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NOTES ON THE LIFE HISTORY OF THE EMERALD TOUCANET

BY HELMUTH O. WAGNER¹

THREE representatives of the Ramphastidae occur in Mexico. Of these the Emerald Toucanet (*Aulacorhynchus prasinus*)² has the widest distribution as well as the most northerly range. It is distinctly a bird of the virgin forest. In southern Mexico I encountered the Emerald Toucanet only in the mountains between 1,000 and 2,500 meters (3,280 and 8,200 feet), never at lower altitudes, even where apparently suitable habitats were available. Farther north in Mexico one finds it at lower altitudes and in much drier habitats. Obviously, then, its ecological requirements are not the same in all parts of the country, and the observations recorded below, which were made in the south of Mexico, are valid only for that region.

OBSERVATION AREA

My observations of the Emerald Toucanet were made close to the Guatemalan border, in the state of Chiapas, during several lengthy visits in the course of the last 10 years (1933 to 1942). I observed the bird at all seasons of the year, sometimes almost daily.

Along the Pacific coast runs a chain of mountains, the Sierra Madre de Chiapas, an extension of the South American Cordillera. In my observation area, near Mapastepec (a railway station between Tonalá and Tapachula), these mountains rise to an altitude of 2,300 meters (7,544 feet). Here the continental divide is at some places no more than 10 miles from the Pacific.

I made observations on both the Atlantic and the Pacific slope of the mountains. Extensive undisturbed virgin forest is the habitat required by the Emerald Toucanet in Chiapas. The bird does not occur where the forest gets drier, as is the case, for example, on the Pacific slope below 1,000 meters (3,280 feet).

¹ Translated by Margaret and Ernst Mayr.

² The Emerald Toucanet was portrayed in color by George Miksch Sutton in an earlier *Bulletin* (Sutton and Burleigh, 1940).—Ed.



PANAMA ANT-THRUSH
(*Formicarius analis panamensis*)

At nest on Barro Colorado Island, Canal Zone, May 19, 1929. The nest was three feet above the ground and contained one egg. Flashlight photograph by Howard H. Cleaves.

Figure 1 illustrates the local conditions in Chiapas—the vegetation zones and the distribution of the Emerald Toucanet at different seasons. The breeding range is in the high mountains in typical cloud forest. Its lower borders are at altitudes of about 2,000 meters (6,560 feet) on the Pacific slope, and 1,750 to 1,800 meters (5,740 to 5,904 feet) on the Atlantic slope. The birds spend most of the time between breeding seasons at lower altitudes. They are found on both slopes of the mountains, but the flocks are much more numerous on the Atlantic side, where the humidity is higher. On the Pacific slope, I have found them only at the bottom of humid valleys.

CLIMATE OF THE HABITATS

Sharply defined dry and rainy seasons alternate in most parts of Chiapas. The beginning and length of these seasons vary from year to year by several weeks, but the rainy season usually extends from the middle of May to October. At an altitude of 1,000 meters (3,280 feet) on the Atlantic slope, the average yearly rainfall (taken over seven years) was 390 cm. (153 inches). At the end of October the heavy rains stop, the sun begins to shine, and both dryness and temperature begin to increase steadily. In April and May, temperatures of 30° and 35° C. are recorded at the local weather station (which is not, however, within the virgin forest).

The climate of the higher altitudes is quite different: there is a pronounced rainy season between May and October, but during the other months, when it is hot and dry at lower altitudes, it is still cold and rainy here. Cold northerly winds from the Gulf of Mexico drive rainclouds against the mountains above an altitude of 1,800 meters (5,904 feet), and these precipitate continual light rains. Thus one cannot speak of a dry season in the higher altitudes, especially in the wide mountain valleys. Unfortunately, I cannot give a figure for the annual rainfall here, but in spite of the fact that rain falls the year round, the annual total is probably less than at lower altitudes, where there is sometimes more than 12 cm. (5 inches) rainfall in 24 hours.

The difference in the climate of the two habitats of the Emerald Toucanet finds its most conspicuous expression in their dissimilar plant associations. In the breeding area, the invariably damp rainforest, large oaks are the prevailing tree. Beneath their high, wide-spreading crowns is only a spare undergrowth, among which large tree ferns are conspicuous. Every bough and twig is covered with a thick water-soaked layer of moss. On the great horizontal boughs of the oaks, 50 meters (164 feet) or more above the ground, there are luxuriant growths of orchids, ferns, and other epiphytes.

