A SURVEY OF THE VEGETATION OF THE TODD'S ROAD AREA,
WITH SPECIAL REFERENCE TO THE WEEDS OF CULTIVATED
LAND AND PLANT SUCCESSION ON LAND WHICH HAS BEEN
ABANDONED.

By

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INTRODUCTION.

Under natural conditions, the vegetation, climate, (sens. lat.) and soil conditions may be regarded as being in a state of dynamic equilibrium. It is also considered logical to include the fauna as a constituent of the system, since it is dependent, and may have a considerable influence upon the vegetation. (Phillips, 1930).

In a rain forest area, for example, the soil is protected against erosion by the vegetation. There is an efficient conservation of soil nutrients, and no wholesale removal of them. Such nutrients as are locked up in the vegetation eventually return to the soil in the form of vegetable debris and the excreta of animals or their dead bodies. Nutrients removed by the slow process of geological erosion are believed to be replenished by the slow weathering of the parent material from which the soil has been derived. For practical purposes, the nutrients may be regarded as moving in a closed cycle:--

Vegetation

Soil → Animals

The climate within a forest tends to be much more equable than outside it, i.e. general climatic conditions are considerably modified within a great mass of vegetation, and it has been suggested that the effect may be discernible beyond the immediate forest boundaries. (Moor, 1939).

Felling the forest prior to the cultivation of the land disturbs the natural equilibrium, and the changes which follow in the climate (sens. strict.), soil and vegetation, are little short of catastrophic. It is seldom realised how great these changes are, and the reactions which follow are not fully understood. The nutrient cycle is broken, a proportion of the available nutrients is removed in the agricultural products, and
most of the remainder is leached out by rain. The soil is laid bare to the extreme climatic conditions which develop, so that it becomes dried out when there is no rain and eroded when rain falls. Cultivation prevents the natural regeneration of vegetation which would normally follow, and by the time that it is allowed to operate, the soil has become considerably impoverished. (Vageler, 1933). It appears that each successive cultivation impoverishes the soil further, especially if no anti-erosion measures are taken, and conditions are so altered, that the normal succession is replaced by a different one, culminating in vegetation of a poorer type adapted to the more severe conditions. In many cases, progress beyond a certain stage may be prevented by fire.

The colonisation of abandoned land by a weed flora very different from that which would be present under natural conditions, is a well known phenomenon in the agricultural areas of tropical countries. It is also recognised that the flora develops by a series of stages, so that eventually the vegetation should, in theory, approximate to what was originally there. More often than not, the succession is not allowed to proceed very far, especially in a thickly populated area where the practice of shifting cultivation is the rule. In the Todd's Road area of Trinidad such is the case. The general practice is to cultivate a piece of land for two years, or until there is no further chance of obtaining a crop, whichever is the longer, and then to abandon it. The land is left untouched for periods varying from two to three years, or longer, according to circumstances, before it is again brought into cultivation.

Investigation of the major ecological features of the vegetation of Trinidad, has been carried out by the Forestry Department, with a view to estimating the frequency of economic
tree species. So far as the author is aware, no detailed studies have been made of the individual ecological units or their constituents in Trinidad, nor of the plant succession initiated when these are interfered with. This applies particularly to land which has been under cultivation and has been subsequently abandoned.

Literature on the subject from other tropical countries is neither abundant nor detailed. The reasons for this, in most cases, appear to be inadequate knowledge of the flora, and the fact that the investigation has been undertaken as a side line, and not as the main object for research. There is, therefore, no adverse reflection on the authors of such papers, rather the reverse.

The object of the present investigation was to find out what plants invaded the different peasant cultivations on the various soil types, and to attempt to trace the plant succession as far as possible when these are abandoned. It cannot be regarded as more than a preliminary survey, in view of the author’s inadequate knowledge of the flora, and the lack of standardised numerical methods for the investigation of vegetation of this type. In view of the size of the area, it was considered advisable to see as much of it as possible, rather than to concentrate on a few small areas in different places, in order to acquire a working knowledge of the commoner plants and a general impression of their distribution in relation to soil type and human interference. Having done so, which took rather longer than expected, it was possible to select examples to illustrate the salient points. In the lists of plants given in this thesis, frequencies are denoted by their initials as follows:

D = Dominant
A = Abundant
F = Frequent
O = Occasional
R = Rare
L = Locally
No numerical methods were used in estimating frequencies and distribution, since they have not been found to be wholly satisfactory, and it would not have been possible to try them out in a short time. Such results as have been obtained are based solely on observation, which is adequate in most cases for the discernment of major differences. No attempt was made to distinguish small differences, which could have been done only by the judicious use of a numerical method.

Three types of vegetation are distinguished by the Trinidad peasant, and these represent the major stages in the plant succession which is instituted when cultivated land is abandoned. Lastro is the term applied to the vegetation which springs up immediately after the land has been abandoned. It is composed of a number of worthless species of herbs and shrubs, which nevertheless provide a certain amount of cover for the soil and so assist in checking erosion. In time the Lastro is replaced by High Bush, which consists largely of dense thickets of large shrubs and small trees, chiefly Melastomaceae, and dense clumps of giant herbs. There is also a considerable proportion of tall forest trees. This type of vegetation is often referred to in the literature as Second Growth Bush; it may contain timber of commercial proportions and a considerable amount of lumber suitable for conversion into charcoal. High Wood is the term used for secondary forest, but no distinction is made between this and primary forest so far as the use of the term is concerned.
REVIEW OF THE LITERATURE.

Marshall (1934) states that in Trinidad second growth bush appears to be of a poorer type than the original, being composed of light demanding species, quick of growth, and whose seeds are readily dispersed by the wind, or fruit eating birds and animals. Such vegetation is seldom left undisturbed, and it is usually found on land which has been abandoned after a short term of cultivation. It is not a luxuriant form of vegetation, and the majority of the species of which it is composed do not occur in true forest. There is evidence that the vegetation invading abandoned land is not the same in all cases, indeed it is not to be expected, since climatic and soil conditions are so variable, even within Trinidad itself.

Wardlaw (1929) has described how destructive the system of peasant gardening is in St. Lucia. The general practice, as in Trinidad, is to clear an area of forest or second growth bush, burn off the fellings, and plant up the area with ground provisions; and taking no precautions to counteract soil erosion, with the result that at the end of two years it becomes necessary to abandon it. Garden land which had been left for a period of 20 years or more, showed no evidence of the initial fertility having been regained, and the soil was considerably more shallow than that still under virgin forest. On a holding abandoned for 15 years some cattle grazing had been practised, and a ground mat of poor grass had developed, together with a few thickets of Miconia, Psidium and some clumps of Heliconia. The poorest soil was under the grass, the best under the Heliconia, while under the thickets of Miconia it was intermediate. Wardlaw came to the conclusion that a type of vegetation should be established, which under the prevailing conditions would prevent erosion, and provide organic matter and root tillage. The regeneration of the
land by the natural flora is slow, as is the development of the flora itself after the first few years. Even after 25 years, there was no approach to the original conditions, showing that soil conservation from the beginning is of primary importance.

Wardlaw (1931) has described how an area in St. Lucia initially under virgin forest was subjected to severe erosion during an attempt to establish a banana plantation. The attempt was abandoned after four years, and two years later it had developed a weed flora dominated by Cyathea, Cecropia, and Sciadophyllum. Beneath this was a shrub layer composed of Miconia spp. and Peperomia spp. Wardlaw observed that ferns such as Gleichenia, Lygodium and Cyathea were among the first colonisers of bare rock faces, landslides, and roadside cuttings, and as such could be taken as indicative of the extent to which erosion had proceeded on cultivated land.

Cook and Gleason (1928) found that on the northern plain of Puerto Rico, the mesophytic forest on the limestone strata had been replaced by a more xerophytic type of vegetation, as the result of interference by man and the consequent alteration of the environment. The hills were covered with a dense growth of shrubs, among which large individual specimens of Cecropia peltata, Elaphrium simaruba, Ficus Stahlii, F. laevigata and Clusia rosea were conspicuous. The bases of these hills, bordering on cultivated and pasture land, were dominated by species of Piper, principally P. aduncum, the most abundant herbs being Elephantopus mollis and Bidens pilosa. Continuation of human interference, in their opinion, will result in the greater reduction of the vegetation to weedy species. On the White sand plains, the vegetation is similar in character, but composed of different species, the commonest being Chrysobelanus icaco, Byrsonima spicata and Myrcia splendens.
Symington (1933) studied the succession on abandoned vegetable gardens in Malaya. He found that the course of the succession varied according to the original colonisers. If woody species became established early on, then the herbs and grasses were followed by shrubs, and finally trees. If, however, colonisation by the taller species did not occur until the herbs were well established, then the succession was liable to be arrested by the rapid assumption of dominance by Lalang grass (Imperata cylindrical). It could, however, be colonised by Melastomaceae and the fern Nephrolepis, these species subsequently becoming dominant. A piece of jungle after clearing was found to be colonised first by herbs, and then by tree species, but plants typical of abandoned land were few in number and transient in appearance, though the new dominants were different from those originally present. Symington concluded that the colonisation of abandoned land was not so much dependent on the condition of the soil, as to the presence of suitable seed parents. From a study of abandoned gardens of different ages, he was able to form an idea of the probable succession, which he considered would eventually end in an approximation to the original vegetation.

Considering the amount of abandoned land in the area studied, it would seem that the presence of seed parents might be of secondary importance compared with soil conditions, otherwise the appearance on the cleared jungle site of plants typical of abandoned land would not have been so ephemeral. No data as to the amount of erosion was given, but it could have been considerable, since it was a rain forest region, and in hilly country.

