricultural practices.

Site Description Vegetation.—The vegetation of the Philippines was described by Brown (1919) and Dickerson (1928) and a detailed study of southeast Asian rain forests was published by Richards (1952). Trees of the family Dipterocarpaceae dominate the rain forests of the Philippines. For the purposes of my study, primary dipterocarp forest is defined as dipterocarp forest that has apparently never been logged. Early second-growth dipterocarp forest is defined as dipterocarp forest selectively logged one or two years previously. It has abundant ground cover of rattan, herbaceous vines, shrubs, and lianas. A few small (<2 m) trees were present, and the ground was littered with fallen logs. Selective logging was practiced at my study sites, and some small dipterocarps were left standing, though not enough to cast appreciable shade. Late second-growth dipterocarp forest is defined as forest selectively logged three or more years ago. It usually had a closed canopy composed of young fast-growing trees (mostly *Trema* species) about 10-15 m tall. Small dipterocarps were present, and the herbaceous understory was extremely dense. The vegetation of my study areas is discussed in more detail in Smith (1985).

Site 1.—This site was located in the coastal mountains (Diuata Range) of east-central Mindanao, 55 km south, 20 km west of Bislig Bay and 10 km southeast of Mt. Agtuuganon (Fig. 1). Areas from 500-800m elevation were sampled. Vegetation of this area was early second-growth and primary dipterocarp forest. Slopes were generally very steep (Fig. 2, 3, 4). This site was sampled from April 6 to August 15, 1982.

Site 2.—This site was also in the Diuata Range, 33 km south and 7 km west of Bislig Bay (Fig. 1). Vegetation at this site consisted entirely of late second-growth

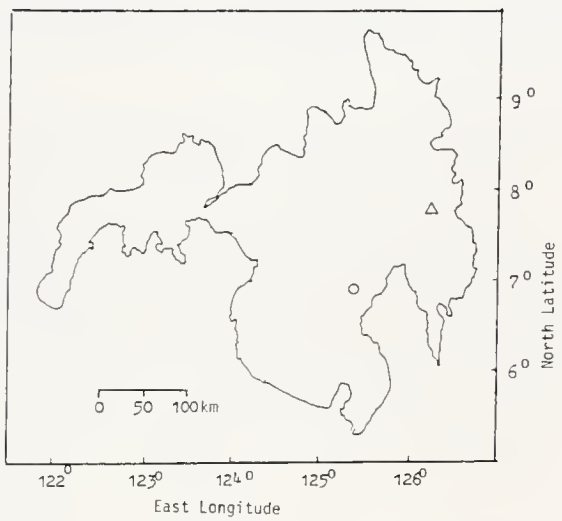

FIGURE 1. Map of Mindanao, Philippine Islands, showing locations of collecting sites 1 and 2 (triangle) and site 3 (circle).

dipterocarp forest. Slopes were moderately inclined to steep. The site was 400 m in elevation, and was sampled from August 21 to September 4, 1982.

Site 3.—I also visited Mount Talomo, a 2693 m peak located 30 km west of Davao City in the Mount Apo Range of southern Mindanao (Fig. 1). I sampled areas around the Philippine Eagle Captive Breeding Project (PECBP) field station (about 1000 m elevation) from September 8-13, 1982. Workers at the field station made incidental collections at this site from April to September. According to residents, logging in this area was discontinued sometime in the mid- to late-1960's. The area was selectively logged and appears to be more similar to typical pristine forest than many other logged areas I visited. Human disturbance is considerable on the slopes of Mount Talomo. Farms extend up the slopes from Davao Gulf to about 900 m elevation. Coconuts, bananas, pineapples, coffee, and various fruits and vegetables are grown. Areas sampled range from 600-1050 m. Slopes are gently to steeply inclined.

