

SUMMARY

The Santa Teresinha region in northeastern Mato Grosso has a varied vegetation which is principally hummock pantanal. The flat clayey alluvial ground between the hummocks is covered with a continuous non-cerrado ground cover dominated by grasses but which harbors sedges and a large herb flora. No woody plants grow in it. The tops of the 10-20m wide, slightly elliptical hummocks, 1.5-2 m high, 10-40 per hectare, are covered with cerrado plants: herbs, semishrubs, thin- and thick-stemmed shrubs and low trees. For 4-5 months during the latter part of the rainy season, the regional water table rises to the surface and the ground between the hummocks becomes saturated or floods up to 1.5-2 m deep. The tops of the hummocks almost always remain above high water level. In the dry season the surface soil dries out completely. This alternation of saturation or shallow flooding and dryness, prevents woody plant growth between the hummocks, and except for a few tolerant species, also prevents woody plant growth on the lower part of the hummocks. The gallery forests in the pantanal are seasonally flooded more deeply but their soil does not dry out so thoroughly in the dry season so woody plant growth is not prevented.

In Central Brazil the middle Araguaia River separates Mato Grosso from Goiás. This part of the Araguaia valley is very flat land, of light gray clayey alluvium with scattered dome-shaped earth hummocks, usually 10-20 m wide and 1.5-2 m tall, about 10-40 per hectare. Every year, at the height of the rainy season, the river rises and for 4-5 months shallowly floods over 600,000 km², most of this being on the so-called Ilha de Bananal (Fig. 1). Normal yearly high water levels do not cover the tops of the hummocks but only the lower part and the flat terrain between the hummocks. The unflooded hummock tops are covered with cerrado scrub and low trees; the flooded part is covered with a short grassy layer with herbs of a non-cerrado flora. Some portions of this landscape do not become actually covered with a layer of water but the water table is only a few cm below the surface of the soil between the hummocks so that it remains saturated (Fig. 8). The flooding or saturation lasts 4-5 months, from December to March or April. In the dry season, from June to September, the surface soil dries out below the wilting point. This alternation

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of saturation for a long period and strong dryness for a long period prevents woody plant growth on the terrain between the hummocks. The periodically flooded land with its hummocks is called 'varjão', and hummocks themselves are called 'monchões' (sing. 'monchão'). From a general point of view this landscape may be considered a type of pantanal, but should be distinguished from the well-known Pantanal Region of western Mato Grosso do Sul and adjacent Bolivia in which hummock land is much less extensive.

In some parts of the seasonally flooded region, there occur shallow depressions and slight rises of ground of all sizes up to a few km². When the depressions are very shallow, they are filled with a type of seasonally flooded evergreen forest; when deeper, with open water with algae and aquatic plants. The slight rises are covered with arboreal cerrado or evergreen forest. Rivers traversing the region usually have narrow to wide gallery forest which is also seasonally flooded, but stretches also occur where the varjão comes to the river's edge. The whole region is very sparsely inhabited.

In the northwestern edge of this flooded region, at the northeastern tip of Mato Grosso, is the small city of Santa Teresinha (10°28'S.50°31'W.) on the west bank of the Araguaia River. To the west is unflooded Amazon forest; to the east across the river is the Ilha de Bananal. The following account is of the vegetation in a square about 20 x 20 km to the north and west of the city. The elevation is about 100 m above sea level, mostly flat but with a few low ridges that rise another 50-150m. The annual rainfall is about 1700 mm with a definite dry season; the climate is Köppen Aw.

Most of this area is covered with the seasonally flooded hummock land, 'varjão', in its typical form (Fig. 2). The hummocks usually contain a termite nest which may reach 2 m tall, often with several subsidiary nests around it. The lower part of the hummocks is purely herbaceous, covered with grass and forbs, usually of different species than those in the flat terrain between the hummocks (Fig. 7). Occasionally a low tree, *Curatella americana* grows on this lower portion (Fig. 2, right). The upper part of the hummocks is covered with a cerrado flora of low shrubs in which taller shrubs and low trees grow. The low trees often include *Syagrus* palms and in places the scrub layer is dominated by a species of acaulescent palm. Most of the trees, except for the palms, are twisted as is typical of cerrado. Occasional open portions in the low-shrub layer are filled with dense grass.

The cerrado trees and shrubs on the upper part of the hummocks are of several species and this species composition varies from place to place. For instance, one count of 20 hummocks in one place, which were round to slightly elliptical in shape, (5-)10-12(-15) m in the largest dimension of base, and (2-)4-9 m in largest dimension of scrubby top portion, had, per hummock, 2-19 (av. 7) shrubs or small trees with circumferences of 10 cm or more (3.2 cm diam.) at 30 cm from the ground. These ranged up to 85 cm circ. (27 cm diam.). They included *Curatella americana*, *Syagrus comosa* (small tree palm), *Casearia* sp., *Byrsonima* sp., *Annona* sp., and several others. The number of species per number of individuals counted is much lower than in areas of continuous cerrado.

Five to 10 plants of this size, per hummock, is about average density. In some parts of the varjão there are fewer or even none. In fact the low shrub layer can also

be missing so that the tops of the hummocks are all grass-covered (Fig. 3) but of the cerrado flora.

The hummocks cover about 10-20% of the total ground area; the scrubby top portion covers about 3%. In some parts of the varjão, besides the regular large hummocks, there are also small round hummocks about 1-2 m wide and 1-3 dm tall. These have a low shrub or two on top (Fig. 4) or only grass and herbs.

The flat ground between the hummocks has a completely different non-cerrado flora of graminoids and forbs only, with cover depending on the season but usually near 100%. This layer is struck by two unfavorable seasons during the year, the flooding or saturation and the drying out. As a consequence it is much less rich in species than a cerrado ground layer would be, which suffers a dry period but not a flooding.

The flooding produces two different general vegetations in the flat ground between the hummocks. 1) When inundated deeply, with over about 30cm of water for several months (Fig. 5, 6), most of the aerial portion of the grass-herb layer between the hummocks dies and only resprouts when the water leaves, which it does rapidly. This layer is not, then, really a seasonal marsh which would require the water level to remain near the surface for about half a year. 2) In the Santa Teresinha region much of the varjão surface is at a slightly higher level so that at high water the flat ground between the hummocks is covered by only up to about 15 cm at most (Fig. 7) or is not covered but the water table is only a few cm below the surface, and this condition is maintained for 4-5 months (Fig. 8, 9). In this second case we have a seasonal marsh of 100% cover. The ground layer is not killed off during the rainy season but thrives and many species flower and fruit then. The water table is retained at or near the surface because the general water table of the region is high because of the rise of the river. So the water in these marshy portions has not come from the river but is the rain that falls there and cannot drain away. When the rains become rarer and stop, some of the water can now drain away (mostly over the surface rather than through the soil because of the high deflocculated clay content) but much is lost directly by evaporation. The seasonal marsh flora is richer in species than the campo flora that is more deeply covered. Obviously, there is a gradient between the two types.

In the seasonal marsh type of varjão there may occasionally be a tree in the land off the hummocks.

The lower part of the hummocks, covered only with graminoids and some forbs is visually similar to the flat ground between the hummocks but its floristic composition is somewhat different because its soil is saturated or covered for a shorter time. It is also different from most of the herbs inside the low shrub layer on top of the hummocks because these are almost never flooded and are shaded by the shrubs. Therefore it is essentially a third flora, although sharing some species with the other two floras.

In approaching a river with its gallery forest, the character of the varjão changes. Starting at a few hundred meters from the river the land starts to incline very gradually so that during high water it is more deeply inundated. The trees on the hummock tops become taller, with straighter erect thicker trunks and start to include non-cerrado

species, either those of the forest, or trees which grow outside forests on seasonally inundated land. The trees grow closer together so that shrubs and the ground layer are densely shaded (Fig. 10). Physiognomically, the hummock tops are now mesophytic forest rather than the xeromorphic open scrub and low trees over a closed low shrub layer of the main part of the varjão. At the same time the ground layer of the flat ground between the hummocks suddenly changes from predominantly grassy to one purely of forbs, generally dominated by one species which varies from place to place.

A little nearer the river, low to tall shrubs or low trees of a species of *Byrsonima* start to appear in the flat ground between the hummocks (Fig. 11, 12) and this species also makes up part of the woody plants of the hummock tops here although it did not occur on hummock tops in the main portion of the varjão further from the river. Still nearer the river the hummocks stop (because they do not occur where the average high water is much over 2 m above the surface) and other low tree species besides the *Byrsonima* occur. These, like the *Byrsonima*, are not cerrado species but rather forest species or those that grow in the open on seasonally flooded ground.