Hanson (1939) considers that too much attention has been paid in the past to native or wild plants and animals.
That is not to say that the study of them should be diminished, but the knowledge so gained should be more freely applied to domesticated plants and animals than has been the case in the past. Also there should be more work done along similar lines with respect to these organisms since they are generally more specialised than their ancestors having been selected or bred for some desirable quality, which can only be fully developed if the environmental conditions are favourable. The burning of sage brush was found to be beneficial in the Laramie River Valley, but further west in a drier area, the same practice was found to be detrimental in that the growth of annual weeds was encouraged.

The failure of wheat farming in the Great Plains area of the U.S.A. he regards as due to the disturbance of the natural equilibria through the ignorant application of farming methods suited to the moister climate of Iowa and Minnesota. Stabilisation can only be attained when all the available scientific knowledge has been utilised in adapting the agricultural practices to the environment of an area in which serious maladjustments exist.

One of the best examples of applied ecology in its widest sense, in relation to agriculture within the British Empire, is to be found in Tanganyika, where the inter-relations of native crop and stock husbandry and the natural fauna and flora are being worked out in connection with Tsetse fly control. (Phillips, 1931). This is perhaps an extreme example, but the principles could be extended; in fact, there is evidence that they are being extended. In a very interesting paper, Pentz (1938) has shown how a survey of the natural vegetation can indicate the system of agriculture which should be carried out in
a given area, if the land is to be kept in good heart, and the best use made of it.

A fuller understanding of the environmental conditions, the plant and animal life which they would support, would exercise a stabilising influence on agriculture. It would mean the evolution of sound agricultural practices adapted to the special conditions found in a given area, the better utilisation and conservation of the soil, and the abolition of shifting cultivation, (Wakefield, 1934) which is known to be so destructive of both soil and vegetation under an increasing density of population. Problems of transport and marketing would be eventually simplified, and the standard of living among the native population would be raised.
HISTORY.

The Todd's Road area was once undoubtedly covered with rain forest, probably of the Crappo-Guatemala-Cocorite type described by Marshall (1934). About thirty years ago, this was extensively cleared and the land planted up with cacao. Previously, it appears probable that the forest had been exploited for timber and charcoal. Since the area is unsuited to cacao, it is not surprising that during the slump which followed a few years after the war of 1914-18, all the worst fields were felled, i.e. those situated on sandy soils of the Valencia series. This land was then utilised for the cultivation of sugar cane, but this also failed, and it is now under a system of shifting cultivation by peasant proprietors. Much of the clay soils are still under cacao or sugar cane, though the yields are very low in both cases. The latter is, for the most part, grown on the relatively rich alluvial soils of the L'Ebranche series in the river valleys, and the cacao at higher elevations on the Talparo clay.

Small remaining areas of forest have been cut over for timber, and for the purpose of charcoal burning, so that it is probably true to say that within the area there is no natural vegetation in the strictly botanical sense. A small area of land has been taken over by the Forestry Department, situated on sandy soil of the Valencia series in the northern part of the area. The vegetation has been allowed to grow up into high bush and the natural succession is being deflected along economically desirable lines by selective felling. Undesirable species are removed by charcoal burners, and in this way the growth and regeneration of the more valuable timber trees is being encouraged.
GENERAL INFORMATION.

The area studied lies in the Caroni county of Trinidad, to the North and West of Todd's Road Railway Station, as shown on the following sketch map, on which the tinted part represents the approximate boundaries of the area studied.

![Sketch Map]

Scale 1:200,000
1 inch = 3.125 miles.

The rainfall (Marshall, 1934) is 70 to 80 inches per annum, distributed as follows:-

January  2-4 inches
February  0-2 "
March     0-2 "
April     2-4 "
May       4-6 "
June      8-10 "
July      8-10 "
August    8-10 "
September 6-8 "
October   6-8 "
November  8-10 "
December  6-8 "

Geologically, the area consists of Miocene sands and clays, and its elevation is between 100 and 200 feet above sea level for the most part. There are three main types of soil in the area, and these have been described by McDonald, Hardy and Rodriguez (1933) and ffrench-Mullen (1940). Over most of the
area, the soil is of the Caroni Sand type, but in the southeastern part it is a clay of the Talparo type. In the river valleys it is an alluvium of the L'Ebranche series.

HIGH BUSH ON CARONI SAND.

An area of bush was found on a small plateau, situated near the northern boundary of the area studied. The soil was a sand of the Valencia series, but the underlying clay was not deep down. Evidence of former cultivation was provided by scattered trees of Mangifera indica and Anacardium occidentale. The vegetation was far from uniform, some places were dominated by shrubs and giant herbs, and others by trees. The cultivation of the land had obviously been discontinued for many years; it is not known how long it had been abandoned but 20 years would be a reasonable estimate. Reversion to forest conditions was by no means complete, but a number of forest trees had become established. It seems possible that in time the vegetation would revert to a condition approximating to the original.

Four layers of vegetation were discernible, two of trees, one of shrubs, and one of giant herbs. In neither of the two tree layers did there appear to be a single dominant, but there was a different set of species in each layer. The shrub layer was dominated by Melastomaceae, chiefly of the genus Miconia, and growing to a comparatively large size, especially in the more shaded situations. The fourth layer was composed of giant herbs more characteristic of clay soils than sandy ones. Dominance was divided between Heliconia bihae and Ranealmia bracteosa, both of which form large clumps to the exclusion of everything else. Woody climbers such as Macfadyena corymbosa, and Bauhinia spp. were locally abundant in the middle layers of vegetation.
where the shrubs and trees were most dense. Under these thickets there was no ground vegetation. The following is a list of the more conspicuous species of which the vegetation was composed.

1. First tree layer.
   - Callophyllum antillanum?
   - Cecropia peltata.
   - Cordia spp.
   - Didymopanax mőrotoni.
   - Ocotea spp.

2. Second tree layer.
   - Coccoloba latifolia.
   - Maximilleana caribbea.
   - Pentaclethra filamentosá.

3. Shrub layer.
   - Cassia bacillaris. O.
   - Miconia spp.

4. Field layer.
   - Costus speciosus. O.
   - Tabernaemontana undulata. R.
   - Diplasia kerataefolia. R.
   - Heliconia bihae. L.D.
   - Renealmia bracteosa. L.D.
   - Heliconia psittacorum. O.
   - H. Pulverulenta. F.

Vegetation after Clearing the Bush.

After the ground has been cleared and burnt, it is entirely devoid of vegetation, which does not begin to reappear until the beginning of the next rainy season, and then only slowly. Owing to the drastic changes in the local climate which follow the destruction of the former vegetation, environmental conditions are so altered that colonisation of the ground by shade tolerant species is impossible; consequently, it is effected by plants better adapted to withstand the more extreme conditions.

Part of the area of high bush described above had been cleared and burnt during the dry season of 1939. A crop of maize had been harvested, and in March when the area was examined,
it was carrying a crop of Pigeon Peas. There was a very mixed crop of weeds which had not been allowed to form a closed cover over the ground. In fact most of the ground was bare, except for a few large patches of grass. It has been observed in Trinidad that grasses are the first plants to form a covering over the ground following burning, and this case is no exception. Digitaria sanguinalis was by far the commonest weed in the crop, and next in abundance were shrubby species such as Solanum juripeba and Lantana camara. Sida acuta and species of Borragia, common weeds of all poor soils, were present in comparatively small numbers. Phytolacca rivicoides was an interesting weed, in that it appears to be one of the first colonisers of burnt areas. Seedlings of tree species were present, but not common. There was a small group of Ochroma pyramidale seedlings, and scattered individual seedlings of Tabebuia pentaphylla and Cecropia peltata. A few stumps of Pentaclethra filamentosa were sprouting again.

On the south-west side, the plateau sloped very steeply down to the flat alluvial land on either side of the Ravine Sable river. The previous history of the land on the slope was the same as that on the plateau, but the maize crop had been followed by Sugar Cane, which had recently been planted. The soil appeared to contain more clay than the rest, but it was still essentially sandy. There were visible signs that it was subject to erosion. The weed flora was somewhat different in that grasses and tree seedlings, with the exception of Cecropia peltata, were absent. On the rather richer soil at the bottom of the slope, Momordica charantia was locally dominant. On the rest of the slope, Phytolacca rivicoides, Lantana camara and Cordia cylindrostachys were equally abundant. Solanum and Cyperus spp. were occasional.
Plants Identified on the Plateau.

Amarantus sp. O.
Bambusine O.
Borreria eryngioides R.
B. verticillata O.
Cecropia peltata O.
Costus spiralis R.
Digitaria sanguinalis D.
Lantana camara O.
Momordica charantia R.
Ochroma pyramidale R.
Pentaclethra filamentosa R.
Phytolacca rivinoides O.
Porophyllum ellipticum R.
Sida acuta O.
Sonchus oleraceus R.
Tabebuia pentaphylla R.

Plants Beside a Boundary Path.

Borreria eryngioides D.
Cassia bacillaris O.
Cordia cylindrostachys O.
Hyptis capitata A.
Lantana camara O.

Plants on the Steep Slope.

Bactris sp. R.
Bambusine O.
Cecropia peltata O.
Cordia cylindrostachys F.
Cyperus sp. O.
Emilia sonchifolia R.
Lantana camara F.
Momordica charantia L.D.
Maximileana caribaea R.
Phytolacca rivinoides F.
Portulaca oleracea R.
Solanum sp. O.
Sonchus oleraceus R.

