

## Tambopata Reserved Zone, Madre de Dios, Perú: History and Description of the Reserve<sup>1</sup>

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### SUMMARY

At least seven major forest types can be distinguished at the Tambopata Reserved Zone. In order to facilitate a uniform use of habitat designations for the many scientific studies being undertaken in the Zone, descriptions and basic measurements are included for each forest type. These data include mean circumference, mean trunk area, and standing wood basal area as well as individual numbers of trees in hectares of each forest type. Soil type and drainage are likely important factors in determining the characteristics of each type of forest and constitute the basis for classification used herein. Location of the Reserved Zone, its diverse soil types, climate, and relief are causes of patchy distribution of forest types within the Reserve and these help account for the extraordinary richness of the fauna.

### SUMARIO

En la Zona Reservada de Tambopata se puede distinguir por lo menos siete tipos principales de bosque. Con el objeto de facilitar una utilización uniforme de las descripciones de habitats para los numerosos estudios científicos que se llevan a cabo en la zona, se presenta descripciones y medidas básicas para cada tipo de bosque. Estos datos incluyen la circunferencia media de los árboles, el área media de los troncos, y el área basal de los árboles en pie, así como el número de árboles por hectárea de cada tipo de bosque. Los tipos de suelo y drenaje probablemente son factores importantes en la determinación de las características de cada tipo de bosque, constituyendo la base de la clasificación aquí adoptada. La ubicación de la Zona Reservada, sus diversos tipos de suelos, climas y relieve son responsables por la distribución heterogénea de los tipos de bosque dentro de la Reserva, y pueden ayudar a entender la extraordinaria riqueza de su fauna.

### INTRODUCTION

In Perú, at 12° 50'S, 069° 17'W, at the junction of the Río La Torre and Río Tambopata, a small pristine forested area of 5,500 hectares has been designated 'Zona Reservada' by the Peruvian Government, for consideration as a possible long-term site for protection of wildlife, and to offer an accessible place both for tourists to visit an Amazonian forest and for scientific studies. These studies have been underway since 1979 when a preliminary biotic survey was completed by Dr. David L. Pearson and a team of Peruvians and North Americans. This survey was initiated by Dr. Max Gunther, owner of the Explorer's Inn, a jungle lodge for tourists which is in a small clearing at the edge of the Reserved Zone. Since 1979, numerous studies have been made on a plethora of taxa, especially insects and their allies, but also including trees, birds, fungi, monkeys, and many other groups. The results of these studies indicate that the fauna, at least, of the area is among the richest in the world. Preliminary botanical studies show that plant richness may also be very high as compared with other regions with a similar climatic regime. Thus, the Reserved Zone of Tambopata is of significant scientific interest and a potential center for long-term conservation of an incredibly rich area.

### HISTORY OF RESERVE

In 1976, Dr. Max Gunther purchased 3 hectares of riverfront property and began building the bungalow which would become the Explorer's Inn. During the building phase, Gunther worked with the Peruvian Government to make the area surrounding his jungle lodge a Reserved Zone. This was accomplished in January of 1977. A subsequent contract, in July, 1977, was let by the Flora and Fauna Administration to Peruvian Safaris, S.A.; this contract assigned that company the custody and responsibility for protection of the Reserved Zone. The first tourists to visit the area had been there in June of the same year. Ornithologists Parker, Ridgely

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and O'Neill visited the area during construction of the bungalows and were the first to note the richness of the bird fauna in the forest there. In 1979, Gunther helped finance the visit of Pearson's team of North American and Peruvian scientists and students. Since this time, the rate of research activities by visiting scientists and the number of naturalists in the Explorer's Inn's naturalist program have increased significantly.