Climate.—Rainfall was heavy at all sites. At sites 1 and 2, there is no marked dry season. The wetter season usually occurs from November to March, with the heaviest rains in December and January (Census Office of the Philippine Islands 1920; Dickerson, 1928; Willmott et al., 1981). Annual rainfall in Surigao (the nearest weather station to sites 1 and 2) is 3647 mm, with 2360 mm falling from November to March, and 1191 mm of this amount in December and January alone (Willmott et al., 1981). Surigao is in the lowlands, and rainfall at my collecting sites may have been higher. Site 3 also does not have a marked wet or dry season (Census Office of the Philippine Islands, 1920; Dickerson, 1928). Annual rainfall in Davao (at the base of the Mount Apo range) is 1942 mm (Willmott et al., 1981). This figure undoubtably increases with elevation. During some times of the year, the PECBP station may be shrouded in clouds for weeks at a time. Temperature was relatively constant at all sites. At site 1 it usually ranged from 20-25 C under the canopy, and from 20-30 C in the open. The minimum temperature recorded was 18 C, the maximum was 34 C. Temperatures at site 2 were similar. Temperature readings were not available from site 3, but it was slightly cooler because of the higher elevation. Humidity at all sites varied from 79-100%. Occasionally typhoons strike Mindanao, but they generally lack the severity of those hitting more northerly islands (Census Office of the Philippine Islands, 1920, Dickerson, 1928). In March of 1982 a typhoon struck Bislig Bay near sites 1 and 2. The only effect at the study sites was moderate, steady rain for several days.

Methods

Specimens were collected using drift fences (Gibbons and Semlitsch, 1981) and by hand. Drift fences were 0.5 m high and 18 m long and constructed as detailed in Gibbons and Semlitsch (1981). Pit-cans and funnel traps were placed at either end of the fence. Pit-cans seemed effective at capturing all terrestrial lizards except *Varanus* spp. Funnel traps were primarily useful in capturing snakes. Drift fences appeared to adequately sample reptiles moving on the soil surface. To sample

FIGURE 2. Primary forest at the edge of a road cut at site 1. The ridge top is about 900m elevation.

arboreal fauna, I examined epiphytic ferns and trees felled during logging. These efforts were largely unsuccessful and arboreal species are under-represented in the collection. Data on macrohabitat (primary, early, or late second-growth dipterocarp forest), microhabitat (fossorial, terrestrial, or arboreal), elevation, date, and time of day were recorded for each specimen collected. Standard measurements including snout-vent (SVL), tail (TL), and total length (TTL) were taken in the field on freshly killed specimens. General weather conditions were noted daily. Specimens were dissected in the laboratory to determine sex, stomach contents, and reproductive condition of females. Food contents were identified usually to family for the arthropod prey of these lizards. Standard scale counts were also taken, but no deviation from previously published data was noted, and scale count data are not reported herein.

Species Accounts

Family Gekkonidae

Cyrtodactylus agusanensis:—Specimens of this species were collected in all habitats at sites 1 and 2. This species' morphology suggests nocturnal habits (vertically elliptical pupils), but half the specimens were captured in drift fences during the day. Specimens captured at night were taken on bushes and logs, 1-3 m above ground. My observations do not agree with Alcala (1986), who states that this species is found in swamps and along rivers. My specimens were all taken far from such habitats. I also did not find this species to be particularly rare, as did Alcala

(1986). Females taken June 14 and 23 had one large egg (15.7-18.2 mm long) in each oviduct. Small males were captured April 2 and 9 and a small female July 31. One juvenile was captured at site 2 on August 26. Stomach contents included insects of several families and a shed skin, probably of *C. agusanensis*.

Specimens examined: LSUMZ 41601-41609, 41640.

Family Agamidae

From their morphology, all agamids collected on the study sites appear to be arboreal, although most specimens, except *Draco* species, were caught on or near the ground.

