The Alto Bermejo community consists of half a dozen scattered houses and crop clearings on a low terrace on the southern banks of the Bermejo River. The vegetation around the station, with only a scattering of montane tree species. It is only after the long traverse of the meseta, interrupted by occasional ravines, that the trail climbs up to a wet shelf where montane tree species are more frequent.

We made camp on this wet shelf, where a hectare-sized clearing 800 m above the floor of the valley gives a commanding view of the surrounding landscape. To the east the Amazonian lowlands stretch to the horizon; to the south one looks across the valley to the Bermejo oilfields on the opposite ridge and the volcanoes Reventador and Sumaco on the horizon; and to the north one looks up at a near-vertical southern flank of the Sur Pax mountain complex, marked by the long waterfalls of the descending Ttone River. From this perspective the forests of the region appear essentially undisturbed in every direction. The only obvious signs of human presence are the nighttime flickering of the Bermejo oilfield gas flares, a bright beacon at the Colombian border, and the lights of the small Amazonian cities on the horizon.

Chandia Na’e trail – This trail leads east from the camp clearing, dropping down to the Chandia Na’e River. The one-to two-hour hike to the river descends ca. 200-300 m in elevation along a narrow forested ridge dotted to either side with successional forest on recent landslides. The trail emerges at the junction of the Chandia Na’e with the smaller Ttone River. The narrow Chandia Na’e tumbles down a steep gradient of huge white quartzite boulders, giving it an appearance that is strikingly different from most of the other streams we saw in the Bermejo area. Note that this river is marked on maps of the area as the Zarayacu or Sarayacu; because that rather recent Quichua name is barely familiar to the inhabitants of the area, in this report we use the traditional Cofán name. Chingual trail – To the west of the Vista camp, a trail descends steeply westwards, crossing the upper reaches of the Bermejo River and leading to the colonist farms along the Chingual River. We did not
explore this trail, but it will be a key route for park guards to patrol when a reserve is established in this area. Under good conditions, the walk to the road takes roughly eight hours.

Bermejo Bear Ridge camp
(00°19'17.7" N, 77°25'10.0" W, ca. 1,920 m)
This was the highest campsite of the expedition, accessed by a steep climb up from the Vista camp and a hike along an ascending ridge through very wet, low, and tangled forest. Camp was established on a thin ridge an hour’s walk below Sur Pax. The low forest around camp appears to grow on a tangle of moss-covered roots, with no rocks or mineral soil visible on the surface and a near-permanent drip from the constant cloud and fog cover (Figure 3C). Another feature of the area is a persistent cool breeze cutting steeply down on the Shishicho ridge and the Sinangoe across the ridge, periodically switching from easterly to westerly. A small lookout at the camp clearing looks steeply down on the Shishicho ridge and the Sinangoe field station to the south (see description below) and on the Chingual River and the new Interoceanic Highway to the west.

Bear Ridge trail – The main trail from this campsite continued north along an ascending ridge, passing through the same very wet and tangled forest type that surrounds the campsite. As elevation increases, the forest becomes lower in stature, with the vegetation around the summit reaching only 10-20 m above the trail. After an hour’s climb the trail reaches a 2,275-m summit just southeast of Cerro Sur Pax proper (summit coordinates: 00°19’54.5” N, 77°25’25.4” W). An impassable ravine prohibited us from reaching Sur Pax itself from this direction, though it was clearly visible and would have been a mere half-hour’s walk away if a trail had existed. A large, eastward-looking clearing at the 2,275-m summit allowed a clear view of the headwaters of the Candoe River. The highest points of that ridge appeared to support a forest type that we saw nowhere else—stunted, shrubby vegetation much lower than that on Sur Pax. There is no doubt that extending the trail northwards (or cutting a new one up from the Chingual River) to reach more of the high-elevation ridges north of Sur Pax will allow biologists access to entire biological communities that we missed on this survey (Figure 3A).

Ttonoe trail – This trail was our attempt to reach an intriguing feature on topographic maps of the Sur Pax area—a broad-bottomed valley ca. 3 km to the east of the peak. The valley is especially interesting because it is very deep (more than a vertical kilometer below the summit of Sur Pax); it is effectively cut off from similar-elevation forest by steep slopes on all four sides; and it has a curiously broad, flat floodplain that is very unlike the V-shaped ravines that characterize most valleys in the area. The access trail, which stopped short of this valley, cuts steeply downhill to the east of the main trail between the camp and Sur Pax. It eventually crosses the boulders of the rushing Ttonoe River, which forms the waterfalls visible from the Vista camp (see above) and ends after traversing one more ridge. The forest along the Ttonoe, in contrast to that of the ridge, is characterized by tall old trees growing on relatively gentle slopes. It was here that one team of the saw a spectacled bear.

SNANGOE

Sinangoe field station
(00°10’49.4” N, 77°29’50.0” W, ca. 600 m)
In July 2000 the Sinangoe community constructed a small house near the junction of the Sieguyo and Aguarico Rivers, directly across the Aguarico River from the town of Puerto Libre (Figures 2, 6C). The station’s proximity to Puerto Libre and the new Interoceanic Highway—just a two-minute canoe trip across the Aguarico—made it an ideal base camp for our inventories in the Sinangoe region. The station is close to the start of the two major trails in the area, one accessing the Ccuccono River system to the west and the other leading north, up and over the Shishicho ridge complex and thence to the Cofanes River (see descriptions of these areas below). Because of its strategic location on the border of the Cayambe-Coca Ecological Reserve (the Aguarico forms the park border in this area), park guards operating out of the field station can play a major role in preventing the rapid colonization along the new highway from spilling over into the reserve.

Station loop trail – The forest in the vicinity of the Sinangoe station is compositionally similar to the lower hill forest of the Bermejo River valley, though drier and with a much stronger secondary element. Significant areas here are dominated by mature old trees in the pioneer family Cecropiaceae. Unlike in Bermejo, where most of the successional forest is clearly related to old landslide patches, the abundance of pioneer species around Sinangoe is something of a mystery. A small fraction of the succession is taking place on abandoned clearings and homesteads (the station clearing itself was once a rice field), and some other patches may correspond to much older settlements. The rest appears to be the consequence of a large natural disturbance, perhaps a large-scale windstorm or flooding episode in the last 100 years.

Botanical trails – During the 2000 and 2001 trips, Robin Foster, Roberto Aguinda, and José Omenda identified more than 300 plant species along trails close to the Sinangoe field station. These plants have been marked with laminated labels that give both the scientific and Cofán names, so that visiting botanists can learn Cofán plant names, Cofán botanists can learn scientific (Linnaean) names, and other visiting researchers can teach themselves how to identify some of the more common plant species in the area (Figure 6D).

Candel trail – This trail leads west-southwest from the Sinangoe station, crossing the Fetsavoe River before ascending a broad, gently sloping ridge to about 1,000 m. It then circles around the headwaters of the Fetsavoe, narrowing to a knife-edge ridge that separates the Fetsavoe from the Candel. Recent landslides tangled with young regrowth alternate with old D acyros forested areas. We were especially interested in visiting this area because Cofán hunting is permitted here under the Sinangoe management plan. We found little difference in occurrence of wildlife or in the wariness of individual animals encountered, indicating low usage of the region. This trail eventually connects with one linking the station to Ccuccono (see below), above the headwaters of the Candoe.

Ccuccono Beach and Ridge camps
(00°07’48.5” N, 77°33’19.0” W, ca. 940 m, and 00°08’39.0” N, 77°32’48.1” W, ca. 980 m)
To reach the Ccuccono River drainage, we hiked five hours west from the Sinangoe field station, along a gradually ascending ridge that peaks at ca. 1,100 m and then drops rapidly down into the watershed. The trail passes through old successional forest for the first several kilometers, before the high canopied of old pioneer trees in the family Cecropiaceae eventually gives way to a much more mature forest. We also noted an apparent moisture gradient along this ridge, with the drier, epiphyte-poor forest lower near the station giving way to much wetter, epiphyte-laden, higher forest dominated by huge old hardwoods closer to the Ccuccono.

Once at the Ccuccono watershed, the bird and herpetofauna team established a base in the D acyros forest to the low ridge just above the Ccangopacho Stream (Figure 3D), a tributary of the Smaller Ccuccono River. The plant and mammal group followed the Ccangopacho down to its junction with the Smaller Ccuccono and camped on the open beaches of the river itself.

Very little of the present-day landscape in the Ccuccono drainage can be understood without reference to a massive earthquake that struck the area in March 1987, triggering simultaneous landslides across several thousand square kilometers of forest. As the temporary dams formed by these landslides were breached, a series of towering flash floods—high enough to wash out the Lumbaqui bridge more than 15 km downstream—scoured the valley clean of vegetation at least 20 m above the current river level, leaving mature forest only on the high ridges along the river. Indeed, present-day satellite images of the area...
show as much as half of some areas of the watershed in the same stage of regeneration (Figure 2). Given the unstable geology of the region, the frequency of earthquakes, and the proximity of active volcanoes, we expect that catastrophes of this kind are a relatively frequent feature of the Cucccono landscape, at least on ecological and geological time scales.

The river in the vicinity of our beach camp still showed clear evidence of the 1987 damage. Cofán team members who had camped at the same site before the earthquake were surprised to find the rather narrow, pretty river they remembered now open to the sky at least 50 m across, littered with boulder fields, sandbars, and weedy islands to either side of the model (ca. 5 m wide) current. Even along the smaller tributaries of the Smaller Cucccono, like the Caongapachoc Stream, large stretches of riverbank that would traditionally be covered with tall gallery forest were still buried under a tangled mess of vines and weedy low trees. This was especially noticeable in the inside bends of the rivers, where flashflood scouring would have been most destructive.

Apart from the station-to-Cucccono trail, we investigated a variety of small tributaries and ridge systems around our two campsites, and describe the most interesting of these below:

Coppaye Fensi (Oilbird) Stream trail – This is a minor tributary that empties into the Smangone field station, climbing about 400 m to the base of the steep, eastern face of Cerro Shishicho. Forest in the vicinity of camp and around the trail from the station is typical mature hill forest, dominated by common lowland tree species (particularly M yristicaceae) and interspersed with small patches of bamboo and successional forest. A few temporary trails lead downhill in different directions from the campsite, through forest very similar to that on the main trail. Just above camp is a several-hectare patch of secondary forest from an old landslide.

Shishicho ridge trail – From camp the trail continues directly up the near-vertical slope of Shishicho, gaining almost 400 m in elevation before reaching a crest just below the main peak. This section of the trail is often rocky underfoot, with patches of loose shale and outcrops of the same material dotting the route. The redeeming feature of this difficult climb is the profusion of spectacular lookouts along the way, which give a panoramic view of the Auquicato River Valley (Figure 2B).

Once the peak of Shishicho is reached, the trail levels off and begins to follow the main ridgeline, which curves towards the north as it continues to gain gradually in elevation. Vegetation here is a mixture of surprisingly tall old trees in the lower sections of the ridge and shorter, more heavily epiphyte-laden trees on the higher sections, and some successional forest in areas of past disturbance. An hour’s climb’s from the crest, one reaches the highest point of the ridge at 1,570 m. As in the Sur Pax summit forest, the trees at this summit are relatively short (to 10 m tall) and the ground disappears under a tangle of moss-covered tree roots. The tree flora here loses most of the lowland elements that are frequent on the lower parts of the ridge and takes on a more obviously montane character, with genera like Viburnum, Brunellia, Tibouchina, and Clusia dominating, and carpets of Sphagnum and other mosses underfoot. The summit forest also appears to be in a rather early successional stage, though it is not clear whether this is chiefly due to wind and storm damage, lightning strikes, or the Cofán habit of felling a few trees in high points for lookout.

The trail forks at this summit. Both branches continue down to the Cofanes River; one follows the main ridgeline to the north and the other follows a different ridge to the northwest. As is the case on most of the Shishicho ridgeline, the northern trail passes through a rather dry forest, exposed to desiccating winds sweeping up the Auquicato Valley. The northwest trail, which is apparently lower and so sheltered from the winds, makes its way through a tangle of much denser and wetter vegetation.

INTEROCEANIC HIGHWAY (between Lumbabui and La Bonita, ca. 500-1,000 m)

In July 2000, Robin Foster, Roberto Aguinda, M argent M etz, Terra Thern, and several members of the Sinangoe community made a preliminary floristic survey of plant communities along the new highway that bisects the formerly continuous forest of Bermejo and Sinangoe (Figure 2A). Because at the time of our visit the highway was still under construction and large-scale colonization of the land along its margin had not yet taken place, the trip gave us rare easy access to intact, botanically unexplored forest. Now that the highway has opened, colonization in the adjacent forest is advancing rapidly. By the time this report is published, most of the forest we explored in 2000 probably will have vanished.

Authors: Nigel Pitman and Robin Foster

BASIC GEOLOGY AND PHYSIOGRAPHY

The landscape around Bermejo and Sinangoe is a jumble of different rock types and geological formations, and for good reason. For the last ten million years, throughout the Andean mountain-building, huge slabs of rock of different ages and materials have been snapped in two and wrecked upwards here, buckled and folded around each other, and then subjected to extreme weathering. Much of the uplifted rock is of Cretaceous age (65-146 million years old), but older Jurassic and even Pre-Cambrian formations also dot the landscape (Baldock 1982, Niets 1991). To complicate the picture further, these different rock groups include individual strata that vary from shales to conglomerates to limestones to sandstones. Each of these are different in the effect they have on the soils derived from them, leaving one to guess at the edaphic characters of any particular site.