The virgin forest at lower altitudes, where pronounced dry and rainy seasons alternate, has a quite different aspect. This forest, too, is luxuriant, and because of the high temperatures, especially quick-

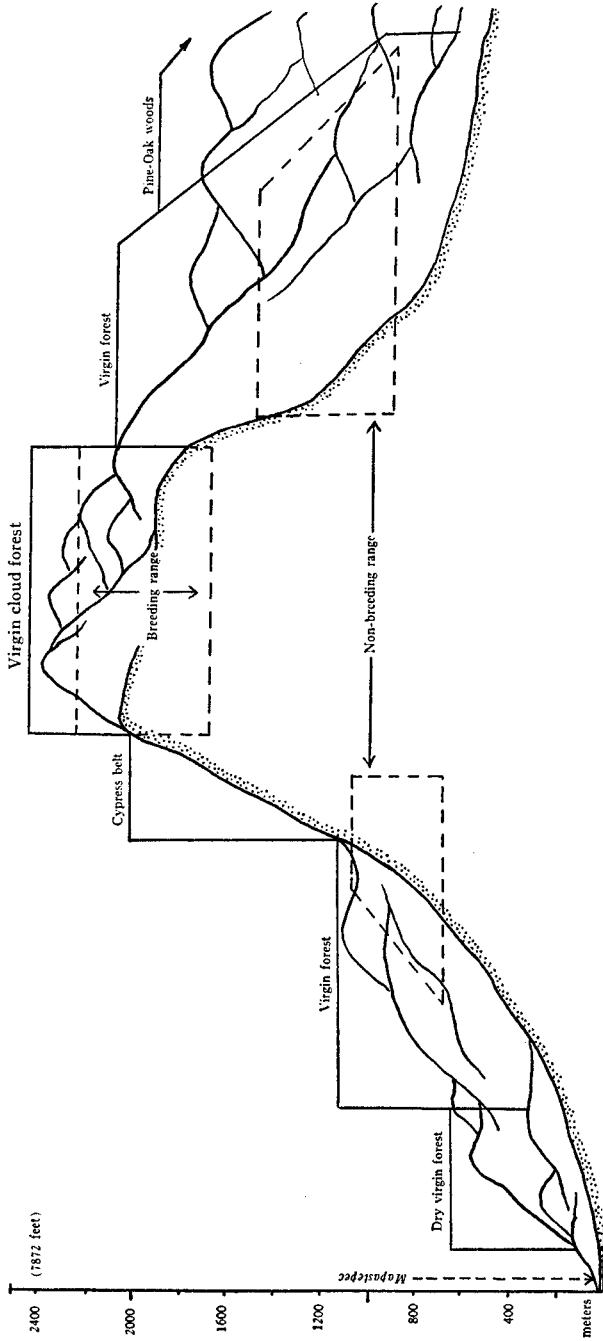


Figure 1. Diagrammatic cross-section through the range of the Emerald Toucanet in the Sierra Madre de Chiapas near Mapastepec, Chiapas, Mexico. The breeding range (Nov./Dec.-May/June) and non-breeding (summer) range are indicated by broken lines.

growing. However, plants requiring uniform moisture throughout the year, which are common at higher altitudes, are lacking here. Distinct seasonal changes are apparent in the appearance of the vegetation, whereas at higher altitudes, only a few miles distant, the same general aspect is preserved all the year round.

VERTICAL MOVEMENTS

The Emerald Toucanet in Chiapas shows a limited adaptability to environment. After extensive observations and comparisons, I have come to the conclusion that it is less the plant associations than a very definite degree of atmospheric humidity that determines the sporadic distribution and the migrations there—changes in temperature and in available food supply playing only a minor part. The seasonal migrations of the Toucanet are regulated by seasonal fluctuations in the humidity of the air; also whenever there is a marked departure in either direction from the optimum humidity, the birds react by a temporary emigration.

The threshold at which the migratory impulse is released can be accurately determined: emigration from the always humid rain forest takes place when the atmosphere has become saturated with moisture, and raindrops on leaves and branches do not evaporate even when the rain stops. The Toucanets, which live in the dense tree tops, apparently dislike to stay in the continuously dripping foliage, and they leave the area for relatively dry places. Mature males and yearlings of both sexes precede the mature females, which are still busy with the care of the young.