Calotes cristatellus:—A female was collected at about 550 m in early second-growth forest at site 1. A male specimen lacks additional data. This species is rare, transient in the habitats sampled, or mostly arboreal and hence under-represented in the collection. It has morphology indicative of a highly arboreal lifestyle. The female, collected on July 1, had one large egg (38.4 and 35.2 mm) in each oviduct. Stomach contents included lepidopteran larvae, unidentified insects, and a snail.

Specimens examined: LSUMZ 41737, 41738.

Draco mindanensis:—Taylor (1922a) collected only two specimens of this species. They were taken at 1100 ft. at the base of Malindang Mountain, northwestern Mindanao. Inger (1983) examined taxonomic characters in nine specimens but gave no ecological data for them. My specimens were taken at 650 m at site 1 in primary forest. The species may be confined to primary forest. *Draco mindanensis* is diurnal and arboreal. A female contained two oviducal eggs 17.5 and 18.4 mm long. The date of capture of this specimen is unknown. Stomach contents consisted of several families of insects. This species is apparently not an ant-feeding specialist like its congener, *D. volans* (see below). *D. mindanensis* is reported from Catagan and Malindang Mountain in northwestern Mindanao (Taylor, 1922a) and the Diuata Mountains in the province of Davao del Norte, east-central Mindanao (this study).

Specimens examined: LSUMZ 41678-41680.

Draco volans.—This species is very common in early second-growth forest and is probably the most conspicuous lizard species in this or any other habitat. Individuals are commonly seen running along branches, displaying, and gliding. They are diurnal and exclusively arboreal. This species was never seen in primary forest. A female containing two eggs (14.7 and 13.9 mm long) was collected on July 20. Taylor (1922a) stated, and my data confirm, that this species feeds exclusively on ants.

Specimens examined: LSUMZ 41741-41748.

Gonyocephalus semperi.—Although arboreal by morphology, five specimens were captured on the ground in drift fences. One was caught by hand 1 m above the ground on a large tree. This species is diurnal, as is its' congener *G. godeffroyi* in the Solomon Islands (McCoy 1980). Four were captured in primary forest, two in late second-growth forest. Due to the species' arboreal habits, it is highly likely that *G. semperi* does not occur in highly disturbed areas largely lacking trees. McCoy (1980) found that *G. godeffroyi* also avoids open areas in the Solomons. One *G. semperi* exhibited aggression and grunted when handled. The single female captured June 16 contained three developing eggs (5.8, 6.6, and 7.3 mm in length). Stomachs examined contained the remains of insects of the families Chilopoda, Coleoptera, Hymenoptera, Orthoptera, and larval Lepidoptera.

Specimens examined: LSUMZ 41730-41735.

Hydrosaurus pustulosus.—This is a juvenile specimen collected by a native on

Figure 3. Early second-growth forest at site 1. This site had been selectively logged two or three years prior to this photograph. Trees in the middle backgound were deliberately left standing during the selective logging procedure.

June 19. Its' stomach was empty. It is said by Alcala (1986) to be omnivorous, which generally agrees with observations of captive specimens at the Dallas Zoo. Auffenberg (1988) states that adult *H. pustulosus* are entirely folivorous in the wild. Captive specimens usually lay 6-8 eggs measuring roughly 50 mm in length about once a year (Mitchell 1985). This species is said to be common in the Philippines near unpolluted mountain streams (Alcala 1986). It has also been observed around coastal fishing villages, utilizing as vertical perches the stilts or piers that support homes over water (L. A. Mitchell, personal observation).

Specimen examined: LSUMZ 41739.

Family Scincidae

In the Philippines, skinks far exceed the other lizard families in number of species, abundance, and probably in the variety of niches they occupy. They are often the most abundant lizards in all habitats sampled, with the exception of early second-growth forest, where *Draco volans* is more abundant. The leaf litter herpetofauna is dominated by species of the family Scincidae.