At a larger scale, the geological setting is more similar to the non-volcanic southern Ecuadorian provinces of M orona-Santiago, Zamora-Chinchipe, and Loja than to adjacent areas in central Ecuador. The reason is that the Serranías Cofán lie just to the north of the zone of young, active volcanoes from Sangay to Reventador. Though their southern portion is affected by Reventador’s activity (see below), the northern portion may be more closely affiliated with the non-volcanic eastern cordillera of Colombia, and the non-volcanic provinces in southern Ecuador.

Topography in the area is just as varied as geology, and is generally determined by the tilt and composition of the uplifted formations. In the lowlands, most geological blocks have been uplifted without much tilting, resulting in the flat-topped terraces just north of the Bermejo and Auquicato Rivers. Closer to the main body of the Andes, where the geological history is much more complex, steeply tilted and twisted formations, weathered for millions of
years, have given rise to the sheer-walled cliffs and gorges around Cerro Sur Pax and the Cofán River.

CATASTROPHIC DISTURBANCE

Just as important as a picture of the region’s surface geology is the recognition that all of it is subject to change at any moment. Immense natural disasters have reworked the landscape around Bermejo and Sinangoe with unsettling frequency, stripping away successive layers of surface material during earthquakes, volcanic eruptions, floods, and landslides. Because the area is already a jumble of different rock strata, the consequence of this constant building up and tearing down of the landscape is that the particular rock group and soil chemistry under a given patch of forest may change greatly in only a few decades or centuries, as different layers of rock are exposed.

Just 10 km south of the southernmost site we visited (Ccuccono) sits one of the most active volcanoes in the eastern Andes: the 3,562-m Reventador. This stratovolcano has erupted at least 24 times since 1541, littering the landscape around it with tons of ash and lava, periodically building itself up and then exploding. During the 20th century, the volcano erupted continuously from 1900 to 1906, then again in 1912, 1926, 1929, 1936, 1944, 1955, 1958, 1960, 1972, 1973-1974, and 1976. The implication of all this activity, which dates back at least to the Pleistocene, is that the southern portion of the Cofán foothills have been blanketed with ashfalls and peppered with pyroclastic bombs from Reventador on a regular basis for at least the last 2 million years (Nieto 1991).

The area is also intersected by a spiderweb of fault lines, along which the landscape shifts occasionally, and with great violence, as part of the ongoing Andean orogeny. On the night of March 5, 1887, back-to-back earthquakes measuring 6.1 and 6.9 on the Richter scale struck the foothills region. The quakes, which were preceded by heavy rains, caused an estimated 100 million cubic meters of soil to peel away from the massive slopes in avalanches of mud and forest, leaving thousands of square kilometers stripped to the bedrock.

Aerial photos taken after the disaster indicate that an area of at least 2,500 km² lost 75-100% of its forests to landslides. An area at least three times larger lost 25-75% of its forest cover (Nieto et al. 1991).

These massive landslides temporarily dammed a large number of rivers in the area; a few kilometers downstream from the epicenter, the bed of the Coca River dried up entirely for several hours following the quakes (Nieto et al. 1991). The breaching of these dams triggered towering flood surges that scoured clean (or buried under debris) the floodplain forests along most rivers in the area, including those throughout the portion of the Cucunco River basin we visited. Indeed, the epicenters of these quakes have been traced to directly beneath the Cucunco watershed, and almost exactly below the campsites we used during the rapid biological inventory (Espinosa et al. 1991).

Even when the landscape is not being torn apart at the seams by catastrophic physical processes, a large proportion of it is quietly collapsing in a less dramatic fashion. The Bermejo Valley basin is excised by a ring of eroding cliffs that slip into the river with such frequency that the water of the Bermejo has a permanently reddish color. Satellite images of the area are dotted with the scars of landslips large and small, recent and old (Figure 2). These slides are so frequent at the very base of the Andes that they form a nearly continuous line tracing the first line of foothills. Not coincidentally, it is at these elevations (roughly 1,000 m) that the precipitation is heaviest in this part of the Andes (OAS 1987).

Large-scale flooding events are also frequent phenomena in the Serranias, and probably have been so ever since the Andes began to rise some 10 million years ago. The community of Alto Bermejo was destroyed by a flood within the last decade. Stories of other catastrophic floods are a mainstay of Cofán legends. Quaternary pollen gathered a few kilometers to the east have led paleoecologists to suggest that a massive, prolonged flooding episode reworked the eastern Ecuadorian landscape as recently as 800-1,300 years ago (Colinvaux et al. 1988). Huge quartzite boulders like those currently lining the banks of the Aguarico River also dot the terraces nearby, providing a reminder of past washouts.

CLIMATE AND PHENOLOGY

Climate in the Cofán foothills is unrelentingly wet, because the prevailing winds on the equator—blowing from east to west—collect evaporation over the Amazonian lowlands and drop it as rain when they hit the Andes. Annual rainfall at the three closest weather stations (Reventador, El Chaco, and Santa Cecilia) ranges from 2.5 m to more than 6 m, and the heavy epiphyte load and moss density at Bermejo and Sinangoe suggest that the sites we visited fall at the high end of this range (OAS 1987). Even in this relatively small area, however, the amount of precipitation that a given site receives may vary dramatically across the landscape. Intermediate elevations receive more rain than higher or lower ones (with the peak at 1,000 m; OAS 1987), and sites at the same elevation but in different drainages may receive dramatically different amounts of moisture, because the complicated topography generates a complex pattern of rain shadows.

Rain here falls year-round, punctuated by weak dry seasons of short duration. The driest time seems to be January-February, which corresponds to the Northern Hemisphere dry season (not unexpected given the latitude here just north of the equator; OAS 1987). Short, unpredictable dry periods can occur at any time of year, but with a greater probability in August, which corresponds to the Southern Hemisphere dry season. These droughts are probably most severely felt on ridges that are low enough to fall below the cloudline but exposed enough to be swept by desiccating winds. At elevations over 950 m, where the vegetation is frequently enveloped in clouds, condensation probably adds significantly to the total amount of precipitation landing on the ground.

Temperature in the Serranias varies linearly with elevation, due to adiabatic cooling. In the lower hill forest, temperatures average around 25°C year-round; at 1,000 m, the average drops to ca. 20°C, and at 2,000 m, to ca. 15°C (OAS 1987).

In spite of the general lack of seasonality and minimal change in daylength throughout the year, many plant species seem to be roughly synchronized in their reproductive and leaf-flushing behavior. This synchrony is probably triggered for most species by the usual, but not reliable, short dry period in January and February. For some it may be the sudden drop in temperature accompanying a specific rainstorm, or a few days of drought stress coming at any time of year. An example is one species of Faramea (Rubiaceae), a shrub in which all the individuals came into flower and finished during one week of our trip. Another is the common tree Dacyrocyes olivifera (Burseraceae), in which all the adult trees seemed to be flushing new leaves during our stay.

A somewhat smaller set of species had flowering, fruiting, or leaf-flushing individuals mixed in the same population, or even on the same individual tree. These asynchrony species may either be responding to repeated signals throughout the year, or merely responding to internal signals of the nutrient status of the tree or branch. An example is the common tree Billia rosa (Hyposmataceae), which we found sometimes with flowers, sometimes with ripe fruit (Figure 4D), and sometimes with neither but flushing new leaves. The wild cherry at upper elevations, Prunus herthae (Rosaceae), was unusual in that all the individuals observed on the slopes above Bermejo were in fruiting condition, whereas on the high ridges of Sinangoe they were all in flower. The most likely explanation for this is some local climatic event that affected one side of the Aguarico and Chingual Valleys but not the other.
FLORA AND VEGETATION

Participating Authors: Robin Foster, Nigel Pimat, and Roberto Aguinda

Conservation targets: Upper and lower hill forests; montane forests; stunted ridgeline and summit forests; plant communities on acidic outcrops; lowland forests with commonly overexploited trees.

Methods

This was a short, fast-moving survey of a large region, with the goal of sketching a quick portrait of the area's vegetation. During our three weeks in the field, we were constantly on the move, hiking from one site to another in an attempt to cover as much terrain and visit as many habitats as possible. We used a variety of formal and informal sampling techniques, and drew wherever possible from the lifelong experience of the Cofán naturalists who inhabit the area.

The groundwork for our exploration of the Bermejo-Sinangoe area was laid by the excellent earlier work of Carlos Cerón and colleagues (1994) from Ecuador's Universidad Central. Some of the observations here also draw on previous visits of RF, RA, M, ET, T. Them, and G. Baker to Sinangoe and the new Interoconic Highway in June 1999 and July 2000. No quantitative sampling was carried out during those visits, but several hundred plants were collected or photographed.

Throughout the 2001 inventory we continued to collect and photograph as many unrecognized species as possible, and kept a running list of species identified in the field but not collected. The database now includes more than 1,000 herbarium specimens representing at least 800 species, and 1,400 photographs of at least 700 species. The preliminary list, given in Appendix 1, incorporates and updates the inventory of Cerón et al. (1994) in the vicinity of the Sinangoe community. This obviously is not a complete catalog of the flora, just as our ecological work is an initial overview to stimulate additional research in the area's plant communities.

We also gathered quantitative data along transects in several of the major habitat types, sampling 969 trees and shrubs in total. Transects were established as opportunity permitted (i.e., adequate time without rain), with priority given to canopy trees and the shrub layer. Sampling followed the rationale of Foster et al. (unpublished manuscript) for variable transects laid out along existing trails. We sampled canopy trees in single, continuous transects of 100 individuals, or fewer if time ran out. Tree transects were 20 m wide (10 m on either side of the observer) and included all trees with a trunk diameter measuring greater than 30 cm at breast height (DBH; ca. 1.3 m from the ground). Species identifications, often to temporary "morphospecies," were made using binocular observations of the canopy, fallen leaves, and cuts in the bark. Trees with insufficient visible leaf material were ignored. The shrub layer was sampled separately, in "interrupted" transects incorporating 100 to 200 free-standing stems measuring 1-10 cm dbh. These transects were 1 m wide on one side of the trail, with subsamples of 20 individuals each separated by 100-m intervals. Vouchers were collected for most fertile morphospecies and for the most abundant morphospecies. We collected and made observations on plants in all habitats, but concentrated our quantitative sampling in upper hill forest, with additional transects in mountain ridge forest and lower hill forest. We did not establish transects in the mountain summit or slope vegetation, or in the riverine plant communities.

These data were supplemented with qualitative observations on vegetation dynamics, habitat composition, and other aspects of plant ecology. In addition, because one of us (RA) speaks the Cofán language, we were able to record the indigenous names and uses of several plants by interviewing Cofán elders in the communities of Alto Bermejo and Sinangoe.

Collections were preserved in alcohol in the field and subsequently dried in Quito. Fertile specimens were deposited at the National Herbarium of Ecuador (QCNE), with additional duplicates sent when available to the Field Museum (F), to family specialists, and to the Catholic University of Ecuador (QCA).

FLORISTIC RICHNESS, COMPOSITION, AND DOMINANCE

Our preliminary vascular plant list (see Appendix 1) lists 1,596 species. Based on field observations to date and on our experience in better-known areas of the Neotropics, we estimate a total vascular flora of 2,000 to 3,000 species for the Bermejo and Sinangoe area.

This is obviously a broad approximation, and the true number will depend on how one draws the boundaries of the area (i.e., how much of adjacent lowland and Andean forests is included). As in other Andean forests, a good estimate of the area's floristic diversity will depend on a good estimate of its orchid diversity; that family typically accounts for a major part of the flora in forests this wet.

Both the regional- and local-scale diversity in the Cofán foothills seem typical of eastern Andean forests—extremely high, especially in the families Orchidaceae, Melastomataceae, Rubiaceae, and Bromeliaceae. The diversity at intermediate spatial scales (i.e., one to several hundred square kilometers) may be lower than in other parts of the Ecuadorian Andean slopes, which have more geological or microclimatic extremes.

The obvious exception in the Serranías Cofán is the astonishing concentration of species in the coffee family, Rubiaceae. We encountered at least 39 genera and over 129 species in the family in a relatively short time of observation and collection. This family has the largest number of species of woody plants in the Neotropical lowlands and is usually abundant in the understory of Neotropical forests. In our experience, however, no other area of Ecuador, South America, or the world has as great a concentration of Rubiaceae as found in the area we visited during this inventory.

The Pacific slopes of Ecuador and Colombia have long been recognized by botanists as a center of diversity for the families Gesneriaceae, Araceae, and Ericaceae. For the Gesneriaceae (41 species encountered) and Anthurium (the largest genus of Araceae; 38 species encountered), the species richness around Bermejo-Sinangoe probably rivals that of a similar-sized area on the Pacific slope, and is certainly higher than in any other forests we have studied at the eastern base of the Andes. For the Ericaceae and the rest of the Araceae, on the other hand, the area does not seem especially diverse. The presence of at least a dozen treefern species (mostly Cyathea) in the area seems high to us by comparison with any area south of the Maláfrán River, but may be shared with the Cordillera del Cóndor and north into the Putumayo drainage.

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Both the regional- and local-scale diversity in the Cofán foothills seem typical of eastern Andean forests—extremely high, especially in the families Orchidaceae, Melastomataceae, Rubiaceae, and Bromeliaceae. The diversity at intermediate spatial scales (i.e., one to several hundred square kilometers) may be lower than in other parts of the Ecuadorian Andean slopes, which have more geological or microclimatic extremes.

The obvious exception in the Serranías Cofán is the astonishing concentration of species in the coffee family, Rubiaceae. We encountered at least 39 genera and over 129 species in the family in a relatively short time of observation and collection. This family has the largest number of species of woody plants in the Neotropical lowlands and is usually abundant in the understory of Neotropical forests. In our experience, however, no other area of Ecuador, South America, or the world has as great a concentration of Rubiaceae as found in the area we visited during this inventory.