This latter vegetation continues directly to the gallery forest along the stream, or, in some parts, up to a brushy field without trees about 100 m wide which itself contacts the gallery forest. In any one of these fields the brush is a single species of medium tall shrub but the species may be different in different places. Between the shrubs the ground layer is still only of forbs with almost no graminoids.

The changing character of the varjão near the rivers is due to the fact that the land is slightly lower so that at high water it is more deeply flooded, 2-4 m. Here, even the tops of the hummocks may be flooded so that only the tops of the low shrub layer stick out above the water, or even this is covered and only the trees stick out. Obviously, the gallery forest is also flooded at high water (Fig. 13). At low water the river is in its channel only, so no trees or perhaps some right at the water's edge only have their bases covered with water.

In one area of several dozen hectares, a variation of the varjão occurred next to a patch of upland forest (Fig. 14). This varjão had hummocks only about 1/2 m tall and were larger in area than in the common more extensive varjão. The hummocks were closer together so that the flat ground between the hummocks occupied a much smaller proportion of the area (Figs. 15, 16). The trees were straight and erect, a mixture of cerrado and forest species, the latter increasing in proportion nearer to the forest patch. The ground surface of the forest patch itself is at a generally slightly higher level and has the same hummocky surface as the varjão outside it. This shows that it was originally varjão which because of a slight buckling of the ground was raised a bit so that its lower portions no longer became saturated and forest then covered the whole area.

Part of this 20 x 20 km square is never flooded upland with continuous forest or cerrado. This upland reaches the Araguaia River, which is why there exists a city at this point. For almost all the river shore along this portion of the Araguaia, both the gallery forest and the varjão behind it for tens or hundreds of km, gets flooded seasonally so there are few sites for settlement (Fig. 1).

The upland here is flat to gently rolling with some low ridges. The more fertile loamy soils support forest, the less fertile sandy soils support cerrado. The upland forest (Fig. 17) (locally called "mata alta", the "alta" referring to the height of the site above river level, not to the height of the trees), is evergreen, with many species of trees, including pau brasil (*Caesalpinia echinata*, with white bark and dark red wood), jatobá (*Hymenaea* sp.), favela, grapiá, "pinho" (a dicot), xixá (*Sterculia* sp.) brejeiro, quare-quare, cacau bravo, mangueira, tarumã (a dicot, not a palm), two species of ipê (*Tabebuia*), mirindiba, sucupira branca, sucupira preta, cedro (*Cedrella* sp.), angico (*Piptadenia* sens. lat. sp.), murici da mata (*Byrsonima* sp.), piquiã (*Caryocar coriaceum*, forest form), and the tall palms babaçu (*Orbignya* sp.), najã cabeçudo (*Maximiliana*), and bacaba (*Oenocarpus* sp.). The giant herb, *Phenakospermum guianense*, occurs in the undergrowth. Almost all areas of the forest contain one or more of several species of canopy palms and in some portions a canopy palm species makes up half the trees, especially babaçu (*Orbignya* sp.). A large bamboo also occurs in the undergrowth. In that part of the area where forest covers the whole topographic profile, that portion bordering the rivers, even if not flooded, contains different tree species from those further upslope, or the same species in different proportions.

Cerrado occurs on two types of site: 1) small areas on the crests of some low ridges (with forest lower down on the ridge slopes), and 2) on flat land off the ridges. The first type is a low-tree and scrub woodland on shallow sand with outcropping blocks of the underlying quartzite (Fig. 18). The second type, also a tree and scrub woodland usually has taller trees and is on deep sandy latosol without stones or laterite (Fig. 19, 20). Two species counts were made in the second type of cerrado, counting shrubs and trees with a circumference of 10 cm or more at 30 cm up. In the first, following a zig-zag strip, 266 individuals gave 35 species, the most common species making up 18% of the sample and 9 species present as only one individual. In a second count of plants of the same size, scattered over 1.6 ha nearby, 320 individuals gave around 45 species, the most common making up 16% of the individuals. There are probably 50-60 species of this size plant per ha, including 8 species of palms. This is a usual species richness for cerrado of this density. The total vascular flora for this density of cerrado, found in several other parts of Brazil, is 300-350 spp per ha.

Soil bryophytes and lichens are very rare in cerrado. These non-vasculars are more common on bark of trees and shrubs and their amount depends on the time since the last fire and the general humidity of the air, but they are always uncommon except in dense cerradões, which have the internal microclimate of forests.

Common cerrado trees and treelets in the cerrado of the region are: *Connarus* spp., *Davilla elliptica*, pau terra (*Qualea grandiflora*, *Q. multiflora*, *Q. parviflora*), murici (*Byrsonima verbascifolia*, *B. coccolobifolia*), candeia, araca (*Psidium* sp.), bruto (*Annona* sp.), puça preto, puça branco (probably *Mouriri* spp.), oiti (probably *Licania* sp.) macambeira (not the bromeliad macambira), and the palms babaçu (*Orbignya*, the same species as in the upland forest), pati (*Syagrus* sp.), babão (*Syagrus comosa*) and piaçaba (an acaulescent palm). In some parts of the cerrado there is a thick layer of the same species

of bamboo as in the upland forest (Fig. 21).

In one place in the middle of the varjão, on land which is slightly raised so that it almost never is saturated or flooded, there is a patch of several dozen hectares of closed cerrado, structurally a forest. Its trees are half babaçu palms and half a mixture of several cerrado dicot species (Fig. 22).

The gallery forests of the region, which border streams running through the varjão, are usually seasonally inundated. Those along the Araguaia River are the broadest. They also start to form on sandbanks deposited in the river, but the changing course of the channels eventually destroys them (Fig. 23). Some low forests occur on narrow, seasonally shallowly inundated levees along the Araguaia River. The gallery forests on the tributaries of the Araguaia are two kinds. There is a taller form with trees up to about 20 m ('mata baixa' or 'mata de vasante') with the following common trees: landim, piraeira, laxador (or vermelhão), canjerana branca, cajã, and bananinha.

On the outer part of this gallery, or making up the whole gallery, is a lower form of forest 4-5 m tall, with vines and interlacing low branches, the trees often spiny. This is 'impuca do rio' or simply 'impuca'. Its common trees are: landim, piraeira, canjerana branca, carvoeiro, and the palms najã (another species of *Maximiliana*) and tucum (*Astrocaryum* sp.). Although I do not have the scientific names for all the trees, by the common names we can see that the upland forest is richer than the two forms of seasonally swampy gallery forest.

Just north of the city is an area of several km² covered with buriti palms (*Mauritia vinifera*). This area is flooded with 2-5 m of water during high water (Fig. 24, 25). Rooted and floating aquatic plants occur. In the dry season the water table is below the surface, the soil remaining moist. In the deeper parts there may be up to 1/2 m of water over the surface even at the height of the dry season. Because the soil remains moist it is a favorite place for snakes to congregate.

One area of several hectares of permanent grassy marsh was seen, with a few low hummocks and occasional buriti palms (Fig. 26).

Much of the upland forest and some of the cerrado has been cut to form pastures in use or abandoned. The varjão is used for extensive cattle grazing but the animals have to be taken out during the flood period. Except for the cleared areas and some low secondary or disturbed primary forest, the vegetation of the region is still in its original state.

RESUMO

Os arredores da cidade de Santa Teresinha, no nordeste do Mato Grosso, têm uma variada vegetação, de floresta de terra firme, floresta ribeirinha estacionalmente inundada, cerrado sobre terreno plano com solo profundo e sobre topos de espigões com solo arenoso raso e rochoso, bem como algumas veredas estreitas e áreas mais extensas de buriti-zaís. Entretanto, a maior parte dos arredores da cidade, como é também o caso na Ilha

do Bananal, no outro lado do Rio Araguaia, é coberta com um tipo de pantanal chamado "varjão", terreno não florestado, anualmente encharcado ou rasamente inundado por 4 - 5 meses, de dezembro a março ou abril, e fortemente ressecado durante a estação seca de junho a setembro. O varjão é salpicado com "monchões", montículos de terra de 10-20 m de diâmetro e 1,5-2 m de altura, 10-40 por hectare, originados provavelmente pela erosão diferencial da água que estacionalmente cobre o varjão. Os topos dos monchões que quase nunca estão cobertos pela água, sustentam uma flora de cerrado, com ervas, semi-arbustos, arbustos e árvores baixas. O solo argiloso, plano, aluvial, entre os monchões traz uma flora não de cerrado, de somente uma camada rasteira dominada por gramíneas de até 0,5 m de altura mas com muitas espécies de ervas e sem plantas lenhosas.