#### DESCRIPTION OF REGION

**Climate:** Rainfall and maximum/minimum temperature data were collected by David Pearson and his students in the clearing adjacent to the Explorer's Inn for two years, beginning in late 1981. Subsequently, these data were recorded by various naturalists and the Resident Manager, Mr. Didier Lacaze Dutertre. No other data are available except in Puerto Maldonado, some 39 km (air) away. Figure 3 shows that two distinct seasons occur but that annual rainfall fluctuates considerably. It also shows that rather erratic fluctuation occurred in the temperature means in late 1983. In the future, more precise measurements must be made both in the forest at ground level and in the canopy. The data in Figure 3 indicate that the Reserve lies at the boundary of Tropical and Subtropical Zones according to the Holdridge system (Holdridge et al. 1971).

**Vegetation:** The vegetation of the region, generally, is one or two layered canopied forest with varied amounts of herbaceous or shrubby understory. Very strong and gusty winds accompanying dry season cold periods cause numerous larger trees to twist off at about 15m above the ground. In some cases, the twist-off tree dies, in others the stump sprouts. In any case, the sunlight reaching the lower vegetation layer stimulates growth in much the same way a tree fall does. The twist-off phenomenon accounts for much of the openness of the forest in this area. Throughout the region, small to large patches of bamboo, mostly *Guadua* spp., occur in the upland forests. The nature of such patchiness is unstudied, but it is possible that forest gaps, from twist-offs and tree-falls, available when bamboo blossoms, are seeded. The rapid growth of *Guadua* spp. would then allow such groves to dominate these patches until the next blossoming and die-back occurs, several years hence.

In the upland forests, and the forest standing on the upper floodplain of the large rivers, there are huge emergent trees, for example *Huberodendron swietenoides*, *Ficus popenoei*, and *Bertholletia excelsa*. The latter is the com-

mercial "Brazil nut" and numerous individuals of this species occur in the Reserve, although the big grove, nearly a pure stand, occurs off the Reserve on the land assigned to the village of Infierno.

#### DESCRIPTION OF RESERVE

The Reserved Zone lies at the juncture of the Ríos Tambopata and La Torre, at 290m and about 100 air kilometers from the Andes. The area has gently rolling hills that are dissected by small streams; these stream valleys are 5m deep on average and empty into one of the mentioned rivers or into cochas (ox-bow lakes) or swamps. At the north end of the Reserve, there is a large cocha bordered on its south shore by high terraces. To the southeast of the cocha, there are several deeply dissected hills with stream valleys 100m or more beneath the hilltops. Most of this rugged topographic formation is just outside the Reserve boundary.