The Pacific slopes of Ecuador and Colombia have long been recognized by botanists as a center of diversity for the families Gesneriaceae, Araceae, and Ericaceae. For the Gesneriaceae (41 species encountered) and Anthurium (the largest genus of Araceae; 38 species encountered), the species richness around Bermejo-Sinangoe probably rivals that of a similar-sized area on the Pacific slope, and is certainly higher than in any other forests we have studied at the eastern base of the Andes. For the Ericaceae and the rest of the Araceae, on the other hand, the area does not seem especially diverse. The presence of at least a dozen treefern species (mostly Cyathea) in the area seems high to us by comparison with any area south of the Maláfrán River, but may be shared with the Cordillera del Cóndor and north into the Putumayo drainage.
This forest type covers much of the Bermejo River valley, and the low ridges and uplifted, sloping terraces between the Cucunoco River and the Sinangoe community. Our best opportunities to study lower hill forests were in the vicinity of the Bermejo and Sinangoe field stations, and on the walks to and from the Bermejo Vista camp and the Shisichio camp. The forest at these elevations is a somewhat less diverse extension of the Amazonian lowland forest just a few kilometers to the east. Like the plant communities around Yausi National Park and the Cuyabeno Wildlife Refuge, this is tall, closed-canopy forest, where the local diversity of trees is among the highest on Earth and most species are rare. Species composition in these forests can vary dramatically from one small area to another in a way that remains poorly understood by ecologists, while at the same time a small group of species occurs fairly consistently, albeit at low densities, across the landscape.

As in the lowland forests farther to the east, the most common canopy tree across the lower hill forest is the ubiquitous palm Iriartea deltoidea (Figure 3E). Palms in general are frequent on the landscape, sharing established in low hill forest around Sinangoe. 59 different species. Cerón et al. (1994) report similarly 100 canopy trees sampled in our transect, we recorded these are extremely diverse tree communities. Of the characteristic of Ecuador’s Amazonian forests—is that them made up more than 10% of the trees. One small group of species occurs fairly consistently, albeit small area to another in a way that remains poorly understood by ecologists, while at the same time a small group of species occurs fairly consistently, albeit at low densities, across the landscape.

At somewhat higher elevations in the lower hill forest, on top of the flat terrace north of Bermejo at 800-900 m, the forest appeared considerably wetter. The canopy here was 30-35 m tall and with few large-diameter trees, but diversity was just as impressive, with 41 species recorded in a transect of 70 canopy trees. Again, the legumes and the Myristicaceae are common in the canopy, along with several species of Virola. The lower hill forests on the small ridges around Sinangoe appear to have similar canopy composition (Cerón et al. 1994).

While these lower hill forests do share most elements with Amazonian forests to the east, we were surprised to note some conspicuous absences. Several species that are common in the lowlands were not registered here at all, including Spondias mombin and Astronium graveolens. Several species in the genus Danaea probably account for half the herbaceous ground cover here (Figure 4C), while dense stands of the aroid Chelyocarpus ulei, several species in the genus Rinorea, and the herb Aechmea longifolia, is the most abundant and conspicuous small tree over the lower hill forest of Sinangoe, up to about 900 m. Ctenanthe is completely missing, however, from the Bermejo area.

An understory fan-palm, Chelyocarpus ulei, is the most abundant and conspicuous small tree over several square kilometers in the vicinity of the Alto Bermejo community, but was not seen anywhere else in the region. It appears abruptly on the trail from Pozo Dos to Bermejo, becoming almost immediately common a few small streams west of the Rayo River, on the south side of the Bermejo River. The population extends upslope to the south for about a kilometer on the trail to Pozo Seco, but does not appear to cross to the north side of the Bermejo River—somewhat strangely, for a species with a small, bird-dispersed fruit. We have observed a large patch of C. ulei in the lowland forests of Yausi National Park, similarly unrelated to any obvious edaphic or topographic features. The population we encountered in Bermejo is the northern-most known in South America.

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ruiziana (Mimosaceae), a characteristic floodplain species of the upper Amazon. On the stable gravel banks grow dense stands of a probably undescribed cane species in the genus Gynium (Poaceae). This species is similar to, but clearly distinct from, the robust and cosmopolitan caña brava, Gynium sagittatum; we observed the two taxa growing together without any evidence of intermediate forms. While the smaller cane is so far considered by grass taxonomists as nothing more than a form of G. sagittatum, the taxon clearly deserves recognition as a distinct species.

Other beach strand species, less predictable in their occurrence, include Brugmansia candia and Solanum spp. (both Solanaceae), Cleome sp. (Capparidaceae), Tovaria pendula (Tovariaceae), Tessaria integrifolia and Mikania micrantha (both Asteraceae), Commelina erecta (Commelinaceae), and even an occasional Bocconia integrifolia (Papaveraceae). On one tributary stream of the Cuccono, the abundance of Canna jaegeri (Cannaceae)—a species widely cultivated by the Cofán and other Amazonian communities for its seeds, which are used as the herthae and Eirmocephala megaphylla (Asteraceae), O chroma pyramidalale (Bombacaceae), Senna ruiziana (Caesalpiniaceae), Podandogyne brachycarpa (Capparidaceae), Ceropogia putumayensis (Crotalariaceae), Banara guianensis (Flacourtiacae), Piper umbellatum (Piperaceae), Triplaris americana (Polygonaceae), and Trena micrantha (Ullmaceae). M. island or rare on these riverbanks are the tree Zygia longifolia (Mimosaceae) and the shrubs Caliandra angustifolia (Mimosaceae) and Adenaria floribunda (Lythraceae), so characteristic of riparian vegetation along other small rivers of the upper Amazon. It may be that the clay banks and rocky borders of these rivers are too unstable to support them, but it is difficult to explain how they are stable enough to support Inga ruiziana.

Small but permanent streams, partly shaded and rocky, often had a distinctive set of species associated with them. These usually included the herb Dicranopygium (Cyanthaceae), various species of Piliet (Urticaceae), and the shrubs Urema baccifera (Urticaceae) and Hoffmannia (Rubiaceae). On some of the small tributaries of the Bermejo, we found a couple of unusual species strictly associated with the stream banks: Callithea gandessi (M. araceae), which until recently was known only from the type collection near Tena, and an apparently new variety of one of the Neotropics’ best-known and most widespread herbaceous species, Cyrtanthus bipartitus (Cyanthaceae; see below in species notes).

Upper Hill Forest (950-1,200 m) We were able to sample this altitudinal range more thoroughly than any other, as we set three of our campites between 950 and 1,200 m. The physical characteristics of forests at this elevation are not greatly different from those of the lower hill forest. The trees are on average not quite as large in height or girth, and the trunks have greater densities of epiphytes, though the bark is still mostly exposed.

Although there is still considerable overlap in species composition with lower elevations, it is in this range that one begins to see abrupt limits to species distributions, apparently associated with elevation. M any plant species seem to appear only above ca. 950 m, while other species suddenly drop out at this elevation. A bright-red-flowered Aphelandra (Acanthaceae), for example, appeared at roughly this elevation at all three sites, while the common herb Ctenanthe ericae (M araceae) disappeared from the two Sinangoe sites (the species was absent in the Bermejo area). We did not notice any turnover of this kind at lower elevations, but it would require thorough investigation to establish that fact. There is also turnover in the flora within this band of upper hill forest, e.g., species that grow only above 1,300 m or species that grow no higher than 1,200 m, but the landscape variation in climate and geology makes it unlikely that these limits would remain constant across the region.

As expected, in our samples of canopy trees in the upper hill forest we found somewhat lower species diversity and more dominance by a few species than in the lower hill forest. We also noted considerable variation in the dominant trees from one site to another. On the steep ridge below the Bermejo Vista camp, a transect of 100 canopy trees contained 47 species (compared to 59 for the comparable lowland transect; see above). Nearly a third of the trees belonged to only two species: Billia rosae (M. araceae; 18% of the sample) and O. toba glycytopa (M. araceae; 12%). On the rolling ridge above Shishicho camp, our 100-tree transect contained 57 species. M. iniquaria guianensis (O. laevis) accounted for 12% of the trees, while three species of M. araceae (Compsoneura ullei, O. toba glycytopa, and Virola sp.) made up 20% (7%, 7%, and 6%, respectively). And on the sloping ridge above Cuccono Ridge camp, an 80-tree transect contained 37 species. Here the dominants were Dacryodes olivera (Bursearaceae; 26% of the total), Billia rosae (9%), and two euhorbas (Conceveba sp. and Hyeromina macrocarpa; 8% and 6%, respectively). Other tree species that are conspicuously abundant at these elevations, though not in the transects, are the large emergent Ficus coerulescens (M. araceae) and the subcanopy Grias neuberthii (Lecythidaceae) and Wettinia anomala (Areaceae).

The dominance of individual species is very patchy, and this patchiness is apparent from the smallest to the largest spatial scales. On one long stretch of the Cuccono trail ridge, for instance, nearly half of the shrub layer stems appear to be Psychotria deflexa (Rubiacae), while on other sites of the same ridge the dominants are an Albertia sp. (Rubiacae) and a M. icinica sp. (Elastomateae), respectively. At larger scales, the most common understory species in our Shishicho camp transect, the palm M. yosepae eulge, is missing or rare only a couple of kilometers away, on the ridge from the Sinangoe station leading down to Cuccono. But this species is common again on the Bermejo Vista camp ridge many kilometers away. Some of this variation in dominant species reflects small-scale heterogeneity or dispersal limitation within a site, while some variation represents large-scale environmental differences across the landscape. For example, although Dacryodes olivera and Compsoneura ullei were absent from our Bermejo Vista camp transect, they were both fairly abundant just above camp, from 1,200 to 1,300 m. By contrast, there is no question that Dacryodes was exceptionally abundant throughout the Cuccono area, since large patches of its newly flushed, orangish leaves were visible on all the surrounding ridges.

Our only transect sample of the shrub layer in upper hill forest was from the Shishicho camp, from 950 to 1,000 m. The 200 stems sampled contained 90 species, with the most common taxa the small palm Hysopathea elegans (11% of the stems) and the shrub
Psychotria betlerioides (Rubiacae; 7%). At the family level, Rubiacae (18 species) and M elastomataceae (14 species) were dominant. These two families account for more than a third of the species in this transect, which supports our casual observations that they dominate the shrub layer of the hill forests throughout this region. In addition to the many Psychotria, the common Rubiacae include various species of Farnaea, Couroua, Ridges, and a widespread small tree of Chmelia. The common M elastomataceae include many Miconia, as well as various species of O seae and Cldenidia.

Acid Ridges in the upper hill forest – All the narrow ridgelines in the Strange area above 1,350 m, including the Shishicho ridgeline, seem to be characterized by a stunted vegetation and a flora indicating highly acidic soils. Where exposed by landslide, the parent material here is a very hard rock, probably quartzite. The areas we visited had characteristically short forest (ca. 10-15 m tall) and trees with small crowns, a solid mat of covering the soil, frequent clumps or carpets of Sphagnum and other mosses on the ground, but little moss cover or other epiphytes on the tree trunks. Except for its stature, this vegetation is very different from that on the higher-elevation mountain summits of the Cerro Sur Pax complex. (described below).

This distinctive vegetation grows very narrowly along the spines of the ridges in this “roller coaster” terrain. This is probably because both the acidic soils and the dry conditions caused by the exposure to wind are confined to a very narrow ribbon of forest running along the highest points of the ridges. On the other hand, the soil on the slopes flanking them, which is more often a dark clay, the trunk-epiphyte load and moss cover is almost as dense as on the wetter ridges, and the vegetation is much more like that of typical upper hill forest, with species such as Votomita weddelliana again prominent in the understory. In traversing the ridgeivine, one passes in and out of the acid ridge vegetation.

One of the most distinctive components of this vegetation, in addition to Sphagnum, is Trichomanes cristatum, an erect, terrestrial filmy-fern with orangish hairs. Other conspicuous and characteristic taxa are Gaffenniera and Tibouchina (M elastomataceae), Guzmania squarrosa and Racinae undulifolia (Bromeliaceae), and Sphaeredia (Cyclanthaceae). Also apparent here are taxa characteristic of the higher mountains that occur in acid soils, such as Brunfelsia (Brunfelsiaceae), Sambanthus (Gentianaceae), Weinmannia (Cononiacae), Prunus (Rosaceae), Centronia (M elastomataceae), and M yrse (M yrseaceae). Also common here are Miconia (M elastomataceae), Cybianthus (M yrseaceae), Palicourea (but not Psychotria), Rubiacae, Vochysia (Vochysiaceae), Ericaceae, M yrseacae, Sapotaceae, and Cshybolanaceae. Legumes are uncommon, except for one distinctive Inga that we could not identify with the recent field guide for Ecuadorian Ings (Pennington and Reveo 1997). The most common palm on the Shishicho ridgeline was a small Gennoma that we encountered in Bermejo only above 1,700 m, on the mountain ridge south of Cerro Sur Pax.

