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Results of the Archbold Expeditions. No. 90 Notes on the Echidnas (Mammalia, Tachyglossidae) of New Guinea

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INTRODUCTION

Surprisingly few published data are available on the distribution of the species of echidnas in New Guinea. Field collecting and observations by seven Archbold Expeditions to New Guinea and one to the Cape York Peninsula of Australia have produced additional information on the habitats, distribution, and life histories of the two genera of echidnas, *Tachyglossus* and *Zaglossus*. George has had the opportunity of making observations on living *Tachyglossus;* Van Deusen on *Zaglossus*. George has also contributed to our understanding of the distribution of *Tachyglossus* in the Western Highlands District of the Territory of New Guinea.

The taxonomy of *Zaglossus,* first described in 1876, has suffered not only because of the rarity of the genus in collections, but also because the available specimens are widely scattered among the museums of the world. No taxonomist has been able to examine more than a fraction of this material. Specimens collected by the Archbold Expeditions add to the evidence that there is wide geographic variation in the characters

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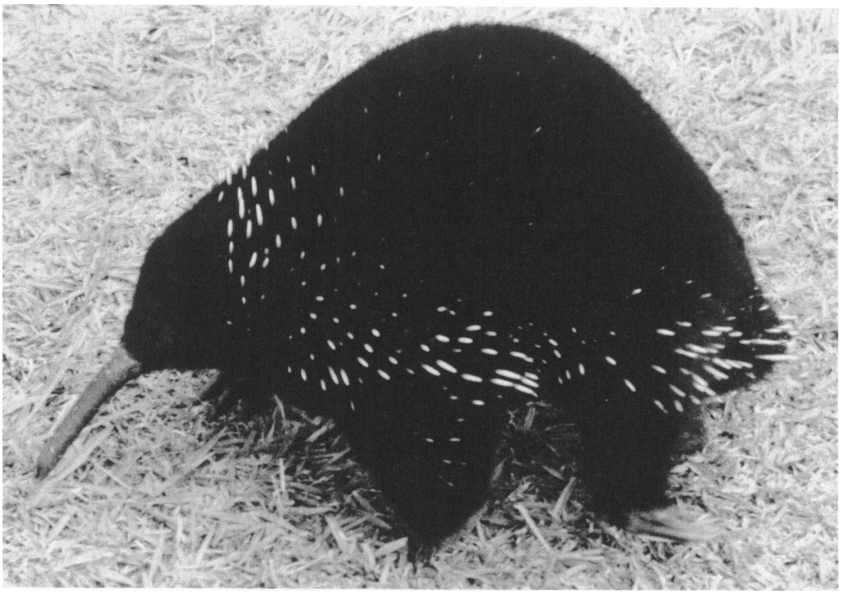

FIG. 1. *Zaglossus bruijni.* A.M.N.H. No. 195146. This picture suggests the extreme flexibility of the back.

upon which the several named species are based. We suggest that only one species of *Zaglossus* should be recognized until the range of variation in these taxonomic characters is clearly understood in this endemic New Guinea monotreme.

There are very few pictures of *Zaglossus* available in the mammal literature. Stanley O. Grierson, a member of the 1964 Archbold Expedition, is to be commended for his photographs of *Zaglossus* caught in the wild which illustrate the present paper.

We are indebted to Dr. and Mrs. Richard G. Zweifel for their care and patience in producing the maps.

Tachyglossus aculeatus lawesi (Ramsay)

SHORT-BEAKED ECHIDNA

The New Guinea population of *Tachyglossus* was named by E. P. Ramsay (1877) of the Australian Museum in Sydney. His type was an adult male collected by the Rev. W. G. Lawes near Port Moresby on the south coast of Papua. The first specimen found by Lawes was, according to Ramsay, "a young specimen with a remarkably short bill, which I believe has been sent to England." The type, Lawes's second specimen, is rather fully de-

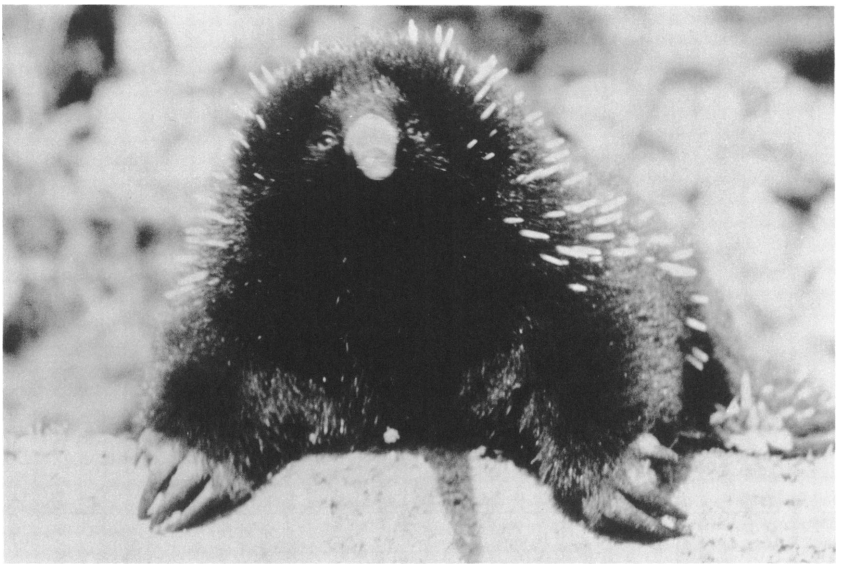

FIG. 2. *Zaglossus bruijni.* A.M.N.H. No. 194702. Front view. Note small eyes near base of beak.

scribed, but it is only in a footnote that a specific name is applied, by Ramsay: "I have not yet learned the name which has been given to this new species, but daily expect to hear of it from my friends in England. Should it, however, still be unnamed, I propose for it the name of *T. Lawesii,* in honor of its discoverer." Evidently no name was given to the specimen sent to England, and we have found no reference to this young echidna in the literature.

In 1877 Andrew Goldie made general collections in southeast Papua. Among the specimens sent to the Australian Museum for study were three skins (without skulls) of *Tachyglossus* (Ramsay, 1879). Oldfield Thomas (1885) reduced *lawesi* to a subspecies of *aculeatus,* the mainland Australian species. His New Guinea material consisted of two females collected by Lawes (one in the Liverpool Museum, the other in the British Museum).