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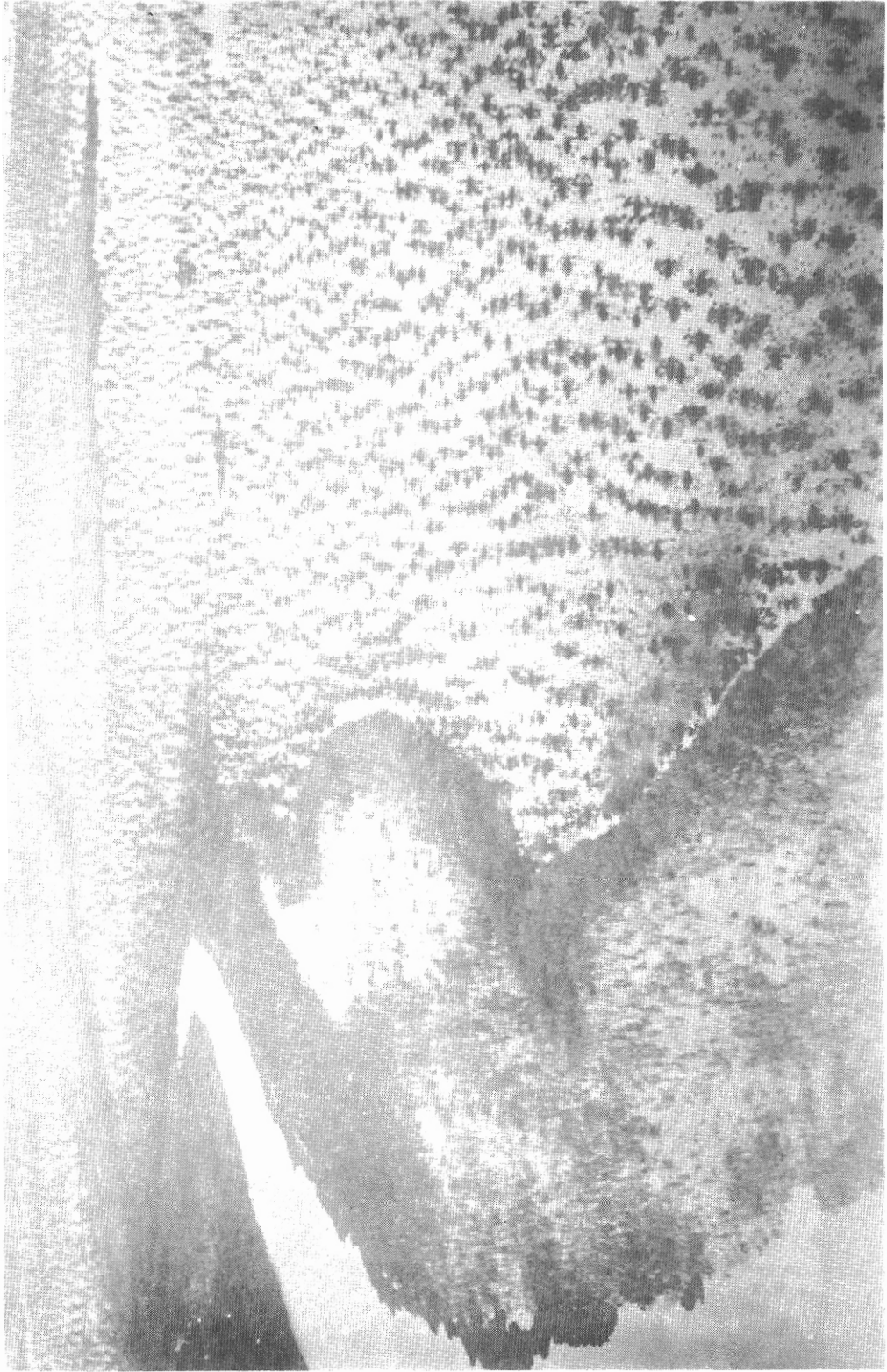


FIG. 1. Araguaia River on left, at height of rainy season, with flooded gallery forest. On the right side of the river is the Ilha do Bananal with shallowly flooded hummock pantanal ("varjão" with "monchoes"). The tops of the hummocks and their cerrado vegetation are emersed. Between Santa Isabel do Morro and Santa Teresinha.



FIG. 2. Hummock in varjão in November, early wet season before the ground becomes saturated or inundated. The flora on the hummock top is cerrado, that on the flat ground between the hummocks is a completely different non-cerrado herbaceous flora. The trees on the lower edge of the hummock are *Curatella americana*, one of the few cerrado species that stands seasonally saturated soil.

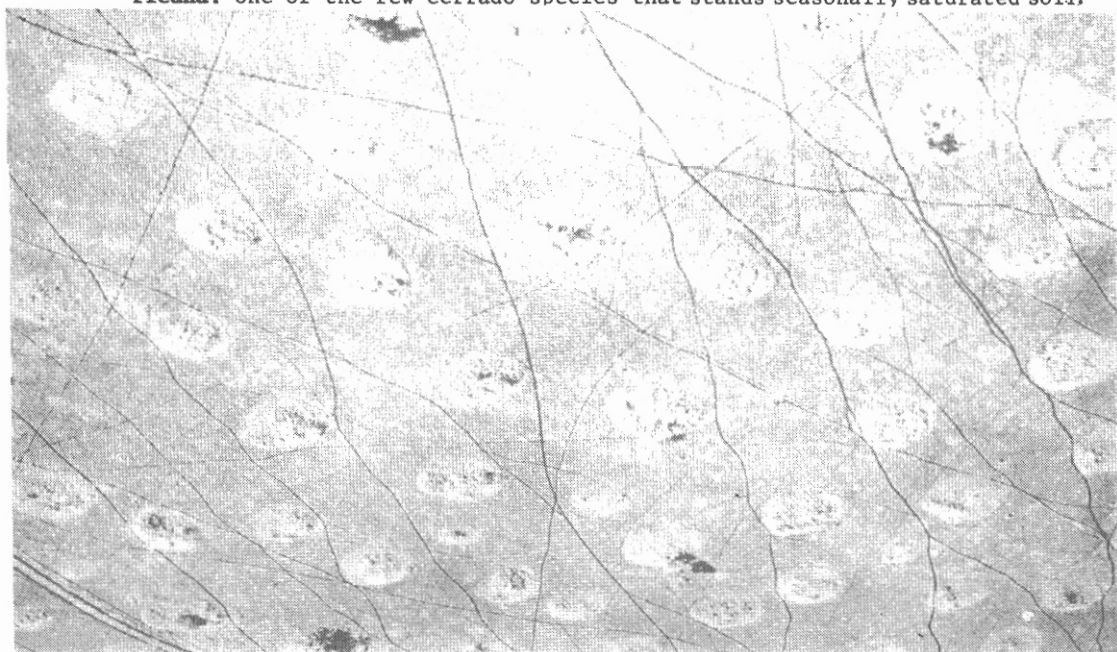


FIG. 3. Hummocks without woody plants or only 1-few shrubs. The herbaceous plants on the hummock tops belong to the cerrado flora, which is completely different from the herbaceous flora between the hummocks. This type of varjão is rare and local. The lines are cattle tracks.