Brachymeles gracilis hilong: — Specimens were captured only in late second-growth forest (site 2, 400 m) and at Mount Talomo (site 3). Brown and Alcala (1980) stated that this fossorial species is found under leaves, duff, rotting logs, and

Figure 4. Small permanent stream in primary forest at site 1. Small streams such as this one were common in areas of primary forest at all sites.

in loose soil, usually only in primary forest from 50-1000 m elevation. This species is apparently rare or absent in early second-growth forest. Stomach contents indicate that this species is a generalized insectivore, however, part of a skink tail (*Mabuya* or *Sphenomorphus* species) was found in one stomach.

Specimens examined: LSUMZ 41719-41725.

Brachymeles schadenbergi orientalis.— This fossorial species was often caught in drift fences after long, steady rains. It is found under logs and in leaf litter and loose soil in primary and second-growth forests at elevations from 50-1000 m (Brown and Alcala, 1980). A female collected July 5 had three developing embryos 18.1, 15.9, and 15.0 mm in her oviduct. Brown and Alcala (1980) stated that this subspecies is ovoviviparous and usually has 2 or 3 young. This species is also a generalized insectivore. In addition, a lizard tail (probably *Brachymeles* species) was found in one specimen's stomach.

Specimens examined: LSUMZ 41726-41729.

Lamprolepis smaragdina philippinica.— This was a very common arboreal species in cultivated areas and villages, and a single specimen was taken in a coconut plantation on Mount Talomo between 700 and 800 m elevation. In contrast to Brown and Alcala (1980) and Alcala (1986), I never observed this species in primary or second-growth forests. My study sites did not encompass

agricultural areas or villages.

Specimen examined: LSUMZ 41648.

Lipinia semperi.—Taylor (1922a) noted that this species is commonly found in old tree stumps and hollow trees. Alcala (1986) states that it is arboreal and rare. My specimen was taken in daylight from an epiphytic fern 4 m above ground in primary forest at 800 m elevation.

Specimen examined: LSUMZ 41740.

Mabuya multicarinata multicarinata.—This is a very active and abundant skink that favors open areas. It is diurnal and terrestrial. All but two specimens were caught in early second-growth forest. One specimen was taken in late second-growth forest. An additional specimen was observed in primary forest, but this was within 100 m of a logging road and it may have been transient. This species seems to be a lizard of open areas, and it may have originally occupied natural treefall gaps in the forest. With extensive clearing of areas for logging and cultivation, *M. m. multicarinata* has probably increased substantially in numbers. Of eleven females collected throughout this study, only two failed to contain well-developed eggs. The rest had 2 (6 specimens) or 3 (3 specimens) large oviducal eggs 11.0-15.5 mm long. Juveniles 29-41 mm SVL were captured on June 24 and August 1, 4, 12, and 26. Another juvenile was taken from the stomach of a snake *(Cyclocorus nuchalis taylori)* that was collected July 1. Stomachs examined contained insects of many taxa, and I consider this species a generalized insectivore.

Specimens examined: LSUMZ 41610-41639.

Sphenomorphus Species

Lizards of the genus *Sphenomorphus* dominate the leaf litter herpetofauna of the primary forest in the areas I investigated, and they are sometimes conspicuous in secondary growth as well. *Sphenomorphus* exceeds all other genera at my sites in number of species and individuals. Its' species are mostly diurnal and terrestrial.

Sphenomorphus acutus:—Brown and Alcala (1980) state that this species is strictly arboreal, which may account for the paucity of specimens collected. However, three specimens were collected in drift fences during daylight, so they are at least occasionally found on the ground. This agrees with Alcala's (1986) observations. Stomach contents included arachnids and orthopterans.

Specimens examined: LSUMZ 41713-41715.