I saw this demonstrated with remarkable clarity in May, 1942. On May 24 I crossed the mountains in splendid weather on my way to the coast. I heard the Toucanets in the dense treetops at a number of spots in the breeding range. When I returned the same way two days later, there was a pronounced change in the weather. The wind was blowing cloud shreds down the slope to the 1,000-meter (3,280-foot) level, and higher up I found myself in dense clouds. When I reached the cypress belt, with its light stands of pines and cypresses, a flock of Toucanets suddenly passed me in the fog, rushing downhill. A second and third flock followed. Beyond the continental divide, at 1,500 meters (4,920 feet), I met another flock, of five or six Toucanets, and later, a flock of more than ten. All these birds were leaving their breeding range, not to return until six months later. I approached the last flock to within five to seven meters, and could tell by the size of the bills that it did not include any young of the year. This is the only time I ever observed such a mass migration of these toucanets. Usually the migration occurs by degrees, probably according to individual variation in the reaction threshold.

The Toucanets return to the high mountains at the beginning of the dry season in November. This return migration occurs when a

certain degree of aridity is reached, which has its visible expression in a conspicuous change in the vegetation's appearance, particularly on the drier slopes. A few flocks linger in deep valleys at about 1,300 meters (4,264 feet), which are more humid because they are surrounded by mountains, and it happens sometimes that flocks of yearlings remain throughout the year at such places.

I have frequently observed that birds in general show a tendency to form larger groups in bad weather. This is also true of the Emerald Toucanet. The small flocks, which roam through the forest in the summer months, gather at the end of August into larger units of up to 20 birds. In September and October, when the soil and atmosphere are saturated with moisture even at the lower altitudes, so that there is no escape for the Toucanets into favorable environments, one finds the species usually on the crests of the mountains, where the foliage dries more quickly. But if during these months there are days on which it rains continuously and the mountains are covered with clouds to below 1,000 meters (3,280 feet), then they gather with other forest birds in the coffee plantations. Since the circulation of air is better in the light stand of trees shading the coffee bushes, it is a little drier there than in the neighboring primeval forest. On such days I have seen Emerald Toucanets perching wretchedly in the Chalun trees quite without their usual vivacity and noisiness. They find no suitable food in the coffee plantations at this season; hence I can attribute their flight only to the desire to avoid contact with the dripping leaves and branches. As soon as conditions at all permit, that is, as soon as the rain slackens and the sun occasionally shines, the Toucanets leave the plantations as quietly as they came.

BREEDING

The Emerald Toucanets breed in the rain forest of the high mountains from March to June. They arrive in their breeding range in December but do not immediately start breeding activities. The flocks (of from 4 to 10 birds) begin to break up in February. The mature females leave first, and the mature males follow shortly afterwards. Birds of the previous year remain in flocks since they are not sexually mature until they are two years old, and the mature males probably return to the flocks as soon as the females have started incubation.

So far as I could observe, the roosting holes were not used as nests. The entrances of the roosting holes were always rather exposed, and the birds could be seen from some distance as they entered or left, whereas the entrances of two nesting holes which I found were so well concealed by branches and creepers that I discovered the nests only by accident.

I have only once had the good fortune to make detailed observations on an occupied nest. On April 15, 1942, I camped in a shallow valley at an altitude of about 1,900 meters (6,232 feet). The spot was a clearing in the woods, which 20 years before had been used as a

camping ground by mule trains crossing the mountains but had since been abandoned. In the intervening years, dense scrub and young trees had grown up between fallen rotting tree trunks, and everything was covered with a thick growth of vines.

While pitching my tent I noticed a Toucanet moving quietly and timidly about the camping ground. I soon found the nest, about 20 meters (66 feet) from my camp, in a rotten tree trunk some four meters high. I then suspected, and later verified, that it contained recently hatched young. From my camp I could watch the nest without interruption while I worked. At intervals the Toucanet came flying from the tops of the forest trees to smaller trees in the clearing which were about 30 meters from the nest. It always waited here a few minutes to reconnoitre. If everything seemed safe (and the bird soon became accustomed to my presence), it moved in low, swift flight to a slender branch about 50 cm. (20 inches) below the nest entrance. Here it paused again for an instant and then jumped to the hole and disappeared inside the cavity. At each such visit it remained inside some 20 or 30 minutes, which was about the same length of time that it stayed away from the nest looking for food. I have several times observed in the tropics that during inclement weather the young are brooded for a certain interval after each feeding. When I recorded the temperature in the immediate neighborhood of this nest, the reason for such behavior became apparent. During the two weeks I spent at this spot, the lowest day temperatures occurred at 6 A.M., and were between 7° and 12° C.; the highest occurred at 2 P.M., and were between 15° and 19° C. The cold was made doubly uncomfortable by the moisture in the atmosphere. And yet March and April are the warmest months there; in winter the temperature sometimes falls below the freezing point.

