The Vegetation
of
Shipstern Nature Reserve
(Corozal District, Belize, Central America)

A structural and floristic approach

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1. Introduction

1.1 Shipstern Nature Reserve

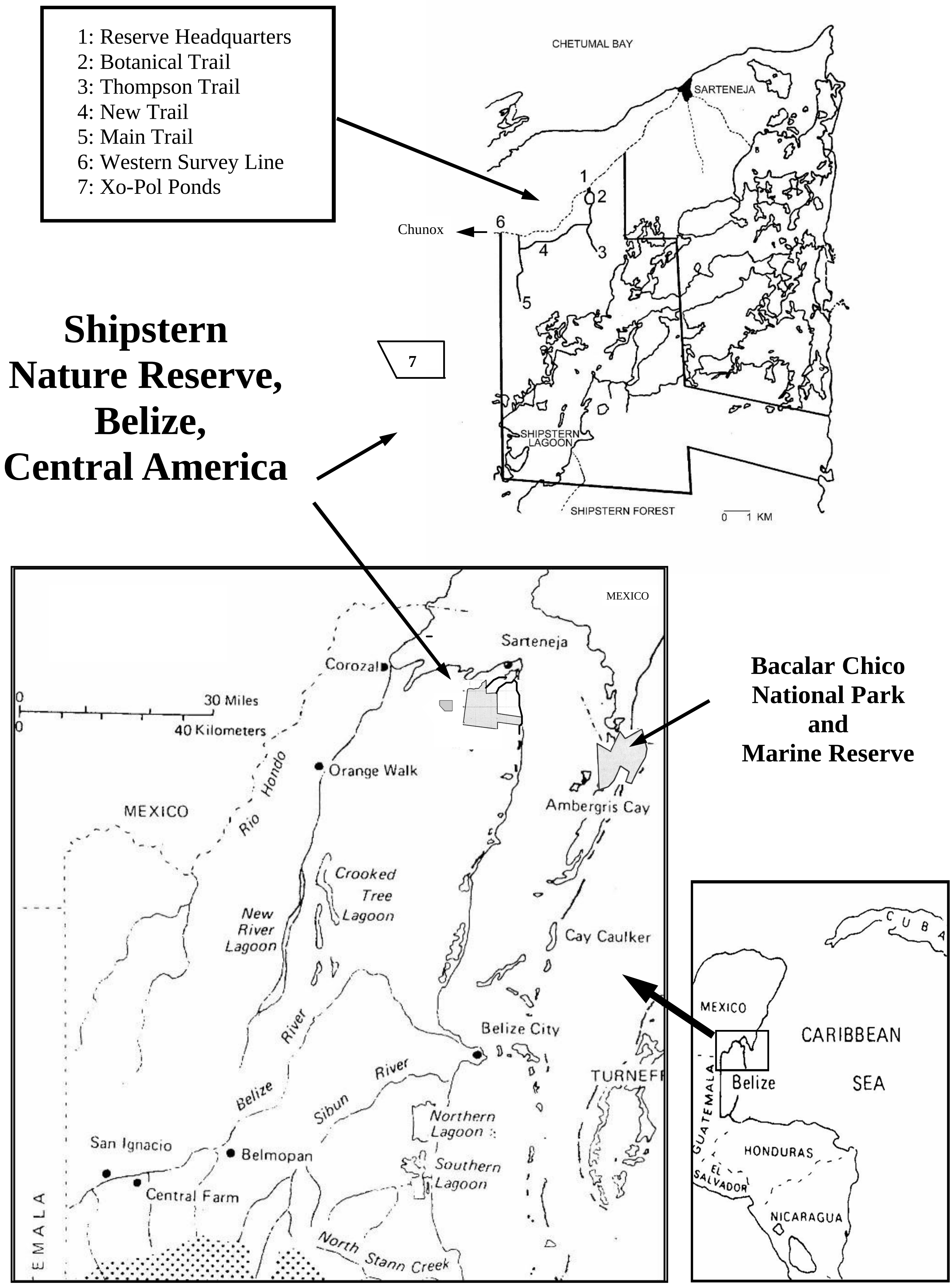
Shipstern Nature Reserve is a private nature reserve owned by the International Tropical Conservation Foundation, based in Marin-Neuchâtel, Switzerland. It is located in the north-eastern part of the Corozal District, on the southern shore of the Chetumal Bay. The road linking the villages of Chunox and Sarteneja delimits the northern border of the reserve.
Created in 1989, the Shipstern Nature Reserve covers approximately 8'000 hectares (20'000 acres). In 1990, a further 13'000 hectares (32'000 acres) on the eastern side of the reserve were declared non-hunting area by the Minister of Natural Resources at the time, the Hon. Florencio Marin. In 1995, the ITCF bought an additional 600 hectares of forest located to the West side of the reserve, including a group of small lakes and marshes called the Xo-Pol ponds. The latter form a very important habitat as they encompass several of the few freshwater bodies of the area (see map, p. 3).