On mainland Australia *Tachyglossus aculeatus* has a continent-wide distribution, and it has successfully adapted to a wide range of habitats: arid plains with great seasonal contrasts in temperature; sclerophyll forest; hot, dry, rocky areas; temperate rain forest; and heath covered ridges and valleys at an elevation of 5000 to 6000 feet (1525–1830 meters) in the Australian Alps. Evidence that this echidna also lives in tropical rain forest came in 1948 when Van Deusen collected a specimen (A.M.N.H.

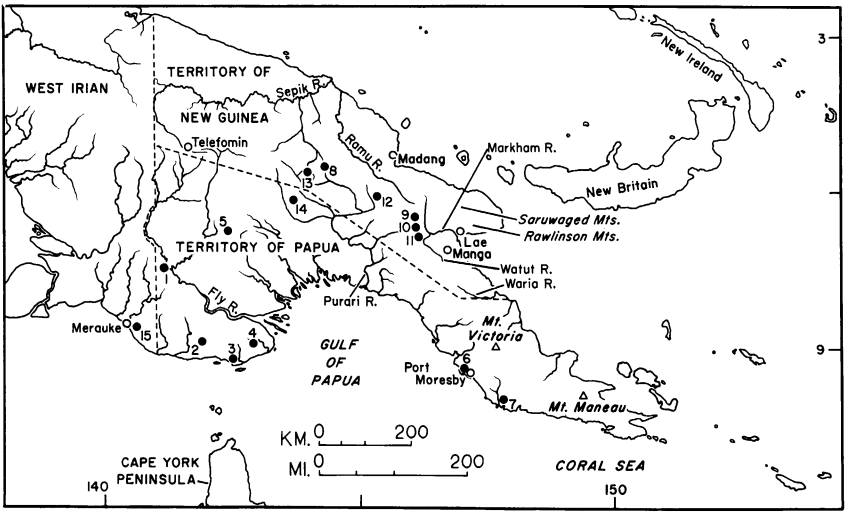

FIG. 3. The eastern portion of New Guinea. Numbers 1–9 are localities represented by the 17 specimens of *Tachyglossus aculeatus* in the Archbold Collections, A.M.N.H.; numbers 10–15 are localities represented by study specimens in other collections or specimens captured alive. Numbers 1–7 and 14 are in the Territory of Papua; 8–13 in the Territory of New Guinea; and 15 in West Irian. (1) Lake Daviumbu, (2) Tarara, Wassi Kussa River, (3) Mabaduan, (4) Dogwa, Oriomo River, (5) Mt. Bosavi, S. W. slopes (formerly Mt. Leonard Murray), (6) Port Moresby area, (7) Rigo area, Kemp Welch River, (8) Jimmi River area, near junction with Ganz River, (9) Kratke Mountains, "Kassam Camp" area, (10) Kratke Mountains, Arau, (11) Kratke Mountains, Apimuri, (12) Goroka area, (13) Baiyer River area, near junction with Lai River, (14) Mendi Valley, vicinity of Bela, (15) Merauke area.

No. 154463) on Mt. Finnegan, Cape York Peninsula, Queensland at an elevation of about 2800 feet (855 meters). In Tasmania *Tachyglossus* inhabits not only open heathlands and light bush country, but also heavy forests (Sharland, 1962).

During the 1930's, two Archbold expeditions collected *Tachyglossus* at a number of localities in the savannas of western Papua (fig. 3). One specimen (A.M.N.H. No. 108998, a partial skull), purportedly from the southwest slopes of Mt. Bosavi at an elevation of about 1500 feet (455 meters), is suggestive of a different habitat. The nearest expedition camp in 1936, however, was on the Fly River about 110 miles (175 kilometers) to the southwest of this mountain. Because this specimen was not collected by an expedition member, we have no definite habitat description of the above locality. In 1964 George photographed a captive *Tachyglossus* in

the Mendi Valley near Bela (Papua). This echidna had been traded from farther south by natives. Bergman (1961) wrote that he bought three live individuals of *Tachyglossus* in the Merauke area of West Irian (fig. 3). This is an area of open forest, and is similar to that of the trans-Fly River collecting localities.

In 1932 Fred Shaw Mayer collected a skin and skull of *Tachyglossus* near Arau at an elevation of about 4600 feet (1400 meters) in the northern Kratke Mountains of the Eastern Highlands District of the Territory of New Guinea (J. E. Hill, *in litt.*). Later in the same year Shaw Mayer collected two additional skulls and a piece of skin in the same general locality (Laurie, 1952). These were the first records of the short-beaked echidna north of the east-west oriented central cordillera of New Guinea. In 1959 Van Deusen and J. D. Collins found further evidence that this echidna had penetrated the range to a point near the rift valley of the Markham and Ramu rivers on north coast drainage. The evidence is a specimen (A.M.N.H. No. 190858) consisting of a partial skull and several claws and spines, the remains of an animal eaten at Arona No. 1 near the Kassam Camp two days before the arrival of Van Deusen and J. D. Collins on October 26. Kassam Camp, at an elevation of 4500 feet (1370 meters) in the Kratke Mountains, was located at the edge of forest that was poor in undergrowth and substage species, and nowhere very mossy (an indication of only moderate rainfall). Brass (1964) characterized this plant association as *Castanopsis*-oak-Lauraceae forest. These forested ridges of the northern Kratke Mountains are (in part) the headwaters of the Purari River, which flows south to the Gulf of Papua, and of the Ramu and Markham rivers.

In the collection of New Guinea mammals presented to the Archbold Collection in 1951 by the late E. T. Gilliard of the Department of Ornithology, the American Museum of Natural History, there is a specimen of *Tachyglossus aculeatus* preserved in alcohol. This specimen is of great interest on geographic grounds because it represents the first record of the occurrence of *Tachyglossus* in the Western Highlands District of the Territory of New Guinea. The echidna (A.M.N.H. No. 156702) was collected in August, 1949 on the Sepik-Wahgi Dividing Range and given to Gilliard by Capt. Neptune E. Blood, a Patrol Officer in the Australian Administration. The collecting locality was on northern, or Jimmi River, drainage at an elevation of about 5500 feet (1675 meters), and foreshadowed the *Tachyglossus* records of Shaw Mayer and George from the Western Highlands in the 1960's.