In a transect of the shrub layer on the acid ridges, a small-leaved M yrse (M yrseaceae) accounted for 11% of the individuals, Miconia (M elastomataceae) 9%, and the Geonoma sp. (Araeaceae) 8%. Of 120 stems there were 49 species. In a mixed-habitat transect of canopy trees that included some of the acid-ridge as well as the adjacent clay-soil slopes and saddles, a Pouteria (Sapotaceae) made up 14% of the individuals, M acrolobium sp. nov. (Celaipiniaceae) 10%, Vochysia sp. (Vochysiaceae) 8%, Licania (Chrysobalanaceae) 6%, another Pouteria 5%, and a new Conceveiba (Euphorbiaceae) for Ecuador 5%. Of 99 trees there were 39 species. The unique M acrolobium was also abundant in patches in the typical upper hill forest at 1,300 m on the southern slopes of the Cerro Sur Pax complex. The Vochysia, although similar in appearance to V. braceliinae of the lowlands, is probably a distinct species.

In the Bermejo area, there seems to be very little exposure of acidic rock, except perhaps on the higher summits. At lower elevations, quartzite is mostly evident as sheer cliffs. Only on the edges of such cliffs did we find characteristic acidophilic species. The lip of the escarpments directly north of the Bermejo River was the only site where we encountered the tree Humiliastrum digense (Humiliaceae), a taxon characteristic of acid soils, and an unidentified purple-flowered Gentianaceae. On the edge of a greater cliff at ca. 1,700 m on the Sur Pax complex, we encountered several individuals of Puridaea nutans (Cyrillaceae), a species known from the acid-rock mountains in the southern provinces of Zavaro-Chinchipe and Morona-Santiago, but not collected north of there in Ecuador.

Mountain Ridges and Summits (1,500-2,300 m)

Mountain ridges – The major break in floristic composition with elevation occurs at approximately 1,500 m. At this height the flora shifts from one of mainly lowland genera to mainly montane genera. On our route up the southern slopes of Cerro Sur Pax, the transition happened to coincide with the presence of a steep cliff at 1,500 m. The abrupt change in flora may have been due, in part, to a change in the rock and soil chemistry above and below the cliff, but it is more likely the result of an elevational transition in cloud and moisture conditions. The 1,500-m mark appears to be the lower limit of the cloudine here—the elevation where the clouds hit these mountains with greatest frequency, especially in the dry season.

Above 1,500 m the canopy is mostly 20-30 m tall and the leaves noticeably thicker than at lower elevations. Tree trunks here are dense with filmy-ferns and other vascular epiphytes, as well as a relatively thin and patchy layer of other mosses. Also characteristic is a high frequency of large hemi-epiphytes such as Clusia (Clusiaceae), Schefflera (Araliaceae), and Blakes or Topoea (M elastomataceae) growing from the crotches of trees; many large trees with prop-roots and a high frequency of resprouted stems; a high density of succulent shrubs such as Geaneraeaceae and terrestrial bromeliads (mainly G uzmania and Pitzcarina); relatively more stumps serving as “nurse logs” (platforms for the germination and establishment of tree seedlings) than in the lower elevation forests; and more organic material and moss (rarely Sphagnum) on the ground.

There are many fewer species of trees on the mountain ridges than in the hill forest, but the flora here is by no means impoverished. In our canopy-tree transect on the ridge ascending Cerro Sur Pax from the south (at 2,800-1,500 m), the 100 trees we sampled represented 24 species. Billia rosea (Hippocastanaeae) made up 17% of the trees, Calatopa sp. (Iicacaceae; identification in doubt but Calatopa fruits found under one of the trees), a freestanding species of Clusia (Clusiaceae) 10%, Tovomita weddelliana (Clusiaceae) 9%, M yrse sp. (M yrseaceae) 8%, Weinmannia cf. pinnta (Cononiacae) 7%, and Clethra revoluta (Ciehaceae) 5%. The transect included mostly montane genera, such as Podocarpus (Podocarpaceae), Hex (Aquilofoliaceae), Prunus (Rosaceae), and Cinchona (Rubiacae). Other, smaller, more montane genera in the sample included Merania (M elastomataceae), H edysmus (Chloranthaceae), Ruagea (M eliaeacae), and Monnina (Polyalgaecae). The arid Stenosperum, generally a trunk epiphyte at lower elevations, appeared here as a shrubby terrestrial plant.

Except for Disterigina and Sphaeropsernum, Ericaceae are not particularly abundant on these high mountain ridges, especially in comparison with the acid ridges we visited in Sinangue. Rubiacae are frequently encountered here at trees rather than shrubs, though the most common species is a small-leaved, orange-flowered Palicourea. Also common are an Eschweileria (Leychihiaceae) treetop with recurved leaves, three species of Guatelia (Annonaceae), and several short tree ferns and Geonoma palms. Bromeliads are also more conspicuous here as understory epiphylls, in addition to the usual high diversity of Araceae and
Pteridophytes. One Burmesteria (Campanulaceae) is an exceptionally common climber on tree trunks. The only bamboo we encountered at these elevations was an infrequent, skinny, clambering Chusquea (Poaceae), and the only legume a large tree, Abarea kilipili.

Along much of the Andean slopes, like in the Salado River drainage to the south of the Sinangoe area, the palm Dictyocaryum lamarckianum replaces Iriartea above 1,500 m, but not here. While Iriartea drops out at these elevations, only a few juvenile Dictyocaryum were seen in the understory, and a couple of emergent individuals were spotted on the ridges to the north and east of Sur Pax. It may be that Dictyocaryum is more adapted to the acid soils that are scattered and rare in the Bermejo area. Probably this species will show up in abundance in the higher southern part of the Sinangoe area, not far from the Salado River drainage. Two tall understory palms of Wettinia, a genus also related to Iriartea, are similarly abundant in the Cofán foothills. Wettinia maynessis is common in the lower hill forest, and Wettinia anomala is common in the upper hill forest and extends into the mountain ridge forest. The transition between the two species is not well-marked, but may occur at roughly 1,000 m.

The most frequent colonists of landslides and treefall gaps at these elevations are a lobed-leaved species of Croton (Euphorbiaceae), similar in habit to Croton lechleri but replacing it at these elevations, an orange-leaved Viuria (Clusiaceae), and various Miconia (Melastomataceae) species. Rarely there are patches of a large white-leaved species of Cecropia (Cecropiaceae), the kind easily spotted from above on a clear day, but these are not as conspicuous an element here as on the western slopes of the Andes at this latitude.

Moutain summits - The southern peak of Cerro Sur Pax (2,275 m), the highest point we reached in this survey, has a much lower and more open canopy than the ridges below it. Most of the species here also grow along the lower mountain ridges, but the stature of the canopy trees is reduced to 10-20 m, the barks of trees more covered in moss and other trunk epiphytes, species associated with disturbance more frequent, and canopy epiphytes more visible and accessible.

The explanation for the low stature and apparently active disturbance regime seems revealed in the clusters of dead snags scattered over the summit. These are symptoms of frequent lightning strikes that usually hit the tallest trees, especially those with monopodial (Christmas tree-like) growth, but also kill many of the adjacent smaller stems when the lightning heats their sap to the boiling point. The cool temperatures and near-permanent cloud cover may also reduce growth rates of the trees. Both factors probably also explain the great accumulation of dead trunks, branches, moss, and other organic material on the surface, which makes walking precarious here.

The northern peak of Sur Pax, which is only slightly higher (2,341 m) than the southern peak we visited, appears to have very similar vegetation. But along the ridge to the east of Sur Pax, on a series of high summits forming the northern wall of the Chandra Na’e River headwaters, the plant community is somewhat different. These summits, which we were unable to visit, mostly have much shorter, shrubby vegetation. They are also flanked by steep, recent landslides, which have exposed large areas of flat rock close to the summit. This is a sharp contrast to the open and tangled forest on the slopes of Sur Pax, which, though subject to landslides, show very little exposed rock. It is not clear whether there is a different type of rock underlying these shrubby summits, whether the rock strata there are tilted at such a steep angle that forest never develops, or whether there is simply a greater frequency of lightning on the northern headwall of the valley. The presence there (seen through binoculars) of a few isolated emergent individuals of the palm Dicycycaryum lamarckianum (see previous section) suggests that the stunted vegetation on these eastern ridges may be largely the result of a distinct soil chemistry related to a different underlying rock.

Natural Disturbance on Slopes and Ridges

Satellite images show as much as a quarter of the Cofán foothills covered by early successional forest growing on recent landslides. Some of these are tiny patches of less than a hectare; others cover square kilometers. One horseshoe-shaped landslide west of Sinangoe is as large as the entire Shishicho ridge system (Figure 2). The pattern of disturbance on ridges throughout area, whether large-scale or small, is basically the same. As streams erode and undermine the slopes, landslides or lateral slumps wipe out whole sections of vegetation, leaving large expanses of mineral soil exposed to sunlight. These open areas are eventually filled with a succession of pioneer species.

On the upper slopes of the landslides, where rock is exposed the soil is very shallow and unstable, the process is slow. Small herbs, vines, and shrubs may persist for a long time, but trees colonize very slowly. Toward the bottom of the landslide, where deep piles of mixed debris are deposited, the regrowth is rapid, with giant herbs and fast-growing trees shooting up to form a closed-canopy forest. The large bamboo, Guadua angustifolia, is frequently found in dense patches associated with old disturbance, but it is not a consistent member of the regeneration community.

In contrast to the ridges, some of the gradual slopes have a very different disturbance regime. These are subject to continuous lateral sliding of the soil and underlying soft rock. The consequence is that large areas of these unstable sloping terraces (sometimes several square kilometers of forest) are in a state of constant disturbance as the soil buckles and slides downhill. Much of the vegetation survives this slippage—a bit downhill from where it was and often with considerable root damage, and now interspersed with a mosaic of breaks in the soil and canopy, where pioneer species can colonize among the mature-forest species. Lianas and vines also benefit from these slips, by virtue of a highly flexible system for establishing new rooting points (as well as taking advantage of the old ones), quickly expanding into the breaks and up and over damaged trees. Thus a large portion of these unstable slips are covered with a disorganized tangle of plants that is very difficult to penetrate. The local Cofán residents in both areas describe these slopes as having always been in this condition of flux, not the result of an earthquake.

New Species and Other Significant Records

Although most of the plants we collected during the inventory have not yet been identified, many collections have already been confirmed as new species. Of the 23 species of Psychotria (Rubiacae) we collected in the Sinangoe region in our preliminary trip in 2000, four (17%) have been confirmed as new to science (C. Taylor, pers. comm.). At least two terrestrial bromeliads—one collected on the southern slopes of Sur Pax (Figure 4B) and the other collected on the Shishicho ridgeline—are undescribed [J. M. Amorales, pers. comm.]. Of the few M yutaecae we collected in reproductive condition is currently being described as a new species of Calathea (E. L. Kawaski, pers. comm.; see Figure 4A and a more complete description of the plant below). One species of Calathea (M arantaceae) has been confirmed as new, and two others are probably new as well (H. Kennedy, pers. comm.; Figure 4E).

Several other taxa we suspect to be new await confirmation. The most common Inga on the acid ridges at Shishicho is different from any of those described and illustrated in a recent monograph of Inga in Ecuador (Pennington and Revelo 1997). Other taxa that appear to be new species include H eisteria (Olacaceae) with strikingly tiny leaves, a Gynura (Poaceae), and a Cyclanthus (Cyclanthaceae).

Many species on our list are not present in the new Catalogue of the Vascular Plants of Ecuador (Jørgensen and León-Yánez 1999), and at least one, a yellow-flowered shrub in Basidendron (Scrophulariaceae), represents a new genus for Ecuador. In some cases, these species may already have been collected in Ecuador but the specimens were either not fertile or not seen by a specialist working on the catalogue.
for other species these are clearly the first specimens known from the country. An example is Conceveiba sp. (Euphorbiaceae), one of the most common trees in both the upper hill forest and mountain ridge forest, but quite distinct from the two species of Conceveiba listed for Ecuador. Other species represent significant range extensions. For example, Cassia grandis (Caesalpinioideae), although known from the Pacific coast of Ecuador, had never before been found in the Ecuadorian Amazon.

We estimate that at least 75% of the species we collected on Sur Pax and Shishichico have never been reported from the province of Sucumbíos. This is because the mountainous, western part of Sucumbíos has had very few visits from botanists. A recent map of plant collection localities in Ecuador shows a gaping hole around the Bermejo area (Jørgensen and León-Álvarez 1999).

**PLANTS IMPORTANT TO WILDLIFE**

Virtually all the dominant trees in the Bermejo-Sinangoe area have animal-dispersed fruit, as do most of the other canopy species. Many of these, such as the dominants Billia and Dacryodes and the subcanopy Grias, produce big nuts, which are a rich resource for many terrestrial mammals such as deer and peccaries but are probably dispersed only by rodents such as agoutis, pacas, and squirrels. Other dominant trees such as Miqueria, Tapirira, Otoba, Virola, Pouteria, the many Inga and Lauraceae, and the scattered giant Ficus, have fruit that attract large birds, monkeys, and terrestrial mammals. Observations of tapir activity in the Cucunco Valley suggest that the soft sweet fruit of the common successional melastome tree, Belicia pentamera, is a favored food (R. Borman, pers. comm.). In the understory, the preponderance of bird-dispersed shrubs and treetops in the Rubiaceae, Melastomataceae, Mirtaceae, and other families is partly responsible for the region’s rich avifauna. The mammal team’s observations on the mountain ridges of the Cerro Sur Pax complex indicate that spectacled bears there eat the tender leaf bases of dense stands of terrestrial bromeliads (Guzmania and Pitcairnia) and the “hearts” of small Geonoma palms. Whether these are really preferred foods, or just abundant edible resources where mountain bamboo species are in short supply, is not clear. It is interesting that of the two bromeliads most eaten, one is an undescribed species and the other may be new to Ecuador.

