HUNTING RUBBER FROM THE AIR

Harry T. Kelsh
Sr. Civil Eng. Head, Map Control Section, Division of Cartography, Soil Conservation Service

IN THE early 1900's the development of a tremendous demand for rubber brought prosperity to the Amazon Valley. It resulted in the creation of a first-class city at Manaos, that is probably unique in many respects; for here we have a large, well-constructed, substantial city, with electric lights, streetcars, paved streets, a sewerage system, and all the usual adjuncts of a modern city; yet it is set in the heart of one of the wildest and least cultivated areas in the world.

It is extremely difficult to make a comparison that will present a relative picture of its location, but some idea may be gained by assuming that if the city were in this country it would occupy the position of Kansas City on the Missouri River. It would be necessary to assume that impenetrable wilderness covered the entire country clear to the Gulf Coast and to the Atlantic seaboard, extending from the very outskirts of the city itself. The only means of communication would be by steamer up the Mississippi and Missouri Rivers from New Orleans, and the time that it would take one of our old woodburning river steamers to make the trip would compare to the journey up the Amazon from the seaport town of Belem. To the westward would continue the same jungle to the base of the Rocky Mountains, which would occupy a position similar to the Andes; and San Francisco, over the mountains, would be at a distance comparable to Lima on the west coast of South America; but this isolated spot was at one time the rubber capital of the world, and at its peak of prosperity highly paid opera singers made the long river journey up the Amazon to sing in the Manaos Opera House.

Manaos lies on the Rio Negro, one of the tributaries of the Amazon, just about ten miles from the confluence of the two streams; and the river is well named, for the water is chocolate brown in color. At this point nearly 1,000 miles inland the river is still nearly a mile and a half in width, and large oceangoing steamers can tie up at the elaborate floating dock.

As a result of the complete lack of roads or trails, everthing is transported throughout the Amazon Valley on its tremendous waterway system; and all of the comparatively small development that exists, lies close to the river banks. The rubber areas that have been tapped are adjacent to streams, which can be used to carry out the crude rubber, yet many of these areas are inundated during the yearly flood season, and the soil is the poorest in the valley for maximum tree growth. The crude rubber, in balls, is shipped to Manaos by boat, where it is inspected, graded, processed, and then sent to the outside world.

The development of rubber in the East Indies brought an end to prosperity for the Amazon Valley. Manaos sank back into a peaceful existence that has lasted unbroken for many years.

With our entry into World War II there came a tremendous resurgence in demand for more and more rubber. With East Indian sources cut off, the question of higher prices was no longer of importance. The Rubber Development Corporation, an agency of the United States Government, was set up to cooperate with the South American countries, and particularly with Brazil, in increasing the amount of rubber exported. Attention was focused upon the Amazon Valley, and Manaos as its headquarters. As the country has not developed materially since the collapse of the previous rubber boom, there was no

supply of labor in the valley, nor can the valley support a sudden increase in population. All supplies for additional labor, as well as the laborers, must be brought in; and while efforts were immediately turned towards solving the situation, the problem is a tremendous one.

