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THE ZOOGEOGRAPHY OF THE HERPETOFAUNA OF THE PHILIPPINE ISLANDS, A FRINGING ARCHIPELAGO

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INTRODUCTION

Inger, in his essay on the zoogeography of the Philippine amphibia (1954, pp. 448–510), presented the first major distributional paper for any part of the herpetofauna since Taylor's essay (1928). The first part of Inger's paper is concerned with the geological history of the Philippines, and the origins and degree of endemism exhibited by the amphibian fauna. Secondly, he discusses the pathways of entry into the Philippines in terms of the location of the nearest relatives and possible time of entry into the Philippines. He notes, for example, that the present distribution of the genus *Platymantis* (replaces *Cornufer*, Zweifel, 1967) suggests two speciation centers, one in the New Guinea-Solomons region and one in the northern Philippines; but by analogy, in comparison with some other amphibians, suggests a Papuan origin and subsequent dispersal into the Philippines. Inger therefore regards these two present centers as peripheral isolated concentrations of a once more widely distributed genus (1954, pp. 494,

497). He suggests that the bulk of the amphibians entered the Philippines by 2 major routes, the Palawan or Sulu-Mindanao routes. He discusses relative time of entry of different components of the amphibian fauna primarily in terms of extent of endemism and distance from areas occupied by presumed nearest relatives. Within the Philippines, Inger recognizes only 2 somewhat doubtful zoogeographic subdivisions. In his discussion of dispersal (pp. 475–484), he notes that both dispersal by way of earlier land connections and over-water dispersal must be considered, and he also notes, in general descriptive terms, possible routes within the Philippines.

Leviton (1963) provides the most recent discussion of zoogeography of the terrestrial snake fauna of the Philippine archipelago. His discussion is primarily concerned with extraterritorial origins, time of entry and endemism, present distributions, and the taxonomic relationships of species within the Philippines. These are considered in terms of past changes in island configurations, and probable internal pathways. He states (p. 377), contrary to Inger's views relative to the dispersal of the amphibians (Inger, 1954, p. 484), that the present distribution of the snakes can, for the most part, be explained on the basis of former land connections. He recognizes 5 faunal (serpentine) subregions within the archipelago at the present time.

Both authors very ably discuss the present distribution of the faunal element with which they are concerned in terms of traditional concepts of extraterritorial origins, pathways of entry and internal dispersal as governed by probable geological changes, time of entry, and means of dispersal.

Darlington (1957, pp. 476–541) discusses the Philippine ichthyological and herpetological faunas in the more general context of distributions on fringing archipelagoes. Immigrant patterns of distribution, where the species are distributed along the migration route with dropouts occurring linearly as determined by distance and relative dispersal abilities, are, he believes, the primary patterns exhibited in fringing archipelagoes. This basic pattern is modified for older relict groups by concentration of species on distal or proximal islands within the archipelago (p. 533).

MacArthur and Wilson (1963) propose the hypothesis that the number of species on an island represents a balance between number of species reaching the island and number of species becoming extinct per unit of time. They point out that a number of interacting variables will determine the point at which these 2 curves intersect. These include distance from source of immigrants, the species pool of immigrants, area of island concerned, or some other limiting factor such as unfavorable climate. They further propose that in time secondary radiation centers should increase with distance of islands from the major source of the fauna, when corrections are made for area or other limiting variables. They also note that the number of species decreases more rapidly for large than for small islands with increasing distance from source of colonization.