The ITCF was instrumental, with the help of funds provided by the European Community, in setting up the Bacalar Chico National Park and Marine Reserve, covering 13'000 hectares on the northern half of Ambergris Caye and bordering the international boundary of Belize and Mexico. The park includes a variety of habitats such as coral reefs, lagoons, mangroves and forest, some of which are similar to those found in Shipstern Nature Reserve.

The Shipstern Reserve includes part of the Shipstern Lagoon, an intricate system of shallow lagoons bordered by mangroves and other saline wetlands, listed in the Directory of Neotropical Wetlands (IUCN/IWRB, 1986). These lagoons are dotted with small mangrove islands that form important breeding habitats for many bird species: among others the reddish egret (*Egretta rufescens*), the roseate spoonbill (*Platalea ajaja*), the white ibis (*Eudocimus albus*) and the american woodstork (*Mycteria americana*). The latter is now a rare breeding bird in Belize and rapidly declining in other parts of its range.
The Shipstern Nature Reserve is approximately 7 km away from Sarteneja, a fishermen community of ca. 1500 inhabitants. The area surrounding the village was fairly isolated from the rest of the country until 1980, when the dirt track were improved into an all-weather road. For this reason, it remained particularly rich with regard to its fauna and forest cover. All five cat species occuring in Belize are present in and around the reserve, and tracks of large mammals such as Baird's Tapir (*Tapirus bairdii*) are regularly observed.
The pressure on the area has, until recently, remained relatively low. Occasional hunting during the closure of the fishing season has always been carried out by the villagers of Sarteneja. Nowadays, with the increase in population, agriculture is being developped further and milpas (slash & burn cultivation) are expanding rapidly (see fig. 2, below).

The hardest pressure on the area, however, comes from the West, where Mennonites (european settlers of swiss, dutch and german origin that came to Belize during the sixties) are expanding their agricultural activities from Little Belize towards Shipstern Lagoon. Villagers

Fig. 2: Map of Yucatan, Belize, Bacalar Chico National Park and Shipstern Nature Reserve.



from Chunox, a community more traditionally based on agriculture, have also cleared further areas of forest south of the Xo-Pol area. Up to now, only minor conservation problems have occured within the Shipstern Nature Reserve, such as occasional poaching or theft of trees. The latter concerns mainly species such as Santa Maria (*Calophyllum brasiliense*, Guttiferae), Ciricote (*Cordia dodecandra*, Boraginaceae) and Mahogany (*Swietenia macrophylla*, Meliaceae). The revival of selective logging in the last forested areas of the eastern part of the Corozal District is disquieting: within little more than a decade, vast areas surrounding Shipstern Nature Reserve have been stripped of their valuable hardwood species, sometimes illegally so. As WRIGHT ET AL. (1959) report, the Mahogany in the forests of eastern Corozal is slow in growing and often stunted, but of excellent quality. Unfortunately, a whole range of species are now harvested, and often undersized trees are indiscriminately taken out. This poses a serious threat to the long-term viability of certain species, foremost Mahogany, and it is to fear that viable populations shall not continue to exist outside protected areas, if effective tree regeneration is impeded. Although forestry regulations are excellent in Belize, their implementation is made difficult by lack of personnel and financial means.