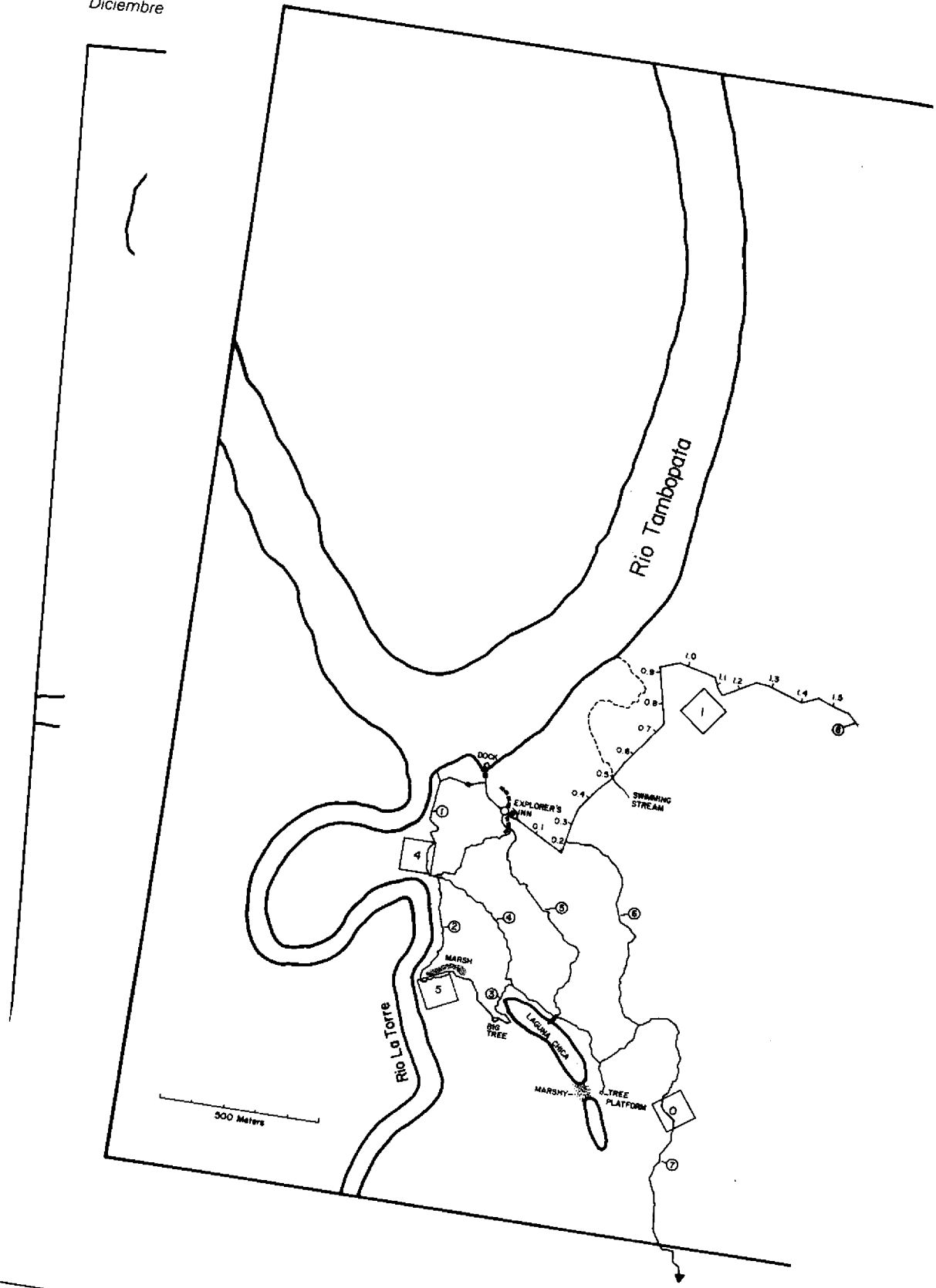
Within the present Reserve boundaries and accessible by trails (Fig. 1), there are at least seven forest types represented and an eighth is suspected to occur in a remote area on the southern perimeter (Table I). These kinds of forests can be classified in various ways (for example, see Gentry 1983), but the most useful is in terms of their soils and topography.

#### Non-flooded Forests

**UPLAND FOREST (Type 1).** Most of the forest of the low undulating hills away from the river courses and lakes stands on compact reddish soil. This soil is dense, very fine-grained, like clay, and drains poorly; it often has standing puddles of water on the surface throughout the entire rainy season. The medium-height (30-35m) forest on this type of soil is rich in individual palms (22%). The number of trees and vines, 10cm dbh (at 1.37m) in diameter or more, averages 585 per hectare (2 ha measured), and the average diameter is 21.64cm. *Pourouma minor* (Family Moraceae; local name "uvilla") is the dominant hardwood tree, at least in the hectare with identified trees. In Brazil, this forest is called Terra Firme Forest and is quite common across the entire Amazon Basin. However, closer examination will likely show the "terra firme" to be composed of many variants depending on soils, climate, and drainage. Within the Reserve, there seems to be minor variation. This forest type covers much of the area in southeastern Perú, at least below 700m elevation.