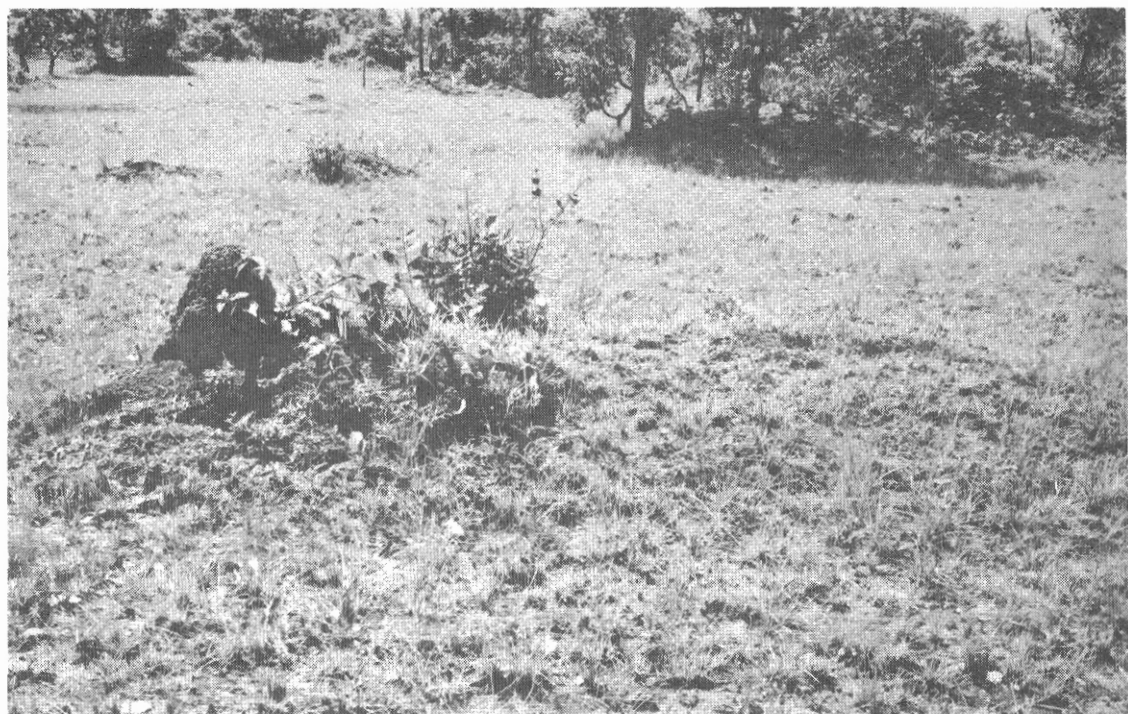


FIG. 4. Small hummock with low shrubs, and a small termite nest on left.



FIG. 5. Flooded varjão, January 1982, with patches of flooded forest. Normal high water for the year. Water in foreground about 1.5 m deep.

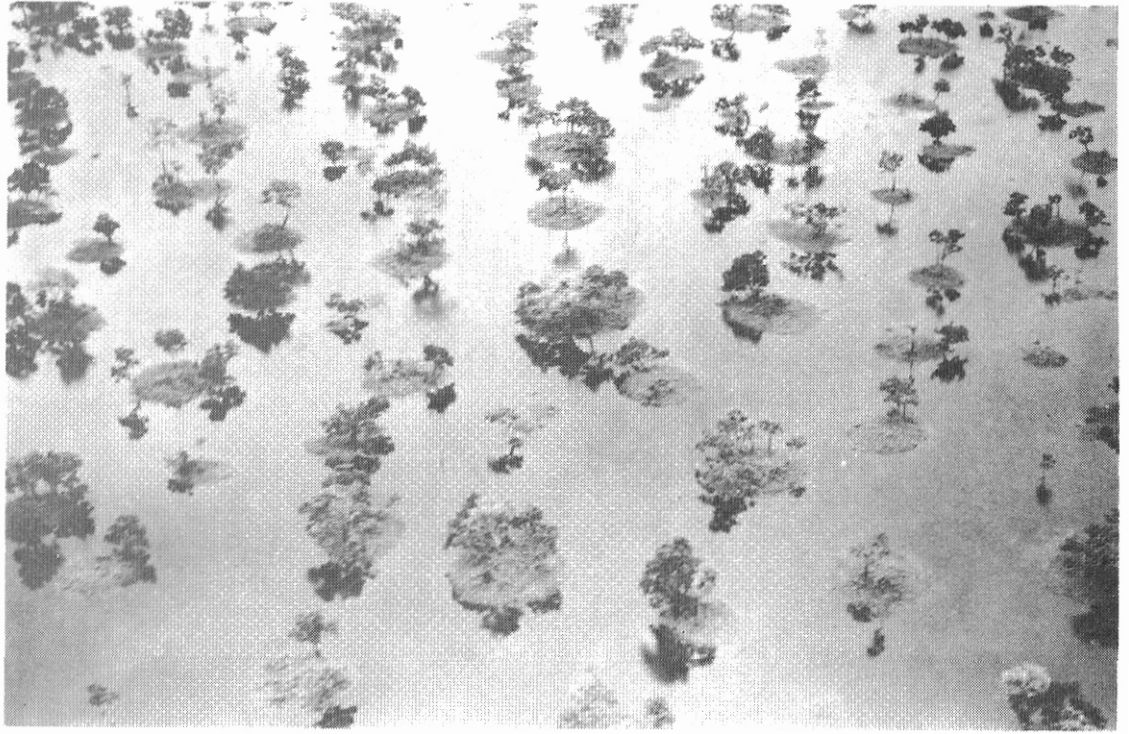


FIG. 6. Flooded varjão at normal high water, here about 1 m deep.

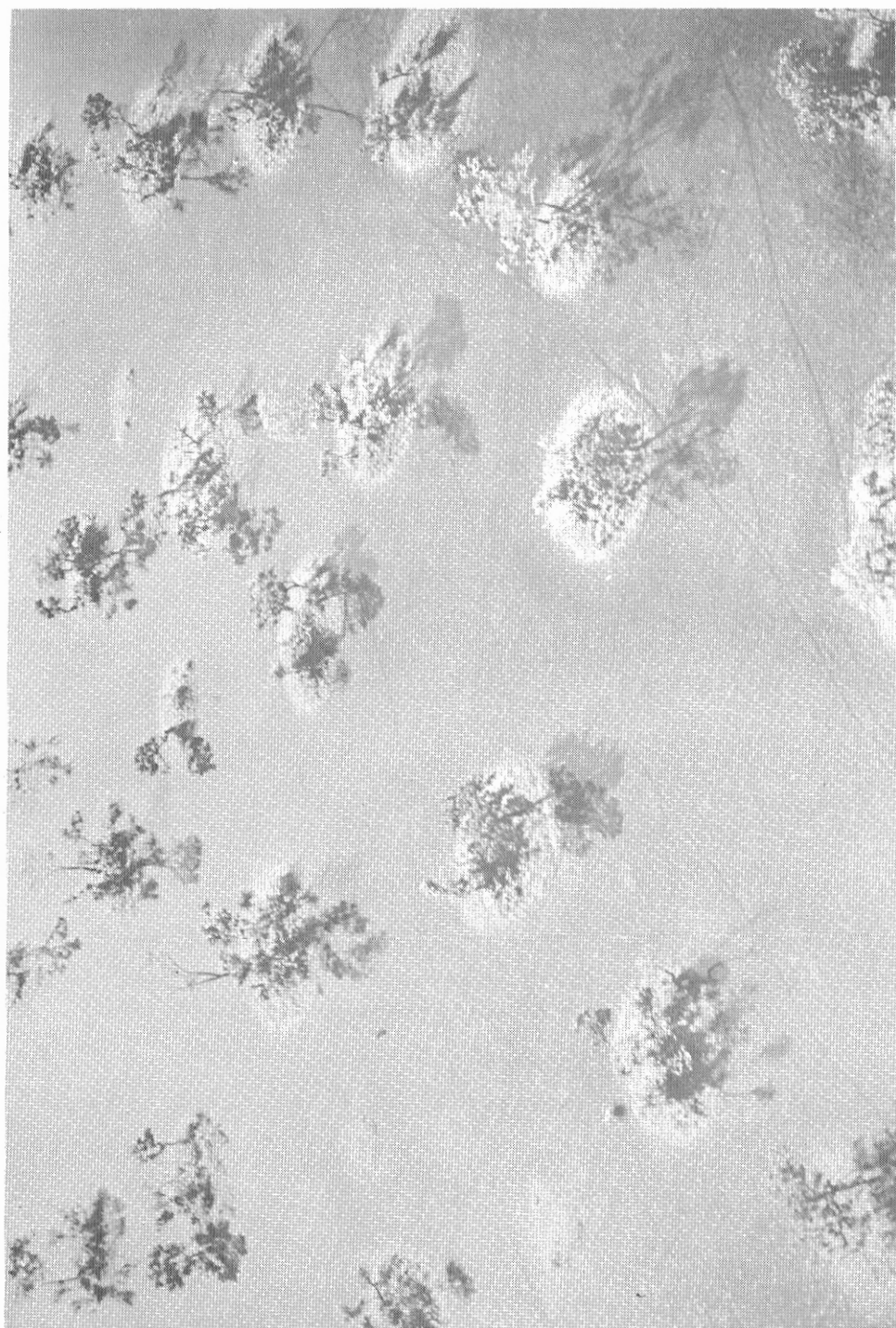


FIG. 7. Shallowly flooded varjão at normal high water, about 15 cm deep.

