

COMPARISON OF THE HERPETOFAUNAL SPECIES RICHNESS
ON NEGROS AND CEBU ISLANDS, PHILIPPINES

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The terrestrial herpetofaunas of Negros and Cebu Islands, Philippines, are compared. The same non-forest species occur on both islands, except for two species recorded from Negros only. Cebu has half of the forest species recorded from Negros, virtually all of them found on both islands. This very close correspondence of species is most probably due to the origin of the Cebu fauna in the late Pleistocene, when Cebu and Negros were part of a hypothetical large island which also included Masbate and Panay. The smaller size of Cebu is probably not the primary factor in accounting for the smaller number of forest species on Cebu, since Bohol Island, nearby and about the same size as Cebu, has almost the same number as Negros. Also, no evidence is available to indicate that the forest species on Cebu have had any advantage in dispersal capabilities. Deforestation is proposed as the probable cause of the low number of forest species on Cebu Island.

The islands of Negros (land area 12,700 sq km) and Cebu (land area 4,400 sq km) lie in the Visayas (central) region of the Philippines, and are separated from each other by a relatively narrow and, in the north, shallow channel. Negros consists mostly of andesitic volcanic rocks and derived volcaniclastic sedimentary rocks, the oldest of which are of Cretaceous age, while Cebu contains old rocks consisting of tightly folded and slightly metamorphosed conglomerate, sandstone, shale, and limestone, basalt and limestone, in which Eocene and Upper Cretaceous foraminifers were embedded (see Hamilton, 1979:210-211). Negros has higher mountain peaks than Cebu. Mt. Canlaon on Negros reaches about 2,466 m above sea level; the tallest mountain on Cebu is only 1,013 m in elevation. It is hypothesized that Cebu and Negros, together with Panay and Masbate islands, formed a single land mass during periods of maximum lowering of the sea during the Pleistocene (see Heaney, 1985). Prior to that time Cebu most probably consisted of a series of raised islets.

In the past, most Philippine islands, including Negros and Cebu, bore a border of mangrove forests along the seacoasts and a belt of typical rain forest elsewhere (see Merrill in: McGregor, 1920). Cebu has lost virtually all its rain forest (Table 1 and Fig. 1). Only scattered patches of typical secondary forest in ravines and approximately 90.6 sq km of mostly man-made forest remain, mostly around Buhisan Dam and Minglanilla.

Deforestation on Cebu appears to have been widespread as early as 1887-88, as inferred from comments of bird collectors. Bourns and Worcester (1894:10) noted that the bird *Iole monticola* (*Phosipetes siguijorensis monticola*) ". . . is a highland form. It was invariably met with by us in the forest on the tops and sides of hills in Central Cebu and was never seen in open or flat country." The failure to find this bird in the lowlands implied that the lowland tropical rain forest was gone, since most species of *Iole* were lowland species (McGregor, 1920). Furthermore, Worcester (1898:576) mentioned the Steere Expedition's difficulty in finding suitable collection areas in Carmen town, "ending only now and then a small patch of trees at the summit of some steep incline." But in 1891, the expedition discovered a "pear-sized patch of forest" in which they collected several species in 1892. This was probably the "small amount of forest left in Cebu" in which Bourns and Worcester found the endemic *Oriolus xanthonotus assimilis* "exceedingly common" (see McGregor, 1909: 701; Rabor, 1959). Deforestation continued through the twentieth century, resulting in the total elimination of the original forest, except for very small patches near Cebu.

In contrast to the sparse forest on Cebu, Worcester (1898:576) wrote about Negros island thus: "It offers excellent collecting ground, as its central chain of mountains . . . is abundantly clothed with forest...." The forested condition of the island persisted through the next two decades. McGregor (1920) included a map of existing commercial forests of the Philippines in his discussion of Philippine birds. The map depicted Negros as heavily forested (about 60% of the area). In the 1930s and the early 1940s no less than 50% of the land area of the island was occupied by lush rain forest (pers. obs. and comm. with long-time residents). At present, less than 10%, probably a little more than 5%, is covered with primary tropical rain forest, and possibly another 20% with secondary forest, based on land satellite photographs and ground-truth verification (Table 1 and Fig. 1).