Succession.

Had the land been abandoned soon after clearing, it is probable that the vegetation on it would have been very similar to that found beside a path marking the boundary between two parcels of land. Here there was a dense growth of Borreria eryngioides, Hyptis capitata, and shrubs such as Cassia bacillaris, Cordia cylindrostachys and Lantana camara. The profuse development of these plants in this situation can reasonably be accounted for by failure of the owner to weed right up to the path. With
the exception of Borreria eryngioides and Lantana camara, these weeds have been successfully kept down by weeding operations and the numbers of the exceptions reduced. The land is not likely to be abandoned until it has been under cultivation for not less than two years, or possibly three. At the end of this time, Borreria verticillata and Sida acuta are the two species likely to have increased in number; the former will probably become the dominant weed. The reason for this is that both species are capable of flowering throughout the year, and unless each plant is rooted right out, it will shoot and set seed before the next weeding is carried out. Shrubs and trees are not likely to increase very much unless the influx of seed is increased or weeding seriously neglected. When the land is finally abandoned, there will probably be a very rapid increase of Borreria, Sida and shrubs such as Solanum, Lantana and Cordia. Further colonisation by larger shrubs, and possibly trees, would proceed more slowly. Cecropia peltata would probably become conspicuous within two or three years, since it is one of the first tree species to appear on almost any land that has been subject to human interference.

THE WEEDS OF CULTIVATED SANDY SOILS.

Towards the northern end of Hercules Trace, in the northern half of the Todd's Road area, three cultivations were examined covering the first three years after burning. The soil in all cases was a sand of the Valencia series, on slopes of varying steepness, with the underlying clay fairly near the surface.

The first one had been covered with forest, of which the principal constituents were Cootea sp. up to about 80 feet high, Didymopanax morototoni, Inga spp. and Aonistus arborescens.
The canopy was closed, so that within the forest there was deep shade which prevented the development of a luxuriant ground flora. There were a few specimens of Heliconia pulverulenta, Miconia sp. and occasional scrambling palms of the genus Desmonous. Woody climbers such as Macfadyena corymbosa and Smilax sp. were also present.

The ground which had been cleared and burnt was practically devoid of vegetation; the only plants present were scattered individuals of Boerhavia paniculata, Porophyllum ellipticum and Sida acuta.

The second area was surrounded by forest of the same type, but it had been cleared for a much longer period – about ten years. Since it was cleared, it had been cropped and abandoned alternately every two years. When examined, it was in the second year of cultivation, the crops being Pigeon Peas, Cassava, a few Cashew trees and Pineapples. It had been cleaned in November, about three months before the visit was made. The weed flora was very dense, and contained a number of species not found on the newly cleared area. The dominant weeds were Borreria eryngioides, Heliconia psittacorum and the grass Orthocladiu laxa. Borreria verticillata, Lantana camara were present in abundance, together with Cyperus spp.

Many other weeds were characteristic of the soils of the area as a whole, e.g. Digitaria sanguinalis, Sida acuta and Solanum juripeba. The presence of certain other species such as Renealmia bracteosa, Costus spiralis and Heliconia psittacorum could be ascribed to the proximity of clay to the surface of the soil. Colonisation had been effected by shrub and tree species such as Cestrum latifolium and Inga venosa respectively, probably owing to the length of time that had elapsed since the last cleaning.
Two Years after Burning.

Cleaned in November.

Borneria eryngioides  L.D.
E. verticillata A.
Cassia bacillaris R.
Cestrum latifolium O.
Costus spiralis R.
Cyperus spp. L.A.
Desmodium supinum O.
Digitaria sanguinalis F.
Elephantopus mollis O.
Eupatorium odoratum O.
Heliconia psittacorum L.D.
Inga venosa O.
I. sp. O.
Lantana camara A.
Maximileana caribaea R.
Momordica charantia R.
Orthocladia laxa L.D.
Piper marginata var. catalpifolia O.
Renealmia bracteosa R.
Sida acuta O.
Solanum jurepeba R.
Synedrella nodiflora O.
Sonchus oleraceus R.

The third cultivation was on the other side of the ridge on a north-east slope. It had been burnt in 1937, so that it was now in its third year of cultivation. The original vegetation was forest similar to that already described. Part of the land had not been cleaned since August and some had been cleaned as recently as January. The holding was traversed by a small gulley which received surface drainage and in which there was a much more luxuriant type of vegetation composed of species different from those on the surrounding land, and more characteristic of clay soils. It is uncertain whether the plants in it had been allowed to grow up on purpose, but they were sufficiently dense to assist in the reduction of the scouring action of drainage water.

On the plot which had not been cleaned since August, there was a rank growth of weeds about two feet in height. Borneria eryngioides was the dominant, but in places it was
superseded by *Digitaria sanguinalis*. The next most abundant species were *Borreria latifolia* and *Hypnis atrorubens*, both annual weeds. *Bidens pilosa* and *Desmodium scorpiurus* were frequent, and the majority of the remaining species were occasional in their occurrence.

The dominant weed of the plot which had been cleaned in January was *Bidens pilosa*, which was by far the commonest species present. *Boerhavia paniculata* was frequent, together with *Digitaria sanguinalis* and *Emilia sonchifolia*, while *Borreria eryngioides*, *Momordica charantia* and *Cyperus spp.* were occasional. The weed flora of this plot contained fewer species than the one which had been cleaned in August, and the frequency of some species common to both plots showed striking differences, due doubtless to recent weeding operations. These are illustrated in the following table.

<table>
<thead>
<tr>
<th>Species</th>
<th>August</th>
<th>Cleaned in</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>January</td>
</tr>
<tr>
<td><em>Bidens pilosa</em></td>
<td>F.</td>
<td>D.</td>
</tr>
<tr>
<td><em>Boerhavia paniculata</em></td>
<td>Absent</td>
<td>F.</td>
</tr>
<tr>
<td><em>Borreria eryngioides</em></td>
<td>D.</td>
<td>O.</td>
</tr>
<tr>
<td><em>B. latifolia</em></td>
<td>A.</td>
<td>L.A. beside path</td>
</tr>
<tr>
<td><em>Cassia bacillaris</em></td>
<td>O.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>Ceropia peltata, seedlings</em></td>
<td>R.</td>
<td>R.</td>
</tr>
<tr>
<td><em>Clibadium surinamense</em></td>
<td>O.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>Cyperus spp.</em></td>
<td>C.</td>
<td>O.</td>
</tr>
<tr>
<td><em>Desmodium scorpiurus</em></td>
<td>F.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>D. supinum</em></td>
<td>O.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>Didymopanax morototoni, seedlings</em></td>
<td>R.</td>
<td>R.</td>
</tr>
<tr>
<td><em>Digitaria sanguinalis</em></td>
<td>L.D.</td>
<td>F.</td>
</tr>
<tr>
<td><em>Emilia sonchifolia</em></td>
<td>O.</td>
<td>F.</td>
</tr>
<tr>
<td><em>Heliconia psittacorum</em></td>
<td>L.O.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>Hypnis atrorubens</em></td>
<td>A.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>Lantana camera</em></td>
<td>R.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>Maximileana caribaea</em></td>
<td>R.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>Orthocladia laxa</em></td>
<td>Absent</td>
<td>R.</td>
</tr>
<tr>
<td><em>Paspalum coryphæum</em></td>
<td>O.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>Philanthus niruri</em></td>
<td>O.</td>
<td>R.</td>
</tr>
<tr>
<td><em>Porophyllum elipticum</em></td>
<td>O.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>Pterolepis glomerata</em></td>
<td>R.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>Solanum juripeba</em></td>
<td>R.</td>
<td>Absent</td>
</tr>
<tr>
<td><em>Tabebuia pentaphylla, seedlings</em></td>
<td>R.</td>
<td>R.</td>
</tr>
<tr>
<td><em>Urena lobata</em></td>
<td>R.</td>
<td>Absent</td>
</tr>
</tbody>
</table>
There are certain differences, however, which cannot be regarded as due entirely to weeding operations but must be ascribed to differences in the soil, since certain species occurred on the August cleared plot which were more characteristic of clay soils, e.g. Clidadium surinamense, Pterolepis glomerata, Desmodium scorpiurus and Heliconia psittacorum. Weeding in January eliminated or greatly reduced perennial weeds such as Lantana camara, Solanum juripeba, Desmodium supinum and Borgeria eryngioides, but the effect on annual weeds was not the same in all cases. Bidens pilosa, Boerhavia paniculata and Emilia sonchifolia had apparently been stimulated by the January weeding, whereas there had been a detrimental effect on Borgeria latifolia, Digitaria sanguinalis, Hyptis atrorubens, Paspalum coryphaeum, Philanthus niruri and Porophyllum ellipticum. The observed differences were probably due to competition effects; the plants in the first group being favoured by the removal of competition from the more robust but slower growing species of the second group.

The difference between the flora of the erosion gulley and that of the rest of the land was due to the accumulation in it of the better soil from the immediate surroundings, and the enhanced water supply. The vegetation was composed largely of shrubs, and of these, Clidadium surinamense was the dominant. In the gaps between the shrubs, Heliconia psittacorum was locally dominant; similarly, on the sides of the gulley, Desmodium supinum was of the same frequency. Of the remaining shrubs, Clidemia neglecta and Cordia cylindrostachys were the next in order of abundance; and of the herbaceous species, Costus spiralis was locally abundant, Borgeria latifolia and Pterolepis glomerata frequent, and the remainder occasional. The following is a list of the principal species and their frequencies.
Plants in the Erosion Gulley.