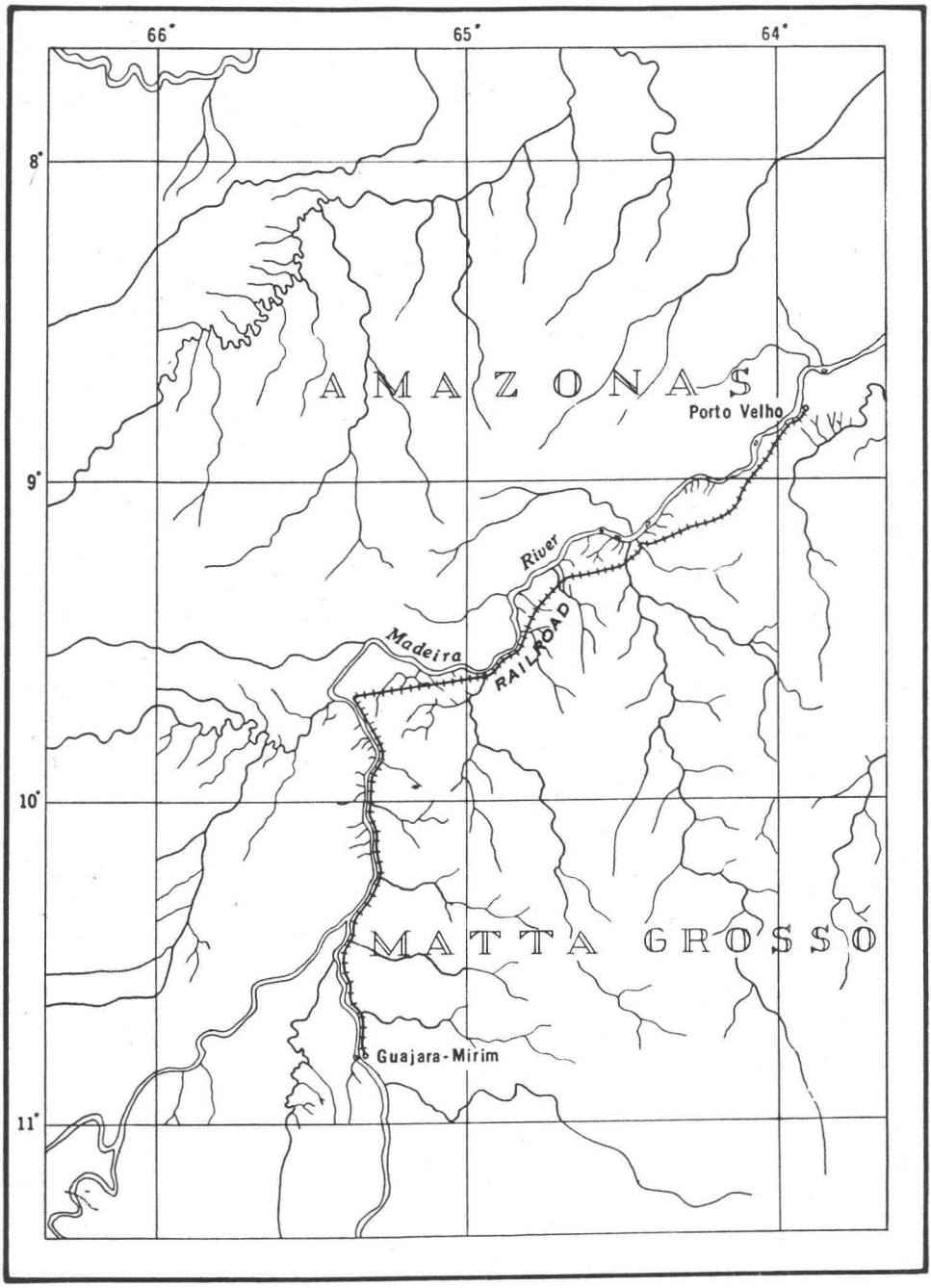

FIG. 1

In order to extend, if possible, the limits of known rubber areas, and to endeavor to reach better and more prolific sources of crude rubber, an Exploration Department was created. Such observations as had previously been made had indicated that back beyond the flood plain, on the well-drained slopes towards the edges of the valley, conditions might be much more favorable to larger and denser rubber tree growth.

500 Miles south of Manaos (7 or 8 days by steamer) is the little, sprawling, outpost town of Porto Velho. It lies on the banks of the Madeira, a stream which empties into the Amazon just below Manaos. South of this river is an almost completely unknown area, the Matta Grosso. It was here that the Exploration Section was authorized to direct its efforts. Porto Vehlo has long been the collection point for rubber in that part of the valley; and the Madeira River and