To answer future questions about Gilliard's use of labels bearing the designation "H.H." the following explanation will be of value. Gilliard

labeled some of his preserved in alcohol New Guinea specimens with numbered tags remaining from the Whitney South Seas Expedition. On Gilliard's 1950 expedition to the Western Highlands (Mayr and Gilliard, 1954) he used tags printed for Hannibal Hamlin, a bird collector, who also collected a few mammals in New Guinea in the early 1930's. Gilliard used tag number H.H. 985 for the specimen of *Tachyglossus* which was given to him by Capt. Blood in 1950.

Fred Shaw Mayer (*in litt.*) wrote that in the early 1960's a live short-beaked echidna had been sent to him from Goroka (Territory of New Guinea). Goroka is in the valley of the Asaro River, another of the important northern tributaries of the Purari River. In September, 1967 George also received a live individual of *Tachyglossus* from the Goroka area. Unfortunately, the exact provenance of these specimens is unknown. In 1966 George acquired three *Tachyglossus* skulls in the Western Highlands District of the Territory of New Guinea: one at the Karap rest house, and two at the Government Station at Tabibuga in the Jimmi River Valley (also spelled Jimi on some maps). These skulls, according to George's native informants, came from echidnas inhabiting a forested area near the Jimmi River close to its junction with the Ganz River (elevation about 3000 feet, 915 meters). George has presented one of these skulls to the Archbold Collection (A.M.N.H. No. 193990). The Jimmi is a southern tributary of the Sepik River which drains a large area in the western part of the Territory of New Guinea. George also reports that on June 18, 1967 local natives brought a live *Tachyglossus* to Fred Shaw Mayer at the Fauna Sanctuary at Baiyer River. About a month later a second specimen was brought to the Sanctuary (now known as the Hallstrom Park Bird of Paradise Sanctuary). According to the natives these echidnas came from the western end of the Baiyer River Valley near its junction with the Lai River. The echidnas could have come from any elevation between 2000 and 5000 feet (610 meters and 1525 meters). The Lai River joins the Jimmi River to the north to form the Yuat River which flows northwest to the Sepik River. These additional distribution records extend the range of *Tachyglossus* in the Territory of New Guinea about 160 miles (256 kilometers) to the northwest of the Kratke Mountains localities. An examination of the drainage patterns of the northern tributaries of the Purari River, especially in the area between the Hagen Range and the Sepik River-Wahgi River divide, suggests one route by which *Tachyglossus* may have crossed over into areas on north coast drainage. *Tachyglossus* probably followed the river courses into the interior valleys of the central ranges. The "Baiyer Gap," elevation about 5500 feet (1675 meters), presents a convenient gap for penetration into

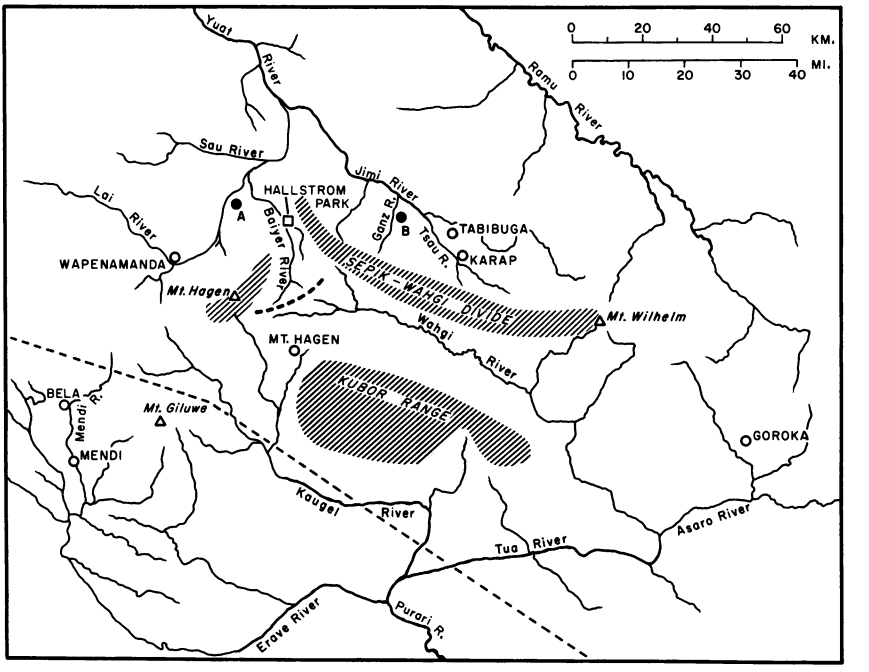

FIG. 4. The headwaters of the Purari River and the Sepik River in the central highlands of the Territory of New Guinea and the Territory of Papua. The light dotted line shows the approximate boundary between the two territories. The short, heavy dotted line indicates the so-called "Baiyer Gap." Black dot A shows area near junction of the Baiyer and Lai rivers in which *Tachyglossus* were captured alive by natives. Black dot B shows area near junction of the Jimmi and Ganz rivers in which several *Tachyglossus* were killed by natives.

the Baiyer River and Lai River valleys and thence into the valley of the Jimmi River (fig. 4).

George kept the Goroka *Tachyglossus* under observation at Wapenamanda for several months. This young male was active during the day, periods of activity depending on the amount of food he could find. His preferred foods were the eggs, larvae, and pupae of a species of black ant common about the garden and lawns. The adult ants were not favored. When feeding, he would probe each ant hole with his sensitive snout and walk on if eggs or pupae were not detected. When a hole with suitable food was located, he would spend five to 10 minutes with his snout in the hole licking up and crushing the eggs, larvae, or pupae within reach. Quantities of soil particles and adult ants were also ingested during feeding and were obvious in the feces. The preference of the

echidna for the immature ants, however, was easily observed when he fed on ant colonies under upturned stones or logs, where concentrations of adults were sniffed but not ingested. If food was out of range of the snout and extensile tongue, the echidna would dig frantically with his front claws and wedge head and shoulders further into the nest. Occasionally he would lap at free water around the garden, but would not take milk, or milk and beaten egg, unless liberal amounts of ant eggs or pupae were added. Consequently the echidna could not be kept and fed in close confinement.