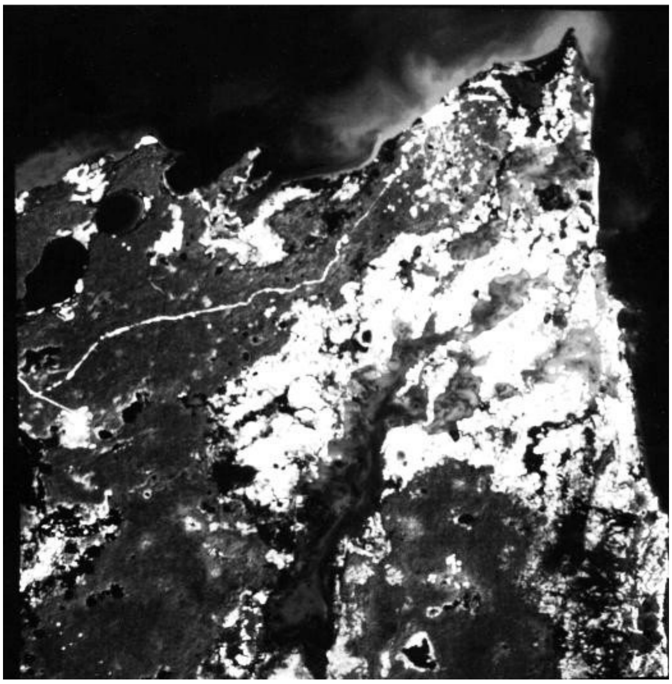


Fig. 2: 1988 satellite photograph of northeastern Corozal District, showing extent of forested areas.

The pressure on Shipstern Nature Reserve will undoubtedly increase as a result of population growth, and the reserve itself will be, at some point in the future, completely surrounded by a mosaic of forest remnants and cultivated areas. It is therefore important to secure more land adjacent to the reserve to ensure its biological viability in the future.

Scientific research in this part of the country has always been relatively poor, a fact probably due to the isolated position of the area. In addition to the vegetation studies to be discussed in the following sub-chapter, various faunal studies have been carried out, in the past 15 years. The University of Leeds carried out preliminary faunal surveys during their expeditions in the mid-eighties. MEERMAN, former manager of Shipstern Nature Reserve, started, together with BOOMSMA, a series of annotated checklists of butterflies (Meerman & Boomsma, 1993), dragonflies (Boomsma, 1993), invertebrates (Meerman, 1993b), reptiles & amphibians (Meerman, 1993c), birds (Meerman, 1993d) and mammals (Meerman, 1993e). A preliminary survey of the freshwater fish fauna was carried out by the author (Bijleveld, 1990). A large-scale mammal survey, made possible by a grant of the SDC (Swiss Agency for Development and Cooperation), was carried out by the Wildlife Conservation Society (Miller, Miller & Quigley, 1995). A team of the University of Neuchâtel collected pedological data during their field course of 1993, some of which are presented here. BÄRTSCHI, of the University of Neuchâtel, carried out an extensive survey on bats during the first half of 1997.

1.2 Earlier vegetation studies in the area

Unlike research in other fields of biology, vegetation studies carried out in the north-eastern part of the Corozal District are scarce. Botanical surveys have been limited to nearby areas such as Freshwater Creek Forest Reserve and Honey Camp (Orange Walk District) south-east of the Shipstern Reserve, and to some areas in the northern part of the Corozal District - according to collecting localities cited in Bartlett (1935), Standley and Record (1936), Lundell (1940), Spellman et al. (1975) and Dwyer and Spellman (1981). The Honey Camp area, together with other areas in the Orange Walk district, have been botanically explored by LUNDELL, MEYER & KARLING in the 1930s. LUNDELL also collected in the adjacent state of Campeche (Mexico), and thus was able to identify the first links between the two floras. GENTLE, a local collector, provided BARTLETT and LUNDELL with numerous plant specimens from the Corozal District. As far as can be concluded from the available sources, plant collecting never took place in the immediate vicinity of Shipstern Nature Reserve, a fact which, again, is very likely linked to the geographical position and remoteness of the area.

During the 1950s, much work was done by WRIGHT et al. (1959) to provide a map and analysis of the vegetation patterns in Belize, based on the Holdridge Life Zone System (1947). The terminology used has changed since then, but the maps are still of particular interest, since the delimited vegetation patterns have not changed much (except for the areas that have been heavily disturbed - unfortunately most of the north-western part of the country). In 1984, HARTSHORN et al. published the Country Environmental Profile of Belize, wherein a corrected version of the life zone map of Belize can be found. Unfortunately, the description excludes minor life zones and transitional areas, rendering its use inadequate as a basis for more detailed vegetation analysis (see also next sub-chapter). More recently, BROKAW et al. (1990) did a study of the vegetation of the Rio Bravo Conservation Area which they regularly update (Brokaw et al., 1995 & Anonymous, 1996). IREMONGER & BROKAW (1994) produced a new Vegetation Classification for Belize, wherein the vegetation zones of Wright et al. (1959) have been corrected: according to WRIGHT himself, the species lists were sometimes short and inadequate, some distinctive vegetation patterns had been omitted and in a few cases vegetation types were shown where they do not exist.