Andropogon bicornis  O.
Anthurium sp.  O.
Borreria latifolia  F.
Calathea discolor  O.
Cassia bacillaris  O.
Clibadium surinamense  L.D.
Clidemia neglecta  L.A.
C. hirta  R.
Colocasia sp.  R.
Cordia cylindrostachys  O.
Costus spiralis  L.A.
Cyperus sp.  F.
Desmodium scorpiurus  O.
D. supinum  L.D.
Elephantopus mollis  R.
Eupatorium odoratum  O.
Gymnogramme calomelanos  O.
Heliconia psittacorum  L.D.
Jussieaeae affinis  R.
Lantana camara  O.
Miconia acinodendron  O.
Pterolepis glomerata  F.
Renealmia bracteosa  O.
Solanum juribeza  O.
Vismia guianensis  O.

Some interesting differences appear when the weed floras of the cultivations visited two and three years after burning are examined. The two year old cultivation had been cleared from lastro, whereas the three year old one was previously under forest. This probably accounts for the comparative rarity on the three year old cultivation of such typical lastro plants as Lantana camara, Cordia cylindrostachys, Sida acuta and Eupatorium odoratum. It also indicates that if the land is left under lastro for only short periods, the growth of valueless shrubby species and perennial weeds is encouraged, whereas if the land is left for longer periods, these would probably be shaded out by taller shrubs and trees capable of casting a fairly deep shade.

Succession.

The plant succession on cultivated sandy soil in the Todd's road area over the first three years after burning appears to be as follows. In the first year, colonisation of the bare
ground is effected by quick growing annual species such as Boerhavia paniculata and Digitaria sanguinalis; the latter rapidly becomes the dominant weed. In the second year, colonisation by many other species occurs, including both herbs and shrubs. The grass, Digitaria sanguinalis, becomes subordinate to perennial weeds such as Borreria, which, in spite of temporary checks due to cultural operations, are able to become dominant. If cultivation is continued for a third year, the small perennial weeds tend to increase their numbers, and shrubs and tree seedlings can become established before the land is finally abandoned.

After the land has been abandoned it is usually left untouched until it is again needed for cultivation, though it may be burnt accidentally. During this time, the smaller perennial weeds such as Borreria eryngioides, E. verticillata and Sida acuta form a thick ground cover, and the shrubs such as Lantana camara, Cordia cylindrostachys and various species of Solanum grow up, the whole constituting a very undesirable type of vegetation and a source of weed seeds for nearby cultivated ground. This state of affairs is likely to continue until the initial dominants are shaded out by taller species of shrubs and trees capable of casting a fairly deep shade. The development of an undesirable type of vegetation could be to a large extent prevented by the use of suitable cover crops, but to be effective in this case, the crop would have to be capable of establishing itself from seed under very adverse conditions, and capable of maintaining itself without further attention for a period of at least two years.

Cover Crops.

Many leguminous cover crops are known, but the appropriate one to use for the control of lastro vegetation could only
be decided upon by experiment. The commonest leguminous weeds in the Todd's Road area were species of Desmodium, but none of them appeared to be sufficiently vigorous to form a really effective cover crop. A suitable strain might be obtained by selection, but there would be other difficulties to overcome, such as the treatment of the seed to remove the adhesive outer covering.

The problem might be capable of solution by planting a suitable tree crop just before abandoning the land, in order to shade out noxious weeds, and to provide timber for charcoal or other purposes when the time came for the land to be cultivated again. Here again the difficulty would arise of selecting a suitable species. The one which immediately suggests itself is Solanum macranthum, which is one of the fastest growing trees known, and it also casts a reasonable shade. It has been used as a temporary shade, but its span of usefulness does not exceed four years. Teak is another possibility, but it needs careful weeding during the first two years after planting, and it is questionable whether it would succeed on the poor sandy soils in the area. A quick growing leguminous tree would probably be the ideal if one suitable for the purpose could be found, but it is doubtful whether a tree crop could build up the supply of humus in the soil to a reasonable level in a short time. It has been suggested by Parnell (1939) that in the Cotton growing areas of Tanganyika the land should be rested under a crop of Pigeon Peas and Buffalo grass. It is possible that the principle of a mixed cover crop, such as the one suggested, might be extended to the control of lastro and maintenance of fertility. Such a crop would have to be readily established from seed and so adapted to local conditions that it could compete successfully
with the plants which would otherwise become established on the land. To do this it would have to consist of two main components, which could compete on equal terms with the two components of lastro, namely a shrub component such as Pigeon Peas to compete with Lantana camara and an herbaceous component composed of grasses, legumes and such other plants which might be useful either as ground cover or forage, to compete with herbaceous weeds of the lastro.

**WEEDS AND SOIL DETERIORATION.**

It is apparent that the weed flora undergoes a change as the length of the period of cultivation increases. In the first year, the weed problem is practically non-existent, especially if the ground has been cleared from forest. The Maize crop can grow away rapidly since the soil is usually fairly fertile, but the spacing and vigour of the crop is seldom sufficient to prevent colonisation by weeds, since it does not form a really dense cover over the ground. The influx of weeds is gradual at first, and it is not difficult to chop out individuals or small patches; nor is it imperative to do this at frequent intervals. The suppression of weeds does not appear to be a strong point with the majority of the local inhabitants, with the result that considerable numbers are left and provide seed for subsequent generations. The plants which appear to be best adapted to the colonisation of cultivated land are Borreria eryngioides, B. verticillata, and Sida acuta. These are all perennial weeds, which flower continuously throughout the year, though there appears to be a flush of blossoms in February at the beginning of the dry season.

By the end of the second year, most of the land has
developed the characteristic weed flora, of which Borrasia eryngoides, B. verticillata, Digitaria sanguinalis and Sida acuta are the most conspicuous constituents. Woody species appear at this stage, and of these Cordia cylindrostachys, Lantana camara and Solanum spp. are the principal ones. Tree species such as Ochroma pyramidale, Didymopanax morototoni, Tabebuia pentaphylla and Inga spp. may also appear as seedlings. Ceropia peltata is almost certain to appear, since it is by far the commonest tree occurring on abandoned land. In the third year, it seems unlikely that the weed flora will undergo any qualitative change, but in all probability the established species will increase in numbers, forming a much denser covering. By the end of the third year, the soil is likely to have become so impoverished that further cultivation is not worth while; this state of affairs is often reached at the end of the second year. The land is therefore abandoned, all human interference is discontinued, and the weed flora is able to develop unhindered.

Of the many factors contributing to the deterioration of the soil, weeds are probably the least important; in fact it is more probable that they exert a conservation effect. With regard to the crops, they are likely to hasten the falling off in the returns, owing to competition for soil moisture and nutrients. All soils are liable to colonisation by weeds, which from the agricultural point of view, are an unavoidable evil. Their control can only be effected by the continual use of suitable measures, such as crop rotations and cultural operations. Crop rotations continually change the environment, so that weeds which are to any extent highly specialised are eliminated, leaving the more adaptable ones which must be attacked directly. In the Todd's Road area, there are no weeds which cannot be
controlled by the use of the cutlass or the hoe. The difficulty of their control lies in the amount of work that would have to be done in continually hoeing or cutlassing the individual holdings, and the reluctance of the proprietors to do more than the absolute minimum necessary to ensure some sort of crop.

The problems of peasant agriculture appear to constitute a vicious circle, and it is difficult to decide where it could be broken with most advantage. Of the many factors, such as Education, Economics, Stock and Crop Husbandry, etc., the question of how to grow better crops is only one, which in itself involves a number of factors. The most important from the botanical point of view are soil conservation, manuring and weed control; and considerable improvement could probably be effected by quite simple and inexpensive methods. Simple methods of erosion control such as strip cropping and contour draining could easily be adopted, and probably without extra expense. The difficulty lies in overcoming the inordinate conservatism of peasant proprietors, and in persuading them that such measures would be worth while. The only way in which it could be done effectively, would be by means of practical full scale demonstrations within their own area.

HIGH WOOD ON TALPARO CLAY.

A small area of High Wood on Talparo clay was found near the junction of Fletcher Road with the Ravine Sable Road, and lying in the fork between them. As far as could be ascertained, the ground had never been cultivated, but it seems probable that the timber on it had been exploited at some time in the past. The trees were about 80 feet high, and many of them were infested with climbing plants such as Macfadyena corymbosa and
Desmoncus major. Under these tangled masses of vegetation, the shade was too deep to allow the development of a ground flora. Owing to the height of the trees it was not possible to collect specimens for identification so the tree species could not be determined. On the margins of the wood there were frequent specimens of Cecropia peltata and Inga venosa, and also a few dense thickets of Bactris major which is a very characteristic palm of Talparo clay in this district, especially where there is a tendency for the soil to be waterlogged. Where the overhead canopy was open, there were dense clumps of Heliconia bihae and Renealmia bracteosa, but in the more shaded places there was an abundance of Heliconia pulvulentia, and occasional individual specimens of Thrinax argentea and Ischnosiphon aroama.

This probably represents the type of vegetation that had to be cleared prior to planting cacao, and which would probably develop on abandoned clay soils if they had not suffered severe deterioration.

The Weed Flora of Cacao Fields.