After an hour or more of feeding, the echidna would bury himself under a few inches of damp soil or garden litter and sleep for about an hour. For practical reasons the animal had to be locked away in a storeroom at night, and, if he had enough food that day, he went straight into a box full of rags and papers reserved for him. If he was still hungry, he would pace up and down the floor, clawing at the crack under the door. However, once he had settled down he would not stir again until the next morning. When food was plentiful, he would sleep until mid-afternoon; during lean periods he would wake early in the day. On waking he would move to a corner to defecate. This required some effort as the feces were often quite bulky with soil. The animal had to arch his body and draw up the hindquarters underneath while balancing partly on the tips of the front claws. In the early morning he was quite sluggish and would bask in the sun with body flattened and legs outstretched for about 15 minutes or so before commencing to search for food.

The memory and sense of direction of the echidna were surprising. He knew his way around the house, and for days at a time had favorite feeding areas in the garden. This habit made it possible to find him fairly quickly on the several occasions that he had escaped from custody. It did not appear that the hind legs were used for digging at any stage, even in soft soil. The long second claw of the hind foot was used only for grooming, and was held clear of the ground when the echidna walked on a flat surface.

Van Deusen, who collected specimens at various localities on the Cape York Peninsula, Queensland in 1948, found *Tachyglossus* active primarily at night. George has encountered echidnas during the day on several occasions in Victoria and Tasmania. In the temperate rain forest of New South Wales J. H. Calaby (1966) has observed echidnas to be active both day and night. Analysis of these and many other observations plainly point to the fact that *Tachyglossus* activity is closely correlated to the ambient temperature. Echidnas exhibit imperfect thermo-regulation; as a result they seek to avoid daily and seasonal extremes of temperature

by one method or another throughout their range. Foraging by day or night is one method; hibernation is an extreme measure used at higher latitudes and higher elevations. We have no information on daily or seasonal activity of *Tachyglossus* living under natural conditions in New Guinea.

Griffiths and Simpson (1966) made extensive observations on the seasonal dietary habits of *Tachyglossus* near Canberra in the Australian Capital Territory; the study pointed out the importance of extending such observations for at least a year. They found that, whereas many species of ants and termites were eaten, the echidna in this area, at least, was primarily an anteater. Jones (1923) stated that the echidna of South Australia fed on a variety of small insects, including large quantities of the "sugar ant" (*Campanotus nigrescens*). *Tachyglossus* is also known to eat earthworms, the larvae of scarab and other beetles, and the larvae of the moth, *Xyleutes.* Bergman (1961), in New Guinea, fed his captive *Tachyglossus* on tree termites which the natives gathered each day.

Griffiths (1965) explained how his 15 captive echidnas crushed the ants and termites that formed the bulk of their diet. Because echidnas have no teeth, the food is triturated to a pastelike consistency within a few seconds by the interaction of a set of keratinous spines situated on an eminence at the base of the tongue and a series of transverse spiny ridges on the palate.

Zaglossus bruijni (Peters and Doria)
LONG-BEAKED ECHIDNA

GREATEST LENGTH OF SKULL: Measurement of five skulls, personally examined by Allen (1912), ranged from 143 mm. to 182 mm. (table 1). Allen also took the measurement of an even larger skull (drawn natural size) from a plate by Gervais as 197 mm. A.M.N.H. No. 190859, as shown in table 1, has a skull measuring 203 mm. Two even larger skulls in the Archbold Collection deserve mention, particularly because the Pleistocene remains of *Zaglossus* in Australia are believed to represent a larger form than that occurring at present in New Guinea. A native "trophy skull" (A.M.N.H. No. 190861, cranium nearly entire, mandible missing) was bought by Van Deusen in 1959 at Arau in the Kratke Mountains, Eastern Highlands District, Territory of New Guinea. The distal end of the beak is missing, but the absolute length of the skull has been estimated as 223 mm. In 1938 natives brought an even larger skull to the Archbold camp located six miles (9 kilometers) northeast of Lake Habbema. The posterior portion of the cranium (including the condyles) is missing. Again, by use of ratios, the length of the skull has been con-

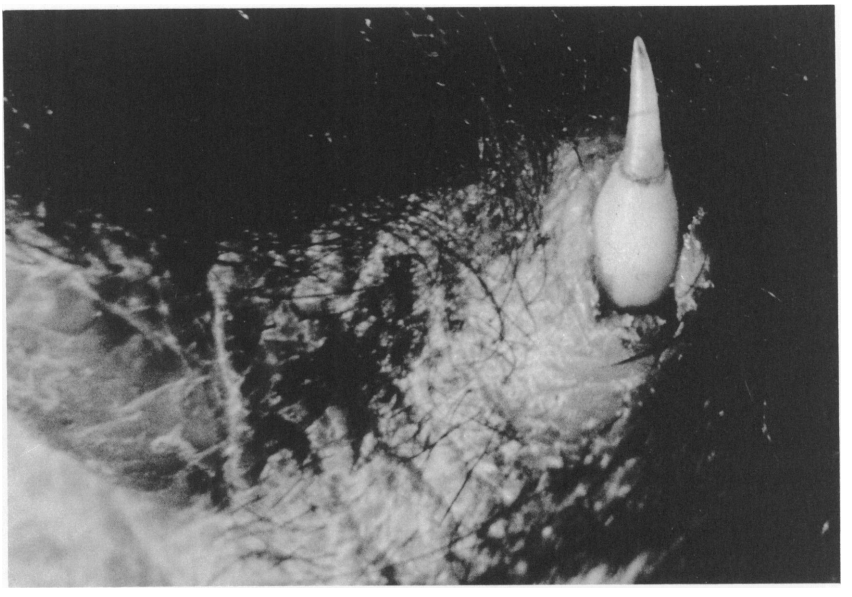

FIG. 5. *Zaglossus bruijni.* A.M.N.H. No. 194702. Spur on left hind foot.

servatively estimated as 231 mm. (A.M.N.H. No. 110047).