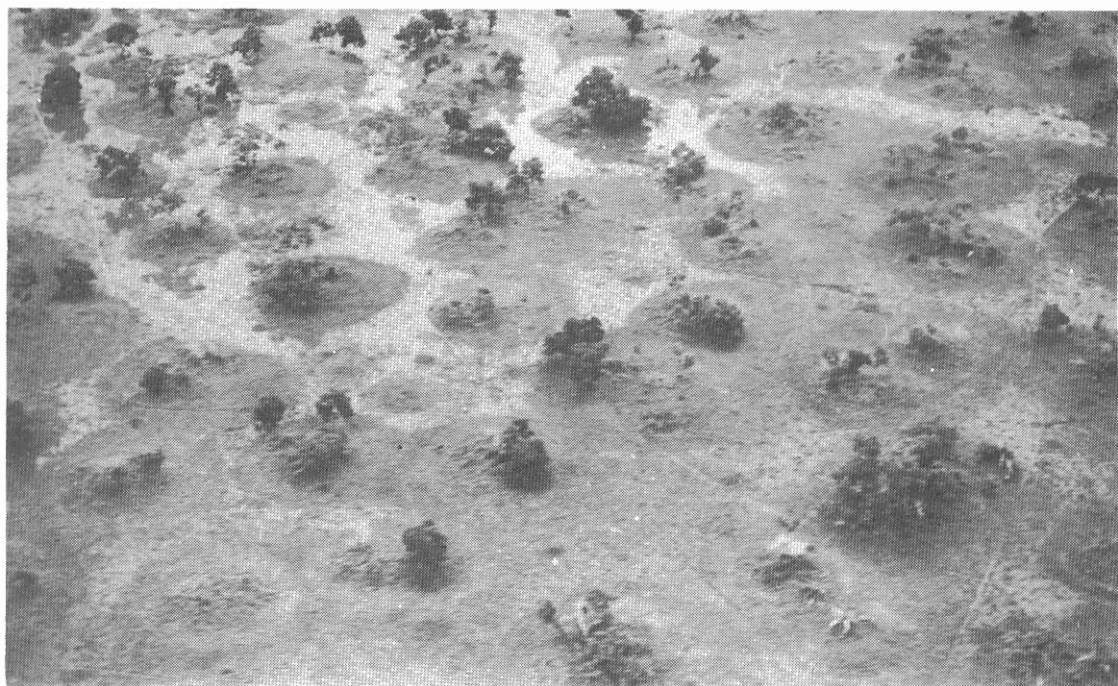


FIG. 8. Partially flooded varjão at normal high water. The water table is at the surface of the ground, a few cm above or below the slightly uneven soil surface. It stays at this position, varying slightly with the rains, for 4-5 months.



FIG. 9. Varjão which is almost never flooded by more than 15 cm of water between the hummocks. This develops a true seasonal marsh flora.

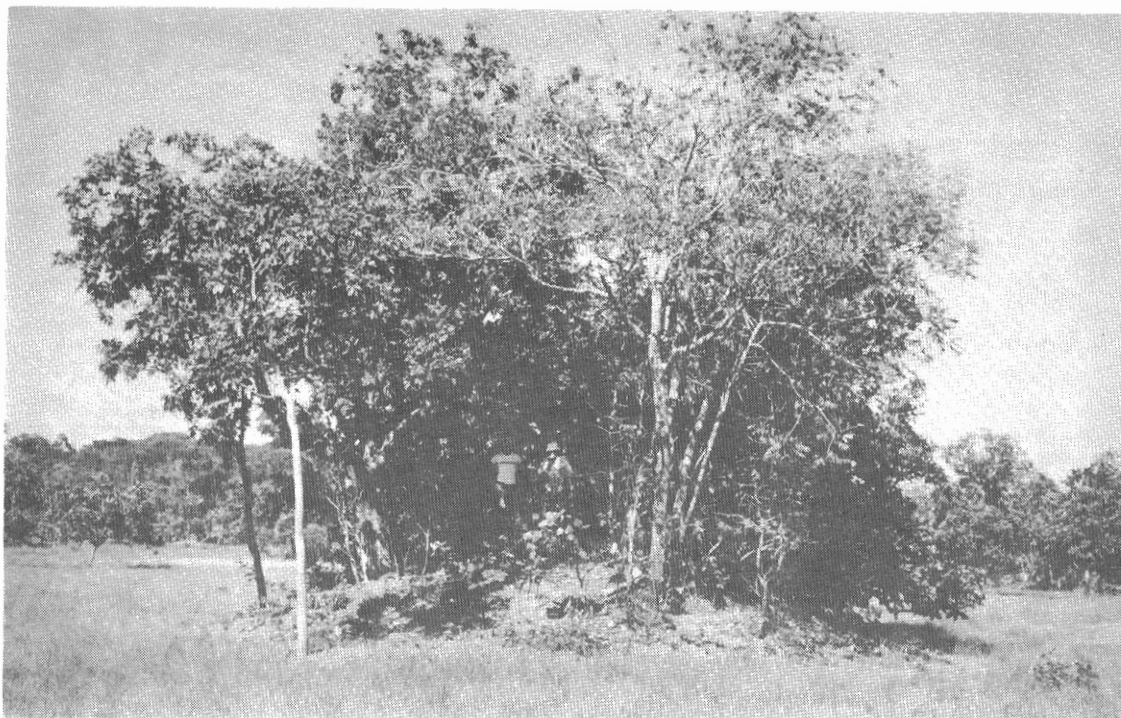


FIG. 10. Hummock in varjão about 300 m from Crisóstomo River (a tributary of the Araguaia) about 15 km NW of Santa Teresinha. The trees are taller, straighter and denser than those on the main part of the hummock area further from the rivers. Some tree species here are of the forest flora or trees that grow outside of forests on seasonally inundated ground. Early wet season before flooding.



FIG. 11. Nearer to river, same place as Fig. 10. Note small trees of *Byrsonima* sp. off hummocks and several tree species on hummock on right.