**PLANTS COMMONLY USED BY THE LOCAL COFÁN COMMUNITIES**

As with most native communities somewhat isolated from western culture, there is considerable knowledge and use of the native plants in the daily lives of the region’s Cofán residents. Especially in the community of Alto Bermejo, which has very limited contact with the outside, botanical knowledge appears to exceed that found among elders of the other Cofán communities.

Even species of small, inconspicuous plants that are largely ignored or forgotten in the forests around other Cofán villages are readily distinguished from each other in Bermejo and have names in current use.

An ongoing project among the Cofán is to catalog the names and uses of these plants before more information is lost, and to link Cofán taxonomy to specimen collections and Linnaean names. This effort builds on the already published work of Cerón and colleagues (1994) for the area around the Sinangoe community; Cerón (1986, 1988, 1995), for the area around the Cofán community of Darenö; and a database of collections and images of plants (Agúnda and Foster, unpublished) for the area around the Cofán community of Z albalo. The following is a brief summary of the plants that the Cofán forebears use most frequently, according to interviews and observations.

For house construction, the underlying posts are usually made of the very durable seña’mba quinisco (M inquaria guianensis, O laeaceae), the floors from split trunks of the common palm bom’bo (Iriartea deltoidea, Areceaceae), and the cross beams of strong but flexible small trees, often in the Amonaceae, especially laso quinico (Cremastosperma gracилipes). In Bermejo, with its dense stands of the small fan-palm tananaco (Chethocarpus ule), this is the preferred roofing material with a very long life-span. In other areas, utuvo (Cariduvicosa palma, Cyclanthaceae), found along the lowland streams, is the next best material for roofs. These plants are not readily available to the downriver Cofán, who usually use Geonoma and Attalea palms (or metal) for roofing.

The larger canoes are usually made from culichico (Cedrelina calientiformis, Mimosaceae), a tree favored by the Cofán because the mountainous, western part of Sucumbíos has had very few visits from botanists. A recent map of plant collection localities in Ecuador shows a gaping hole around the Bermejo area (Jørgensen and León-Álvarez 1999).

**ADDITIONAL SPECIES NOTES**

• Miconia calvenses (M. elastomatæae), with its large, roundish leaves, usually red when newly emerged, was occasional on stream margins and other disturbed sites, mostly at middle elevations above 800 m. What makes this species important is that it has somehow arrived on Hawaii, Samoa, and many other islands of the Pacific Ocean, and has become one of the most widely dispersed plant species in the region. The key to controlling this species elsewhere might be found among its natural pests in Ecuador.

• Piper (Piperaceae) is a large genus of shrubs characterized by long skinny spikes of tiny flowers and...
In the Bermejo area we collected a small variety of perched. At higher elevations we encountered in the mountain ridge forest, appears to be sufficiently considered to be a highly variable species, the purple-flowered variety with consistently narrow leaflets and heterophylla (Melastomataceae). The latter is also occasionally found on the abandoned Atta nests, although not harboring ants itself.

Another ant-plant, the small tree Psychotria polyphlebia (Rubiaceae), has other species associated with the clearings created by the ants around its stems. Two of the most frequent associates are the low shrublet Psychotria polyphylla (Rubiaceae), and the shrub Osaean bolivianus (Mastomataceae). The latter is also occasionally found on the abandoned Atta nests, although not harboring ants itself.

INFERRED HISTORY OF HUMAN USE

Alto Bermejo

The Bermejo community shows the usual patchwork of currently cultivated plots and regenerating old ones. Human impact beyond this is barely noticeable. Even a short distance away on the trails, valuable timber species such as Cedrela odorifera (Mimosaceae) are abundant. Palms and other species important for house construction are harvested nearby, but on a small scale.

Given the tiny footprint of the Bermejo community, it is not surprising that as we walked the several kilometers of trail to ascend from 450 to 2,300 m we passed little sign of human impact. The exceptions are a few small campsites, near streams or on promontories such as our Vista camp, and a small clearing at 1,600-1,700 m on the southern slopes of Sur Pax, made ten years ago in an attempt to cultivate potatoes. This clearing has now regenerated into a 10-m tall forest dominated by small, herbaceous plants, especially herbaceous wildflowers. The Sinangoe field station above the Sieguyo River, our base of operations for this region, is built on a small flat terrace that was cleared for rice cultivation roughly 30 years ago. Other nearby areas to the east appear to have been cleared around the same time. Prior to being cut again for the present station in 2000, the regrowth on this terrace consisted mainly of medium-sized Jacksonia copaia (Bignoniaceae) and Cecropia scadophylla (Cecropiaceae) trees. Closer to the confluence of the Seguyo and Aguarico Rivers, there are many small abandoned clearings from colonization attempts in the last decade. All of the failed colonization lends additional support to the impression that the area is poorly suited to agriculture (OAS 1987).

Just north of the Sinangoe field station, the trail to Shishicho passes a large stump of what appears to be a cedro (Cedrela fissilis, M. laciniosa), cut into boards with a chainsaw. It seems likely that most of the mature cedro this close to Puerto Libre has already been cut. However, even far from human settlements cedro are only encountered sporadically, leading us to conclude that it has probably never been an important timber resource for the area. It is apparently more common in the vicinity of La Sofia (L. Narvaez, pers. comm.). This trail to Shishicho partly follows an old path, so well-used in the past that it is now marked in places by deep erosion gullies. Scattered on the trail to the Cuccono River are a few small campsites, but human use seems minimal. Any human impacts in the bottom of the Cuccono Valley would have been obliterated in the massive washouts following the earthquake of 1987.
That is critically important, because plants with restricted ranges face an elevated risk of extinction. In the recently published Red Book of the Endemic Plants of Ecuador, Valencia et al. (2000) outline the precarious conservation status of the country’s endemic flora. Fully 36% of all Ecuadorian endemics are known from a single population, 75% have never been registered within a protected area, and 83% qualify as threatened with extinction under World Conservation Union (IUCN) guidelines. Here we present some initial observations on plant endemism in the Cofán foothills. It is still too early to draw precise conclusions about endemism in this poorly explored region, and we have tried to avoid the trap of thinking that all the strikingly unfamiliar plants we observed in the field were endemic species. Instead, our aim is to open the discussion with some preliminary observations from the field and the herbarium, and to suggest some avenues for further study. Considering the profusion of endemic taxa in adjacent areas of the eastern Andes, our caution will probably prove unwarranted. A large proportion of the plants we registered are most certainly unique to the area.

REGIONAL-SCALE ENDEMISM

The preliminary list of plants assembled for the Bermejo and Sinangoe region (see Appendix 1 and the preceding chapter) contains at least 15 species currently believed to be endemic to Ecuador. Since most of the plants on our checklist for the region have not yet been identified to species (and since widespread species are often identified first), we predict that the actual number of endemics is at least ten times higher. Ironically, the discovery of these species in the Cofán foothills almost guarantees that most of them will eventually lose their endemic status, because our collection sites are just a few kilometers from the Colombian border. As plant-collecting programs continue in the eastern Andes of Colombia (especially along the Pasto-Mocoa road), a large number of species currently considered endemic to Ecuador, and many of those present in our area, will probably be crossed off the list. The evidence suggests, however, that many of those will prove endemic to a small stretch of the eastern Andean slopes (i.e., a few degrees of latitude). Botanists working along the length of the Andes have documented thousands of plant species that appear to be restricted to very narrow sections of the cordillera (e.g., Hersholt 1999, Valencia et al. 2000), and it is unlikely that all of these are artifacts of a scanty collection record.

Prominent among the confirmed Ecuadorian endemics in the Cofán foothills list—and in the list of endemics expected to occur there—are epiphytic orchids and bromeliads. The two undescribed species of bromeliads we collected around Cerro Sur Pax and the Shishicho ridgeline probably have narrowly restricted ranges as well (J. M. Amazancares, pers. comm.). By contrast, we found an oddly meager diversity and abundance of micro-orchids in the tribe Pleurothallinae, and especially in the genus Lepanthes, which contains hundreds of species endemic to the Ecuadorian Andes. In the Pastaza River valley alone, L. justi has recently documented 90 co-occurring species of Lepanthes. 25-30 of these can occur together on a single mountain covering the same elevational range as Cerro Sur Pax (L. justi, pers. comm.). But the only site where we found species of Lepanthes during the survey was on the upper-most slopes of Sur Pax, between 1,900 and 2,275 m. Even there, methodical searches of the understory and canopy during our three days of collecting only turned up seven or eight individual plants, of mostly the same species. We may have spent too little time or covered too little ground in the higher-elevation forests that these taxa prefer. Or we may simply have overlooked dozens of these notoriously inconspicuous plants (Endara and justi 2000).

SMALL-SCALE ENDEMISM

Botanists working on the opposite side of the Ecuadorian Andes have suggested that levels of “micro-endemism” among plants in the western foothills may be astronomically high. The idea is that a large number of the species endemic to forests of western Ecuador might, in addition, be restricted to a single ridge, valley, or mountaintop. In Gentry’s (1986) famous description of the Centinela ridge, just south of Santo Domingo, he hypothesized that several dozen plant species might not occur anywhere else in the world but that small hill (5-10 km²) at the base of the Andes. Although Gentry’s report has proven somewhat premature—most of the putative Centinela endemics have now been collected elsewhere in coastal Ecuador, and only five species are still known only from that mountain (Valencia et al. 2000)—the idea of this single, rather unremarkable ridge harboring five unique plant species is itself astonishing (Dodson and Gentry 1991). If confirmed, the Centinela hypothesis would imply the existence of hundreds of micro-endemics in the Cofán foothills.

The most intriguing example of this sort of endemism that we encountered in the rapid inventory was an undescribed shrub in the genus Calyptranthes (M yraceae, the guava family; Figure 4A). This shrub was well known to the Cofán members of the team as ishoaquinico, a plant Cofán communities used, until very recently, in coming-of-age ceremonies for young men. The species was abundant along trails in the vicinity of the Sinangoe station and present on the lower portion of the trail up to the Shishicho campsite, but we did not encounter it anywhere else in the region. Indeed, the Cofán apparently used to make the fruits. The bromeliad Werauhia haltonii was known from just one other population in the Cordillera de los Guacamayos (more than 100 km to the south) before we found it growing on the 2,275-m summit just south of Cerro Sur Pax.

OTHER ENDEMICS OF INTEREST

• Passiflora popenovii (Passifloraceae), a vine endemic to Ecuador but apparently extinct in the wild (Jørgensen 2000), is cultivated along the new road from La Bonita to Puerto Libre (P. Fuentes and X. Aguirre, pers. comm.). The La Bonita-Sucumbios Foundation in the town of La Bonita is now developing a program to prepare preserves from the fruits.

• The bromeliad Werauhia haltonii was known from just one other population in the Cordillera de los Guacamayos (more than 100 km to the south) before we found it growing on the 2,275-m summit just south of Cerro Sur Pax.

THREATS AND RECOMMENDATIONS

These patterns of endemism are important for conservationists because species with small geographic ranges will be the first to go extinct as habitat loss and climate change intensifies. In the case of micro-endemics, even moderate forest clearing on isolated mountaintops and ridgelines, where endemics may persist in tiny remnant populations, can potentially result in local extinctions (Dodson and Gentry 1991). On the larger scale, restricted-range species are protected by fewer parks and reserves than more common species. Plant species endemic to the San Miguel or Bermejo watersheds—like, apparently, the new species of Calatheas species that may illustrate this pattern. One of them, a striking herb with purple flowers and pink bracts (Figure 4E), was a common sight along the trail leading from the Bermejo Vista camp up the southern slopes of Cerro Sur Pax. At the same elevation on the Shishicho ridge, 10 km to the south, we encountered a superficially similar plant that, on closer inspection, proved distinct in several respects. Whether these taxa are still in the process of speciation or simply replacing each other in alternate drainages remains to be determined. In the meantime, it is interesting to note that the closest taxon to these in the Flora of Ecuador is a species that was first collected on the Centinela ridge by Al Gentry (Kennedy et al. 1988).
AMS MEASURING THE PRECISE NUMBER OF SPECIES DENIC TO THIS AREA—AND TO ANY PARTICULAR SECTION OF THE ANDINE RANGE—IS STILL BEYOND THE REACH OF SCIENTISTS. CONSIDERING HOW CRITICAL THE PROJECT IS FOR THE EFFECTIVE CONSERVATION OF THE ANDINE FLORA, WE ARE ASTONISHED THAT IT HAS ATTRACTED SO LITTLE RESEARCH ATTENTION TO DATE. WITHIN THE COFAN FOOTHILLS, THE FIRST STEP WOULD BE TO SAMPLE SYSTEMATICALLY RIDGE TOPS THROUGHOUT THE REGION, FOCUSING ON TAXA WITH A PROPENSITY FOR ENDEMISM (I.E., ORCHIDS, BROMELIADS, GENIERICASE, ETC.). CAREFULLY DESIGNED AND CARRIED OUT, SUCH AN EFFORT WOULD PRODUCE INVALUABLE DATA FOR CONSERVATIONISTS AND BIologists ALIKE.

AMPHIBIANS AND REPTILES

Participants/Authors: Lily O. Rodriguez (field) and Felipe Campos (museum)

Conservation targets: species with restricted ranges; species of higher elevations (Hyla phyllognatha, Liophis epinephelus, Neusticurus cochranae, Chironius monticola); taxa with declining populations, e.g., glass frogs (Centrolenidae) and poison-arrow frogs in the genus Cystostoma (Dendrobatidae); taxa with little prior fieldwork (one specimen apiece) and deposited all specimens in the collections of the zoological museum of the Pontificia Universidad Catolica de Ecuador (QCAZ).