The difficulty of keeping a Cacao field free from weeds is chiefly a matter of shade. The deeper the shade, the less troublesome the weeds. If the shade is inadequate, the weeds must be kept down by outlassing at least twice every year; the usual times for this operation are the months of September and March. In a well-kept Cacao field, the ground vegetation usually consists of Tradescantia geniculata, Phaerosphaerion persicarac-folium on sandy soils, and several species of fern. These occur under dense shade, but where more light can penetrate, Setaria poiretiana and shrubby species such as Piper hirsutum and P. marginata var. catalpifolia appear.

If the field has been neglected, colonisation is effected
by species characteristic of forest areas where the tree canopy is thin. A very good example of this was found on the Todd's Road boundary of the area, situated on steeply sloping ground. The soil was Talparo clay, merging into alluvium of the L'Ebranche series at the bottom of the slope. The forest had been cleared about thirty years ago, and Cacao was planted. The owner of the field could give no satisfactory estimate of when it had last been cutlassed, but judging from the appearance of the field, it could not have been touched for at least ten years. Many of the shade trees had died out, and had not been replaced, and a large proportion of the Cacao was also defunct. The remaining trees were thickly covered with epiphytes, chiefly Bromeliads and Ferns, and also the climber Macfadyena corymbosa.

Taking the vegetation as a whole, five distinct layers could be distinguished, three layers of trees, and two of shrubs and herbaceous species. The upper tree layer was composed of the remaining shade trees, which were Erythrina glauca, and up to 70 feet in height. They were heavily infested with epiphytes, and did not appear to be in a healthy condition. The middle tree layer consisted of tall specimens of Cecropia peltata in the gaps left by fallen shade trees; and they ranged from 20 to 50 feet in height. Smaller specimens occurred in the lower layers of the vegetation. The remaining Cacao trees, 15 to 20 feet high, made up the bulk of the lower tree layer, but where they had died out, Cecropia peltata had replaced them. The fourth layer was composed of tall shrubs, and giant herbs up to 10 feet high. The dominant species varied according to the amount of shade cast by the canopy above. Where the canopy was open, the dominant shrub was Cestrum latifolium and Heliconia pulverulenta was frequent in occurrence. In the more shaded
places. Piper hirsutum was the dominant shrub, growing to a height of 6 to 8 feet. In the more open places it formed part of the next lower layer. Heliconia bihae and Renealmia bracteosa were present in large clumps in the more densely shaded places, though they are herbs with a wide range of shade tolerance. They appear to flourish best in moist situations in partial shade. In many cases they may dominate a considerable area, and they are a conspicuous feature of the vegetation of second growth bush on many types of clay soils. Heliconia vulnerulenta is similar in its requirements, but it does not appear to form dense clumps. Costus spiralis was occasional in its occurrence in the shade. It is a characteristic plant of clay soils, on which it appears to grow best in partial shade. It will grow under the deep shade of Cacao, but not at all strongly, and it has not been observed as a dominant species. The fifth, and lowest layer, was the most dense of them all. The constituents were rarely over 4 feet in height, and here again, the dominants varied according to the density of the shade. In the open spaces, Setaria poiretiana was the dominant species, though in places it was superseded by Piper hirsutum. Piper marginata var. catalpifolia was abundant and became dominant where the shade was deepest. Like the other species of Piper in Trinidad, it appears to be adapted to shade conditions, but rather deeper shade than is favourable to the other species.

**Succession.**

Leaving aside questions of unsuitable soil and disease, the deterioration of a Cacao field may be regarded as beginning with the death of the shade trees. The increased exposure resulting from this weakens the Cacao, and the opening of the canopy facilitates the colonisation of the ground by species
adapted to rather more extreme conditions in their environment. It is not possible to state the course that the plant succession would take under such circumstances in more than general terms. It is reasonable to suppose that the primary colonists are plants more or less adapted to conditions of partial shade. Such plants as Piper marginata var. catalpifolia, P. hirsutum and Heliconia bihae might be expected to appear first. In the more open situations, grasses such as Setaria poiretiana and woody species such as Cestrum latifolium and Cecropia peltata might be the primary colonists, followed by Melastomaceae and forest trees. In outline, the course of events could probably be represented as follows:

Death of the shade trees. - Invasion by Piper spp.
and giant herbs. - Death of the Cacao. - Invasion by
Cestrum, Cecropia, etc. - Invasion by Melastomaceae
and forest trees. - Development of secondary forest.

The succession might reasonably be expected to culminate in secondary forest, but no estimate can be made as to the length of time that would have to elapse before this end could be achieved, assuming that there would be no interference by external influences due to the activities of Man. A great deal undoubtedly depends upon the proximity of sources of seed, and the means by which it is dispersed. Most of the early colonists postulated above bear seed in fleshy fruits, which might conceivably be dispersed by birds.

The following is a list of the principal species:

1. First tree layer.
   Erythrina glauca
   D.

2. Second tree layer.
   Cecropia peltata
   D.

3. Third tree layer.
   Theobroma cacao
   L.D.
   Cecropia peltata
   L.D.
4. **First shrub layer.**
- *Cestrum latifolium* L.D.
- *Piper hirsutum* L.D.
- *Heliconia bihae* O.
- *H. pulverulenta* O.
- *Renealmia bracteosa* O.
- *Costus spiralis* O.
- *Cassia spp.* R.

5. **Second shrub layer.**
- *Piper hirsutum* L.D.
- *P. marginata var. catalpifolia* L.D.
- *Setaria poiretiana* L.D.
- *Miconia spp.* R.
- *Ferns* A.

**THE WEEDS OF CULTIVATED CLAY AND ALLUVIAL SOILS.**

At the end of January a small area of Sugar Cane was examined, situated on the top of a clay ridge, about 5/8 mile from Todd's Road Station along Fletcher Road. The soil was a clay of the Talparo type, and on the west side of the ridge there was a landslide about 20 years old. Owing to illness the owner of the land had been unable to clean the crop since planting it at the end of the dry season of 1939. The ground had not been cleaned, therefore, for at least six months, and during that time a rank weed flora had developed.

The Sugar Cane was about four feet high, and it had probably exerted a considerable modifying effect on the weed flora. Nevertheless, the soil between the cane stools was almost completely covered with weeds, amongst which grasses were conspicuous. A number of typical lastro plants such as Lantana camara, Cordia cylindrostachys and Sida acuta had become established in fairly large numbers. Sugar Cane is a light demanding plant that will not tolerate shade. It therefore appears probable that in a few years time, provided that there is no external interference, it will be shaded out by Cordia and Lantana, or any other tall growing shrubs which may appear.

The following is a list of the principal weeds:
Allamanda cathartica
Andropogon bicornis
Bactris major
Bidens pilosa
Borleria eryngioides
Cecropia peltata
Clidemia hirta
Commelina elegans
Cordia cylindrostachys
Costus spiralis
Cyperus spp.
Digitaria sanguinalis
Emilia sonchifolia
Eupatorium odoratum
Gymnogramme calomelanos
Hyptis capitata
Inga venosa seedlings
Lantana camara
Momordica charantia
Paspalum conjugatum
Philantus niruri
Sida acuta
Solamum spp.
Sonchus oleraceus

A similar piece of Sugar Cane growing on alluvial soil of the L'Ebranche type was about six feet high, but much less infested with weeds since it had been cleaned since planting. In this case members of the Compositae were the conspicuous feature of the vegetation, though no single species could be described as dominant. Shrubby invaders were rare, and it appeared that weeding coupled with the shade cast by the Cane was sufficient to keep down the weeds very effectively. Eryngium foetidum was a characteristic weed of Sugar Cane on this type of soil, and it was usually abundant on the sides of the banks near the drains.
Next to the area of Sugar Cane mentioned above, there was a plot of Sweet Potato in process of being harvested. This land had not been cleaned for two months, and there was a considerably more luxuriant growth of weeds, containing a greater proportion of shrubs and grasses, probably as the result of less severe competition. Cordia cylindrostachys and Lantana camara were abundant, and Vismia ferruginea was beginning to appear. Eryngium foetidum was absent, but it was replaced on the sides of the ridges by Cyperus spp. and a fern commonly found in Cacao fields. Grasses were present in greater abundance, and considered as a whole they constituted the dominant feature of the vegetation.

Bidens pilosa
Borreria eryngioides
Cordia cylindrostachys
Cyperus spp.
Digitaria sanguinalis
Emilia sonchifolia
Fern sp.
Lantana camara
Momordica charantia
Panicum zizanoides
Philanthus niruri
Rotboellia exaltata
Sebastiana sp.
Setaria poiretiana
Sida acuta
Sonchus oleraceus
Synedrella nodiflora

Succession.

On the Talparo clay and L'Ebranche alluvial types of soil, plant succession appears to begin with a rapid development of annual compositae and grasses, followed by perennial grasses and shrubs. Borreria does not commonly become a dominant as it does on sandy soils, owing to severe competition from grasses such as Paspalum fasciculatum, which is a common grass of abandoned clay soils. This grass appears to be comparable with Imperata cylindrica in Malaya (Symington, 1933) in that it may
retard plant succession if it can become dominant at an early stage. This was particularly noticeable on abandoned Cane land in the Ravine Sable valley, most of which was covered with a dense growth of this grass, and scattered bushes of Cordia cylindrostachys. If Cordia cylindrostachys and Lantana camara become established in sufficient numbers before the grass has become dominant, it will eventually be shaded out by them, and colonisation by other shrubs and trees becomes possible, and a field layer of giant herbs may develop.