Brown and Alcalá (1970:111) listed 23 species (not including *Phosipetes*) which are very wide-ranging in the Philippines, occurring primarily in or adapting readily to habitats other than dipterocarp (lowland tropical rain) forest or secondary growth forest. In characterizing species in terms of their abilities to adapt to habitats other than primary or secondary forest or such man-made habitats as abaca and coconut groves which are in contact with or close to such forest patches,

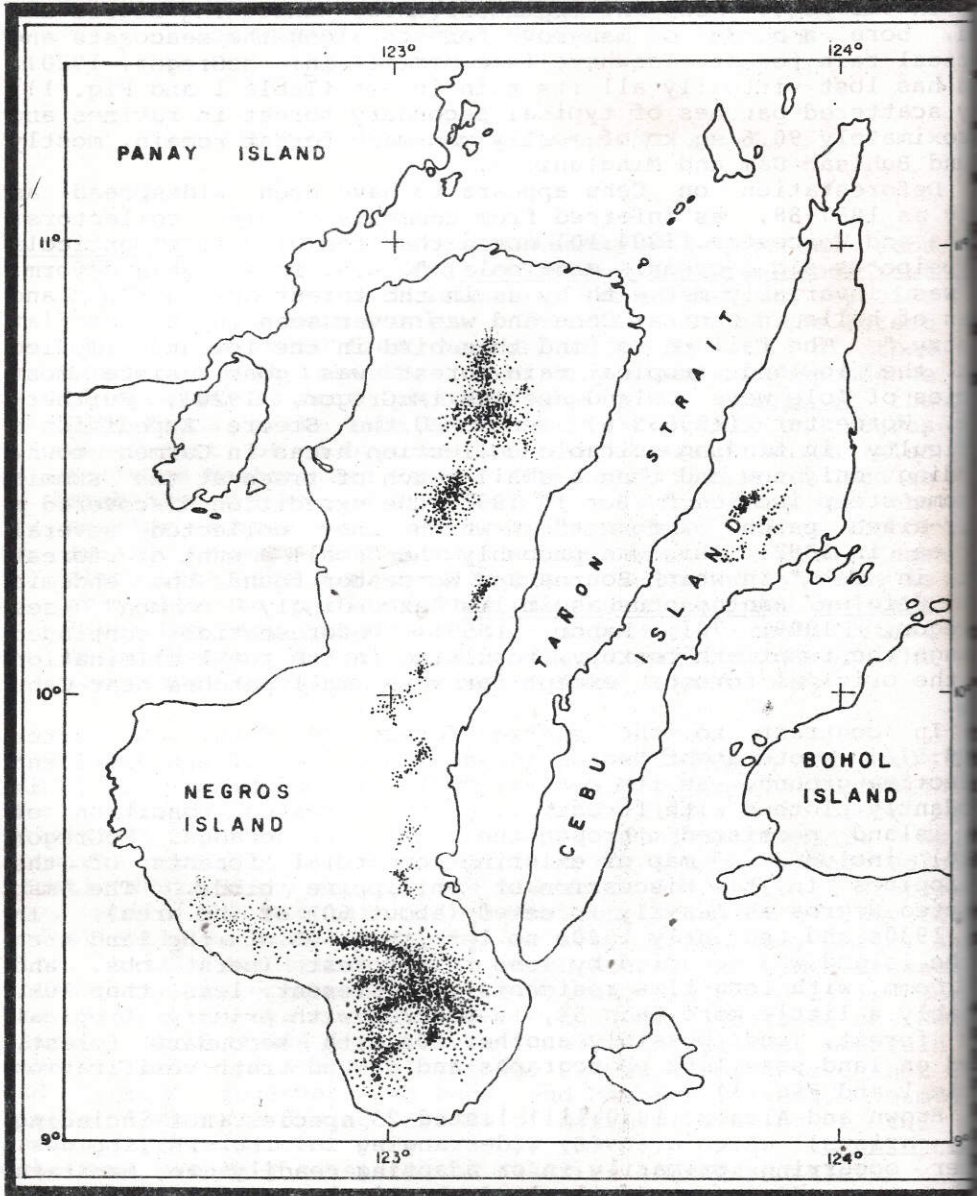


Fig. 1. Map showing the extent (stippled areas) of the remaining primary rain forest on Negros Island and the man-made forest on Cebu Island.

Table 1. Summary of land areas, forest areas and herpetofaunal species of Negros, Cebu and Bohol Islands, Philippines.

	Negros	Cebu	Bohol	Philippines
Land Area (sq km)	12,700	4,400	4,000	300,000
Primary Area of Tropical Rain Forest as of 1980 (sq km)	1,000*	91#	64+	-
Number of Amphibian Species	18	10	22	67
Number of Reptile Species	67	48	59	169
Lizards	35	27	35	109
Snakes	30	20	23	80
Turtles	1	1	1	3
Crocodiles	1	0	0	2
Total Number of Species	85	58	82	261

*Primary Rain Forest, based on land satellite photograph, courtesy of the Philippine National Resources Management Center; forests are 1,000 m and above elevation.

#General communication, Bureau of Forest Development (BFD), Cebu City; about 91 sq km are man-made forest; some trees 50-65 years old.

+General communication, BFD, Cebu City; ca 64 sq km of mostly secondary forest and man-made forest.