**UPLAND FOREST (Type 2).** Ancient alluvial terraces standing high above present river systems are composed of very sandy soils, red-

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Fig

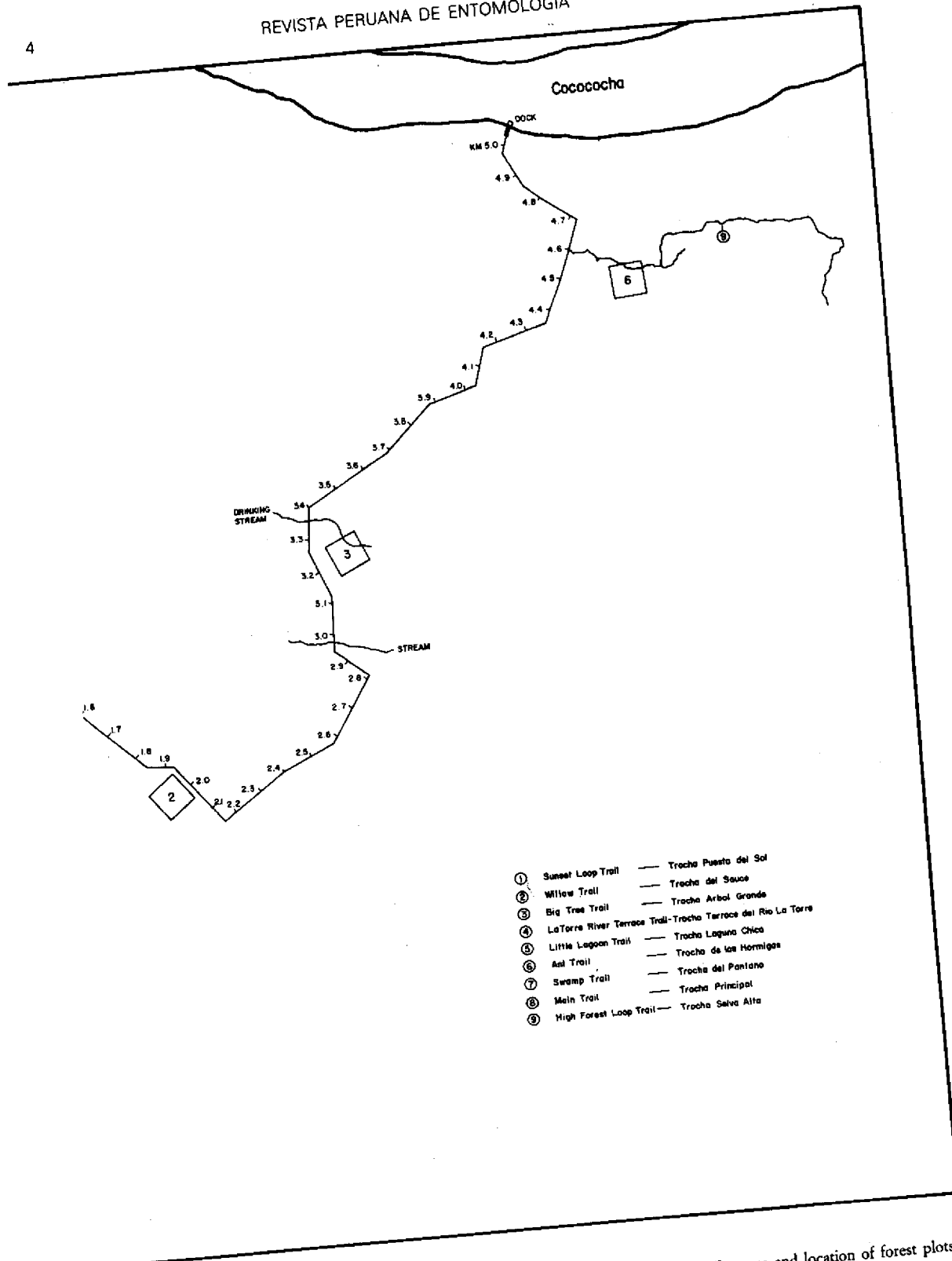


Figure 2.— Enlarged section of main trail system proximate to Explorer's Inn with trail names and location of forest plots numbered in Table 1.

dish in color, and which are well-drained. The tall (35-40m) forest on these soils has characteristically few individual palms (3%) compared to the number of hardwood trees and vines. The number of trees and vines, 10cm dbh in diameter or more, averages 583 per hectare (2 ha measured), and the average diameter is 20.05cm. *Iryanthera* (Family Myristicaceae; local name "Cumala de hoja menuda") is the dominant hardwood tree genus, at least in the hectare with identified trees. This type of forest is not as common as the preceding type, and its average tree size is slightly smaller, but it extends over a few hundred hectares south of the Reserve's large ox-bow lake, Cocococha.