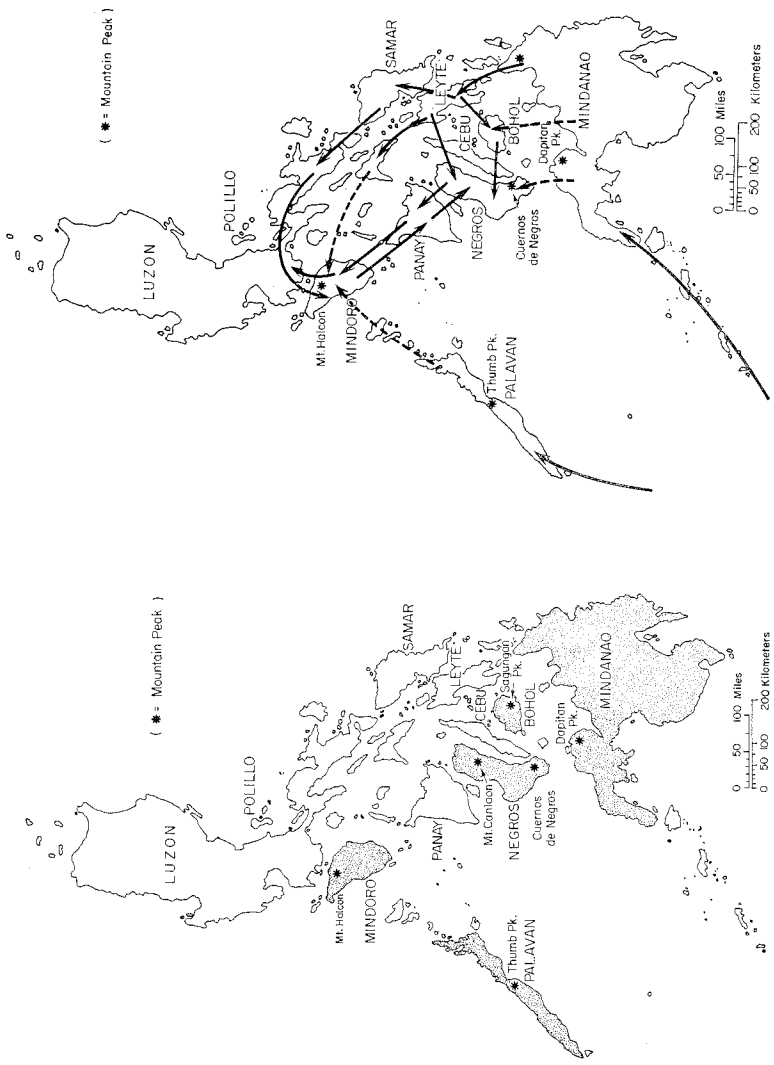

FIGURE 1. a. Islands surveyed during our recent expeditions, 1958–1963. b. Entryways and proposed dispersal routes within the Philippine Archipelago.

PROBLEMS AND METHODS

Recent intensive exploration of the herpetofaunas of 5 Philippine islands, Palawan, Mindanao, Bohol, Negros, and Mindoro (fig. 1a), makes possible more critical examination of many of the zoogeographic hypotheses suggested by previous authors. Factors which we believe make this possible are: 1) intensive sampling techniques which provide more accurate estimates of species-diversity; 2) choice of islands from proximal, distal, and intermediate regions of the archipelago (fig. 1a); 3) range in size from 5,000 to 95,000 square kilometers

TABLE 1. *Intensively explored areas on the five islands included in the recent survey.*

Mountain Region	*Altitude (meters)*	*Island*	*Island Area (sq. km.)*	*Exploration Date*
Cuernos de Negros	1,903	Negros (southern part)	12,700	March—May 1958 (about 7 weeks)
Mt. Canlaon	2,463	Negros (northern part)	"	March—April 1962 (about 4 weeks)
Dapitan Peak	2,199	Mindanao (Zamboanga Peninsula)	94,600	March—May 1959 (about 6 weeks)
Thumb Peak	1,286	Palawan (central part)	11,800	April—May 1961 (about 7½ weeks)
Mt. Halcon	2,580	Mindoro (northern part)	9,750	April—May 1963 (about 4 weeks)
Sagungan Mountain	870	Bohol (southeastern part)	4,100	April—May 1962 (about 4 weeks)

(table 1); 4) choice of islands which encompass sufficiently large areas of original and/or secondary lowland forest as to make negligible differences in diversity which might be due to major differences in the dominant type of plant community (see Brown and Alcala, 1964).

The techniques stressed intensive sampling of arboreal, surface, and subterranean strata in the lowland forest whenever possible, as well as selected mountains. The expeditions to each of the 6 mountain areas on the 5 islands were carried out by crews of 8 to 10 men over 4 to 7½ week periods (table 1).

TABLE 2. *Number of species recorded for the islands included in this study. The number in parentheses is the number of species belonging to the group of 23 widely distributed species associated with man's economy or beach communities. The number in brackets is the number of relict species.*

	Palawan	*Mindanao*	*Bohol*	*Negros*	*Mindoro*	*Leyte*	*Luzon*
Caecilians	1	1					
Frogs	22 (4)[1]	34 (4)[3]	21 (3)[4]	16 (4)[4]	12 (4)[2]	16 (3)[3]	21 (4)[6]
Lizards	23 (11)[1]	52 (10)[6]	31 (11)[4]	33 (11)[4]	27 (11)[2]		34 (8)[7]
Snakes	33 (9)[0]	39 (9)[2]	20 (8)[1]	29 (9)[2]	19 (8)[1]	18 (7)[1]	39 (9)[3]
Total	78 (24)[2]	125 (23)[11]	72 (22)[9]	78 (24)[10]	58 (23)[5]		94 (21)[15]