I never observed near the nest more than the one bird, and this later proved to be a female. It is possible that her mate had been killed, but I suspect that in this species the male does not take part in the rearing of the young. In the same week I shot two adult males from wandering flocks, which, since the sex ratio in this species is apparently balanced, would also tend to indicate that the female rears the young alone.

I never saw food in the bill of the female when she was flying to the nest, and on dissection, I found no crop for the transportation of food. While the young are small the food is either carried inside the parent's mouth or it is regurgitated.

My observations were abruptly ended on April 20. At twilight I suddenly heard distress calls from the nest of the Toucanet. When I approached the tree trunk I heard sounds of a struggle. I plugged the nest entrance to prevent escape of the predator, and at once everything was quiet. I then cut a small hole in the trunk below the nest entrance, and seeing the eyes of the predator, I fired a load of birdshot. When I

opened the trunk further I found the dead Toucanet, which had been bitten through the occiput, a dead weasel (*Mustela frenata*), and two live young Toucanets. The opened trunk and the young are shown in Figure 2. A tangle of creepers, which originally covered the trunk completely, was removed before the photograph was made. Only the lower half of the nest cavity was opened, and the undisturbed entrance can be seen in the upper part of the picture.

The lower edge of the entrance was 260 cm. (8½ feet) above the ground. Fresh wood was exposed only where the Toucanet, in passing to and fro, had worn away the edges of the hole. I assume that the cavity had been excavated originally by a Green Woodpecker (*Piculus rubiginosus*)—the site in an old rotten trunk is typical of that species. A comparison with three other Green Woodpecker holes which I measured showed that this Toucanet's breeding cavity was only slightly larger. Apparently the only work which the new occupant had undertaken was a vertical extension of the entrance, which can be seen in Figure 2. The End Figure shows the measurements of the nest, which contained no nest material. The flat bottom of the cavity was perfectly clean and was lightly covered with wood dust.



Figure 2. The Emerald Toucanet's nest, with two young. Entrance is shown in upper part of picture.

NESTLINGS

To judge from their size, the two young were about 10 days old. They were 9.6 and 9.9 cm. long, respectively. The eyes had not yet opened, and I had the impression that they would not open for another 10 days. The dried vestiges of the yolk-sacks were still attached to the young. No feather tracts or down were visible, and merely a few bristles showed on the head and tail region. The ear opening was barely visible and still closed. The peculiar shape of the young bird is illustrated in Figure 3*a*. It is apparent that the abdominal cavity comprises a very large part of the body. At this age the sternum is quite undeveloped. The ratio, length of sternum to length of the ventral surface of the abdomen (measured from sternum to vent), is 1.2 cm. to 4.8 cm. in the young bird. In an adult male this ratio is 9.2 cm. to 4.7 cm. The abdominal length is thus the same in young and adult birds, whereas the sternum in the adult is 7.5 times as large as that of the young.

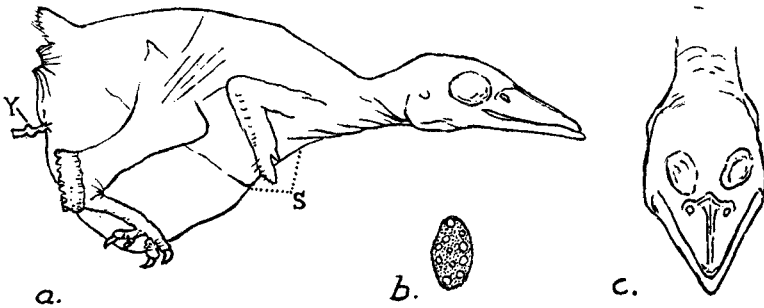


Figure 3. Emerald Toucanet. *a*. Nestling about 10 days old. *b*. Heel-pad viewed from below. *c*. Head of nestling viewed from above, showing the projecting lower mandible. *Y*. Vestige of yolk-sack. *S*. Sternum.