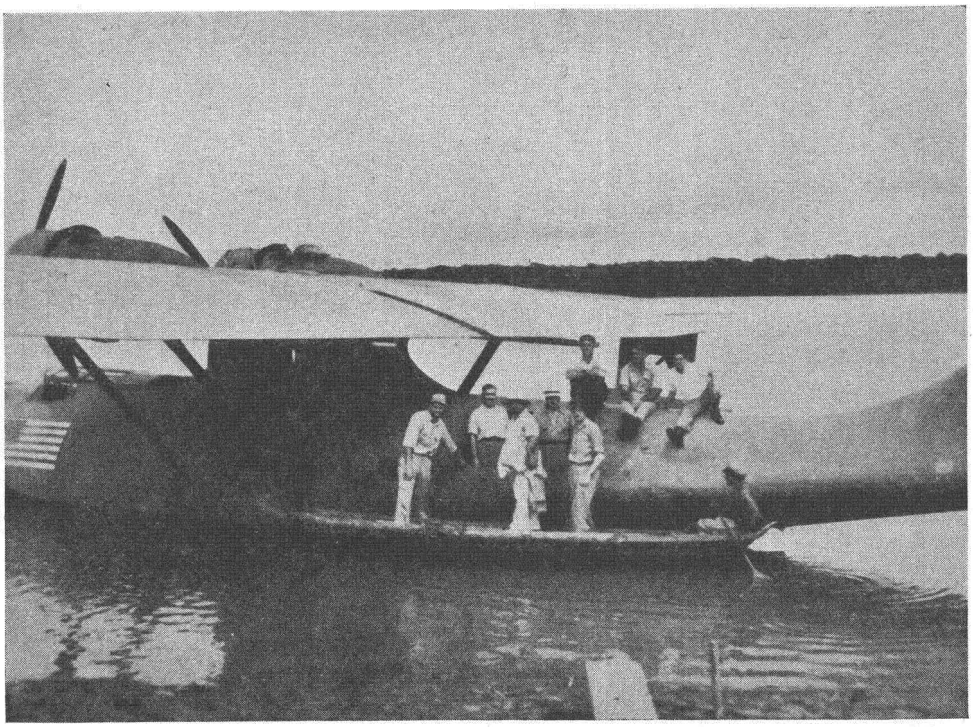

FIG. 2. The aerial exploration party on the Madeira River.

the mouths of the rivers tributary to it, and draining the Matta Grosso area, are reasonably well mapped. The upper stretches of these tributary streams differ materially, however, from their delineated positions on present maps. (Figure 1)

As a very necessary part of the exploration work, the particular detail to which I was assigned, and for which my loan from the Soil Conservation Service, Department of Agriculture, had been requested, was to make a reconnaissance map as quickly as possible of this area, so that a trail might be driven in the best general direction, and at minimum cost, towards the supposedly better rubber country lying to the south. In addition to this work, it was the hope that some photographic method might be developed that would allow the cruising of the area from the air, so that the percentage of rubber trees could be determined.

We were fortunate enough to secure the hearty cooperation of the United States Air Forces, who not only agreed to supply any type of photographic equipment which I considered might be of value, but in addition assisted us with the flying equipment and personnel for the necessary mapping operations and aerial tree studies.

I have endeavored to create a picture of the valley as it has existed for many years. Of course, we are in the midst of a tremendous change. The week's journey from Belem to Manaos can now be made in less than a day by air. The flight from Manaos to Porto Velho takes only four hours. However, since the number of planes operating in the valley is very limited, and the type of equipment necessary for reasonably safe flying under present conditions is still ex-