SPUR: The presence or absence of a spur on the hind foot of nine specimens of *Zaglossus* in the Archbold Collection has been noted in table 1. Figure 5 shows the protruded spur on the left hind foot of A.M.N.H. No. 194702. The spur consists of a yellowish white (color in preserved specimen) basal portion, and a distal, needle-pointed, light horn-colored tip. Allen (1912) dissected two specimens with well-developed spurs, and found both to be males. Most writers have assumed that only the male *Zaglossus* has spurs. Allen wrote, "it is generally considered absent in the adult female." Does this statement mean that Allen had evidence that spurs may also be found at some earlier stage of development in the female? Griffiths (1968), writing about *Tachyglossus aculeatus* in Australia, said, "on the inside of the ankle in all males and in some females is a hollow perforated spur 0.5–1.0 cm. long from the base of which a duct leads up the leg to a gland buried among the muscles just below the knee . . . we have found large glands about 2 cm. in diameter in males taken during the breeding season; the spur and its glandular apparatus is not poisonous as it is in *Ornithorhynchus* at certain times of the year." In the Archbold Collection there are two *Zaglossus* preserved entire in alcohol; also, three bodies (removed from specimens made into study

TABLE 1

MEASUREMENT (IN MILLIMETERS) OF GREATEST LENGTH OF SKULL, CLAW LENGTH AND WIDTH, AND ABSENCE OR PRESENCE OF SPUR OF *Zaglossus bruijni*

Locality	A.M.N.H. No. 190859 T.N.G.: Sepik Dist.; Telefomin area	A.M.N.H. No. 190862 T.N.G.: Morobe Dist.; Watut River Headwaters W. of Edie Creek area	A.M.N.H. No. 190863 T.N.G.: Morobe Dist.; Watut River Headwaters W. of Edie Creek area	A.M.N.H. No. 66194 T.N.G.: Morobe Dist.; Huon Peninsula, Saruwaged Mts.	A.M.N.H. No. 194702 T.N.G.: Morobe Dist.; Huon Peninsula, Saruwaged Mts.	A.M.N.H. No. 195146 T.N.G.: Morobe Dist.; Huon Peninsula, Saruwaged Mts.	A.M.N.H. No. 195147 T.N.G.: Morobe Dist.; Huon Peninsula, Saruwaged Mts.	A.M.N.H. No. 104020 Papua: Wharton Range, Murray Pass	A.M.N.H. No. 157072 Papua: Milne Bay Dist.; Mt. Maneau
Skull, greatest length	203	186	193	168	154	—	—	(180)[a]	158
Forefoot, left									
Digit No. 1	15 × 8	(11)[a] × 6	13 × 6	11 × 5	12 × 5	12 × 6	12 × 6	10 × 6	9 × 5
Digit No. 2	27 × 10	29 × 10	30 × 9	22 × 7	23 × 8	26 × 9	25 × 9	26 × 11	20 × 8
Digit No. 3	30 × 11	34 × 11	35 × 9	27 × 8	26 × 8	31 × 9	30 × 9	32 × 10	23 × 8
Digit No. 4	27 × 11	31 × 10	31 × 9	24 × 7	25 × 8	29 × 9	27 × 10	29 × 12	21 × 8
Digit No. 5	15 × 9	16 × 7	17 × 7	13 × 6	14 × 6	16 × 7	16 × 7	13 × 7	12 × 6
Forefoot, right									
Digit No. 1	14 × 7	13 × 6	14 × 6	10 × 5	10 × 5	12 × 6	12 × 6	11 × 6	9 × 5
Digit No. 2	27 × 10	29 × 10	31 × 9	23 × 7	22 × 7	26 × 9	25 × 8	25 × 11	21 × 8
Digit No. 3	30 × 12	33 × 11	34 × 9	27 × 8	27 × 8	31 × 9	28 × 10	(29)[a] × 11	24 × 8
Digit No. 4	27 × 11	31 × 11	32 × 9	25 × 8	24 × 7	29 × 9	26 × 9	29 × 13	22 × 8
Digit No. 5	16 × 8	16 × 7	18 × 8	13 × 6	14 × 6	16 × 8	14 × 6	14 × 8	12 × 6
Hind foot, left									
Digit No. 1	15 × 9	15 × 8	14 × 8	13 × 8	12 × 6	14 × 8	14 × 7	15 × 9	9 × 7
Digit No. 2	42 × 9	52 × 8	48 × 7	44 × 7	41 × 7	53 × 7	46 × 7	50 × 9	40 × 6
Digit No. 3	36 × 7	43 × 7	40 × 7	32 × 6	35 × 6	41 × 6	39 × 6	39 × 8	33 × 5
Digit No. 4	29 × 6	34 × 6	(33)[a] × 6	29 × 6	29 × 5	36 × 6	31 × 7	24 × 8	27 × 5
Digit No. 5	(Claw absent)	14 × 6	14 × 5	(13)[a] × 5	16 × 5	17 × 5	14 × 5	11 × 5	6 × 4
Hind foot, right									
Digit No. 1	14 × 9	15 × 8	14 × 8	12 × 7	12 × 6	14 × 8	15 × 7	14 × 8	10 × 7
Digit No. 2	45 × 9	49 × 7	49 × 7	45 × 7	43 × 7	53 × 7	45 × 7	47 × 8	39 × 6
Digit No. 3	36 × 8	41 × 7	41 × 6	37 × 5	34 × 6	43 × 6	40 × 6	(38)[a] × 8	32 × 5
Digit No. 4	29 × 7	34 × 7	34 × 6	(24)[a] × 6	28 × 4	35 × 6	31 × 6	(28)[a] × 7	25 × 5
Digit No. 5	(Claw absent)	14 × 5	16 × 5	12 × 5	15 × 5	16 × 5	12 × 4	9 × 6	5 × 4
Spur, hind foot	absent	?	present	present	present	present	present	present	present

[a] Best possible measurement of damaged specimen.

FIG. 6. *Zaglossus bruijni.* A.M.N.H. No. 194702. Note the typical outward rotation of the hind foot. The forefoot is normally oriented in the anterior-posterior plane.

skins) in alcohol. The anatomy of the spur and its gland, and the question of their presence or absence in female specimens will be the subject of a later note. At present we would say that the sexing of *Zaglossus,* using only the presence or absence of the spur as a criterion, may lead to error.