**WHITE-SAND FOREST.** Throughout the Amazon Basin, especially in the northern and central parts, white or light-colored pure sand outcrops occur. These have very special floras and have been of great interest to biologists. Notes made by Dr. Gary Hartshorn during the 1979 survey of the Reserve indicate that one of these outcrops with a low forest occurs along the southern perimeter of the Reserve in the Tres Aguas Negras stream system. It has not been visited since, thus no hectare survey is yet available.

### Seasonally Flooded Forests

**LOWER-FLOODPLAIN FOREST** (white water). The margins of large rivers are subjected to flooding both during the rainy season and dry season, when mountain storms dump rain in the headwaters, or when local rain storms may raise the river level dramatically, yet temporarily. During the rainy season, inundation may be prolonged over many days or even weeks in the upper reaches of the Amazon drainage. This is the case for the two rivers of the Reserved Zone. Any plants growing along the edge of the Río Tambopata and Río La Torre must endure these perturbations both annually and occasionally, every few days in the rainy season. Only certain species are capable of doing so. There are two zones on the lower-floodplain, and different plants, or communities of plants, occur in each of these zones. The lower zone, which floods and drains many times during the year, consists of bare stretches of sand, or a fine-grained alluvium on top of sand, or washed clay covered with grasses and willows. The upper zone on the other hand, which may only flood once or twice per year, has a well-established forest standing on grey clay-like soil with 460 trees and vines per hectare, 10cm dbh or more in diameter, and the average diameter is 17.82 cm. This short (10-20m) forest has fewer and smaller trees than all the other studied forest types at the Reserve;

there are characteristically few palm individuals (4%) compared to other trees, but many *Cecropia* (18%) and *Calycophyllum* (5%) which are dominant genera.

**UPPER-FLOODPLAIN FOREST** (white water). Long-term climatic cycles in which very heavy rains occur, years or even decades apart, cause tremendous flooding periodically in the upper reaches of the Amazon drainage system. These very high flood waters create a secondary floodplain above the primary (described above), especially outside sharp bends of the river. Alluvium is thus periodically deposited, making the soils richer than in the upland forests, giving plant life the potential of being richer as well. However, the long-standing plant life which occupies this secondary floodplain, must be able to withstand periodic inundation of rapidly moving water. The medium-height (25-35m) forest of the upper floodplain has 540 trees and vines per hectare, 10cm dbh or more in diameter, and the average diameter is 22.60m; there are more palms (28%) in this type of forest than in any other at the Reserve. The dominant genus is *Iriartea* (Family Palmae; local name "pona").

**SWAMP FOREST** (Type 1). Isolated Swamp Forests with intermittently standing water occur in low places, away from the river systems, among the rolling hills. These low places are completely surrounded by ridges and low hills, therefore the watershed has internal drainage and periodic standing water derived solely from rainwater moving through the system. Water stands for over six months during the year in the lowest parts, and here even in dry years the highly organic soil remains soggy. Tannins leached from the leaf litter make the water acidic and clear reddish in color. Very few species of trees tolerate such standing acidic water, but those that do are gigantic in size, and their lower trunks are laden with epiphytes. The slopes of the internal watershed has a characteristic similar to that of Upland Forest Type 1. The medium-height (20-30m) forest of this type of watershed system including the swamp has 678 trees and vines per hectare, 10cm dbh or more in diameter, and the average diameter is 35.97cm making it the forest with the largest trees, on average, in the Reserve; there are characteristically many palms (11%), but only one measurable species, *Mauritia flexuosa*, grows in the wettest part of the system. In all likelihood, this is a secondary succession stage of an old ox-bow lake that is in the process of being filled in with silt and organic debris.