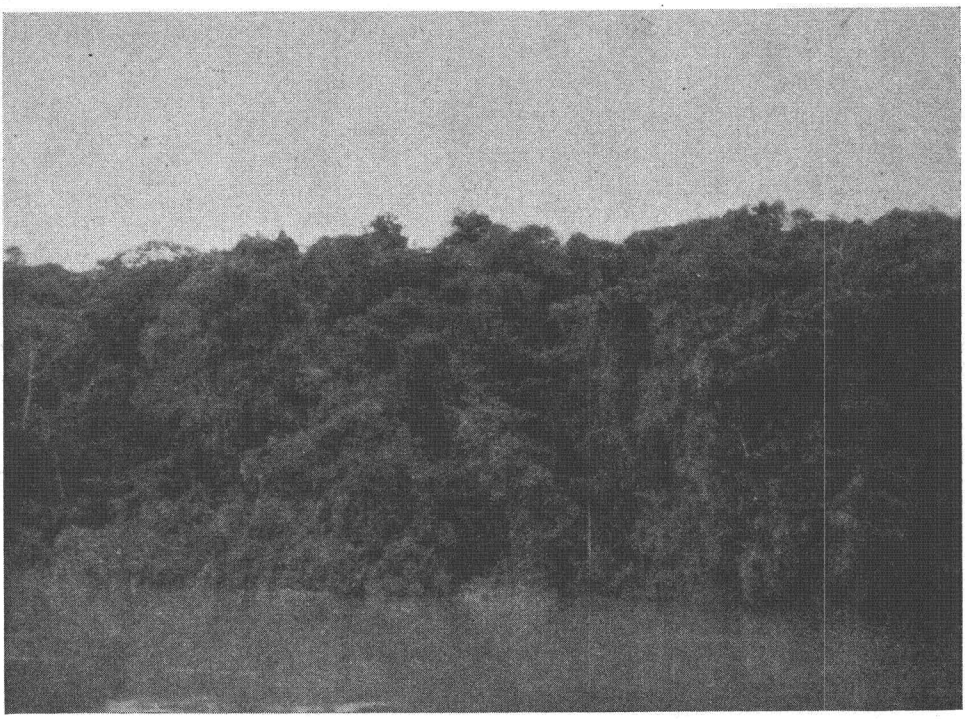

FIG. 3. Typical Jungle.

tremely expensive; transportation for the general public and for freight is still almost entirely dependent upon river steamers.

Porto Velho represents the upper limits of river transportation on the Madeira. I was surprised, therefore, as I landed from the flying boat that brought me there, to hear the sound of a modern locomotive engine whistle. I found that from this little town, to Guajara-Mirim on the Bolivian border, a distance of 365 kilometers, a substandard gauge railroad has been cut through the heart of the jungle. It was constructed as part of a settlement of boundary disputes between Brazil and Bolivia, so that the latter country could reach the navigable portion of the Madeira River, and thus be able to ship its goods by the Amazon River system to the east coast. Once a week the little combination passenger and freight train makes the journey from one end of the line to the other, and back.

The railroad immediately suggested a means of securing ground control for

any mapping operations in the vicinity, and request was made to their local management of the road for copies of the right-of-way plats. Their desire to co-operate was heartily expressed, but only a few of the plats could be found. However, one of the employees remembered there was a brick vault down the track which he thought might contain the missing tubes in which the plats had been stored. Upon investigation we found a substantial vault, overgrown with