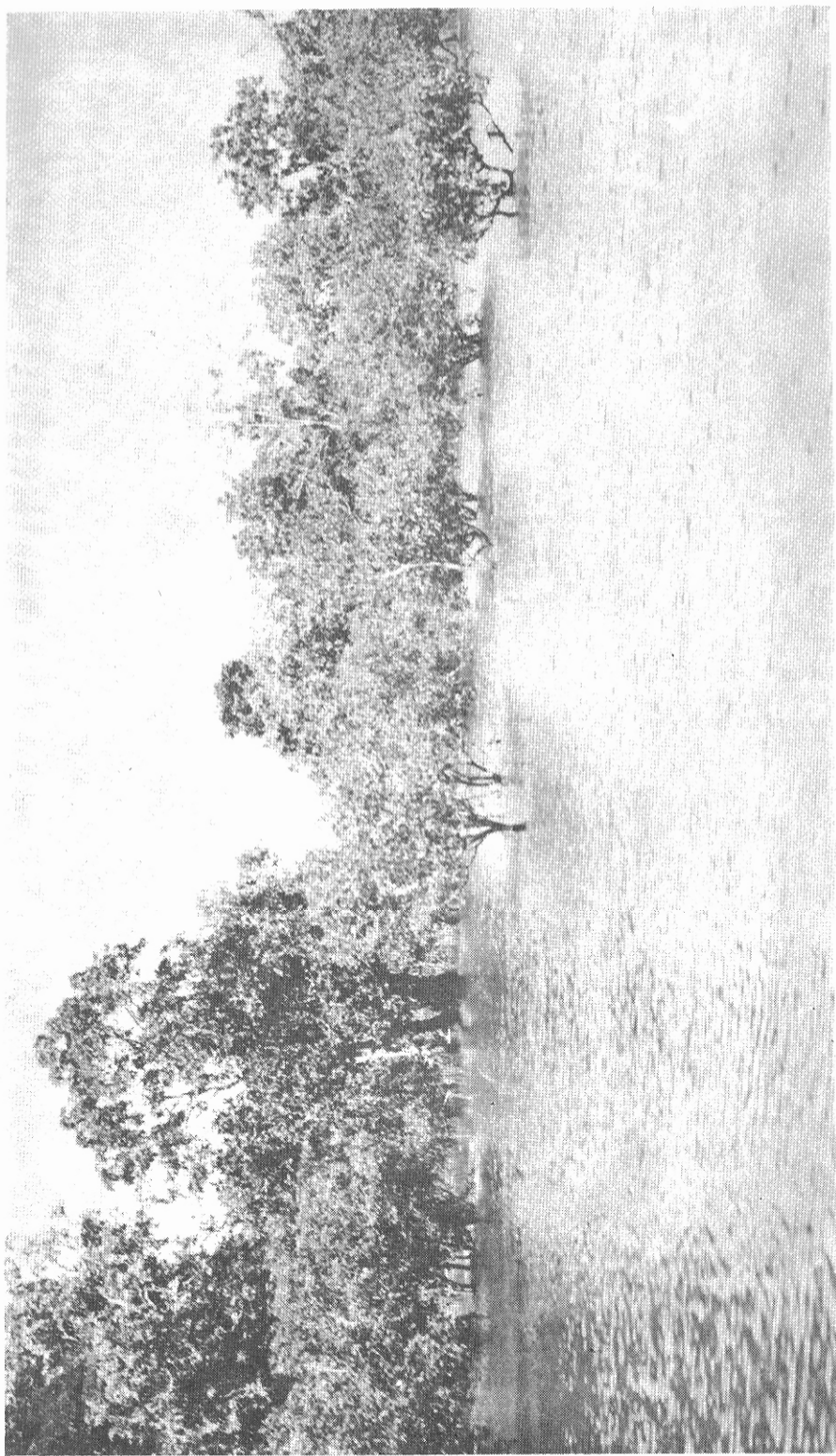


Fig. 12. Same kind of vegetation as in Fig. 11, but near Araguaia River a few km north of Santa Teresinha. When photographed, was flooded 1.5 m deep, average high water. Note impuça forest in back and isolated *Byrsonima* treelets.

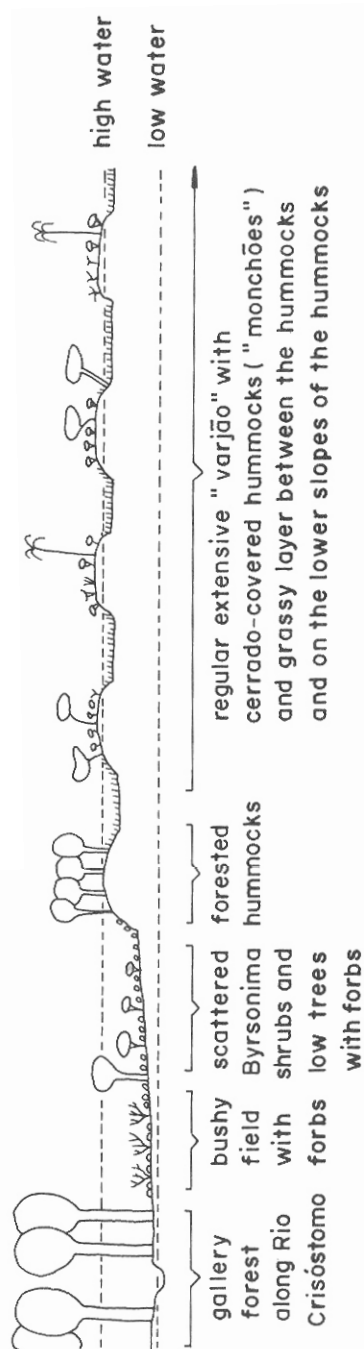


FIG. 13. Diagrammatic profile of vegetation transect at right angles to river, from gallery forest to the extensive regular varjão on slightly higher ground.



FIG. 14. Airview of special type of varjão 1/2 km N of Bom Retiro. The trees on the hummock tops are a mixture of cerrado and forest species. Never-flooded forest grove in background. The vegetation is in its original state and the spacing of the trees is natural; none have been cut.



FIG. 15. Ground view of the special varjão of Fig.14 early in wet season before flooding.



FIG. 16. Same varjão as in Figs. 14 and 15, with 10 cm deep water between the low wide hummocks. Middle of wet season. The water layer covers the ground for several months.



FIG. 17. Undisturbed upland continuous forest, with pau brasil *Caesalpinia echinata*).

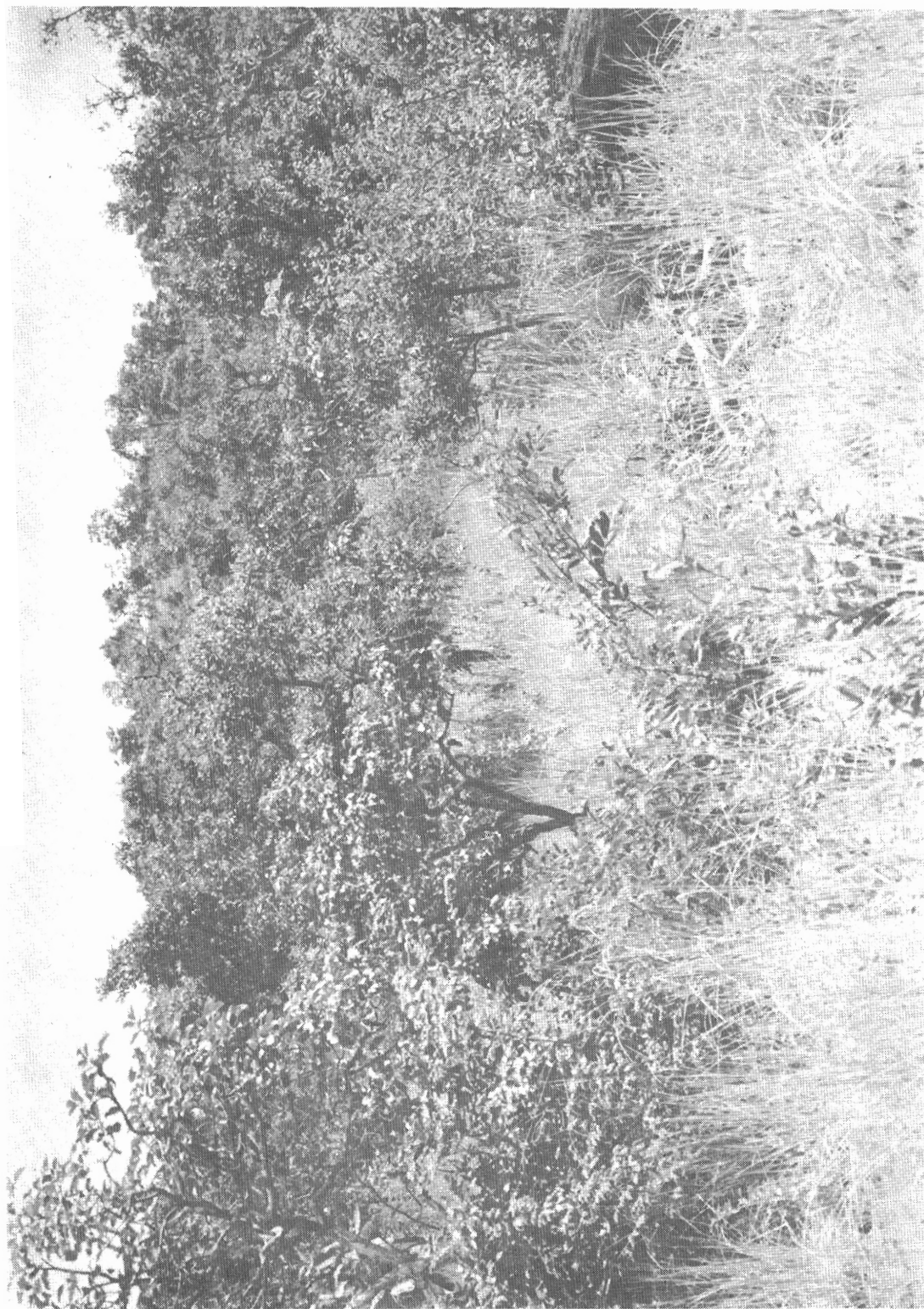


FIG. 18. Semideciduous broadleaf low-tree and scrub woodland cerrado on thin sandy soil on rocky top of low ridge.



FIG. 19. Part of an extensive undisturbed semideciduous broadleaf tree and scrub woodland cerrado on flat ground of deep sandy latosol. The tree density varies from place to place.



FIG. 20. Same cerrado where trees are less dense, forming a patch of open scrub or scrub savanna.