We now regard the following list as probably more accurate. Two species of snakes included in 1970, Ahaetulla prasina and Phamodynestes pulverulentus, have been deleted and several others added. Based on the data on habitats used by the Negros species (Brown and Alcalá, 1964) and some subsequent data, 31 species are recognized as having adapted to man-made as well as dipterocarp, coastal vegetation types and sometimes to man's gardens and houses:

Amphibians	Lizards	Snakes
<u>Bufo marinus</u>	<u>Cosymbotus platyurus</u>	<u>Ramphotyphlops</u>
<u>Ooeidozyga laevis</u>	<u>Gehyra mutilata</u>	<u>braminaes</u>
<u>Rana cancrivora</u>	<u>Gekko gekko</u>	<u>Python reticulatus</u>
<u>Rana erythraea</u>	<u>Hemidactylus frenatus</u>	<u>Chrysopelea parad</u>
<u>Rana limnocharis</u>	<u>Hemiphyllodactylus</u>	<u>Dendrelaphis</u>
<u>Polypedates</u>	<u>typus</u>	<u>caudolineatus</u>
<u>leucomystax</u>	<u>Lepidodactylus herrei</u>	<u>Dendrelaphis pict</u>
<u>Kaloula conjuncta</u>	<u>Lepidodactylus lugubris</u>	<u>Elaphe erythrura</u>
<u>Kaloula picta</u>	<u>Draco volans</u>	<u>Hurria rhynchops</u>
	<u>Varanus salvator</u>	<u>Lycodon aulicus</u>
	<u>Emoia atrocostata</u>	<u>Calliophis</u>
	<u>Lamprolepis smaragdina</u>	<u>calligaster</u>
	<u>Lipinia quadrivittata</u>	<u>Acrochordus</u>
	<u>Mabuya multifasciata</u>	<u>granulatus</u>

Although comparable data on habitats are not available for Cebu, 29 of these non-forest species have been recorded from the island.

The purpose of this paper is to compare the herpetofaunal species richness of Negros and Cebu Islands and to evaluate probable reasons for any observed differences.

RESULTS

Negros and Cebu herpetofaunas compared.