REJMÁNKOVÁ et al. (1996) did extensive research on the wetland plant communities of northern Belize, whereas KING et al. (1992) provided a Land Resource Assessment of Northern Belize together with maps of current and past land use based on aerial photographs and satellite imagery. ZISMAN (1992) analysed the distribution of mangroves throughout

Belize using GIS methods.

In neighbouring Mexico, a typology of vegetation zones and patterns was established by MIRANDA & HERNANDEZ (1963), and completed by RZEDOWSKI (1978). The vegetation of the Biosphere Reserve of Sian Ka'an, in the province of Quintana Roo, has been studied in many aspects: OLMSTED & DURAN (1986) brought to light differences in plant communities of low inundated forests, whereas ESPEJEL (1986) classified the vegetation of littoral sand dunes. DURAN (1986) did some extensive research on low semi-deciduous forests occurring in the area. SANCHEZ (1987) studied the composition and structure of the semi-evergreen forest of the CIQRO Botanical Garden at Puerto Morelos, Quintana Roo, whereas ESCALANTE (1986) studied the overall flora of the same garden. SOUSA SANCHEZ et al. (1983) gives a summary of information about forest associations in Quintana Roo, Mexico.
Within the immediate surroundings of Shipstern Reserve, vegetation studies include only two references: WALDREN (1985), a member of the University of Leeds expedition, did a preliminary survey of transition patterns in the vegetation bordering Shipstern Lagoon, whereas MEERMAN (1993a) provided an annotated plant list for Shipstern Nature Reserve, the only published study documenting the flora of Shipstern Nature Reserve.

1.3 Climate

Belize lies in the outer tropics, i.e. in the subtropical belt, between 15 - 19° N latitude. The type of climate of this area mainly differs from the one occurring in tropical regions by its higher extreme temperatures. Mean monthly minima temperatures range from 16-17°C in winter to 24-25°C in summer, while mean monthly maxima range from 28°C in winter to 32-33°C in summer. Some maxima measured in the past exceed 40°C (Walker, 1973). Data from Santa Cruz (Corozal District) show an annual average temperature of 26°C (King et al., 1992) .

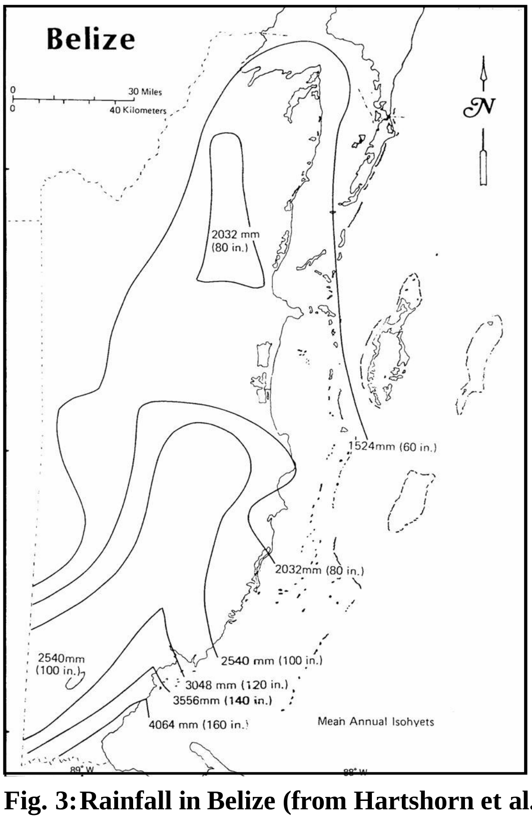
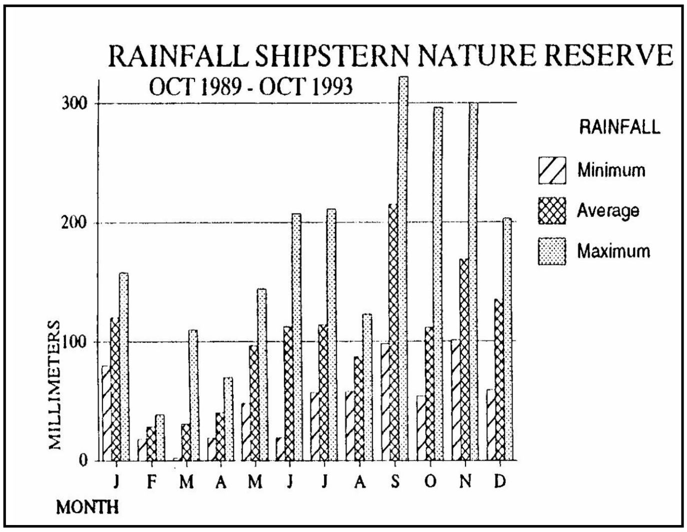


Fig. 3: Rainfall in Belize (from Hartshorn et al.)