Sphenomorphus coxi coxi.—This was the most common ground-dwelling lizard in the primary forest and is the most conspicuous member of the leaf-litter herpetofauna in this habitat. It is fairly common in second-growth forest as well, but it is not seen in the open as often as *Mabuya multicarinata multicarinata*. Although unquantified, I believe that these observations represent a real difference, and that *M. m. multicarinata* replaces *S. c. coxi* as the dominant skink in second-growth habitats. Gravid females were collected April 27 (1 egg, 5.2 mm long), July 3 (2 eggs, 8.5 and 9.2 mm), and August 5 (2 eggs, 14.7 and 15.2 mm). One juvenile was collected May 21 and two on May 24. Four others were collected August 9, 13 (2), and 28. These juveniles measured 34-45 mm SVL. One small specimen identified as a male measured 45 mm SVL. These data suggest two hatching seasons during the six months of this study, one in May and the other in August. Apparently, reproductive maturity is reached at approximately 45 mm SVL. Stomachs examined contained insects of many taxa. I consider this species to be a generalized insectivore.

Specimens examined: LSUMZ 41649-41677.

Sphenomorphus decipiens.—Although Alcala (1986) states that this species is rare, I found it to be a fairly common diurnal

member of the leaf litter herpetofauna in primary forest. It was never found in second-growth forest. A juvenile (25 mm SVL) was collected June 23. Stomachs contained larval lepidopterans and other insects. Specimens examined: LSUMZ 41704-41711.

Sphenomorphus fasciatus.—Brown and Alcala (1980) noted that this species was a common terrestrial skink. During my study, I collected only one specimen at site 1. Since my capture techniques seemed especially efficient in sampling the terrestrial herpetofauna, I conclude that *S. fasciatus* was rare at my collecting sites. The stomach of this specimen contained insects of several taxa.

Specimen examined: LSUMZ 41716.

Sphenomorphus steerei.—This species is common in primary forest, and is occasionally found in second-growth forest. In my study, it was more common above 650 m elevation, although Brown and Alcala (1980) stated that it occurs from sea level to 2000 m. Stomachs contained insects of several different taxa.

Specimens examined: LSUMZ 41697-41703, 41712.

Sphenomorphus variegatus.—This species is a common diurnal leaf-litter lizard of the primary forest. It was never found in early second-growth forest, but two specimens were taken in late second-growth forest. *S. variegatus* appeared to be completely absent from highly disturbed areas. Females taken April 11 and May 24 each contained two eggs (11.0 and 10.3 mm; and 6.5 and 6.1 mm, respectively). Juveniles (SVL 24-39 mm) were captured May 23, June 29, August 9, and August 26. Stomachs contained insects of many different taxa.

Specimens examined: LSUMZ 41681-41696.

Tropidophorus partelloi.—This species was found to be active during the day and night. Specimens collected during the day were either captured in drift fence traps or found under cover. At night, individuals were found actively foraging. This species is apparently secretive during daylight. Specimens frequently grunted during capture and attempted to bite. All specimens were caught in primary forest except one caught in late second-growth forest. This species is apparently absent from highly disturbed areas. Gravid females were caught March 16 (5 eggs, 3.5-6.3 mm) and June 14 (5 eggs, 12.3-13.9 mm).

Specimens examined: LSUMZ 41641-41647.

Discussion

The continuing destruction of tropical rain forest worldwide makes it imperative that species of special concern are identified in these habitats. In the section below, I will attempt to pinpoint species which could be adversely affected by continuing deforestation, where my data are adequate to do so. I make special reference to the lizards of the forest floor, since I feel that these lizards were the most accurately sampled species with the techniques that I used. These species are all skinks: *Mabuya multicarinata multicarinata, Sphenomorphus coxi coxi, S. decipiens, S. steerei, S. variegatus,* and *Tropidophorus partelloi. Sphenomorphus fasciatus* is not considered, since only one specimen of this species was collected.