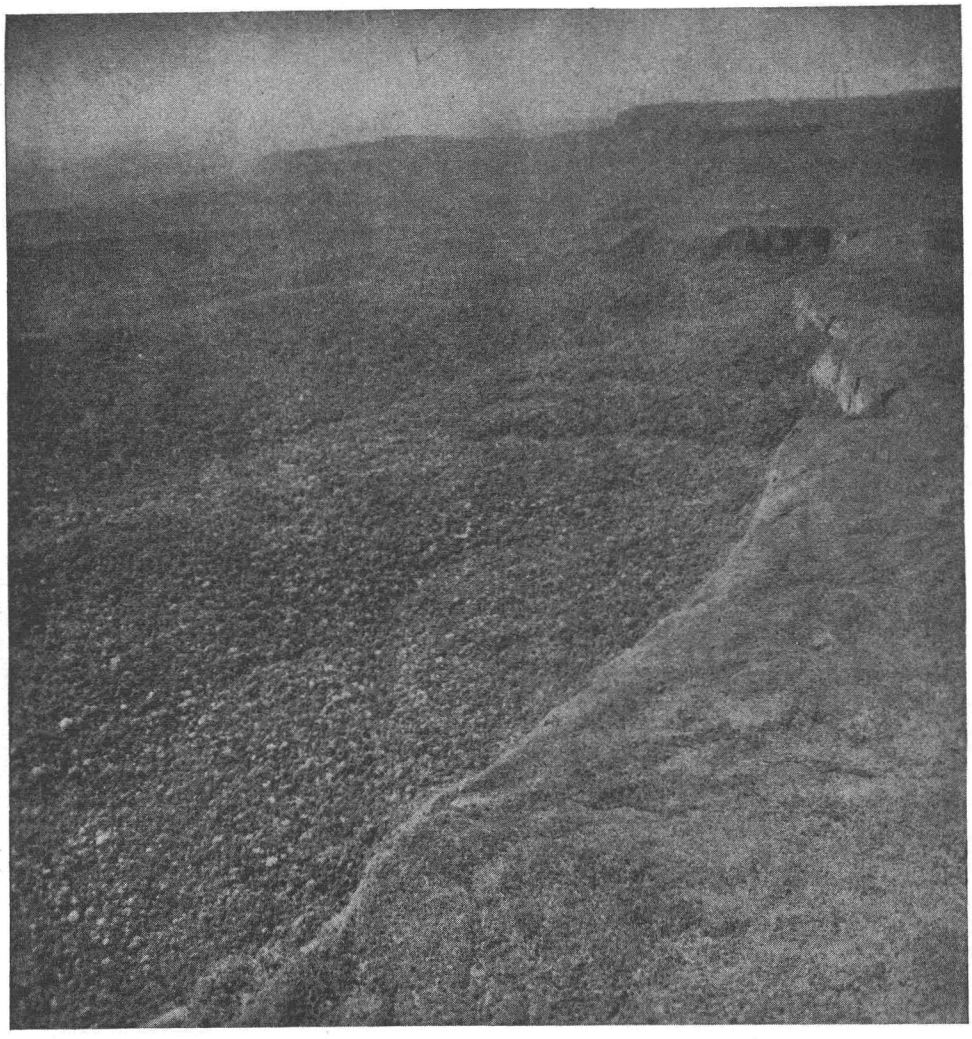

FIG. 4. The southern limits of the valley, at the escarpment.

weeds, equipped with combination-lock doors; but fortunately someone had kindly written the combination on the outside of the door so that we had no difficulty in opening the vault. In spite of the fact that the tracings had been stored without care for years we were able to recover all of them in good condition, and thus to secure the data necessary to compute a broken base line, which, as may be seen on the map, borders our area on the north and west sides, giving us comparatively good control.

The general mapping work had been planned so that all preliminary reconnaissance flights would be out of the way before the advent of the dry season, during which there is a comparatively brief period of clear weather suitable for aerial mapping. For the greater part of the year, in the Amazon Valley, the sky is covered with large cumulus clouds. Much of our exploratory work was done in weather not particularly suitable for aerial photography. In fact it was often necessary to cut the work short and head for home.

The original flight was made due south from Porto Velho into the heart of the Matta Grosso area. The situation in South America is, as I said before, rapidly changing with the advent of airplanes, but nothing of known value lies in this particular direction, and since there are no known landing spots, this portion of the map has been rather carefully avoided. The only inhabitants are a few remaining Paca Nova Indians, and since they violently dislike having the benefits of civilization thrust upon them, and express their resentment forcibly if given an opportunity, we started out on this flight with a sincere hope that everything would function perfectly.

Leaving Porto Velho behind we found 40 or 50 miles of compartively flat forest, broken only by the meandering rivers flowing north. Gradually, however, small granite outcroppings came into view, projecting above the general forest crown. These increased in size and number as we went south, and the rivers began to wind in small gorges through these rocky hillocks. A low range of forest-covered hills appeared, and it was at this point that we folded up our maps and dusted off the compass. Ahead, at a distance of some 120 miles south of Porto Velho, we saw, to our surprise, a sheer escarpment rising nearly a thousand feet above the general valley floor. This marks the southern limit of the Amazon Valley, (Figure 4) and it is along the base of this cliff, and to the northward of it, that the exploration party has hoped to find heavier stands of rubber, with trees of larger growth.