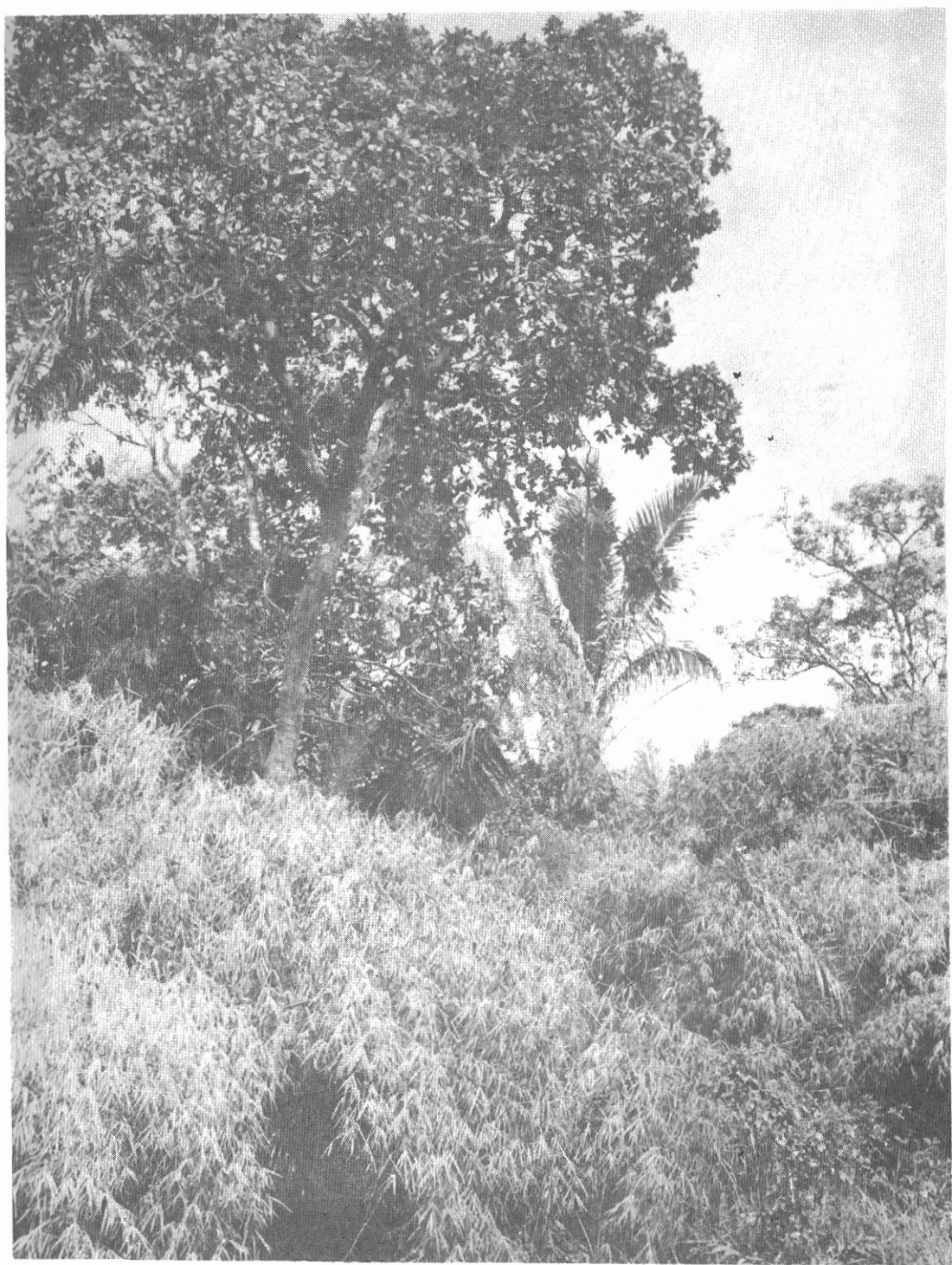


FIG. 21. Same cerrado where native bamboo forms a closed scrub layer, giving the form "closed bamboo scrub with emergent semideciduous broadleaf trees".

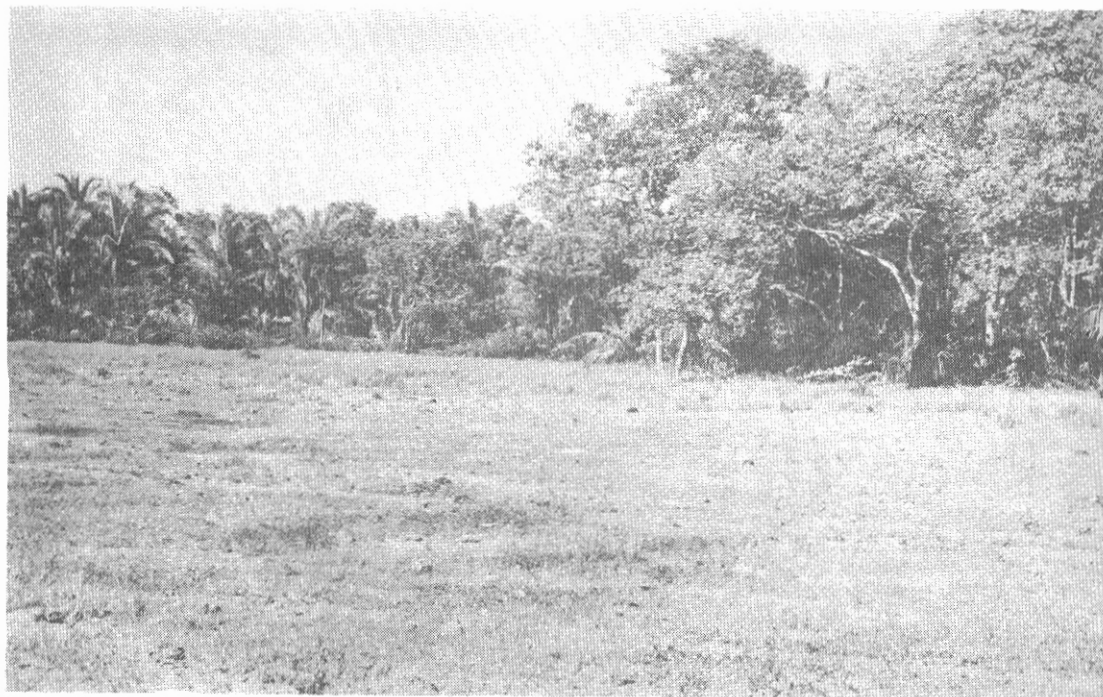


FIG. 22. Grove (with its natural undisturbed edge) of closed cerrado, structurally a forest, of babaçu palms and semideciduous broadleaf dicot trees. The broadleaf herb field in foreground is natural.

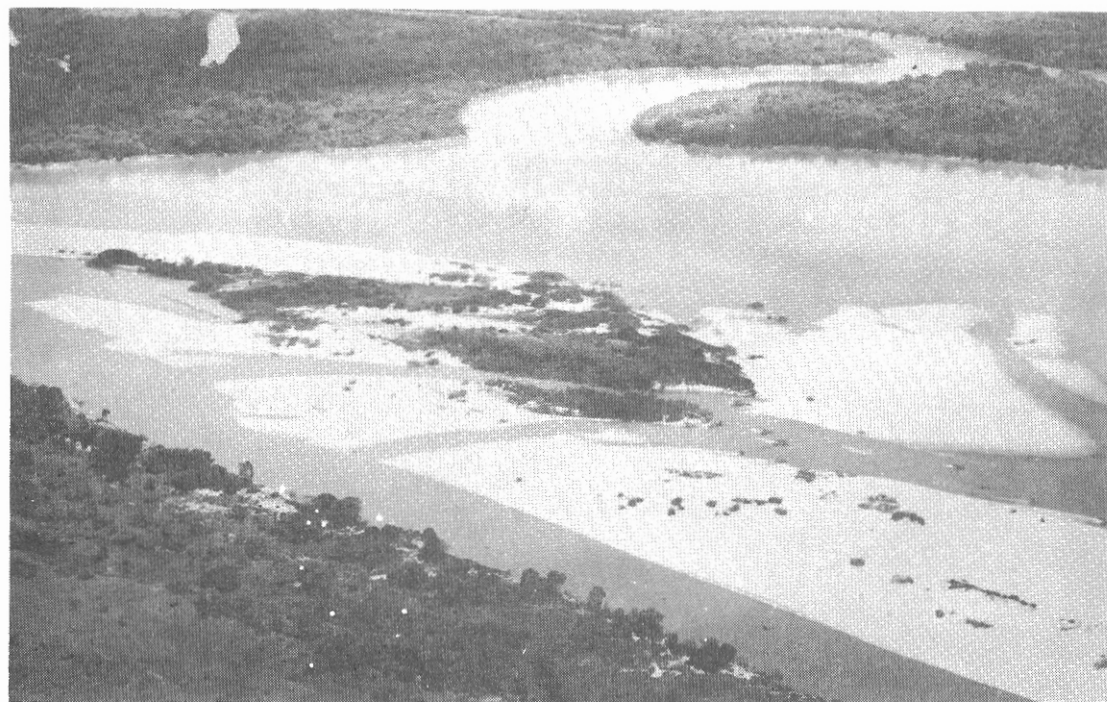


FIG. 23. Araguaia River south of Santa Teresinha, with sand bank and developing gallery forest. In foreground are sparse scrub on bare sand, grass-herb campo, and open-canopy forms of the gallery forest. These are primary successional stages of the gallery forest, shown in its closed form on the other side of the river.