The data on the herpetofaunas of the two islands are based on the limited, early records (prior to 1950) and the extensive field studies of the authors from 1955 to 1983. These studies have confirmed and more than doubled the number of species on Negros, and quadrupled the number for Cebu as reported by early authors (Taylor, 1920, 1922a, 1922b; Inger, 1954). For example, Brown and Alcalá (1961:631) noted that, prior to their survey of southern Negros Island 31 species of amphibians and reptiles had been reported from that area. We now have recorded 85. In (1954) and Taylor (1922a, 1922b) reported only five definite 12 probable amphibians and reptiles from Cebu. We recorded 12. The lack of early records for amphibians and reptiles on Cebu have resulted from lack of interest on the part of most of the collectors due to the early deforestation of Cebu.

Ten amphibians are now recorded from Cebu, all of which are also known from Negros. Six of these are on the list of widespread species or those which can adapt to a wide variety of lowland habitats, often including man's agricultural habitats. Four are primarily forest species; seven of the additional 12 species recorded from Negros are also forest species.

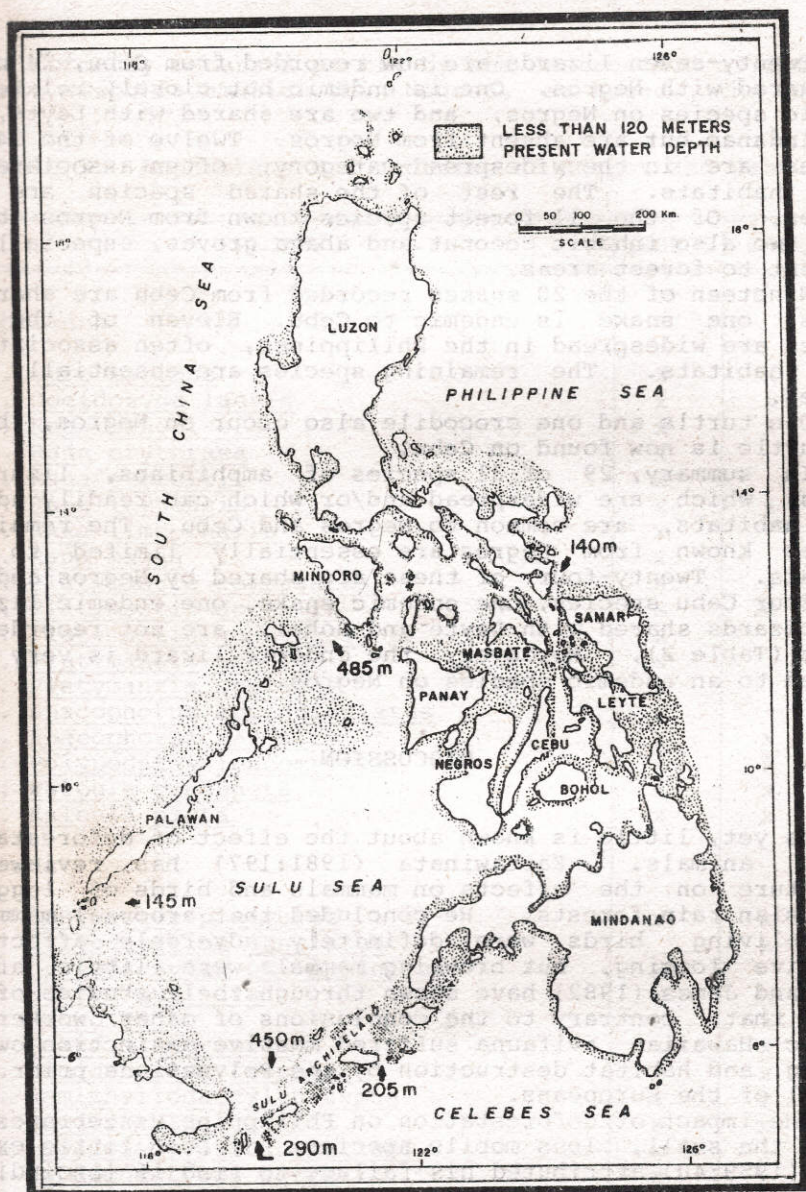


Fig. 2. Map of the Philippines showing present island boundaries (solid lines) and postulated extension of land masses during the late Pleistocene (stippled areas), at which time sea level is presumed to be at least 120 meters below the present level (after Heaney, 1985).