CLAW MEASUREMENT: This measure is subject to individual judgment. The difficulty lies in deciding the exact point on the basal portion of the claw from which to measure. One could measure only the exposed part of the claw. However, just as in the human finger and toe nails there is a well cornified portion of the claw extending beneath the soft epidermal growth at the base of each claw. In *Zaglossus* study skins this basal growth has dried and is usually shrunken, exposing more of the claw. The claw measurements given in table 1 therefore represent as extensive a measure of each claw as possible. The curved claws on digits two, three, and four of the hind feet were measured along a chord (that portion of a straight line between two of its intersections with a curve). Allen (1912) gave a few measurements of what he considered to be abnormal or extra claws. In view of the fact that a large majority of western New Guinea specimens lack claws on digits one and five, table 1 is presented to show the measurements of the claws, not only on one and

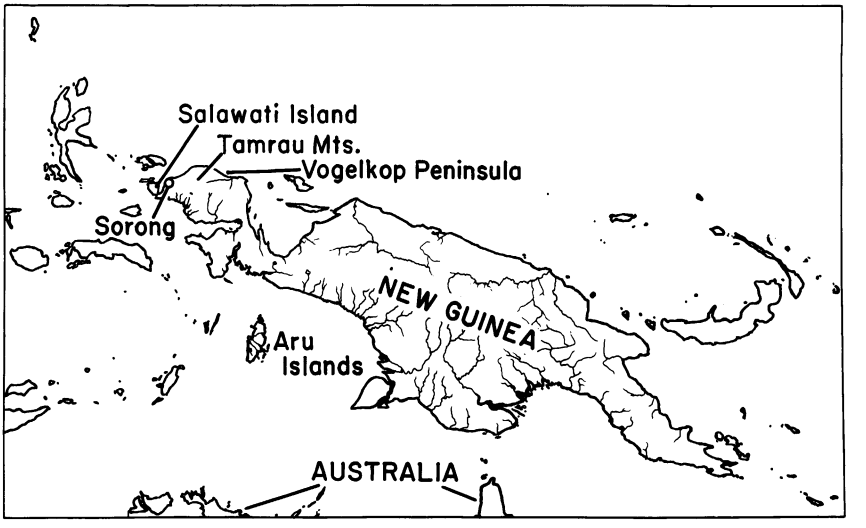

FIG. 7. New Guinea and adjacent islands.

five but also digits two, three, and four of the Archbold Collection specimens.

We follow Allen's convenient system of using numerals to express the presence of a claw on its respective digit, and a zero to indicate the absence of a claw. The formula for A.M.N.H. No. 190859 is as follows: L $\frac{54321}{04321}$ R $\frac{12345}{12340}$. The claw on digit five is absent on both hind feet. A.M.N.H. No. 190859 is the only one of the nine Archbold specimens to have this formula. The remaining eight specimens have the formula L $\frac{54321}{54321}$ R $\frac{12345}{12345}$. The digits on the fore and hind feet are numbered one to five from the medial border outwards. In many study skins the hind legs have been positioned so that digit one is on the outside. However, since digit two has the longest of the three curved claws, it is possible to orient the hind feet correctly. In life a *Zaglossus* in standing position has the hind feet turned outwards at about a 90 degree angle to the anterior-posterior plane. The toes of the forefeet point forwards; occasionally the forefeet turn inwards slightly.

RANGE: Whether or not the ranges of *Tachyglossus* and *Zaglossus* are sympatric in New Guinea is raised by this more detailed understanding of the range of *Tachyglossus* in forested areas of the Territory of New Guinea. *Zaglossus,* with an extensive distribution on mainland New Guinea from the Vogelkop Peninsula in West Irian to the east end of Papua, has a known altitudinal range in the montane forests from about

3770 feet (1150 meters) to about 9400 feet (2865 meters). In Van Deusen's experience *Zaglossus* is an inhabitant of the humid montane forests that are almost continually blanketed by cloud cover. The short-beaked echidna evidently occupies drier, more open forests at low to mid-montane elevations in the Territory of New Guinea than does *Zaglossus.* The habitat at these favored levels may be: mixed rain forest; a transition type between mixed rain forest and oak forest; or a *Castanopsis*-oak forest. The type depends on elevation, amount of rainfall, exposure, and edaphic factors. Although there is some overlap in altitudinal range, we have as yet no case of proved sympatry. Habitat preferences and related differences in diet are probably the critical factors.

Two puzzling locality records of *Zaglossus* from West Irian are in the literature. Allen (1912) recorded two specimens bought by T. Barbour from natives in 1906 at Sorong, a small, low island close to the northwest coast of the Vogelkop Peninsula (fig. 7). They were said to have been captured in the hills which lie a few miles back from the swampy coastal plain bordering the mainland shore. *Zaglossus* is known to occur in the Tamrau Mountains less than 65 miles (104 kilometers) to the east.

Thomas (1907b) described a new species, *Acanthoglossus* [=*Zaglossus*] *goodfellowi,* from Salawati, a large island narrowly separated by shallow water from the west coast of New Guinea. The greatest elevation on Salawati is 2740 feet (835 meters). Thomas stated that the collector, Walter Goodfellow, obtained two specimens on the island and that these were kept alive for some months. Thomas remarked that the type specimen, an old female, had a "coat much more spinous and less hairy than in any of the forms of *A. bruijni.*" He also commented, "the island of Salawatti being throughout comparatively low, it is not surprising that the *Acanthoglossus* [=*Zaglossus*] occurring there should be different in the development of its coat from its New Guinea ally [*Z. bruijni*]." Allen (1912) expressed skepticism about the provenance of Goodfellow's specimen (the type of *Z. goodfellowi*), which, although it was obtained from the island of Salawati, could originally have been brought to the island from the nearby mainland by natives. Rothschild (1913) wrote that he had three specimens of *goodfellowi* in his museum at Tring in addition to the type specimen at the British Museum; he considered *goodfellowi* a subspecies of *Z. bruijni.*

Bergman (1961), who visited this island hoping to collect living *Zaglossus,* wrote that the Rajah of Salawati told him that the long-beaked echidna was not present on the island, but that it lived in the Tamrau Mountains on the north coast of the nearby Vogelkop Peninsula. There continue to be many surprises in mammal distribution on New Guinea, however, and therefore it is dangerous to summarily dismiss records such as the Sala-