Primary Forest

This was the richest habitat sampled, containing all six of the skinks mentioned above. Of these six, five seem to be regular inhabitants of the primary forest. In addition, there were two common arboreal lizards: The gecko *Cyrtodactylus agusanensis* and the agamid *Gonyocephalus semperi.* The most commonly collected terrestrial lizards listed in decreasing order of abundance were: *Sphenomorphus coxi coxi, S. variegatus, S. steerei, S. decipiens,* and *Tropidophorus partelloi.* Species which were sparsely collected in primary forest include the

arboreal lizards *Calotes cristatellus, Draco mindanensis, Lipinia semperi,* and *Sphenomorphus acutus,* and the terrestrial lizard *Mabuya multicarinata multicarinata.* I do not consider *M. m. multicarinata* to be a regular inhabitant of primary forest.

Early Second-Growth Forest

This was the most depauperate habitat sampled. Two arboreal lizards were common: *Cyrtodactylus agusanensis and Draco volans,* the latter species being the most common lizard observed in any habitat. The common terrestrial lizards were: *Sphenomorphus coxi coxi* and the extremely abundant *Mabuya multicarinata multicarinata.* This habitat contained only three of the six terrestrial skinks of interest. The skink *Sphenomorphus steerei* was only represented by two individuals collected in this habitat, and I consider it to be rare in early second-growth habitats. *M. m. multicarinata* was virtually absent in primary forest, but it was found to be twice as common in second-growth habitats as the next most common lizard, *S. c. coxi.* I spent approximately two man-months apiece working in primary forest and early second-growth forest at site 1. I have assumed that the time spent in these two habitat types was equal and have calculated the Brillouin diversity index (Krebs 1989) for each habitat using the absolute number of specimens collected in each habitat type of the six terrestrial skinks of interest noted above. Indices of 0.610 and 0.309 are calculated for primary forest and early second-growth forest habitat types, respectively. Although not an exact measurement, this rough estimate of diversity points out the major difference in biodiversity between these two habitat types as regards terrestrial skinks.

Late Second-Growth Forest

I spent very little time in this habitat type, yet the species collected here provide valuable insights into possible lizard population successional patterns. The arboreal agamid *Gonyocephalus semperi,* absent in early second-growth forest, was found in late second-growth forest, whereas *Draco volans,* common in early second-growth forest, was absent from late second-growth forest. The terrestrial skinks *Sphenomorphus variegatus* and *Tropidophorus partelloi,* both absent from early second-growth forest and common in primary forest, were collected in late second-growth forest.

Species of Special Concern

It is clear that less complex habitats will support a less complex community of plants and animals, by definition. Although my data are sparse, it is obvious that the biodiversity of terrestrial skinks (and other lizards) is far different after logging operations alter the forest structure. The clearing of primary forest creates habitat for open habitat specialists such as *Mabuya multicarinata multicarinata* and *Draco volans,* while decreasing habitat for the species which seem to be confined to the primary forest. Especially notable is the lack of *Sphenomorphus variegatus,* which is common in primary forest but absent in early second-growth forest. Other species which may be adversely affected by logging activities include the skinks *Tropidophorus partelloi, Sphenomorphus steerei,* and *S. decipiens;* and the agamids *Draco mindanensis* and *Gonyocephalus semperi.* Except for *D. mindanensis,* all these species were collected in late second-growth and primary forest. *D. mindanensis* was only found in primary forest. *Sphenomorphus coxi coxi* was the only lizard commonly found in all habitats, although it was less frequently seen in the open where it was syntopic with *Mabuya multicarinata multicarinata.*

Conclusions

The collection of primary forest species in areas of late second-growth forest points towards the possibility of a sustained harvest of the primary forest for lumber. However, there is absolutely no data on the periodicity of such a harvest, nor any precise information on changes in biodiversity through a successional series. It is imperative that primary forest be conserved as a refuge for certain species

which may only occur there, such as *Draco mindanensis*. Possibly, a system of reserves with rotating areas of selective logging may help to conserve Philippine lizard species. However, at the present time research towards such an end is entirely lacking, and the conversion of large parts of the Philippines towards a much impoverished lizard fauna continues unabated.

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