Two species on the list correspond to photographs taken by other team members in the Bermejo region. Little prior fieldwork has been done in this mountainous region of Sucumbios. The study conducted by Altamirano and Quiguango (1997) in Sinangoe focused on reptiles and amphibians between 555 and 670 m elevation. Not surprisingly, the species registered in their 34-day inventory (using transects and plots) were all lowland taxa shared with earlier lists from Santa Cecilia, with the exception of Eleutherodactylus cf. incomptus. Campos et al. (2001) inventoried herpetological communities around La Bonita (between 1,700 and 2,000 m) and Rosa Florida (1,400 m), and their results are summarized in Appendix 6 of this report.

METHODS

This report combines L. Rodríguez’s fieldwork around Sinangoe during the inventory with longer-term observations of the region’s herpetological communities by F. Campos (who was not able to join us in the field). Supplemental observations were made by other members of the rapid inventory team, in the form of photographs taken at Bermejo. Fieldwork was restricted to the lower and upper hill forests around Sinangoe, at elevations between 800 and 1,450 m. During my (LR) 11 days in the field, I spent 78 hours actively searching for amphibians and reptiles, mostly around the Cuccono Ridge camp and the Shishicho camp. Sampling consisted of visual and auditory observations during walks on existing trails, both during the day and at night. I focused my searches on the taxa that are less common and widespread and that best characterize the type and condition of different habitats (e.g., Anurans, particularly Eleutherodactylus and Dendrobatidae). I also paid special attention to the stream habitats preferred by many species. I recorded some songs in the field, to compare later with published records. I collected ten species that I could not identify in the field (one specimen apiece) and deposited all specimens in the collections of the zoological museum of the Pontificia Universidad Catolica de Ecuador (QCAZ). Two species on the list correspond to photographs taken by other team members in the Bermejo region. Little prior fieldwork has been done in this mountainous region of Sucumbios. The study conducted by Altamirano and Quiguango (1997) in Sinangoe focused on reptiles and amphibians between 555 and 670 m elevation. Not surprisingly, the species registered in their 34-day inventory (using transects and plots) were all lowland taxa shared with earlier lists from Santa Cecilia, with the exception of Eleutherodactylus cf. incomptus. Campos et al. (2001) inventoried herpetological communities around La Bonita (between 1,700 and 2,000 m) and Rosa Florida (1,400 m), and their results are summarized in Appendix 6 of this report.

RESULTS OF THE HERPETOLOGICAL SURVEY

We observed 85 amphibians and reptiles (excluding tadpoles) during the rapid biological inventory, corresponding to 31 different species. The list includes six species of snake, six lizards, 17 frogs and toads, a salamander, and a caecilian (Appendix 2). Among the most notable records are a new lizard species in the genus Dactyloa (Figure SE), and the first Ecuadorian record for the lizard Ceratosaura ocellata. We expect that a more complete survey, especially at higher elevations, will reveal several additional undescribed species and extend the altitudinal ranges of many known species.

The Cofán foothills lie just 20 km to the west of Santa Cecilia, whose forests held the world record for amphibian diversity until they were destroyed in the 1980s (Duellman 1988; see also Figure 7). The implication is that the lowest elevations of our study site—particularly the floor of the Bermejo River valley, at ca. 450 m—also harbor very diverse communities, including most of the species that were extirpated over the last two decades at Santa Cecilia; see Figure 5A.

Species richness drops significantly as elevation increases, though our data are not sufficient to give a clear picture of how the diversity of this region compares with similar-sized areas elsewhere in the Andes. Between 900 to 1,200 m in the Andes, one typically expects to find 30 or fewer amphibian species (Duellman 1988; species records for Cordillera del Condor and Cordillera del Cutucu in Ecuador, and the foothills of M anu in Peru). In just 11 days in the field, I recorded half this number, probably indicating that species richness in the region is high. By contrast, endemicism is low. Most of the species in this region are shared with foothill forests in neighboring Colombia or with lowland forests in western Amazonia (Lynch et al. 1997).

Not surprisingly, the herpetological community in the Cofán foothills is a complex overlap of Amazonian- and Andean-centered fauna. Most of the species we observed in the field have altitudinal ranges rising from the base of the Andes to approximately 2,000 m elevation, and many are mostly known from the adjacent Amazonian lowlands. For example, the black-banded robber frog, Eleutherodactylus nigrivittatus, and at least seven other amphibian species on our list have been collected in Santa Cecilia (Duellman 1978), Yasuni National Park (Ron 2000), and lowland forests farther to the east (Lynch et al. 1997). As usual in these forests, the small, hard-to-identify frogs in the genus Eleutherodactylus made up a disproportionate number of the species I registered in the field. We list nine in the checklist, though at least four others were seen and not identified.

Other taxa are more characteristic of montane forest. Among the amphibians, for example, the montane species Hyla phyllognatha (Figure 5C) ranges widely in the Andes from Colombia to Bolivia, always between 600 and 1,700 m. It is worth noting, however, that the different populations of H. phyllognatha might eventually prove to be distinct species; the songs we heard in this survey were different from the typical songs of this species in southeastern Peru [pers. obs.] and from the Ecuador recordings published in Duellman 1972. It would appear that the herpetological communities in the Andean foothills near the equator have somewhat broader elevational ranges (though similar diversity) compared to foothill communities at higher latitudes, like those in Peru’s M anu National Park. This will require more detailed studies to confirm. On the other hand, none of the species in our list that I consider to be taxa of montane forests (Hyla phyllognatha, Liophis epinephelus, Neusticurus cochranae, Chironius monticola) were reported by Altamirano and Quiguango (1997) at their lower-elevation study site around Sinangoe.

While much of the herpetofauna we registered in the Serranias Cofán is shared with lowland sites like Santa Cecilia, most species possess particular adaptations for the steep foothills landscape, where swampy areas are rare and most water is in the form of rushing streams. Thus Eleutherodactylus juveniles hatch directly from eggs, while H. phyllognatha and Cochranella mimus reproduce in rushing streams. Reptiles are rarely informative in rapid biological surveys because their population densities are so low as to make observations sporadic. I was surprised, then, to find considerable reptile populations during the survey, registering six snake species without any special effort. One of these was a bushmaster (Lachesis muta) coiled next to one of our tents at the Shishicho campsite (Figure 5B). At least two other snakes—Liophis epinephelus in Shishicho, and Chironius cf. monticola in Cucuno—appear to be restricted to higher-elevation forest. We also identified six different species of lizards. Neusticurus cochranae—a lizard known only from the eastern slopes of the Ecuadorian Andes, where it can reach 1,300 m—appears to be common in the region. We found it in...
both the Cucuno and Shishicho camps, close to streams, at ca. 1,000 m. Of all Neotropical species, this species seems to be the least aquatic (Uzzell 1966).

While the density of amphibians fell within a typical range for forests of this kind, the animals did not appear to be in a particularly active season. The large number of juvenile animals we saw and the scarcity of singing males suggest that our survey may have coincided with the end of the mating season. While Crump (1974) and Duellman (1978) pinpoint the beginning of the mating season at Santa Cecilia (350 m) in August and September, it may be that the reproductive schedule and activity of the species shared with that site is different here due to the higher altitude. This sort of altitudinal variation in the mating schedule of a single species has been documented for amphibians and for forest birds in southeastern Peru.

Notable for their absence in the survey were species in the genera Colostethus (Dendrobatidae), Bufo and Rhamphophyine (Bunodidae), and Hemiopla (Hyliidae), as well as glass frogs (Centrolenidae), all of which are normally present in forests at this altitude. These absences may be related to the alarming declines observed elsewhere in the forests at this altitude. These absences may be related to habitat differences among sites, but the details are not at all understood.

**THREATS AND RECOMMENDATIONS**

Some alarming but poorly understood declines have been observed among amphibian populations in this part of Ecuador, particularly at higher elevations in the Cayambe-Coca Ecological Reserve (see also Appendix 6). Most notably, several species in the families Centrolenidae (glass frogs) and Dendrobatidae (poison-frog species) are present in the forests around our campsites that suggests that these absences were not related to environmental quality. More intensive surveys may eventually register the missing species, at low population densities. It is also possible that microhyliid frogs like Syncope antenori are present in the moss-covered Shishicho ridge, or in the common epiphytic bromeliads in the Cucuno watershed. Similarly, we found perfectly good habitat for Colostethus cf. marchesianus in the forest below our Shishicho campsite and in the vicinity of our Cucuno Ridge camp, but not the frog itself. I heard (but was not able to record) songs that may have been this species; the species may simply have escaped detection.

Even after such a short time in the field (four days at each site), simple abundance patterns and differences between sites are fairly clear. Eleutherodactylus nigrovittatus was the most common amphibian species in Shishicho, while Bolfystoxosa peruviana dominated in Cucuno and Epedipobates femoralis in Shangano. Of the three, E. nigrovittatus appears to have the broadest local distribution, as it was recorded at all three sites. The dominant species in an earlier survey at Shangano (Eleutherodactylus lanhanthes; Altamirano and Quijigango 1997) was only moderately abundant in our survey, and the most common amphibian at Santa Cecilia (Eleutherodactylus variabilis; Duellman 1978) was not even recorded. This sort of temporal and spatial variability points to habitat differences among sites, but the details are not at all understood.

**METHODS**

The principal ornithologist on the rapid biological inventory team (July-August 2001) was Thomas S. Schulenberg. Supplemental observations were made by other members of the survey team, but primarily by Debra K. M. Sornovit and Randy Borman. In addition, our records from Bermejo are supplemented by the list of species recorded there by Douglas F. Stotz, M. Sornovit, and Jennifer M. Shopland during a short visit from 7 to 9 November 1998.

The basic protocol for the rapid surveys involved walking trails through the forest to locate and identify birds. I attempted to be in the field from first light (or very shortly thereafter), although early morning rains sometimes resulted in a later start. Usually I would remain in the field until late afternoon or dusk. I made an effort to survey all habitats in the area, but focused most of my efforts on closed-canopy forests. I carried a portable cassette tape recorder and directional microphone to make sound recordings of bird species. These sound recordings will be deposited at The Museum of Natural Sciences of Philadelphia (ANSP) conducted a short ornithological survey from 11 to 17 March 1993 at 850-1,000 m in the Bermejo oil fields, at a site about 12-13 km south-southeast of the Cofán community of Alto Bermejo (M. Robbins, pers. comm.; the field team was M. Ar. B. Robbins, Francisco Sornoza M., and M. Arco Jacome). Separately, Mena (1997) reported on the birds observed at the Cofán community of Shangano, and at two sites about 8 km to the southwest of Shangano. His list includes around 70 species not recorded by our rapid inventories. On the basis of the species listed by Mena (discounting the few apparent misidentifications, e.g., H. toloxoa jacula, a species of the western cordillera) as well as on a more general consideration of Ecuadorian bird distribution (Ridgely and Greenfield 2001), I estimate that the total number of bird species found in the Serranías Cofán may exceed 700 species. This would represent an essentially "complete" avifauna for the elevational range found in this area.

Of the 399 bird species recorded during the rapid biological inventory and Stotz's earlier visit, fully 85% (339 species) were observed in the Bermejo region. In contrast, our totals for Shishicho (135 species; 34% of the total) and Cucuno/Shangano (209 species; 52% of the total) are notably lower. There are several reasons for these disparities. The list for Bermejo reflects in part the more intensive coverage that this site received (all or part of 13 days during the rapid biological survey, plus three days by Stotz, as compared to all or part of five days for Shishicho and all or part of ten days for Cucuno and Shangano). Bermejo also has been visited during different seasons (July and August versus the rapid biological inventory, and November versus the rapid biological inventory), and differences between sites are fairly clear.

**RESULTS OF THE BIRD SURVEYS**

The team recorded a total of 350 species during the three weeks in the field in the Serranías Cofán, and an additional 49 species were recorded in the Bermejo area by Stotz and others in November 1998. The avifauna documented by us to date totals 399 species (see Appendix 3).
Birds of the Lower Hill Forest

The extensive lower hill forests in the Serranías Cofán are where the greatest species richness is expected, because of that forest type's similarity to the adjacent, and extremely diverse, lowlands. Endemism, on the other hand, is low here, with most of the species widely distributed. Although my best opportunities to study this avifauna were cut short by rain (especially at Bermejo), we did record some species of interest. One interesting discovery was Helemisicus zosterops (White-eyed Toddy-Tyrant), an Amazonian species that was of regular occurrence in lower hill forest throughout the Serranías Cofán. This species previously was known in Ecuador only from areas south of the Napo River (Ridgely and Greenfield 2001), although Mena (1997) also recorded H. zosterops at all of his study sites near Sanango, and there are a few records for H. zosterops in adjacent Amazonian Colombia (Hilty and Brown 1986). Our records both extend the distribution of the species in Ecuador and help to “fill in” what had been an anomalous hole in its distribution.

Relatively few truly Andean bird species are found in the lower hill forests of the Serranías Cofán, but among these are several of particular interest. Chlorostilbon rutilans (Carmiol’s Tanager) is known in Ecuador primarily from Sucumbios. The narrow distribution of this species in Ecuador is something of a surprise, as farther south (in southern Peru and Bolivia) C. rutilans is very widespread and common in lower hill forest. In contrast, Snowornis subalaris (Gray-tailed Piha), a bird of the hill forests that is known from rather few localities within its geographic distribution, occurred all the way down to around 450 m near Bermejo, perhaps the lowest elevation at which this species has been found.