From November to February, arctic air masses sometimes penetrate far to the south. These cold, wet masses enter the country from the North-East and affect temperatures severely. It is not unusual that temperatures drop as low as 10°C. Normally, coastal areas in Belize are exposed to southeast tradewinds.
Rainfall in Belize increases on a North-South gradient. For example, the village of Libertad, Corozal District, has an annual rainfall average of 1347 mm, whereas Barranco in the Toledo

District receives an average of 4526 mm.
Rainfall at Shipstern Nature Reserve was measured over a period of 4 years (Meerman & Boomsma, 1993). Results showed that the area receives only 1260 mm a year, with a mininum of 1029mm/ year and a maximum of 1610mm. From the available data can be concluded that Shipstern Nature Reserve and its immediate surroundings are the driest areas in Belize.



Graph 1: Rainfall in Shipstern NR, Oct.1989 to Oct.1993 (from Meerman & Boomsma, 1993)

The dry season usually starts in mid-January and ends in May, February and March being the driest months. The end of April generally sees the first showers, and rain falls more regularly as from May onwards. August, again, is a somewhat drier month. On average, the highest rainfall occurs during the month of September.
These climatic data permit some conclusions as to the exact place of Shipstern Nature Reserve in the Holdridge (1947, 1967) classification of life zones. Unfortunately, the average temperature for the area is unknown which prevents a precise positioning in the system. The Shipstern Nature Reserve area is probably a transition between the subtropical moist forest, the subtropical dry forest and the tropical dry forest life zones. Santa Cruz (Corozal District), of which the mean average temperature is known, falls into the subtropical dry forest life zone, although it is more probably also transitional.
September and November occasionally see a climatic phenomenon with sometimes dramatic consequences: hurricanes. These are, depending on their wind speed and duration, classified as tropical depressions, tropical storms or hurricanes. Hurricanes are the most powerfull of all cyclone types and may have, when they do reach coastal areas, devastating effects. It is astonishing to see that between 1886 and 1978, only 5% of the recorded hurricanes that developped in the tropical part of the Atlantic Ocean ever reached Belize. It is even more astonishing to note the extent of the damage caused by the very few that did. The hurricane that hit the country in 1931 nearly destroyed all of Belize City. The same town, among other areas, was struck again in 1961 by hurricane Hattie. This made the British government decide to move its administration to a more sheltered inland area that was to become the capital Belmopan in 1971.
Hurricane Janet hit Belize in 1955, and greatly affected the northern part of the country: it destroyed Sarteneja, then passed over the area that now encompasses Shipstern Nature Reserve, spared - to a certain degree - the village of Chunox, before finally hitting and destroying Corozal Town. The extent of the damage was not only horrendous with regard to habitations and people, but equally the vegetation: the forest in the area was completely flattened, and subsequently suffered from severe fires (J. Verde, pers. comm.). The extent of

the area hit by the hurricane is, nowadays, difficult to assess. According to J. VERDE, "an area between Sarteneja and Chunox was completely flattened, and, could the eye have seen that far, it wouldn't have taken much more destruction to actually have been able to see that village". It is obvious that certain areas must have been more seriously affected than others: for example, very large trees are still standing in the forest south of Shipstern Lagoon, whereas they are virtually absent in the forest north of the lagoon. This may give some indications as to the width of the path followed by the hurricane.
After the hurricane, logging companies were granted concessions to retrieve fallen logs by the thousands (an estimated 12'000, J. Verde, pers. comm.), a fact that indicates the state of maturity of the forest before 1955.