Twenty-seven lizards are now recorded from Cebu, 24 of which are shared with Negros. One is endemic but closely related to endemic species on Negros, and two are shared with Leyte, Bohol and Mindanao but are absent from Negros. Twelve of the 24 shared species are in the widespread category, often associated with man's habitats. The rest of the shared species are forest species. Of the 11 forest species known from Negros but not from Cebu, two also inhabit coconut and abaca groves, especially the adjacent to forest areas.

Nineteen of the 20 snakes recorded from Cebu are shared with Negros; one snake is endemic to Cebu. Eleven of the shared species are widespread in the Philippines, often associated with man's habitats. The remaining species are essentially forest species.

One turtle and one crocodile also occur on Negros, but only the turtle is now found on Cebu.

In summary, 29 of 31 species of amphibians, lizards and snakes, which are widespread and/or which can readily adapt to man's habitats, are common to Negros and Cebu. The remaining species known from Negros are essentially limited to forest habitats. Twenty-four of these are shared by Negros and Cebu. Only four Cebu species, one endemic snake, one endemic lizard and two lizards shared with Leyte and Bohol, are not recorded from Negros (Table 2). Moreover, the endemic lizard is very closely related to an endemic species on Negros.

DISCUSSION

As yet, little is known about the effect of deforestation on forest animals. Kartawinata (1981:197) has reviewed the literature on the effects on mammals and birds of logging in Indonesian rain forests. He concluded that arboreal mammals and canopy-living birds were definitely adversely affected by selective logging, but browsing mammals were little affected. Olson and James (1982) have shown through their studies of forest birds that, contrary to the conclusions of other workers, the endemic Hawaiian avifauna suffered massive extinction owing to hunting and habitat destruction by the Polynesians prior to the arrival of the Europeans.

The impact of deforestation on Philippine vertebrates, especially the small, less mobile species, has been little examined. Rabor (1959:40) attributed his failure to find 16 (including nine endemic) forest species of birds, which were previously recorded from Cebu, as most probably the result of their disappearance due to deforestation. However, he admits that there is a possibility that some of these missing species may still exist in some small isolated areas of second growth which he and his assistants failed to find. Ross and Alcala (1983) explained the absence and near disappearance of the Philippine Crocodile from islands

which it formerly occurred partly by the destruction of forest. Since Cebu is smaller than Negros, as noted, the question

Table 2. Amphibians and reptiles of Negros and Cebu.

SPECIES	NEGROS	CEBU
Amphibians		
1. <u>Bufo marinus</u>	x	x
2. <u>Ooeidozyga laevis</u>	x	x
3. <u>Rana cancrivora</u>	x	x
4. <u>Rana erythraea</u>	x	
5. <u>Rana everetti</u>	x	
6. <u>Rana leytensis</u>	x	x
7. <u>Rana limnocharis</u>	x	
8. <u>Rana magna</u>	x	
9. <u>Platymantis corrugatus</u>	x	x
10. <u>Platymantis dorsalis</u>	x	x
11. <u>Platymantis guentheri</u>	x	
12. <u>Platymantis hazelae</u>	x	
13. <u>Platymantis spelaeus</u>	x	
14. <u>Rhacophorus appendiculatus</u>	x	
15. <u>Rhacophorus pardalis</u>	x	x
16. <u>Polypedates leucomystax</u>	x	x
17. <u>Kaloula conjuncta</u>	x	x
18. <u>Kaloula picta</u>	x	x
Lizards		
1. <u>Cosymbotus platyurus</u>	x	x
2. <u>Cyrtodactylus annulatus</u>		x
3. <u>Cyrtodactylus philippinicus</u>	x	
4. <u>Gehyra mutilata</u>	x	x
5. <u>Gekko gekko</u>	x	x
6. <u>Gekko mindorensis</u>	x	x
7. <u>Hemidactylus frenatus</u>	x	x
8. <u>Hemiphyllodactylus typus</u>	x	x
9. <u>Hemidactylus garnoti</u>	x	x
10. <u>Lepidodactylus christiani</u>	x	
11. <u>Lepidodactylus herrei</u>	x	x
12. <u>Lepidodactylus lugubris</u>	x	x
13. <u>Lepidodactylus planicaudus</u>		x
14. <u>Luperosaurus cumingi</u>	x	
15. <u>Pseudogekko brevipes</u>	x	x
16. <u>Calotes marmoratus</u>	x	
17. <u>Draco volans</u>	x	x
18. <u>Gonyocephalus sophiae</u>	x	