It was in the lower hill forest, at the Sanango field station, that I had very good looks at a rare and poorly known swift, Cypseloides lemosi (White-chested Swift). I suspected the presence of this species over the Bermejo station as well, but was never able to confirm it there. Until recently, Cypseloides lemosi was only recorded from southwestern Colombia, but in recent years there have been records from several sites in eastern Ecuador and at one site in Peru (Schulenberg et al. 1997). This bird does not use the lower hill forest itself, but it presumably roosts, and perhaps even breeds, in the cliffs and waterfalls at higher elevations of the Serranías. Other, even lesser-known swifts, such as C. cryptus (Gray-tailed Swift) and C. cherriei (Spot-fronted Swift), may also occur in the Serranías Cofán. Due to the great similarities among all Cypseloides, and especially between C. cryptus and C. cherriei, their presence in the region would be very difficult to confirm. Attention should be paid, however, to the possible presence of these species near waterfalls and other likely nesting sites.

Birds of the Upper Hill Forest

We recorded Crax salvii (Salvin’s Curassow) at the uppermost elevations in the lower hill forest (900 to 1,000 or 1,100 m) at all three of our study sites. This large gamebird is primarily a lowland species, and is known only from parts of the northwestern Amazon basin, from southern Colombia across eastern Ecuador and south into northwestern Peru. The Crax is heavily hunted, and already has been exterminated from many areas within its range (especially in Ecuador). Although it was encouraging to find this species still widely distributed within the Serranías Cofán, the fact that the curassow seemed to be much more common in, or even restricted to, the uppermost elevations of lower hill forest within the region may be a telling indication of the hunting pressure it faces, even in an area with a relatively low human population.

We had no records during our brief inventory of Heliodoxa gularis (Pink-throated Brilliant), a hummingbird that is regarded as globally near-threatened (BirdLife International 2000) or threatened (vulnerable; Ridgely and Greenfield 2001). This rare species was found, however, at the ANSP study site southeast of Bermejo, and also along the Due River (Ridgely and Greenfield 2001). The ANSP survey also recorded another near-threatened species, Pipreola chloroploiodota (Flaring-throated Fruit-tanager). Both of these species surely occur at or close to our study sites. Although not recorded during our 2001 survey, Falco deiroilocus (Orange-breasted Falcon) was observed by Stotz during his earlier visit to Bermejo. This falcon is a widespread species that is nonetheless scarce throughout its range. Other interesting species recorded by Stotz include Tinamus tao (Gray Tinamou) and Tntour purpurata (Sapphire-rumped Parrotlet), two species with wide geographic distributions that are known in Ecuador from only a few records each (Ridgely and Greenfield 2001).

The upper hill forest, a narrow and fragile ribbon of habitat running the length of the Andes, has one of the most poorly studied avifaunas in South America. Although some elements of this region’s bird communities are widely distributed, it also is characterized by a large number of bird species that occupy very restricted geographic or elevational ranges. Historically, the bird communities of the upper forest in Ecuador were best known from the Sumaco region, perhaps because this area was visited repeatedly, over many years, by collectors, ornithologists, and birdwatchers. Some of the rarer bird species of that region have since been discovered at additional localities in eastern Ecuador, but even these still are known, in most cases, from only a very few localities each. The avifauna of the upper hill forest in Sucumbíos province in particular seems to have been almost unknown prior to our visit.

Even during the short period of our rapid biological inventory, and though we visited only a few sites, we encountered some of the least-known and most geographically restricted bird species of the upper hill forest. The most important of these may be Myiopagis otilaia (Foothill Elaenia), a species that was discovered only very recently (Coopsman and Krabbé 2000). This small flycatcher previously was known from only three localities: Sumaco and the valley of the Bombucaru River in eastern Ecuador, and from a site in southwestern Colombia. We expected that this poorly known bird would be discovered eventually at additional localities; our record from the Serranías Cofán, however, is also a significant range extension.

Another major discovery was the first record for Ecuador of Tinamus osgoodi (Black Tinamou). This rare bird previously was known only from two small regions, in the head of the Magdalena valley in southern Colombia and in the Andes east of Cusco in southern Peru. It may be more widespread in Ecuador; however, birds believed to be this species have been seen as far south as Coca Falls (R. Borman, pers. comm.). Tinamus osgoodi is regarded as globally threatened (vulnerable; BirdLife International 2000). Other highlights among the species of the upper hill forest include Hylophilus semibrunneus...
several of our sites was known in Ecuador only from Sumaco and the adjacent Archidona road; Hemitrichus rufigularis (Buff-throated Tody-Tyrant), previously registered at only three sites within Ecuador (and not known from Colombia); and Phylloscartes hemileucurus (Ecuadorian Piedtai), a small hummingbird known previously in Ecuador from only five sites (and elsewhere from only a single site in Colombia, and two sites in northern Peru).

Two important aspects of the bird community of upper hill forests in the Serranías Cofán are that many of these species—even those that are considered among the rarest and most locally distributed—were found (1) at all of our study sites and (2) on a regular basis. For example, Campylopterus villaviscensio (Napo Sabrewing), Phylloscartes gualaquiae (Ecuadorian Tyrannulet), and Snowornis subaliris all seemed much more common in the Serranías Cofán than at any other site where I have encountered them. The high relative abundance of these species is particularly important because two of them (Campylopterus villaviscensio and Phylloscartes gualaquiae) are, like the Phylloscartes hummingbird, entirely restricted to a small area of the Andes between Colombia or eastern Ecuador to the north, and northernmost Peru to the south, and these species typically occupy only a narrow elevational band within this region.

Also present in the Serranías Cofán is a population of A. militaris (Military Macaw). Although this species has a wide distribution, it is decreasing in abundance throughout its range. Its populations are increasingly fragmented, and the species is regarded as globally threatened (BirdLife International 2000). Within Ecuador, A. militaris previously was known from only six sites (none of them in the province of Sucumbios). Since we encountered the species at all of our study sites (although always in small numbers), the species is considered to be globally near-threatened (BirdLife International 2000). We did not encounter Chamaepeza goudotii (Sickle-winged Guan) during our short visit, although it is reported to be present in the area (R. Borman, pers. comm.).

Chamaepeza remains relatively common in Ecuador, but Aburria is generally uncommon in this part of its range and may be vulnerable to hunting pressure.

We have a little data on the presence in the Serranías Cofán of nearctic migrants (bird species that breed in the Northern Hemisphere and spend the northern winter in tropical latitudes), thanks to Stotz’s visit to Bermejo in November 1998. During the three days that he was present in the region, Stotz recorded eight species of nearctic migrants, which is about half the number of migrant passerine species that would be expected to occur in forested habitats of the Serranía. Dendroica cerulea (Cerulean Warbler), Thamnophilus unicolor (Uniform Antshrike), Ochthoeca cryptolophus (Spotted Antwren), and Hemitriccus rufigularis (Black-throated Tyrant) were also recorded in the Serranías Cofán.

Birds of the Mountain Forests (1,500 to 2,300 m)

Given the relatively small area of mountain forest habitat at the crest of the ridges of Cerro Sur Pax, it was something of a surprise to encounter as many montane bird species there as we did. Among the numerous birds characteristic of higher elevations but present on Sur Pax were several species with extremely limited distributions within Ecuador. Perhaps the most significant of these is Grallaria aleni (Moustached Antpitta). This species currently is considered to be globally threatened (endangered; BirdLife International 2000). Until recently it was known only from two specimens from Colombia, but now has been found at additional sites in Ecuador (Krabbe and Coopmans 2000). Though G. aleni remains a poorly known bird recorded at only a few places within a limited geographic area, a ranking of “endangered” may overstate the level of threat. Also of interest were Eriocnemis aliae (Emerald-bellied Puffleg), a small hummingbird previously known from only three other sites in Ecuador, and Campylopharmhus pucherani (Greater Suthehilli), a scarce species that previously had been recorded at only six sites in Ecuador.

We also were surprised to find evidence of species turnover at the higher elevations, with some congeneric replacements occurring even between the Bear Ridge camp and the ridgeline just below the crest of Cerro Sur Pax. Coeligena coeligena (Collared Inca), adapted to the lower elevations of the Serranía, was known in Ecuador only from Sumaco and the adjacent Archidona road; Coeligena torquata (Black-throated Tyrant), a species of the hill forest that is known only from a single site in the geographical range. I also was impressed at Bermejo by the relatively high abundance of Frederikensia unduligera (Undulated Antshrike), an Amazonian species with a wide distribution, but which usually is very scarce.

The area around the Vista camp was where I had my first indications that the Serranías Cofán contained a significant number of hill forest bird species that are elevationally or geographically restricted. Among these were a few species that, during our survey, were notable at Bermejo, however, later were noted at our other sites as well, such as Campylopterus villaviscensio, Hemitrichus rufigularis, and Snowornis subaliris. Another such species, Phylloscartes hemileucurus, not observed by us
in the Bermejo region, was found by Stotz at about 900 m on a ridge between Pozo Seco and the community of Bermejo.

A very large number of obligate and regular ant-following species were active around Bermejo to the surprisingly high elevation of 1,400 m, and we observed a large number of obligate and regular ant-following birds, generally considered to be lowland species, as high as 1,200 m: Neomorphus geoffroyi (Rufous-vented Ground-Cuckoo), Myrmeciza fortis (Sooty Antbird), Pitathis albifrons (White-plumed Antbird), and Gymnophlytis leucaspis (Bicolored Antbird). Also notable at this site was a family group (two adults and two juveniles) of Aramides calopterus (Rufous-winged Wood-Rail), a widespread but scarce species that has been reported only a few times in Ecuador.

Our brief visit to the crest of Sur Pax was our only investigation of the higher areas of the Serranías Cofán (those above ca. 1,500 m). The ridges that we surveyed in the Serranías Cofán only barely reach the elevation at which the avifauna of the upper hill forest typically is replaced, in part, by a montane bird community. Often in such situations most or all of the expected higher-elevation bird species are lacking (presumably because the area of suitable habitat on top of the ridge is too small), and the bird species of lower elevations may extend their distributions up to higher altitudes than would be the case on higher ridges. In the Serranías Cofán, however, we found a significant degree of turnover in the bird community at the crests of the highest ridges.

In view of the tiny extent of these mountain forests on the ridges that we surveyed, I was somewhat surprised to find some species with extremely limited distributions within Ecuador. The most significant were the rare Gallaria allichi, the near-threatened Campylophoramus pucherani, and the scarce and locally Eriocharis allichi.

Shishicho
I was present at the Shishicho camp (1,000 m) during the nights of 6-9 August. Casual observations were made along the trail between the Sinagoe field station and Shishicho during the ascent (6 August) and descent (10 August). From Shishicho, I primarily explored the higher elevations along the ridge farther out the trail (7, 9 August), to about 1,500 m. The day of 8 August, however, I spent at elevations of 900-1,000 m along the trail between Shishicho and the Sinagoe station.

The most important discovery at Shishicho was of the poorly known tinamous Tinamus osgoodi, previously known only from two isolated populations, one in southern Colombia and one in southern Peru. A single bird was seen well at 1,400 m on 7 August, and I heard a tinamous song that I assume to belong to this species. The tinampions are the only species at rare intervals at comparable elevations both on 7 and 9 August.

Among other species noted only at Shishicho were the scarce hummingbird Colibri delphinae (Brown Violetear), feeding on a blue-flowered Pilocarpaceae tree; Pipreola frontalis (Scarlet-breasted Flowerpiercer), a cotogna that has not been recorded in Colombia (previously known only to the Sumaco region); and Piranga flava (Hepatic Tanager), a species that is widespread in the Andes but not known from the eastern Andes of Colombia (the few prior records for eastern Ecuador all are from the south, in the provinces of Morona-Santiago and Zamora-Chinchipe). Also interesting was an unidentified Knipolegus flycatcher seen at 1,450 m; this individual differed from the expected species, K. pocellurus (Rufous-tailed Tyrant), by having a brown (not reddish) iris and appearing medium brown (not pale gray or grayish brown) above, with the upper tail coverts more rufescent than the back, buffy wing bars, and blury streaking on buffy brown underparts.

Cucunco and Sinagoe
I spent the nights of 11-14 August at Cucunco, on a ridge above the river, at 1,000 m. The days of 12 and 14 August I worked northeast along the trail from the Cucunco camp back towards the Sinagoe station, down to elevations of about 900 m. On 14 August I descended from the camp to the Ccuccono River, and worked areas along the Ccangopacho and Copayae Feni streams as well. I stayed at the Sinagoe station the nights of 5, 10, and 15-16 August. During most of these visits, we were en route to another site such as Shishicho or Cucunco, and I made only casual observations around the station. M. uch of 16 August, however, I spent investigating trails near the station, primarily the lower part of the trail towards Cucunco, and also from the station down the Seguyo River towards the Aguarcito River.

Cucunco was the only site where I saw Phlogophorus hermosus during the rapid inventory. It was registered in the Bermejo area, however, by both Stotz and the ANSP team, and seems to be widespread in the region. This small hummingbird can be locally common, as it was at Cucunco, but it has a limited geographic distribution encompassing a few localities from extreme southern Colombia south to extreme northern Peru. Another noteworthy observation at Cucunco was an army ant swarmed at 1,000 m. This was not attended by obligate ant-following antbirds, but on two successive days I observed a Neomorphus geoffroyi at this swarm.

Several large, empty, cup-shaped nests were noted on the face of a small cliff near a stream feeding into the Cucunco River. Piles of palm seeds and germinating palm seedlings were present beneath these nests, at the base of the cliff. The initial identification of these as Oriolus (Staenorini caprifinis) nests led the team to name the adjacent stream Copayae Feni (“Oriolus Creek” in Cofán), but the substantial size of the nest cups suggests that they may have been nests of another species (Rupicola peruana, Andean Cock-of-the-Rock) instead.