### Flooded Forests

**SWAMP FOREST (Type 2).** Swamp Forest Type 2 occurs only along the shores of ox-bow lakes, or cochas, and in early stages of succession as these cochas fill-in. This medium-height (20-25m) forest type consists of nearly pure stands of the palm, *Mauritia flexuosa*. These forests are permanently flooded, and the water level fluctuates little during the course of the year. Although this type of forest is extensive at the east end of Cocococha, I have not yet surveyed it.

Other types of forest may occur within the Reserve as well, particularly along the margins of a "black-water" drainage system that empties into the Río La Torre along the southern perimeter of the Reserve. Although this river system is not truly "black-water" in the sense that the Río Negro of northern Brazil is black-water, the river-edge forest has a different appearance than others in the area. It must eventually be surveyed. Should the Reserve be expanded toward the Río Heath as proposed, several more biotopes or forest types will be included.

Table I. TAMBOPATA RESERVED ZONE, PERU, Forest survey summary data, 23 October 1983

Forest type	Forest N°	N° Tagged	N° 10cm	$\bar{x}D$	$\bar{x}C$	s	$\bar{x}K$	s	total K	N° palms	palm forms	% palms
<b>Non-flooded Forests</b>												
Upland Forest												
Type 1	0	614	585	.22	.68	.05	.46	.13	32.30	126	8	21.5
	1	587	542	.24	.76	.07	.53	.17	36.85	137	7	23.3
Upland Forest												
Type 2	3	637	589	.20	.62	.05	.45	.12	28.37	17	8	2.8
	6	585	576	.20	.64	.05	.47	.13	28.79	28	5	3.3
White Sand Forest	7	not yet surveyed										
<b>Seasonally-Flooded Forests</b>												
Lower Floodplain Forest (whitewater)	5	460	422	.18	.56	.04	.38	.09	17.35	17	2	4.0
Upper Floodplain Forest (whitewater)	4	593	540	.23	.71	.07	.61	.36	38.41	150	10	27.7
Swamp Forest												
Type 1	2	687	678	.25	.80	.08	.57	.13	54.86	77	9	11.3
Lower Floodplain Forest (blackwater)	8	existence in question, not yet surveyed										
Upper Floodplain Forest (blackwater)	9	existence in question, not yet surveyed										
<b>Permanently Flooded Forests</b>												
Swamp Forest												
Type 2	10	not yet surveyed										

Note:  $\bar{x}D$  = mean diameter at 1.37m;  $\bar{x}C$  = mean circumference at 1.37m; s = standard deviation;  $\bar{x}K$  = mean trunk area at 1.37m; K = index of total standing wood as a function of basal area only.

### DISCUSSION

The diversity of forest types in and around the Reserved Zone is, in part, a likely cause for the extraordinary richness of the fauna as documented elsewhere in this publication. And, the diversity of forest types results from Tambopata's location at the edge of the Amazon Basin, its proximity to the mountains, hence its special climate, and perhaps most importantly from a diversity of soil types. Preliminary

observations of the canopy arthropod samples I made in 1983 and 1984 support not only the documented richness of the fauna (papers in this volume), but also indicate that the forest types are distinct, at least in terms of the insect faunas which inhabit them. Even so, Gentry (pers. comm.) reports that many of the forest types at Tambopata have the same species of trees, but individuals of these species occur in differing numbers among the forests. Hubbell