1.4 Geology and soils

Limestones dominate the geology of Belize, with the exception of the Maya mountains, where large upfaulted blocks of intrusive (such as granite) and associated metamorphic sedimentary rocks (such as talc and white mica) are preponderant (see Hartshorn et al. (1984), also for further details on the geology of the southern half of the country).
The northern half of the country is largely composed of a thick sequence of limestone, dolomite and evaporites called *Coban limestone* deposited in early to mid Cretaceous, overlaying a relatively thin bed of jurassic red shales. This *Coban limestone* is covered by two more recent limestones: the *Campur limestone*, the outcrops of which show a well developed karst topography, and the *Lacandon formation*, composed mainly of fragmented limestones, including recrystalised calcites and dolomites. The early Tertiary formations covering these Cretaceous limestones belong to two series: the *Santa Amelia formation*, consisting of dolomites, limestone and evaporites, is thickest near the Guatemalan border and along the Rio Hondo, but non-existant east of the New River and Crooked Tree Lagoons. The *Buena Vista formation* is a denser and more fossiliferous limestone of similar age that extends into the Shipstern area. It was long thought to be of Oligocene age, but this idea was refuted by FLORES (1952). Most rock outcrops in the area of Sarteneja belong to an old reef composed of hard, very porous, highly fossiliferous limestone, probably of Miocene to Pleistocene age, similar to the one found on the northern part of Ambergris Caye. Although only a small scale karst topography exists, numerous sink-holes, caves and natural wells are to be found in the area of Sarteneja. The sinkhole situated approx. 2.5 km south of the village is the largest in the area, and referred to by locals as "Cenote". Its diameter is approximately 60 m, and its depth unknown. In the village and on some milpas, numerous undeep wells of classical maya times can be found.They never exceed 4-5 m in depth. The water extracted from these wells either originates from perched aquifers over salt water, or from discharges of the underlying *Campur limestone*, depending on authors. The name Tzaten-a-ha, meaning "water among the rocks" in yucatec maya, was probably based upon this geological pecularity (J.Verde, pers. comm.).
The Coastal Plain and Belize Shelf developped in the Quaternary period and is a direct result

of the slumping of the eastern edge of the Yucatan platform due to numerous faults that trend north-northeast. Evidence of this slumping is given by the Rio Bravo and Booth's River escarpments, the New River Lagoon, and less evidently so by the much shallower Crooked Tree and Shipstern Lagoons. The sediments of these coastal deposits contain, quite logically, more limestone fragments in the northern half than in the southern half of the country.

Soils have been fairly well studied in Belize, first by CHARTER (1941), followed by Wright et al. (1959), BIRCHALL & JENKIN (1979), CHRISTIANSEN (1986) and finally by KING ET AL. (1992) who updated and amplified available data. Their soil classification is based on a "suite-subsuite-series" system employed by all previous authors. Suites are defined mainly in terms of parent materials, although sometimes soil features such as colour and mineralogy are used. The *Tintal Suite* is an exception to this definition: it includes all soils seasonally or permanently inundated, but formed out of a range of various transported parent materials.
Soils in the north-eastern corner of mainland Belize are closely related to the underlying limestone bedrock and belong to two main categories (King et al., 1992): the *Pembroke Suite* **-** *Xaibe Subsuite* and the *Bahia Suite* **-** *Remate Subsuite*, both of which are briefly described hereafter. Soils of inundated areas, underneath wetlands, mangroves and other marshes belong to the *Tintal Suite.*

Soils of the *Xaibe Subsuite* have been deposited on late Cenozoic limestones. They are typically composed of mostly shallow red clays over soft weathering limestone, usually with an intervening hard limestone stone line. The base status is generally good, whereas the nutrient status is rather moderate. These soils have a relatively simple morphology: the shallow topsoil is dark brown or dark reddish brown clay, with a blocky or granular structure. The subsoil is made of red clays of a very firm to almost compact consistence. The dominant red colour is due to free ferruginous sesquioxides. This iron is assumed to be an impurity in the limestone, and is thought to have been added to the latter during its deposition via volcanic ashes. It is not quite clear, however, how these ashes were deposited: either windborne, or floating and concentrated by wind and wave action.
In the international systems of classification, these soils are, when shallow, *Chromic Cambisols* (FAO/UNESCO) or a probable kind of *Eutropept* (USDA); when deeper, they qualify as *Chromic Luvisols* (FAO/UNESCO), *Rhodudalfs* or *Rhodic Kandiudalfs* (USDA).
According to Wright et al. (1959), the natural vegetation occuring on these soil is low medium-sized semi-deciduous broad-leaved forests with dominant species such as Sapote (*Manilkara zapota*, Sapotaceae), Mahogany (*Swietenia macrophylla*, Meliaceae) and Chechem or Black Poisonwood (*Metopium brownei*, Anacardiaceae).
Nowadays, these soils are used in various ways: in the northern part of the district, most areas have been cleared for sugar cane, whereas relatively large tracks still remain in the eastern corner, i.e. close to Shipstern Reserve. The soils cultivated by the Mennonite community of Little Belize typically belong to the *Xaibe Subsuite*. These soils are sometimes recognisable along the Chunox-Sarteneja Road, the Ramonal/Xcopen Road and, within