Table 2. (Continued.)

SPECIES	NEGROS	CEBU
19. <u>Hydrosaurus pustulosus</u>	X	
20. <u>Varanus salvator</u>	X	X
21. <u>Dibamus novaeguineae</u>	X	X
22. <u>Brachymeles boulengeri</u>	X	X
23. <u>Brachymeles cebuensis</u>		X
24. <u>Brachymeles talinis</u>	X	
25. <u>Brachymeles tridactylus</u>	X	
26. <u>Emoia atrocostata</u>	X	X
27. <u>Lamprolepis smaragdina</u>	X	X
28. <u>Lipinia auriculata</u>	X	X
29. <u>Lipinia pulchella</u>	X	
30. <u>Lipinia quadrivittata</u>	X	X
31. <u>Lipinia rabori</u>	X	
32. <u>Mabuya indeprensa</u>	X	X
33. <u>Mabuya multicarinata</u>	X	X
34. <u>Mabuya multifasciata</u>	X	X
35. <u>Sphenomorphus arborens</u>	X	
36. <u>Sphenomorphus jagori</u>	X	X
37. <u>Sphenomorphus steerei</u>	X	X
38. <u>Tropidophorus grayi</u>	X	X
Snakes		
1. <u>Ramphotyphlops braminaes</u>	X	X
2. <u>Typhlops canlaonensis</u>	X	
3. <u>Typhlops cumingi</u>	X	
4. <u>Typhlops hypogia</u>		X
5. <u>Typhlops luzonensis</u>	X	X
6. <u>Python reticulatus</u>	X	X
7. <u>Ahaetulla prasina</u>	X	X
8. <u>Calamaria gervaisi</u>	X	X
9. <u>Chrysopelea paradisi</u>	X	X
10. <u>Cyclocorus lineatus</u>	X	X
11. <u>Dendrelaphis caudolineatus</u>	X	X
12. <u>Dendrelaphis pictus</u>	X	X
13. <u>Dryophiops philippina</u>	X	
14. <u>Elaphe erythrura</u>	X	X
15. <u>Gonyosoma oxycephala</u>	X	
16. <u>Hurria rhynchops</u>	X	X
17. <u>Lycodon aulicus</u>	X	X
18. <u>Natrix dendrophiops</u>	X	
19. <u>Oligodon modestum</u>	X	
20. <u>Oxyrhabdium leporinum</u>	X	X
21. <u>Psammodynastes pulverulentus</u>	X	X
22. <u>Pseudorabdion mcnamarae</u>	X	X

Table 2. (Continued.)