Some of the rivers flowing north apparently have their sources on the top of this plateau, dropping over the cliff side in high, sheer waterfalls, and flowing through narrow gorges into the broad plain below. Where the cliff line has broken down the forest extends nearly to the top of the plateau, but most of the plateau itself appears to be covered only with sparse and lower plant growth. Continuing over the ridge still farther, we saw indications of more open country towards the southeast; and there is a probability that emergency landing fields could be established here.

Using the data from the first flight, we were able to plot our course with reasonable precision, and to use the results on additional flights over the areas in which we were principally interested. We made one flight at an elevation of about 250 feet over the tree tops in an endeavor to see if rubber could be visually identified from a fast-moving plane at low altitudes, but without success. Rubber trees do not grow in stands similar to most of the forest trees with which we are familiar in this country. Two rubber trees per acre is as good or better than the usual average in the Amazon Valley. This, of course, refers to the areas adjacent to the navigable streams, which have been worked for that particular reason, that is, for convenience to water transportation.

There are a number of varieties of rubber trees in this area, the most common of which is the Hevea Brasiliensis. It is easily recognizable either by visual inspection, or by photography, if located in a place where such inspection is possible at close range. The tree is tall and slender with the first branches often as much as 20 to 30 feet above the ground and the lowest leaves at still greater distances. The leaves grow in threes; and are, at maturity, from six to eight inches

in length (Figure 5). In the fall the green leaves turn to typical autumnal colors ranging from brown to bright yellow, and the tree with its whitish bark has at a distance somewhat the appearance of our northern birch.