Shipstern Nature Reserve, along the Main Trail (see fig. 2, p. 3 for location).
The soils of the *Remate Subsuite* are shallow to very shallow stony clays developed over coral, either massive or fragmented. They occur mainly on the low areas around Chetumal Bay. To this subsuite also belong soils that are found as linear bodies on low ridges of protuberant coral within the *Xaibe Subsuite*, where their distribution is generally very patchy. In profile, these soils are simple, shallow and weakly developed: stony clays becoming stonier with increasing depth until massive (or bouldery) limestone predominates, generally after 30cm or less. The colour of the clay may vary from reddish to dark-brown or dark grey, depending on the amount of iron contained in the parent material. In general, soils of the *Remate Subsuite* are blacker in coastal areas and redder when located within an area dominated by soils of the *Xaibe Subsuite*, but local variations exist. These soils are neutral to alkaline, and fully base-saturated, but with a calcium dominancy.
Soils of this subsuite are classified as various *Leptosols* (FAO/UNESCO) and probable *Lithic Eutropepts* or *Rendolls* (USDA).
The main characteristic of the *Remate Subsuite* soils is their extreme limitation in moisture storage capacity. This makes them unsuitable for most agricultural crops, but possible uses include permanent tree-crops such as avocadoes.
The vegetation on these soils is reported to be low deciduous forest, with high proportion of Sapote, Red Gumbolimbo (*Bursera simaruba*, Burseraceae) and Chechem (King et al., 1992).

Worth mentioning are soils belonging to the *Yaxa Suite* that include all the well and imperfectly drained clays over hard Miocene limestones. They are all fine textured, neutral to alkaline, and completely base-saturated, mainly calcium. These soils are not very different from those of the *Remate Subsuite*, but are much deeper and well developed.
The natural vegetation occurring on these soils is lowland forest with numerous Mahogany, Cedar (*Cedrela mexicana*, Meliaceae), Sapote and sometimes for some subsuites, massive Guanacaste trees (*Enterolobium cyclocarpum*, Mimosaceae). Cohune Palms *(Orbignya cohune*, Palmae) are quite abundant and tall, but of patchy distribution.
Soils of the Shipstern Forest in the southern part of the reserve are very much believed to belong to this suite.

To conclude, the *Tintal Suite* should be mentioned because all permanently or seasonally inundated soils of Shipstern Nature Reserve undoubtedly belong to one of its subsuites, with the possible exceptions of some very undeep saline soils over coral, which belong to the Turneffe Suite - Shipstern subsuite.
The Tintal Suite is composed of the *Chucum Subsuite*, with seasonally gleyed soils in limestone depressions, the *Sibal Subsuite*, with permanently waterlogged mineral and organic soils of freshwater swamps and, finally, the *Ycaco Subsuite*. The latter contains deeper permanently wet mineral and organic soils of mangrove swamps and saline wetlands. The typical vegetation on these soils are mangroves, but these include a heterogenous set of associations depending on inundation frequency and salinity of flood waters (Zisman, 1992, in: King et al.). These soils vary in depth and structure and are sometimes organic, although mostby consist of wet and structureless grey silts and clays, often of soft consistence. Some

of them contain abundant gypsum, soluble chloride and/or sulfate salts. The dominant chemical characteristic is the salinity.

These soils are pedologically very young, as parent material in most cases is still accumulating. Some of these soils may qualify as *Histosols* (FAO/UNESCO/USDA) because of their deep organic upper layers, but the majority are mineral soils, i.e. *Gleysols* (FAO/UNESCO) or *Tropaquents* and *Tropaquepts* (USDA).

Some soil profiles of Shipstern Nature Reserve that were described during the 1993 University of Neuchâtel Expedition (Mitchell et al., 1993) are added to profiles described during the present study. Soil profiles have been described by E. Mitchell of the Laboratory of Plant Ecology of Neuchâtel University, while the analyses were carried out by 3rd year students under his guidance.

1.5 Phytogeographic aspects

The relationships of the flora of Belize with that of the rest of Central America and the Caribbean have long been recognised (Standley & Record , 1936). In general, the flora of the northern plains of the country is typical for the Yucatan Peninsula, whereas the flora of the southern mountainous areas and the Toledo Plains relate to that of adjacent Guatemala. But, the majority of plants growing in Belize have a wider distribution, often ranging from Southern Mexico to the north of South America.