SPECIES	NEGROS	CEBU
23. <u>Pseudorabdion oxycephalum</u>	x	x
24. <u>Pseudorabdion montanum</u>	x	
25. <u>Zaocys luzonensis</u>	x	
26. <u>Boiga angulata</u>	x	
27. <u>Calliophis calligaster</u>	x	x
28. <u>Ophiophagus hannah</u>	x	x
29. <u>Trimeresurus flavomaculatus</u>	x	
30. <u>Trimeresurus wagleri</u>	x	
31. <u>Acrochordus granulatus</u>	x	x
Turtles		
1. <u>Cuora amboinensis</u>	x	x
Crocodiles		
2. <u>Crocodylus mindorensis</u>	x	

as to whether or not size might be a primary factor in accounting for the smaller number of forest species found on Bohol. Our data on the herpetofauna of Bohol (4,000 sq km), an island to the southeast of Cebu and about the same size, might provide a measure of the importance of island size. Bohol, like Cebu, is not heavily forested. In the 1960s and early 1970s, when we were conducting our survey of Bohol, the Sierra Bullones rain-forest had been reduced to about 43 sq km, and other scattered areas of man-made and secondary forest amounted to about 60 sq km.

On the basis of area alone, the expected number of species on Negros, according to MacArthur and Wilson's (1967:14) formula ($S = 1.83A^{.263}$) is 74, versus an actual number of 85; on Cebu it is 56 versus 58, and on Bohol 54 versus 82. The present Bohol herpetofauna greatly exceeds the expected; that of Negros is excessively excessive, that of Cebu close to the prediction. This comparison supports the hypothesis that island size alone is not a good predictor of species richness; other factors, such as elevation and diversity of habitats, also partly determine species richness (MacArthur, 1972; Lazell, 1983; Heaney, 1983).

The relatively high species richness of Bohol, which equals that of Negros, suggests that the critical area for this number of species (80+) has been reached by an island the size of Bohol.

or Cebu. On this basis, if size were the primary factor affecting species richness, one could argue that Negros provides space for a much greater number of species than are presently known. This may be so, and the present number may be the result of the inability of some species to disperse to Negros in the past. The low species richness on Cebu compared to Negros and Bohol (Cebu has even more varied terrain than Bohol), however, must be attributed to some factor other than size.

The fact that 54 of the 58 species of amphibians and reptiles presently recorded from Cebu are also known from Negros while only two are endemic and two are shared with Leyte and Bohol but not with Negros, strongly supports the hypothesis that the herpetofauna of Cebu is (geologically speaking) a relatively recent acquisition and is essentially derived from the Negros fauna. The phenomenon also can be satisfactorily explained by the hypothesis that Negros, Cebu, Masbate and Panay formed a single land mass in the late Pleistocene, during the period of maximum lowering of sea level (Fig. 2).

Since the number of widespread, non-forest species is about the same for Negros and Cebu, what factor or factors can explain why about half (26) of the primarily forest species occurring on Negros are presently not found on Cebu? The small size of Cebu might be one explanation; but, as indicated earlier, this is unsatisfactory in view of the fact that Bohol, an island of approximately the same size as Cebu, of similar elevation and located but a short distance to the east, has about the same species richness as Negros.

Lack of opportunity to migrate to Cebu might be proposed as an explanation. However, there is no evidence that the group of forest species shared by Negros and Cebu had any advantages over the non-shared group of forest species in terms of dispersal over probable land connections during the Pleistocene or earlier over a narrow water barrier.

A third possible explanation for the low number of forest species on Cebu is that it has been the result of reduction due to deforestation. Unfortunately, since the only available herpetofaunal records for Cebu until very recently (long after the almost complete removal of all original forest) were for a few widespread species, the evaluation of this explanation must be on the basis of indirect evidence.

Two lines of indirect evidence may be cited. First, by analogy, based on evidence on forest birds, another taxon of terrestrial vertebrates, reduction of species due to deforestation is a logical expectation.

Second, on the assumption that the primarily arboreal forest species would have been much more strongly reduced in number during deforestation early in the century and during the time of development of second growth forests, we have made this comparison for Cebu and Negros: of 52 forest species on Negros, 15 (29%) are primarily arboreal, while of 25 forest species on Cebu, three (12%) are primarily arboreal.

The above indirect evidence supports the hypothesis that the present low number of forest species of amphibians and reptiles on Cebu as compared with Negros is most probably due to complete removal of the original rain forest from Cebu by the early part of this century.

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