The wings are still very undeveloped. On the legs, the strongly developed heel-pads are conspicuous. The heel-pad is a plate attached to the ventral side of the intertarsal joint (Beebe, 1917:206; Van Tyne, 1929:30). The part of the leg above the heel-pads is strongly developed in contrast with the foot, which is still soft and flabby—an indication that the pads function earlier than the feet. The spikes or tubercles on the pads seemed to be neither definite in pattern nor constant in number. One of the young had 10 and 11; the other 12 and 14 (Figure 3*a* and 3*b*).

The bill of the young bird is rather remarkable. Its shape is very different from that of the adult bill. It is flattened (the greatest diameter at the base being lateral instead of vertical) and the lower mandible projects markedly beyond the upper (Figure 3*c*), perhaps an

adaptation for receiving food from the mother. The tongue is smooth and shaped like the bill. It is still soft, not horny and fringed as in the adult, and can be freely moved.

I do not know when the young leave the nest, but I believe it is not before the age of six weeks. Van Tyne (1929:34) estimates the nest-leaving age to be 45 days in *Ramphastos brevicarinatus*. Beebe (1917:201) figures a nestling of *Pteroglossus aracari*, but the age of 10 days which is given for the bird is most improbable. I would estimate at least 20 days. The same bird is shown when seven days older, and one can see how slow growth is, especially in the bill. In fact, it is the small size of the bill that makes it possible, even in the field, to distinguish birds several months old from adults. (The plumage of the immature is so similar in color to that of the adult that it is difficult to distinguish the birds in the field by plumage characters.) In the male, the bill reaches its full size only in the second or third year.

POPULATION

The population density on the breeding ground is very low, but it is even lower in the range which the Emerald Toucanet occupies between June and November, because that extends over a much greater area. One can count only three to five small flocks in one valley about 7 to 10 km. long, whose slopes have an altitudinal range of 500 to 700 meters (1,640 to 2,296 feet). In spite of this, the Emerald Toucanet cannot be easily overlooked, for its continuous calls can be heard at a distance of several hundred meters.

CALLS

The calls of the Emerald Toucanet are so varied that it is impossible to describe them in detail. One thing they have in common, they are all loud and penetrating. These birds are good mimics, but they apparently imitate a given call only so long as they continue to hear the original caller from time to time. During the breeding season in the high mountains I heard most frequently the *yow yow* call of the Mexican Trogon (*Trogon mexicanus*), the *rayg rayg* of the Quetzal (*Pharomachrus mocinno*), or the *eeya eeya* of the Azure-hooded Jays (*Cyanolyca mitrata*). In the non-breeding range, I heard none of these calls, but instead the *dir-rit* of the common Jalapa Trogon (*Trogon collaris*) or the typical *hoot hoot* of the male Lesson's Motmot (*Momotus momota lessonii*). Sometimes these mimicked calls deceived me, and I would expect to see a different bird in the foliage.

FOOD

All the Emerald Toucanets which I examined (eight birds at different seasons) had only vegetable food in their stomachs. Their preference for ripe berries rather than large fruits is the reason that one

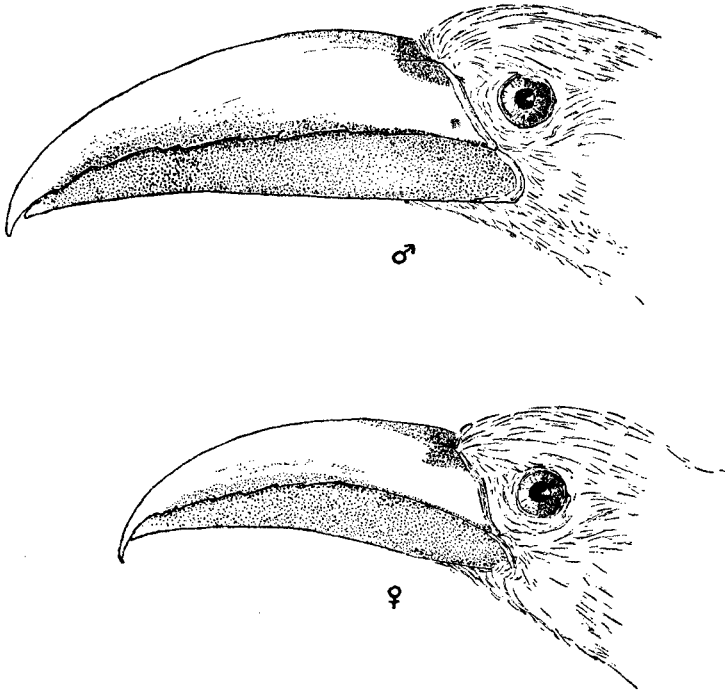


Figure 4. Heads of male and female Emerald Toucanet, showing difference in size and shape of bills. Two-thirds natural size.