If, as is often the case on Talparo clay soils, the top soil has been removed either by erosion or landslide, the vegetation that arises may consist of a shrub layer dominated by Clibadium surinamense, and a field layer of which the dominant is Andropogon bicorns. Whether succession would proceed any further, and what the next stage would be, it is not possible to say, but it seems reasonable to suppose that no useful type of vegetation would develop naturally within a reasonable time, say 50 years at least, and it would be very difficult if not impossible to establish one.

**THE EFFECT OF FIRE ON THE SOIL AND VEGETATION.**

In the Todd's Road area, the usual practice when clearing bush prior to cultivating the land is as follows. The bush is cut down, and the larger timber, i.e. material of about 8" in diameter and over may be converted into charcoal. All the small brushwood, etc. is left to dry out, and it is subsequently burnt. Simple precautions against the spread of the fire to the surrounding bush are compulsory, and a license must be obtained before burning can be carried out. In spite of these precautions, considerable areas of resting bush are burned unnecessarily
If the burn is really effective, all vegetable matter, with the exception of large stumps and tree trunks, is consumed in the flames, leaving a thin covering of ash over the surface of the soil. This layer of ash considerably enhances the fertility of the surface three inches of soil, but its effect is transitory, since the mineral salts thus made available are rapidly leached out by heavy rain. A serious disadvantage of this method of clearing, is the destruction of vegetable matter, which if left to decompose would improve the humic status of the soil. The sandy soils of the area have a fairly good humus content when newly cleared, but this rapidly deteriorates under conditions of cultivation, and this is probably one of the chief reasons for the rapid loss of fertility of these soils.

There is also the grave danger of soil erosion. The burn is naturally carried out in the dry season, but planting of crops is not done until the beginning of the rainy season. The soil is therefore completely devoid of cover until the crop is well developed. The first crop taken after burning is usually Maize, rather widely spaced, so that an effective cover is not really attained until a crop of weeds has grown up.

Newly burned land is very free from weeds, especially if it has been recently under forest, or Cacao, and it is not difficult to keep clean after the Maize crop has been planted. Colonisation of the ground by weeds among the first crop is slow, and it is retarded by clean weeding operations. These operations could be made to assist in the control of erosion if they were carried out along the contours of the ground, and not straight up and down the slope, as is the case in this area.

Fire in the resting bush is generally started accident-
ally through the carelessness of the local inhabitants. It runs through the dry undergrowth and plant residues on the ground very quickly and scorches the larger shrubs and trees severely. The ground cover and decaying plant residues are completely destroyed, so that protection of the soil from heavy rains is considerably reduced. Not only is the soil exposed to the erosive action of rain, but the normal course of plant succession on such areas must be seriously interfered with, and the rate at which a forest cover develops is retarded. Comparatively few species are resistant to fire, the outstanding ones being Coccoloba latifolia and Maximilleana caribbea, but there are several others which can recover after being severely scorched.

THE VEGETATION OF TRACES AND FOOTPATHS.

The traces in the area are continually being cut over to provide fodder for livestock. The effect is very noticeable in that all the traces are very tidy in appearance because the grass is kept short, and it is often remarkably free from woody species and tough wiry weeds. The grasses on different soils showed marked differences, those on the clay being more luxuriant and forming a closer cover. Panicum fasciculatum was one of the commoner grasses on the clay soils, but on the sandy soils there was less grass and a greater abundance of wiry and tough weeds. Sporobolus indicus was common together with Borreria and Sida, though these varied in their abundance with the grasses. Borreria was particularly abundant on the traces where little or no stock was kept. This was particularly noticeable in the northern part of the area, where there was a considerable amount of High Bush on land which had been abandoned for a long time.
In places, small patches of ground at the side of the trace are kept grazed down by tethered animals, but here the grass is not kept short, nor is it often cut, so that tall woody species of Cordia, Solanum, Miconia, etc. are often present. It appears that cutting out the woody species encourages the growth of grass as one might expect, but grazing alone is not sufficient owing to the unpalatability of the undesirable plants. A small piece of Savannah outside an Indian dwelling showed that it might be possible to encourage the growth of grass by suitable management.

The savannah in question was situated on Caroni sand, the worst type of soil in the area, and its purpose was to provide a certain amount of grazing for a cow. It was kept short by grazing, and at the beginning and end of the dry season it was cut short with a cutlass. A short distance away was a piece of ground that was grazed but not cutlassed. The difference between the two was very striking, for tough and woody species such as Lantana, Urena and Borreria were predominant. Such grass as existed there was not in such good condition as that on the cutlassed plot, nor was it in such abundance. A similar piece of savannah in a different place showed what appeared to be the effects of overgrazing. There were many small patches of bare ground, there was practically no grass, and the dominant constituent of the vegetation was Borreria verticillata. The soil was the same as in the first example, consequently the observed differences may reasonably be put down to differences in management.

Savannah near Indian Dwelling:

Axonopus ciliaris  
Borreria verticillata  
Cenchrus echinatus  
Cyperus spp.  
Desmodium supinum  
D. triflorum

D.  
F.  
O.  
O.  
O.  
O.
Urena lobata
Microtea debilis
Ocimum
Portulaca pilosa
Phyllanthus niruri
Sporobolus indicus

The heavy treading on the footpaths precluded the growth of any vegetation, but on the edge of them, especially where they formed the boundary between two pieces of land, there was usually an abundant growth of weeds, amongst which Borreria and Sida were conspicuous, especially on sandy soils.

THE VEGETATION OF LANDSLIDES.

Landslides are common on the Talparo clay soils in the south-eastern part of the Todd’s Road district. They occur in the rainy season on the steeper slopes, carrying away the top soil and exposing the infertile subsoil which is useless for agricultural purposes. The vegetation arising on landslides appears to vary with the severity of the slide and its age. The oldest landslide seen was about twenty years old, and there were still large patches of bare soil on it. There was only a sparse covering of Andropogon bicorinis, and a few plants of Clidemia hirta. Another rather extreme example, of unknown age, was completely covered with a species of Lycopodium on the lower half, and the upper half was covered with Paspalum fasciculatum and bushes of Clibadium surinamense and Clidemia hirta. On less severe landslides there were often zones of vegetation which appeared to correspond with the different zones of soil resulting from the disturbance. A particularly good example of this was found on the western side of the ridge traversed by Fletcher Road, about one mile from Todd’s Road railway station.

The landslide was three years old, and had occurred when the land was bearing a crop of Sugar Cane. The land had
naturally been abandoned, but there were scattered stools of Sugar Cane still growing. The undisturbed ground at the top of the ridge was fairly level, but it sloped abruptly away where the clay had slipped, and as the lower limits of the landslide were approached the slope became less steep. There were two ridges running along the contour about half way down, with a hollow between them in which water had accumulated. The vegetation was examined along a line running from the top to the bottom of the landslide and extending a little way into the lastro beyond. Eight zones of vegetation were distinguished and a list of the species in each zone was made. Samples of the surface soil were taken at various points, in order to try and decide its origin.

(1) The undisturbed soil at the top of the slope was covered with a dense growth of Paspalum fasciculatum, and amongst it Panicum zizanoides was abundant. The only other herbaceous species present was Stachytarpheta jamaicensis. There were a few shrubs, notably Cordia cylindrostachys, Lantana camara, Cassia undulata and Psidium guajava, and a few stools of Sugar Cane. The soil, which had not been disturbed, was dark brown in colour and contained a fair proportion of sand. The organic matter content was high probably owing to the dense covering of grass. It contained a fairly good percentage of nitrogen, and the C/N ratio was high, indicating that much of the organic matter was undecomposed.

Cassia undulata
Cordia cylindrostachys
Lantana camara
Pancium zizanoides
Paspalum fasciculatum
Saccharum sp.
Stachytarpheta jamaicensis

R.
R.
R.
A.
D.
O.
O.

(2) On the steep initial slope at the top of the landslide there was very little vegetation and most of the ground was bare.
Paspalum fasciculatum was the commonest plant in this zone, and of the few others, Clidemia hirta and Miconia acinodendron were of rare occurrence. The slipping away of the top soil had left the parent material exposed. This was a blue grey clay, with a yellowish brown coating over the crevices, and red and yellow streaks inside the larger masses. There was a very thin layer of soil on the surface, brown in colour, but not more than an inch deep. Analysis of a sample showed that it was slightly acid, very poor in organic matter and nitrogen, and having a low C/N ratio. The figure for the average nutrients was very high, probably owing to the presence of gypsum, which is a common feature of Talparo clay soils.

Clidemia hirta  R.
Miconia acinodendron  R.
Paspalum fasciculatum  D.

(3) Below the second zone the slope of the ground became less steep, and the vegetation more luxuriant. Panicum zizanoides was the dominant plant of this zone, where it grew up to a height of about three feet. There were occasional plants of Cyperus spp. and Paspalum conjugatum. Lantana camara and Solanum sp. were present, but not in sufficient numbers to constitute a shrub layer in the vegetation. This soil was brown in colour, and more acid in its reaction than in the zones above. It contained a fair amount of organic matter, and the nitrogen content was fairly good, giving a C/N ratio indicative of well decomposed organic matter. The analysis suggested that the soil of this zone was probably composed largely of the original top soil.

Asclepias curassivica  R.
Cyperus spp.  O.
Lantana camara  R.
Panicum zizanoides  D.
Paspalum conjugatum  O.
Solanum sp.  R.