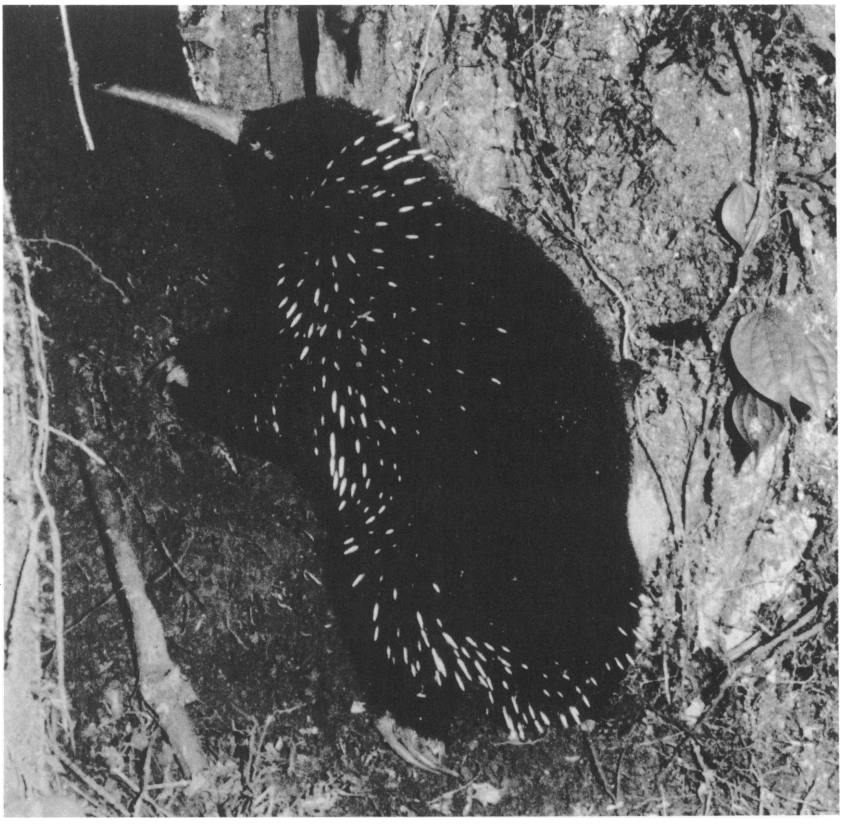

FIG. 8. *Zaglossus bruijni* at termite nest, base of tree. A.M.N.H. No. 194702.

wati one, even though we know that there is much coastal trading by natives between mainland localities and the islands west of the Vogelkop Peninsula.

FOOD: Fred Shaw Mayer (*in litt.*) has observed that *Zaglossus* will feed on worms in captivity. Pocock (1912) described the feeding habits of specimens of *Zaglossus* exhibited at the London Zoological Gardens: "the food, which consists of raw meat mixed with milk, is taken in with the help of the tongue. They are very fond of earthworms, but seem unable to imbibe them unless grasped either at the head or tail. In finding the extremity, the echidnas are apparently guided entirely by the tactile sense of the lips; but when once it is found, the worm disappears as if drawn in by suction." Worms are abundant in the loose humus layer of the humid montane forests of New Guinea. A young *Zaglossus* kept alive in the Arch-

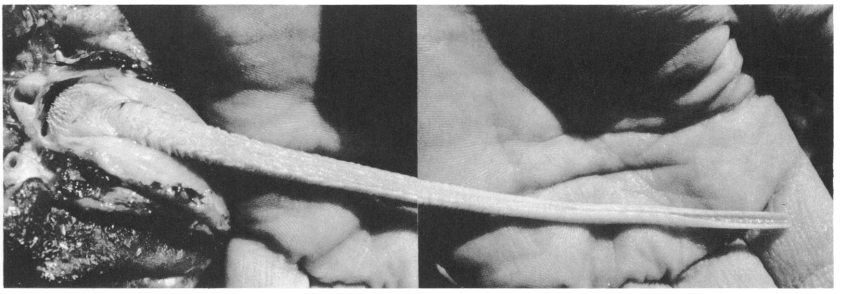

FIG. 9. *Zaglossus bruijni.* A.M.N.H. No. 194702. Dorsal view of tongue. Note open structure of distal end of tongue. Length (in alcohol) 220 mm.

bold Expedition's Gang Creek Camp in the Rawlinson Mountains in 1964, systematically probed with its long beak a termite mound composed of relatively soft earth at the base of a tree (fig. 8). Another individual was introduced to a broken-open ant nest, but paid no attention to the swarms of adults. T. Barbour, quoted in Allen (1912), kept a *Zaglossus* in captivity in New Guinea for about a month. He observed that "it fed on ants only, which were procured by placing in a dish a considerable amount of shredded cocoanut. The ants soon swarmed in this and the whole was

FIG. 10. *Zaglossus bruijni.* A.M.N.H. No. 194702.

FIG. 11. *Zaglossus bruijni.* A.M.N.H. No. 194702. Front view. Note setting of eyes near base of beak, and the nostrils at the distal end of beak.

then placed in the Proechidna's cage. It ate the insects by thrusting its long tongue down into the cocoanut. It took a little water or water with condensed milk, but seemed to drink very little. Ripley (1942), speaking of a captive *Zaglossus* he bought at Sansapor on the Vogelkop, said that "the echidna is supposed to live on ants although this one would never touch them, much preferring papaya and raw eggs." We suspect, but we do not know for a certainty, that the two genera of echidnas may have basically different diets. Much additional observation on non-captive individuals throughout the year is needed to resolve this question.

TAXONOMY: Since the discovery of *Zaglossus* in 1876, several specific names have been proposed for the various populations of this endemic genus. Allen (1912), however, recognized only one full species, *Zaglossus bruijni.* Rothschild (1913) also recognized a single species, *Z. bruijni,* and in his key he accepted four geographical subspecies besides the nominate subspecies, *bruijni.* One subspecies, originally described by Thomas (1907a) as *Acanthoglossus Bruijnii Bartoni* [= *Zaglossus bruijni bartoni* in Rothschild (1913)], was advanced to specific rank by Thomas and Rothschild (1922);

FIG. 12. *Zaglossus bruijni.* A.M.N.H. No. 194702. Dorsal view of left forefoot. Note claws on all five digits.

they remarked, "no doubt *Z. bartoni* is quite a good species." In the same paper Thomas and Rothschild described a subspecies, *Z. bartoni clunius,* from the mountains of the Huon Peninsula in what is now called the Territory of New Guinea. Thomas and Rothschild (1922) were very likely influenced in this matter of considering *bartoni* a full species by Kerbert (1913). Kerbert proposed a new genus, *Prozaglossus,* to receive the five-clawed subspecies *bartoni* described by Thomas (1907a) from Mt. Victoria, British New Guinea (now the Territory of Papua). Thomas and Rothschild (1922), however, did not accept this new genus. By 1922 there were enough study skins in museums to demonstrate the fact that considerable variation existed in the number of clawed digits in *Zaglossus.* In the absence of good cranial characters, Thomas and Rothschild took a strong stand against using the number of claws as a generic character. Rothschild, in Thomas and Rothschild (1922), recognized six subspecies of *Zaglossus bruijni* and