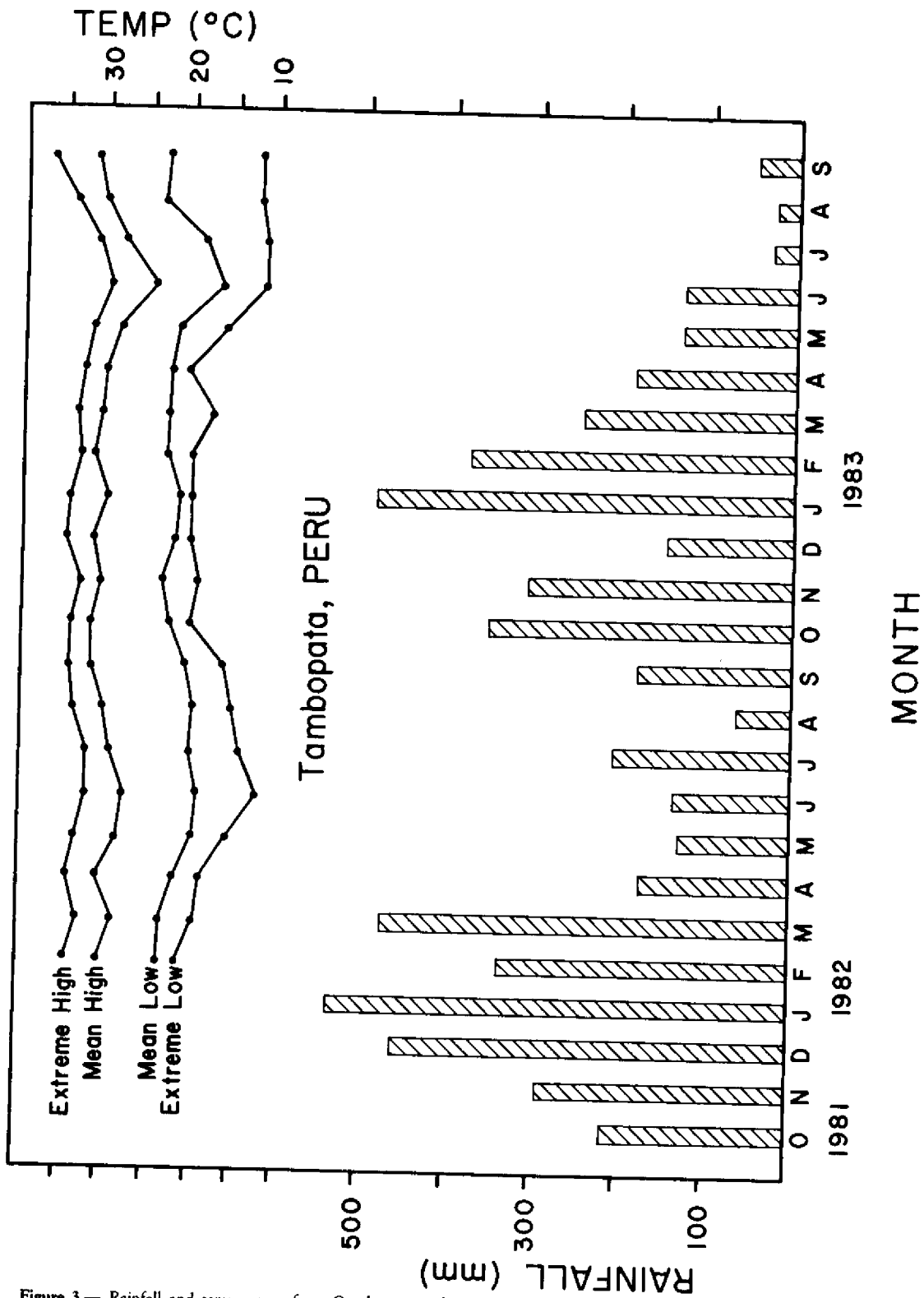


Figure 3.— Rainfall and temperature from October 1981 through September 1983, using standard max/min thermometer located on porch of Naturalists' bungalow and raingauge located in clearing near main bungalow.

and Foster (1983) showed that spacing between individuals of tropical forest tree species at Barro Colorado Island in Panamá varies considerably depending upon species. Preliminary observations at Tambopata indicate that spacing between individuals of tree species depends on forest type (Erwin, in prep). If this is so, individuals of insect species favoring certain trees would tend to be clumped in certain forest types and rare in others. However, where the appropriate tree resource was rare, its occurrence would still provide a steppingstone to another clumped resource on the other side. Such physical distribution and use of resources (i.e., patchiness) helps explain the pattern often observed in tropical insects, that of rarity in one place and confined commonness in another.

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