(4) The vegetation of the first ridge had the appearance
of lastro in that there were two distinct layers, one of shrubs and one of herbaceous species. Lantana camara and Cordia cylindrostachys were the dominant shrubs, while Cassia undulata and Vismia ferruginea were rare. In the lower layer of vegetation Paspalum fasciculatum was the dominant, and Panicum zizanoides was frequent. There were occasional specimens of Desmodium supinum and a few stools of Sugar Cane. Owing to the presence of Sugar Cane, it was presumed that the soil had not been seriously disturbed by the downward movement, and therefore consisted largely of the original top soil. Analysis showed that it was very similar to the soil in the zone above, but not so rich in nitrogen and paler in colour. The C/N ratio indicated a certain amount of undecomposed organic matter. The lower nitrogen content may account for the less luxuriant development of grasses, and the consequent development of shrubs.

**Shrub layer.**

<table>
<thead>
<tr>
<th>Plant</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassia undulata</td>
<td>R.</td>
</tr>
<tr>
<td>Cordia cylindrostachys</td>
<td>Co.D.</td>
</tr>
<tr>
<td>Lantana camara</td>
<td>Co.D.</td>
</tr>
<tr>
<td>Vismia ferruginea</td>
<td>R.</td>
</tr>
</tbody>
</table>

**Field layer.**

<table>
<thead>
<tr>
<th>Plant</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costus spiralis</td>
<td>R.</td>
</tr>
<tr>
<td>Desmodium supinum</td>
<td>O.</td>
</tr>
<tr>
<td>Eupatorium odoratum</td>
<td>R.</td>
</tr>
<tr>
<td>Panicum zizanoides</td>
<td>F.</td>
</tr>
<tr>
<td>Paspalum fasciculatum</td>
<td>D.</td>
</tr>
<tr>
<td>Saccharum sp.</td>
<td>O.</td>
</tr>
</tbody>
</table>

(5) In the hollow between the first and second ridges Paspalum fasciculatum and Panicum zizanoides were co-dominant. Hyptis capitata was abundant, Phyllanthus and Cyperus spp. occasional. There was no shrub layer since Lantana camara was only of rare occurrence. No samples of the soil were taken in this zone or the one below, but the appearance of it suggested that it was a mixture of top soil and subsoil.
Clidemia hirta  
Cyperus spp.  
Hyptis capitata  
Lantana camara  
Panicum zizanoides  
Paspalum fasciculatum  
Phyllanthus niruri  

(6) On the second ridge the vegetation was relatively sparse, and consisted of very few species. Paspalum fasciculatum was dominant and Panicum zizanoides frequent. In places Andropogon bicornis was dominant, but there was a considerable amount of bare ground in this zone. The soil was for the most part grey in colour with brown mottlings, which would seem to indicate that it was probably subsoil pushed out from the foot of the landslide.

Andropogon bicornis  
Panicum zizanoides  
Paspalum fasciculatum  

(7) Beyond the foot of the landslide, the vegetation was more luxuriant, and differentiated into two layers. The upper layer consisted of Cordia cylindrostachys, which was the dominant, and Lantana camara, both of which grew to a height of about ten feet. There were scattered individuals of Cassia undulata and Cecropia peltata, the latter growing to about 20 feet high. The ground vegetation was dominated by Paspalum fasciculatum and Panicum zizanoides was abundant. Desmodium supinum was occasional, and there were scattered specimens of Costus spiralis and frequent stools of Sugar Cane. The soil was light brown in colour, containing a considerable proportion of sand. It was slightly acid, the organic matter and nitrogen contents were low, and the C/N ratio indicated well decomposed humus. There had apparently been no mechanical disturbance of the soil, but the high proportion of sand is suggestive of hill wash, especially in view of the fact that the soil of the top of the hill contained a fair amount.
Shrub layer.

- Cassia undulata
- Cecropia peltata
- Cordia cylindrostachrys
- Lantana camara

Field layer.

- Costus spiralis
- Desmodium supinum
- Panicum zizanoides
- Paspalum fasciculatum
- Saccharum sp.

(8) In the lowest zone of vegetation examined, the shrub layer was similar to that of the preceding one in that Cordia cylindrostachrys was the dominant, with Lantana camara abundant. The general height of the shrub layer was about 15 to about 25 feet. Psidium guajava was a constituent of the shrub layer in this zone, which together with the state of the field layer, indicated that the lastro here was rather better developed that in the preceding zone. The field layer consisted of a layer of giant herbs, and a lower layer of smaller herbs and shrubs characteristic of shade conditions. The soil in this zone was similar to that of the zone above. The apparently high content of organic matter, and very high C/N ratio, are due to the presence of free carbon in the sample which may have arisen from a fire or charcoal burning operations.

Shrub layer.

- Cassia undulata
- Cecropia peltata
- Cordia cylindrostachrys
- Lantana camara
- Psidium guajava

Upper field layer.

- Heliconia bihae
- Rhesalmia bracteosa
- Saccharum sp.
Lower field layer.

Clidemia hirta
Cyperus spp.
Ferns
Miconia acinodendron
Monstera sp.
Piper marginata var. catalpifolia
Solanum sp.

R.
O.
O.
F.
R.
O.
R.

Landslip in the Todd's Road Area.

Fletcher Road, 1 mile from Todd's Road Station, western side of the trace. Talparo clay type soil, sampled 2nd February, 1940.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Depth</th>
<th>Sand %</th>
<th>I.T.</th>
<th>Reaction</th>
<th>O.M.</th>
<th>N %</th>
<th>C/N Av.</th>
<th>Rate</th>
<th>P₂O₅</th>
<th>Nut. sol'n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2&quot;</td>
<td>16.8</td>
<td>37</td>
<td>5.2</td>
<td>4.5</td>
<td>4.13</td>
<td>0.24</td>
<td>10.1</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2&quot;</td>
<td>2.5</td>
<td>36</td>
<td>5.8</td>
<td>5.4</td>
<td>0.29</td>
<td>0.06</td>
<td>2.7</td>
<td>550</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2&quot;</td>
<td>3.4</td>
<td>37</td>
<td>4.9</td>
<td>4.0</td>
<td>1.74</td>
<td>0.23</td>
<td>4.4</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2&quot;</td>
<td>7.8</td>
<td>40</td>
<td>4.7</td>
<td>3.8</td>
<td>1.32</td>
<td>0.12</td>
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<tr>
<td></td>
<td></td>
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<td>19</td>
<td>5.1</td>
<td>3.9</td>
<td>0.65</td>
<td>0.11</td>
<td>3.8</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2&quot;</td>
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<td>5.0</td>
<td>4.4</td>
<td>2.53</td>
<td>0.09</td>
<td>16.2</td>
<td>41</td>
</tr>
</tbody>
</table>

# Contained particles of charcoal.

PLANT SUCCESSION ON ABANDONED LAND.

The general trend of succession on abandoned land is from a simple to a complex type of vegetation passing through lastro and High Bush to High Wood. The main types of vegetation are the same in all places where the soil and climatic conditions are favourable to the development of a forest flora. In the area studied, succession on both clay and sandy soils was essentially the same, but the species concerned were for the most part different. In both cases the management of the soil appeared to have a considerable influence on the succession when the land was subsequently abandoned, frequently to such an extent that the succession appeared to be arrested at a comparatively early stage, or deflected along a different line. The intricacies of the relationship between succession and the previous treatment of the soil have not been disentangled, and it is merely a generalised
account that is presented here. Any type of vegetation may be cleared prior to the cultivation of the land, but there is naturally a strong preference among the peasants for forest land which has been newly cleared and burnt, because the soil is comparatively rich and free from weeds.

On sandy soils the land is rapidly colonised, after clearing and burning the original vegetation, by annual weeds, chiefly grasses and members of the Compositae. These are usually followed by perennial weeds of which the chief ones are Borreria eryngioides and B. verticillata. When the soil has been in cultivation and abandoned at frequent intervals, the development of Borreria on newly cleared land occurs sooner, and in some cases it may be replaced as a dominant by Sida acuta, or Urena lobata. Such plants may therefore give some indication of soil deterioration. The shrubs which follow the smaller perennial weeds are the ubiquitous Lantana camara and Cordia cylindrostachys, of which the former is the more abundant on sandy soils. These plants become the dominant species of the shrub layer within the first three years after the land has been abandoned. Colonisation by tree species may occur at the same time as the former, and form the groundwork for the development of High Bush. The trees which usually appear first are Cecropia peltata, Cithrom pyramidalae and Didymopanax morototoni, and under them a shrub layer of Miconia and Clidemia spp. develops, with a field layer of giant herbs. This type of vegetation may develop further into secondary forest containing a number of trees such as Cocotea sp., Tabebuia pentaphylla, Pentaclethra filamentosa and others. The succession may be deflected by fire, in which case an apparently stable type of vegetation is developed, dominated by Maximilleana caribsea, but the stages leading up to it are not known.
On the clay and alluvial soils, annual grasses and Compositae appear to be the primary colonists, and they are soon followed by perennial grasses and shrubs. Borreria eryngioides is a common weed, but it does not become dominant as it does on sandy soils. Within a year Cordia cylindrostachys becomes the dominant plant of the shrub layer, though Lantana camara is usually very abundant. The clay and alluvial soils are usually kept in a state of continuous cultivation, since they do not appear to suffer the same rapid rate of deterioration as sandy soils, consequently the plant succession seldom proceeds beyond this stage. If the land is abandoned, colonisation by Cecropia peltata soon occurs, and within the next five years the vegetation becomes differentiated into four layers. The tree layer consists mainly of Cecropia peltata and possibly Didymopanax morototoni, while the shrub layer is dominated by Cordia cylindrostachys with Lantana camara as the sub-dominant. Below the shrub layer, two field layers develop, the upper one consisting of giant herbs such as Heliconia bihae, and the lower one of a heterogeneous mixture of grasses, Piper spp., and Miconia spp. Thus on clay and alluvial soils, giant herbs and other plants adapted to a moist and partially shaded environment, come in at a much earlier stage in the succession. Provided that the development of Giant Herbs is not too vigorous, colonisation by trees and subsequent development of High Bush and High Wood is possible. If the soil tends to be at all waterlogged, dense thickets of Bactris major and Renealmia bracteosa are liable to arise, to the exclusion of all other species. On alluvial soils succession may be arrested at least temporarily by the vigorous development of Panicum fasciculatum.
DIAGRAM OF THE PLANT SUCCESSION ON SANDY SOILS.