FIG. 24. Airview of 4-5 m deep seasonally flooded buriti palm grove several km NW of Santa Teresinha. The spacing of the trees makes this a palm woodland.

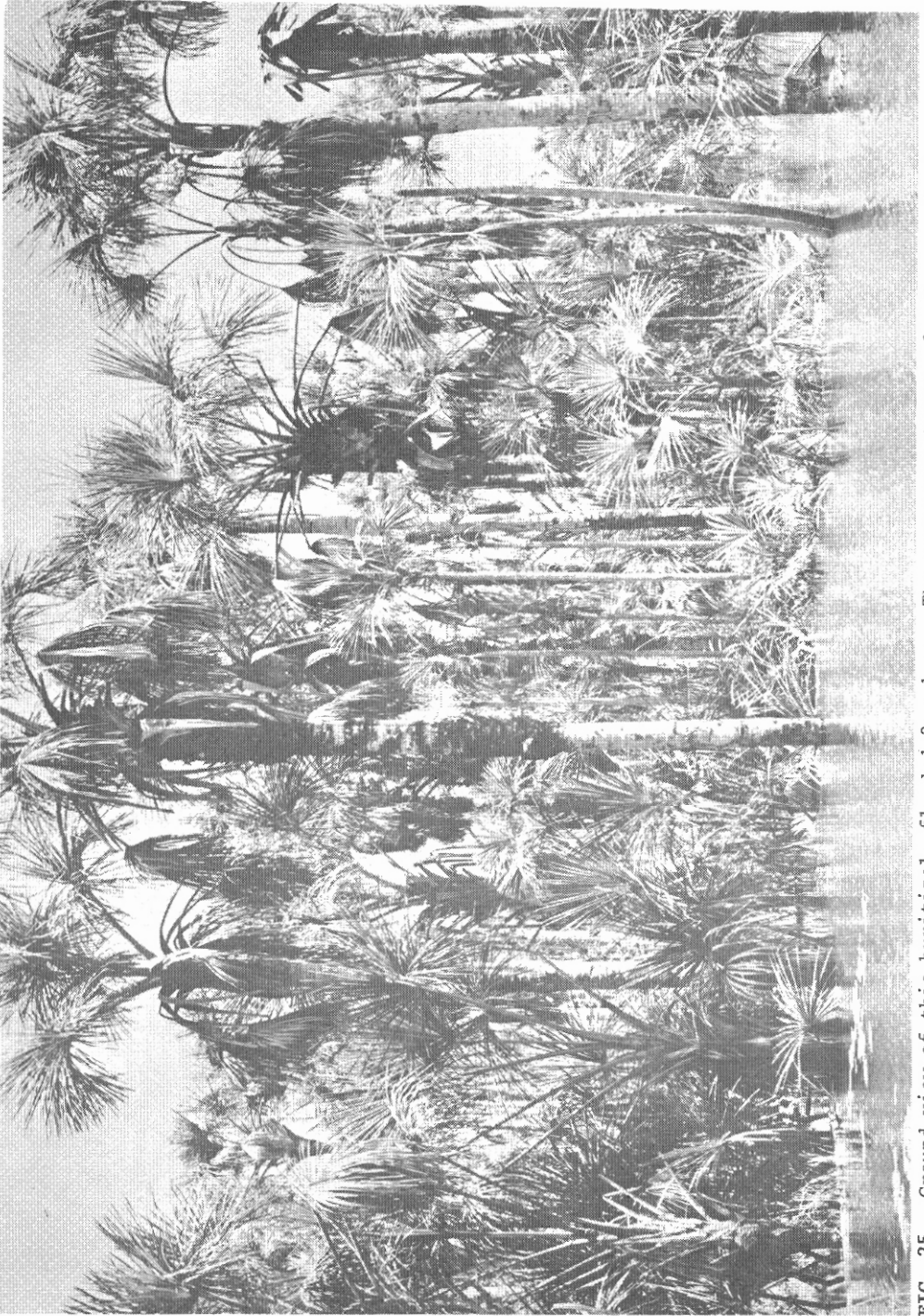


FIG. 25. Ground view of this buritizal, flooded 3 m deep. The trees are denser, forming a palm forest.

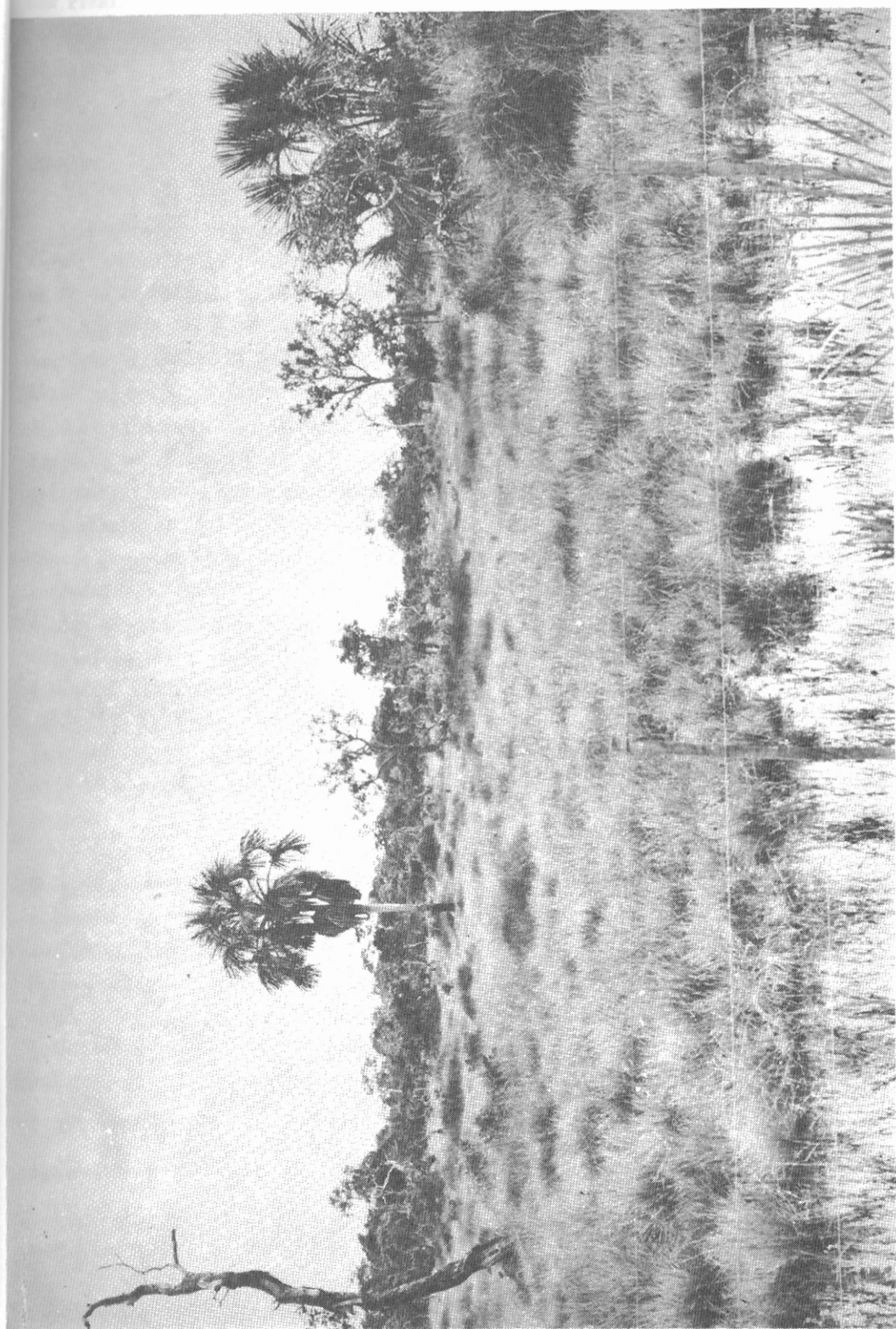


FIG. 26. The only extensive area of permanent marsh in the Santa Teresinha area. Note the small low hummocks and occasional buriti and dicot trees. The marsh is undisturbed, the physiognomy natural.