finds them at given seasons, year after year, on certain trees scattered through the wide virgin forest. They feed on fruit with large pits and little pulp only with reluctance, presumably because these fruits are more difficult to eat. Several flocks may gather on a tree with an abundance of food, but they form a single unit only while they are feeding together.

During the breeding season in April (to judge from the stomach contents of the four birds which I examined) they feed mainly on a small blue berry which grows on low bushes on the highest peaks, where the prevailing winds prevent a high growth of trees. The Toucanets are joined at this season by a number of other berry-eaters from neighboring forest valleys, and it is most surprising to encounter such a flock of tropical birds where an icy wind blows shreds of cloud through the dwarf bushes.

THE FUNCTION OF THE BILL

One cannot avoid asking the reason for the singular shape of the toucan's bill. No one who has an opportunity to observe toucans, especially the larger species, can fail to notice how cumbersome the bill is.

It has been generally held that the bill was so shaped to facilitate the picking of berries and fruit. It seems to me that exactly the opposite is true: the bill is often an impediment during feeding. This is obvious to anyone observing them when they need to bite pieces from large fruits. The broad bill of the trogon, which feeds on the same berries and fruits, is, for example, much better adapted to eating this kind of food.

In my opinion the form of the bill is a secondary sexual character, originally present in the male only, appearing subsequently in the female, though in a less striking form. The bill of the adult male is both larger than that of the female and different in shape (Figure 4). Van Tyne (1929:39) believes that "the bill of the toucan is not a special correlation of structure to function . . . but is rather to be explained perhaps as the result of an orthogenetic evolution leading to increased size of bill."

SUMMARY

The Emerald Toucanet was studied in Chiapas, southern Mexico, at intervals from 1933 to 1943.

The habitat in Chiapas is virgin forest, at altitudes above 1,000 meters (3,280 feet), the occurrence and movements of the birds being determined by a definite degree of atmospheric humidity.

The breeding range in Chiapas is above 2,000 meters (6,560 feet) on the Pacific slope, and above 1,750 meters (5,740 feet) on the Atlantic slope. The birds spend the non-breeding season at lower altitudes.

The birds live in flocks during the greater part of the year. The adults leave the flocks in February, but yearlings (not yet sexually mature) remain in flocks.

The population density is very low.

An occupied nest was found on April 15, 1942, and observed until April 20, when a weasel killed the parent bird (a female). No male was noted near the nest during the five days of observation.

Intervals spent in brooding were about equal to intervals spent away from the nest (20 to 30 minutes).

The two young (about 10 days old) found in the nest were naked except for bristles on the hand and tail. Both eyes and ears were still closed. Wings and legs were still very undeveloped. The tubercles on the heel-pads seemed to be neither definite in pattern nor constant in number. The bill of the young was flattened, and the lower mandible projected beyond the upper. The tongue was still soft and freely moveable.

Young birds, though similar in plumage and body-size to the adults, can be distinguished in the field by the smaller size of the bill for some months after nest-leaving.

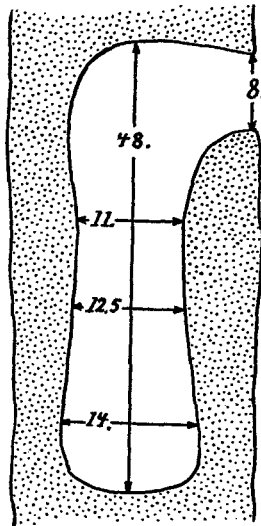
The Toucanet's calls are loud and varied and include imitations of many local species of birds.

All of the Toucanets examined (eight birds at different seasons) had only vegetable food in their stomachs.

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APARTADO 7901, SUCURSAL 3, MEXICO, D. F.



Measurements (in centimeters) of Emerald Toucanet's nest. Width of entrance: 6.1 centimeters.