High Wood → Primary forest.
Ocotea
Tabebuia etc.
↑↓
High Bush
Didymopanax
Cecropia
Melastomaceae
↑↓
Lastro
Lantana
Borreria
Fire
Maximilleana
↑↓
Garden
Borreria
Compositae
Grasses.

DIAGRAM OF THE PLANT SUCCESSION ON CLAY AND ALLUVIAL SOILS.

High Wood → Primary Forest
↑↓
High Bush
Cecropia
Didymopanax etc.
↑↓
Lastro
Cordia
Heliconia
↑↓
Garden
Lantana
Grasses
Grasses
↑↓
Compositae

Carapa
Eschweilera
Maximilleana
Cleared ground

Bactris
Cleared ground
SUMMARY AND CONCLUSIONS.

As soon as the vegetation is destroyed or interfered with in any way, the process known as plant succession begins to operate in such a way that the original vegetation tends to be restored. Many factors come into operation which delay, deflect or arrest this tendency. On cultivated soils, weeding operations and competition from crops prevent the development of all but the primary stages of the normal succession. Continued cultivation, especially on sandy soils, leads to soil deterioration through erosion and the removal of plant nutrients, and so produces a deflection of the normal succession. Cultivation and abandonment at frequent intervals, not only hastens soil deterioration, but it tends to encourage a type of vegetation composed of troublesome weeds capable of invading cultivated land. In this way an important object of resting the land under bush is defeated, for instead of the weeds being killed out by the shading effect of taller species, they are able to increase their numbers, since the species which would succeed them never have an opportunity of becoming established. If soil deterioration has been severe, the deflected succession may be arrested at an early stage, beyond which there can be no further development owing to unfavourable soil conditions. Fire is another important factor, since it not only deflects the succession by the elimination of species which cannot withstand fire, but it is liable to give rise to a type of vegetation different from that which would normally arise.

The major differences in soil and climatic conditions are clearly reflected in the vegetation, and detailed study would probably reveal a close connection between all three in tropical regions. If such a connection could be established, the vegetation would give a reliable indication of conditions which could not otherwise be detected except by careful chemical analysis.
and the collection of meteorological data. The chief disadvantage is that the indications given by the vegetation would only be applicable over a small area, or a limited range of conditions. The initial type of vegetation existing on land which has never been cultivated can only indicate the type of agriculture which could be pursued. In the absence of more detailed knowledge, the vegetation might be indicative of initial fertility, but it would not give any indication of the nutrient resources of the soil, nor of the reactions which would follow when the land was brought into cultivation. The matter would be very much simplified if single species of plants could be found which could be relied upon as indicators of different sets of conditions. Since most plants are fairly adaptable to a range of conditions, a single species cannot usually be taken as indicative of a given set of conditions without due regard to the other constituents of the vegetation, i.e. the vegetation as a whole is a better indicator than a single constituent of it.

Of the soils in the Todd's Road district, those of the Valencia series are the most infertile, and they should never have been brought into cultivation. Present conditions could probably be ameliorated by establishing a suitable type of vegetation before the land is abandoned. One of the outstanding soil requirements is organic matter which could be supplied by a cover crop. Such a crop should be dug in or mulched down and not burnt off when the land is again brought into cultivation. To find a suitable plant for the purpose would not be easy, and it might be easier and better to select a mixture of shrubs and herbs which would replace and compete with the lastro which would otherwise arise.
ACKNOWLEDGEMENTS.

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PLANTS FOUND ON CLAY SOILS IN THE TODD'S ROAD AREA.

Aeschynomene americana
Andropogon bicornis
Asclepias curassavica
Bactris major
Bidens cynapiifolia
Borresia laevis
B. latifolia
Bravaisia floribunda
Brownia latifolia
Calathea discolor
Clidium surinamense
Clidemia hirta
Coccoloba latifolia
Costus speciosus
C. spiralis
Coutoutbea spicata
Desmodium adscendens
Desmoncus major
Dioclea megacarpa
Echinocloa colonum
Eclipta alba
Emilia sonchifolia
Eryngium foetidum
Gymnogramme calomelanos
Heliconia bihae
H. psittacorum
H. pulverulenta
Hymenocallis tubiflora
Ischnosiphon arouma
Jussaeia affinis
J. decurrens
Leptochloa virgata
Lyco podium sp.
Mimosa pudica
Palicourea crocea
Panicum laxum
P. stoloniferum
Panicum sizzanioides
Paspalum conjugatum
Paspalum fasciculatum
Phenex vulgaris
Physalis angulata
Piper hirsutum
P. peltatum
P. tuberculata
Pseudoelephantopus spicatus
Leguminosae
Gramineae
Asclepiadaceae
Palmae
Compositae
Rubiaceae
Acanthaceae
Leucaena
Marantaceae
Compositae
Melastomaceae
Polygonaceae
Zingiberaceae
Gentianaceae
Leguminosae
Palmae
Leguminosae
Gramineae
Compositae

Musaceae
Amaryllidaceae
Marantaceae
Onagraceae
Gramineae
Lycopodiaceae
Leguminosae
Rubiaceae
Gramineae
Urticaceae
Solanaceae
Piperaceae
Compositae
Renealmia bracteosa
Rothoeelia exaltata
Sebastiania sp.
Solanum jureipeba
Synedrella nodiflora

Thespesia argentea
Vismia ferrugineum

Spathiphyllum cannafolium
Sphenocea zeylanicum

Scitamineae
Gramineae
Euphorbiaceae
Solanaceae
Compositae
Palmae
Hypericaceae
Araceae
Campanulaceae

PLANTS FOUND ON THE SANDY SOILS OF THE TODD'S ROAD AREA.

Axonopus ciliaris
Bidens pilosa
Boerhavia paniculata
Bryophyllum calycinum
Bromelia pinguin

Cassia alata
C. bacillaris
Cenchrus echinatus
Centratherum muticum
Cephaelis tomentosa
Clidemia neglecta
Combretum fruticosum
Cousarea paniculata
Cyathula achyranthoides

Desmodium supinum
D. triflorum
Digitaria sanguinalis
Diplasia keratafolia

Elephantopus mollis
Hyptis atrorubens

Miconia lacera
M. longifolia
M. nervosa
M. racemosa
Microtea debilis

Nepsera aquatica
Ochroma pyramidalare
Ocimum sp.
Orthocladia laxa

Paspalum coryphaeum

Gramineae
Compositae
Nyctaginaceae
Crassulaceae
Bromeliaceae
Leguminosae

Gramineae
Compositae
Rubiaceae
Melastomaceae
Combretaceae
Rubiaceae
Amarantaceae

Leguminosae

Gramineae
Cyperaceae

Compositae

Labiatae

Melastomaceae

Phytolaccaceae

Bombacaceae
Labiatae
Gramineae
Pentaclethra filamentosa  
Phaeosphaerion persicarafolium  
Piper marginata var. catalpifolia  
Portulaca pilosa  

Sabiaceae trinitensis  
Sporobolus indicus  

Tabernaemontana undulata  
Tecoma serratifolia  
Triumfetta berthamia  

Urena lobata  
Vanilla inodora  
Vismia cayennensis  

Xyphidium floribundum  

Leguminosae  
Commelinaceae  
Piperaceae  
Portulacaceae  

Rubiaceae  
Gramineae  

Apoecynaceae  
Bignoniaceae  
Tiliaceae  

Malvaceae  
Orchidaceae  
Hypericaceae  

Haemodoraceae  

PLANTS FOUND ON BOTH TYPES OF SOIL.

Aconitum arborescens  
Ageratum coryzoides  

Borreria eryngioides  
B. verticillata  

Cassia undulata  
Cecropia peltata  
Commelina elegans  
Cestrum latifolium  
Cordia cylindrostachys  

Desmodium adscendens  
D. scorpiurus  
Didymopanax morototoni  
Dioscorea spp.  

Hyptis capitata  
Ischnosiphon arucama  
Inga venosa  

Lantana camara  

Macfadyena corimbosa  
Maximiliania carriabea  
Miconia acinodendron  

Philanthus miruri  
Psidium guajava  
Pseudoelephantopus spicatus  
Pterolepis glomerata  

Setaria poiretiana  
Smilax spp.  

Solanaceae  
Compositae  

Rubiaceae  

Leguminosae  
Moraceae  
Commelinaceae  
Solanaceae  
Boraginaceae  

Leguminosae  
Araliaceae  
Dioscoraceae  

Labiatae  
Marantaceae  
Leguminosae  

Verbeneae  
Bignoniaceae  
Palmæ  
Melastomaceae  

Euphorbiaceae  
Myrtaceae  
Compositae  
Melastomaceae  

Gramineae
Solanum jamaicensis  
Sonchus oleraceus  
Tradescantia geniculata  
Vismia ferrugineum  
Solanaceae  
Compositae  
Commelinaceae  
Hypericaceae
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