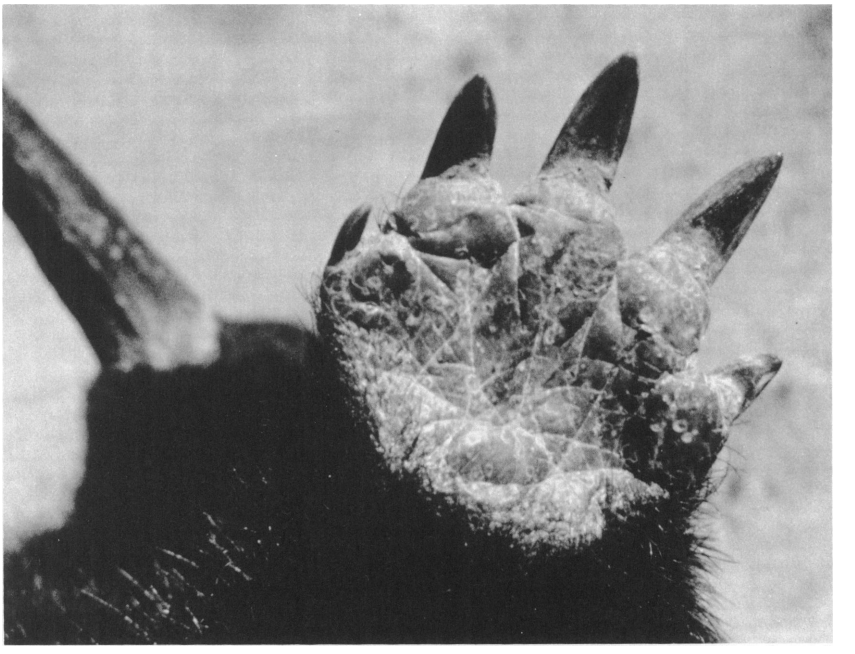

FIG. 13. *Zaglossus bruijni.* A.M.N.H. No. 194702. Ventral view of left forefoot. Basal portion of beak at left.

two subspecies of *Z. bartoni* in his "Key of *Zaglossus.*" Laurie (1952) described a new species, *Zaglossus bubuensis,* from the Territory of New Guinea. Laurie and Hill (1954) recognized the above named three species; these authors followed Rothschild's 1922 "Key" in the listing of subspecies of *Zaglossus.*

The above papers show clearly that on the species level the range of variation in critical characters has yet to be demonstrated. Variable characters (amount and color of hair; color, shape, size, and distribution of spines; and the number of claws) have been widely used as distinguishing taxonomic characters. What, for example, is the "normal" claw formula for the fore and hind feet in *Zaglossus?* A great majority of the early specimens of this genus were collected in what was then Netherlands New Guinea (roughly, the western half of the island). Allen (1912) wrote, "since some twenty-five or more specimens are recorded in which the claw formula for each foot is 0, 2, 3, 4, 0 [each number represents a clawed digit, zero a digit without claw], this must be considered the normal condition, from which regressive variation sometimes takes place." Allen

FIG. 14. *Zaglossus bruijni.* A.M.N.H. No. 194702. Dorsal view of left hind foot. Digit one at bottom of picture. Note claws on all five digits.

also gives a table of six "abnormally clawed Proechidnas" [*Zaglossus*]. These specimens include individuals: with claws on all five digits of both fore and hind feet; with claws absent only from digit one of both hind feet; with claws absent from digit one of all four feet; with claws absent from digits one and five of the forefeet and the first digit of the hind feet; with claws absent from digits one and five on all feet except the right forefoot which has a claw on digit one; with claws absent from digits one and five on all feet except the left forefoot which has claws on all five digits. Eight of the nine specimens in the Archbold Collection have claws on all digits of both fore and hind feet. The ninth specimen has claws on all digits except digit five of the hind feet. If Allen had had only the Archbold specimens to study in 1912, the "normal" claw formula would have been given as 1, 2, 3, 4, 5.

Thomas (1907a) did not specify the number of claws on the type specimen of *bartoni* from Mt. Victoria. In a footnote of a later paper, however, Thomas (1907b) recorded the number of claws on this specimen as "five

FIG. 15. *Zaglossus bruijni.* A.M.N.H. No. 194702. Ventral view of left hind foot. Note spur at bottom of picture.

claws on both fore and hind feet." Laurie (1952) reported on three specimens of *Zaglossus* at the British Museum (Natural History) collected by Fred Shaw Mayer on Waria River drainage in the Morobe District of the Territory of New Guinea. Two specimens were identified by Laurie as *Zaglossus bartoni bartoni.* The third specimen was made the type of *Zaglossus bubuensis.* In her description she remarked that *bubuensis* was "similar to *bartoni* in having five claws on all the feet." We can therefore safely assume that all three of these individuals were five clawed.

We have not had the opportunity of examining *Zaglossus* specimens in European and Australian museums, but the available data in Allen (1912), Laurie (1952), and other publications, as well as the new data from the Archbold Collection, strongly suggest an east-west cline in which five-clawed individuals are found in most of Papua and the Territory of New Guinea and four-clawed and three-clawed individuals (in various combinations) in West Irian. The one individual in the Archbold series with hind

feet having four-clawed digits comes from the Territory of New Guinea near the West Irian border.

Series of study skins are necessary for taxonomic studies, but in the case of *Zaglossus* hunting pressure and destruction of habitat have seriously reduced the numbers of this unique monotreme in many parts of New Guinea. *Zaglossus,* roasted in the coals of a fire, is considered a great delicacy by all New Guinea peoples. There is no further pressing need for collecting series at random localities, but there is a great need for detailed life history studies on this echidna. Certainly in the museums of the world there is ample material for a thorough taxonomic study of the genus on the species level, and, in some cases, on the subspecies level. However, until such time as a taxonomist can examine and evaluate this range of material personally, we agree with Allen (1912) that only one species, *Zaglossus bruijni,* should be recognized.

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