CONSERVATION IM PORTANCE
Even our brief survey of the Serranías Cofán was sufficient to establish the presence of a rich hill forest bird community, especially in the upper hill forest. Two features of this bird community make it of special importance for conservation: the presence of a significant number of species that are endemic to a small geographic area of the Andes, or which have been recorded at only a few locations; and the fact that most of these species were encountered at most or all of our study sites, indicating that the Serranías are an important center of population for these species. Among these are birds that are considered to be globally threatened, such as Tinamus osgoodi, Touit stictoptera (Spot-winged Parrotlet), considered vulnerable, BirdLife International (2000), and Gallarilla alleni (but see my note on this last species above), as well as several species that are regarded as near-threatened, such as Aburria aburri, Campylopterus villavicencio, Phlogophorus hermosus, Campylophoramus pucherani, and Hemitrichus rufugularis. Indeed, the number of threatened and near-threatened bird species recorded even from this brief survey of the Serranías Cofán are sufficient to make this region one of the most important sites for bird conservation in eastern Ecuador (Wege and Long 1995).

Other species of special conservation interest include birds known from relatively few sites or with constricted distributions, such as Myiopagis olallai, Phylloscapus gualaquiae, and Hemitrichus rufugularis. More intensive surveys almost surely would discover the presence of additional range-restricted species within the Serranías.

THREATS AND RECOMMENDATIONS
The Serranías Cofán are an important refuge for populations of large, vulnerable birds, like the parrot Ara militaris and the large cracids Crax salvini and Aburria aburri. Ara militaris is considered globally threatened (BirdLife International 2000). Both Crax salvini and Aburria aburri are declining in Ecuador, and Aburria is considered to be globally near-threatened. These cracids are threatened not only by habitat loss (deforestation), but also by hunting, as they commonly are shot for food. It is not known what level of hunting pressure these gamebirds can sustain, but within the Serranías will need to be strictly regulated to maintain stable populations for the long term.

Aburria aburri, Campylopterus villavicencio, Phlogophorus hermosus, Campylophoramus pucherani, and Hemitrichus rufugularis. Indeed, the number of threatened and near-threatened bird species recorded even from this brief survey of the Serranías Cofán are sufficient to make this region one of the most important sites for bird conservation in eastern Ecuador (Wege and Long 1995).

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The Cofán community at Zábaló has implemented a community-based regulation of hunting loads and initiated a program of wildlife censusing (R. Borman, pers. comm.) that is a good model for Cofán residents in this area.

Mammals in this area are of conservation importance and are restricted to relatively undisturbed habitats. Consequently, this avifauna is at risk from the colonization currently taking place along the Interoceanic Highway from Tulcán to Lago Agrio (Figure 2A). Species that are hunted for food (such as the guans and curassows) will be particularly vulnerable to the growing human presence, and even to relatively transient impacts (e.g., miners who enter the region only for short periods).

A additional surveys of the avifauna of the Serranías Cofán, particularly those that would be expected to occur in these foothills, and that should be targets of future investigations, include two threatened species that are regarded as vulnerable (BirdLife International 2000), one guan (Callipepla cyanea) and one quail (Cyrtonyx mitrata), as well as several near-threatened bird species: Heliodytes gularis, X. anxerhus singularis (Equatorial Greytail), Pipreola chlorolepidota, and Chloropipo flavicapilla (Yellow-headed Manakin).

**LARGE MAMMALS**

**Participant/Author:** Randall Borman A.

**Conservation targets:** Mammals classified as CITES I (threatened with extinction) and CITES II (potentially threatened if no action is taken), including Alouatta seniculus, A. vociferans, Atele belzebuth, Callitrichus moloch cupreus, Callitrichus torquatus, Cebuella pygmaea, Cebus albifrons, Cebus apella, Herpailurus lemurinus, Lagotricha lagotricha humboldti, Lophodon parallelis, Lophodon wiedii, Lontra longicaudis, Mymecophaga tridactyla, Pteronura brasiliensis, Pteronura manchurica, Priodontes maximus, Puma concolor, Saimiri sciureus, Sanguinus nigricollis, S. nasua olivacea, Tapirus pinchaque, and A. lemurinus. These are all montane species that are similar to lowland species and could easily be confused by local residents.

Several of the mammal species confirmed for the Serranías Cofán are extremely rare or considered globally threatened by the World Conservation Union (IUCN). Eight species are listed in CITES Appendix I, 17 in Appendix II, and six in Appendix III. The recently published Libro Rojo de Mammíferos de Ecuador (Tirira 2001) lists six of our 42 confirmed species as threatened, with one of these classified as endangered (Priodontes maximus) and five as vulnerable. Two of the four unconfirmed species are listed in CITES Appendices I or II; the first of these qualifies as endangered (Tapirus pinchaque), while the second is considered vulnerable (A. lemurinus). Several additional species we recorded, like the short-eared dog, Atelocynus microtis, are so rare that their conservation status is entirely unknown but potentially critical.

During the field work we were unable to validate reports from local Cofán hunters of a miniature woolly monkey said to inhabit the higher elevations of Bermejo. The animal has reportedly been spotted several times and hunted twice by Cofán, who insist that it is different not only in size but in habits, sounds, and color patterns from the more common Lophotrix lagotricha. Note that the Cofán communities are harvesting animals more intensively than the Sinangoe community. This hypothesis can probably be rejected, however. Sinangoe's Cofán population is ten times larger than Bermejo's, and the Sinangoe community is also occasionally hunted by outsiders, suggesting that animals are being harvested much more intensively than in Bermejo. It is true that hunters in Bermejo range more widely and hunt more aggressively than those in Sinangoe, but I suspect that this is a consequence of low animal densities, not their absence.

**METHODS**

The large-mammal fauna of the Serranías Cofán was a blank spot on the map for biologists at the time of this inventory, though it has been well-known for centuries to the Cofán hunters and naturalists inhabiting the area. Because I grew up within the Cofán culture, I speak the language, and have hunted and fished with Cofán for most of my life, it was easy to draw up a checklist of expected species. The challenge during the inventory was to confirm the presence of the species already known to the Cofán inhabitants, and to estimate their local abundances, over the course of our 24 days in the field.

We first compiled a list of 46 expected mammal species, spanning six orders and 14 families, based on the taxonomic literature, personal experience, and interviews with Cofán who live in the Bermejo and Sinangoe areas. We excluded bats, marsupials, and most small rodents from the list, because inventoring these groups effectively in such a quick survey is next to impossible. Instead, we concentrated on species that are either important to the Cofán inhabitants as game animals or provide a good indication of the ecological health of the region.

In the field, I tried to cover as much ground and as many habitats as possible in each area we visited, often following unmarked paths or animal trails away from the main trails. I remained alert for visual sightings, but also recorded identifiable tracks, scat, and feeding sites, I also kept a record of all mammals sighted by others during the rapid inventory—both by the members of the scientific team and by the more than 30 Cofán who assisted us in the field. From these data, supplemented by conversations with local Cofán and by my own prior experience in the area, I derived estimates of population size for each species.

**RESULTS OF THE MAMMAL SURVEY**

Of the 46 species of large mammals expected to occur in the area, 42 were confirmed and 32 directly detected during the inventory (see Appendix 4 for the species list and abundance estimates). The tally includes 12 species of primates, nine of which were detected in our 24 days in the field. We also found dozens of records of tapirs and peccaries throughout the area, indicating a rich and largely intact mammal community, despite the small-scale hunting by the local residents. Another ten species are confirmed by local Cofán inhabitants, leaving four species unverified (M. rufina, N. olivacea, T. pinchaque, and A. lemurinus). These are all montane species that are similar to lowland species and could easily be confused by local residents.

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Bermejo

My initial assessment of Bermejo’s large-mammal community divides the region into three important sub-regions, distinguished by differences in elevation and productivity: (1) rather unproductive lowlands; (2) more productive mid-elevation forest; and (3) steep slopes and ridges of the higher-elevation forest.

Much of the lower-elevation forest in the Bermejo River valley—at elevations of 400-1,000 m—grows on hills of soft red silt that are very unstable and constantly eroding. Sizeable landslides seem to occur with every rain, giving the Bermejo River its distinctive reddish color, and the waterlogged, nutrient-poor soils are probably as unproductive for wild fruit crops as they are for agriculture. As a result, natural forests in this subregion are dotted with patches of successional forest choked with vines and brush. Deer, armadillos, and the larger forest rodents thrive in this landscape, but collared peccaries (Tayassu tajacu), which usually adapt well to secondary forests and easily resist hunting pressure, were surprisingly scarce.

Collared peccaries were far more common in the more mature forests of the second sub-region, from 1,000 m up to 1,200 m. This sub-region is characterized by dark organic soils that seem to provide far more productivity: (1) rather unproductive lowlands; (2) more productive mid-elevation forest; and (3) steep slopes and ridges of the higher-elevation forest.

The Sinangoe landscape appears far simpler than the Bermejo landscape. The Sinangoe area—the huge, mostly flat alluvial plain between the Ccuconn and Aguarico Rivers, and the more mountainous and rugged landscape to the north and west—show few differences in mammal composition, apart from some predictable turnover related to elevation.

One of the few differences we noted between the mammals of the two sub-regions was the surprising absence of most large primate species from the alluvial plain. We sampled this region on three different occasions, and discussed its fauna at length with the Sinangoe community. Remarkably, and in spite of a great deal of available habitat, the only common large primate here is the howler monkey. Interviews with older Cofán inhabitants confirmed that while spider monkeys have occasionally been seen in the region, woolly monkeys have never been sighted. This is puzzling, especially given that hunting pressures have been quite low for at least a century and that we spotted several groups of woolly monkeys in the adjacent Cero Shishichó. It may be that one of the catastrophic geological events that seem to be a common occurrence in the Ccuconn River drainage (e.g., earthquakes, floods, volcanic eruptions) eliminated woolly monkey populations in the recent past, and that subsequent recolonization is occurring at a slow pace.

**Species notes:**

_Cebus apella_ (Brown Capuchin Monkey)

We encountered this species only once during the inventory, at 2,100 m on the southern slopes of Cerro Sur Páx. I believe that the two specimens I hunted in 1999 constitute the only confirmed records of _C. apella_ north of the Pastaza River watershed in Ecuador. My own decades of field experience in Ecuadorian Amazonia and numerous conversations with Cofán, Secoya, Siona, Quichua, and Huaorani hunters have failed to turn up any indications of the species’ presence in the Napo and Aguarico watersheds. Reports of _C. apella_ from Cuyabeno and Yasuní have generally been made by scientists unfamiliar with _C. apella_ populations in other regions, and in most cases I believe they can be attributed to confusion with the large, dark, and thickly haired _C. albifrons_ males. Adding to the confusion is the fact that indigenous hunters in lowland Amazonia often have a distinct name for these males.
the past century. This is partly because Shishicho is now off-limits to Cofán hunters (see below).

*Lagothrix lagothricha humboldti* (Woolly Monkey)
Although no woolly monkeys were sighted by the team during our Bermejo inventory, the Bermejo residents encountered at least four groups in hunting trips during the same time. All four encounters were in the relatively productive area on the meseta below the Bermejo Vista camp, between 600 and 900 m. Cofán familiar with woolly monkeys in eastern Ecuador were surprised by the robustness of the individuals at Bermejo.

In the Sinangoe region, the distribution of *L. lagothricha* shows several interesting patterns. Farther downstream, the Aguarico River forms the border between the subspecies *humboldtii* (to the north) and *papaegi* (to the south). In the headwaters of the Aguarico, this border follows the Due River, a major and wide-channeled tributary of the Aguarico. It appears *humboldtii* was able to cross the upper Aguarico tributaries (the Chingual and Cofanes) but not the Due. Just as interesting is the patchy distribution of woolly monkeys between the Due and the Aguarico (see discussion in Sinangoe section above).

The fact that healthy populations of *Ateles* and *Lagothrix* seem to occur around Cerro Shishicho, a region designated off limits to hunting by the Sinangoe community, suggests that these populations will be viable and stable for the long term if colonist incursions can be minimized. They can then serve as “seed” populations to recolonize adjacent areas.

*Atelocynus microtis* (Short-eared Dog)
This animal, perhaps the most elusive and least-studied carnivore in the Amazon basin, was sighted in Bermejo by D. Moskovits. At 4:30 PM on a rainy afternoon, she observed a solitary dog trotting towards her along a heavily used trail in mature forest near the Bermejo Vista camp, just above 1,200 m elevation. Apparently oblivious to her presence, the animal passed within ca. 30 cm of her before disappearing into the undergrowth. This is the highest elevation at which *Atelocynus* has ever been recorded (Leite and Williams in press).

**THREATS AND PRELIMINARY RECOMMENDATIONS**

Developing appropriate management plans for these forests will require studies on current hunting practices and their effects. The Sinangoe community has already implemented some simple rules for hunters, mostly by establishing some areas that are off-limits and others that are fair game. Our observations of dense animal communities at both Shishicho (off-limits) and the Candue (fair game) suggest that management in those areas is on the right track, at least for the time being. In Bermejo, on the other hand, no attempts have been made to manage game populations, and the apparent abundance of monkeys there is a simple consequence of the small population of hunters. Establishing simple hunting rules for Cofán hunters in Bermejo, and reinforcing the rules in Sinangoe, should be one of the highest priorities for the conservation and management of the area’s wildlife. Initially, a system of zoning will probably give the best results, with further management tools being developed in tune with the community’s ethic and needs. Engaging local Cofán residents in wildlife censusing programs will provide important data on population dynamics and hunting levels, and these will help construct a sensible management plan.