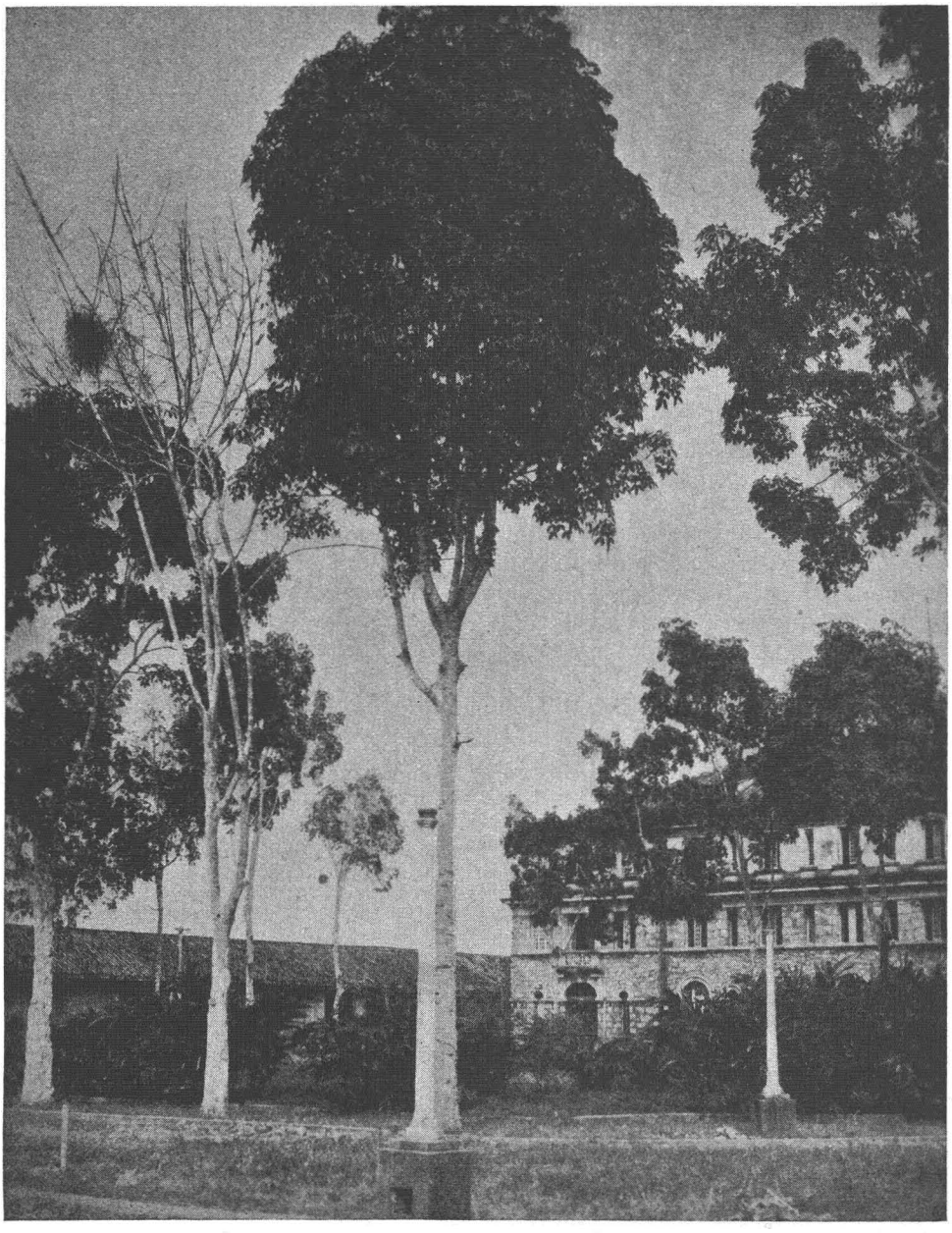

FIG. 5. Plantings of rubber trees in the yard of the rubber factory at Manaos.

In view of the density of the general forest cover, however, it was somewhat with hope, rather than expectation of solving the problem of rubber identification from the air, that we turned to this part of our work. A series of studies

was initiated in the grounds of a rubber factory at Manaos, where a number of rubber trees had been planted. Photographs of these known rubber trees were taken from a distance of a thousand feet, using a 12-inch lens, and the distance decreased and the focal length of lens increased until we had reached a distance of 150 feet, with 24-inch lens, (Figure 6 is reduced to $\frac{1}{2}$ taking scale). The tree, under these conditions, of course, is clearly recognizable. The trefoil leaf arrangement is clearly visible, as well as the characteristic shape of the trunk, and branches, of the tree itself. But as we get farther away, the leaf form becomes indistinguishable, and, of course, in the forest the general tree form would be indistinguishable as well. From above, there is no opportunity to

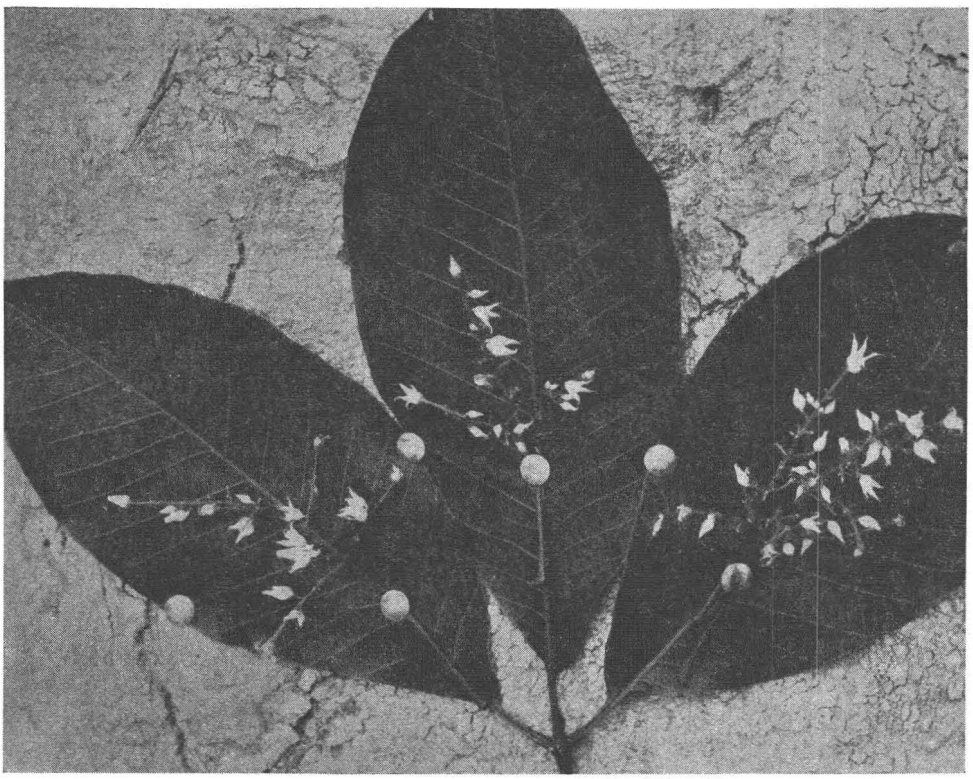

FIG. 6. Characteristic trefoil leaf arrangement; and flowers. Comparison for size can be made with the thumb tacks used to pin leaves to bark of rubber tree.

judge the color or shape of the trunk and branches. We are merely looking down upon a comparatively small mass of leaves crowded in by the other trees; since, while tall, the tree does not stand above the general forest crown. As we continued our studies we noted that, following the period of autumnal coloring, the tree becomes practically denuded of leaves. (Tree to left of center, Figure 5.) This suggested a possible means of identification from the air since the majority of tropical trees do not lose their foliage in this manner, but in view of the fact that rubber is so sparsely distributed, there are quite apt to be also a considerable number of dead trees of other species.

We continued our studies through the period when the first leaves appear.

The trees flower immediately thereafter with small bright yellow bell-shaped flowers (Figure 6), and there was hope that these would be in sufficient profusion to create a perceptible and distinguishable color. However, as the flowers unfold the leaves tend to cover them. Black and white photographs were taken from a tower looking obliquely down on a tree from a distance of approximately 150 feet. Even at this short distance, and with a 24-inch lens, the flowers were indistinguishable. The experiment was repeated with Kodachrome. Unfortunately the first exposures were lost in a plane accident and the results of the second series taken have not as yet been received. I expect, however, that these will actually show the flowers; but to the eye from that distance there is no perceptible coloring of the tree.

To surmount the difficulty of securing sharp photographs at sufficiently low altitudes to have even a chance of identifying rubber trees, the Sonne continuous strip camera was tried out. Strips were flown over the same rubber plantation as used for ground studies, at altitudes of 1,500, 1,000, and 500 feet. Using color film for this work it was fairly easy, at low altitude, to pick out the definite characteristics of known rubber trees in an open yard, but as said before, practically all opportunity to see most of these characteristics disappears over dense forest.

I believe we definitely eliminated the possibility of aerial photographic identification from the flowers. The bare tree period offers some possibility, subject to confusion with dead trees. The period in which the leaves are turning offers the best chance for photographic identification (using color film), although there are other trees with somewhat similar coloring.

There is, however, one more objection to photographic identification. The time from full leaf to full leaf extends over a period of two to three months, and it does not occur at the same period for trees even when standing side by side (Figure 5, where tree to left of center is completely bare, while tree in center is in full leaf, and the tree on the opposite side of the yard, between the two, is in new leaf).

It is, naturally, with regret that a negative report such as this tree study, is submitted, but it may have value in subsequent studies, or may direct them into more productive lines.

The photography for reconnaissance mapping has been completed, and it is possible now to delineate accurately all the streams; about the only identifiable map objects. The small rivers are sufficient in number that the distances between them are comparatively short; and well within the present limitations of flight of a two place helicopter. I believe that one of these, equipped with pontoons, offers interesting possibilities for cruising country of this type, since it is possible to hover over the trees at an altitude not feasible for standard aircraft, but which our studies have indicated is necessary for accurate rubber tree identification.