Since Belize has no natural barriers with the adjoining countries, the percentage of endemic species cannot be expected to be very high. If endemismis to be considered, it should be on a larger scale, i.e. the Yucatan Peninsula as a whole (Standley, 1936). At the time of publication, the Flora of Yucatan (Standley, 1930) pronounced 17% of the species to be endemic, a number that has undoubtedly increased since then. The close relationship of the flora of northern Belize with that of the Yucatan Peninsula is indicated by a wide array of shrub and tree species known only from these two regions. The flora of Yucatan itself is, on a wider scale, very much related to the West-Indies. It is often included in a Caribbean Region covering the Greater and Lesser Antilles, the coastal plain of the southern United States (Florida and Texas), the Yucatan Peninsula of Mexico and the northern half of Belize (depending on the floristic group studied, see Henderson et al., 1995). According to STANDLEY (1936), the Yucatan Peninsula can be considered as one floristic unit, despite the

fact that most of its flora is related to the West-Indies and some elements to the Central American region. As a matter of fact, there are numerous endemics, especially within families such as the Sapotaceae, that would allow such a distinction. GENTRY (1982, 1995) includes the Yucatan Peninsula in a phytogeographic region covering Mexico and Central America, having taken a slight spillover of Antillean endemics into Yucatan into account.
The same author (Gentry, 1982) describes the origin and possible explanations for the incredible neotropical floristic diversity. As a matter of fact, the flora of the neotropics is nowadays estimated to contain approx. 90'000 species, three times as much as tropical Africa and 2,5 times more than tropical Australasia. The origin of the flora of tropical America is very bi-polar, with on the one hand a flora of Gondwanan origin in the south and on the other hand, a flora of Laurasian origin in the north. Originally, the mixture of these two floras, during the Miocene to Pliocene closing of the Isthmus of Panama, was thought to be at the base of today's diversity in species. However, northward migrating Gondwanan species so much overwhelmed southward migrating Laurasian species that the latter's contribution to the present neotropical diversity can only have been marginal.
The origin of this diversity is probably a conjunction of three main factors:

- the uplift of the Andes, which produced a burst of speciation in a number of Gondwanan families.

- the direct floristic interchange made possible at the end of Cretaceous times by "island-hopping" along the proto-Antilles. Many of the dry-area taxa that show differentiation both in North and South America certainly reflect this early interchange.

- Pleistocene climatic fluctuations associated with glacial advances and retreats at higher latitudes created an alternance of dry/wet climates, but did not have a great influence on temperatures of the lowland tropics. Nevertheless, the tropical vegetation was forced into refuges of forest islands were speciation readily occured.

The floristic diversity of Central America has many interesting aspects. For example, within Central America, Amazonian-centered taxa are decreasingly represented along a south-north gradient, with most species not going further up than Nicaragua. Yet, the few that do constitute virtually all of the lowland canopy species.

An important family, the Bignoniaceae, well represented in Belize, shows two different migrating patterns: the Crescentieae (a tribe whose members are mostly specialised for edaphically dry areas as limestone outcrops or seasonally inundated savannahs), derived from the essentially South American Tecomeae. They clearly have a long history of differentiation in Central America. Most other Central American Bignoniaceae show no differentiation from their South American counterparts, even at species level. This may corroborate the second factor of speciation cited above.

The distribution, diversity and high endemism in dry-area taxa of northern Central America and Mexico is worth mentionning. For example, endemism in Mexico is highest in dry areas, although species of lowland rainforests rank highest in the overall number of species of the country's flora (Rzedowski, 1978). These taxa mostly have Gondwanan affinities (and are not of northern temperate origin such as those in North American deserts), either clearly so or by phytogeographical analogy (Gentry, 1982). Thus, this high species-diversity of dry areas would be a result of secondary differentiation rather than ancient arrival or autochthonous origin. AXELROD (1979, in Gentry, 1982) suggests that this specialisation occured in edaphically dry areas, and that the resulting taxa further spread with the expansion of dry climates during late Tertiary and Quartenary periods. In his review of neotropical dry forest floristics, GENTRY (1995) showed that the centre of endemism for all Central American dry forests down to Costa Rica is Western Mexico, particularly the dry forests of Jalisco. Interestingly, the northern half of Belize is included in his definition of neotropical dry forests.

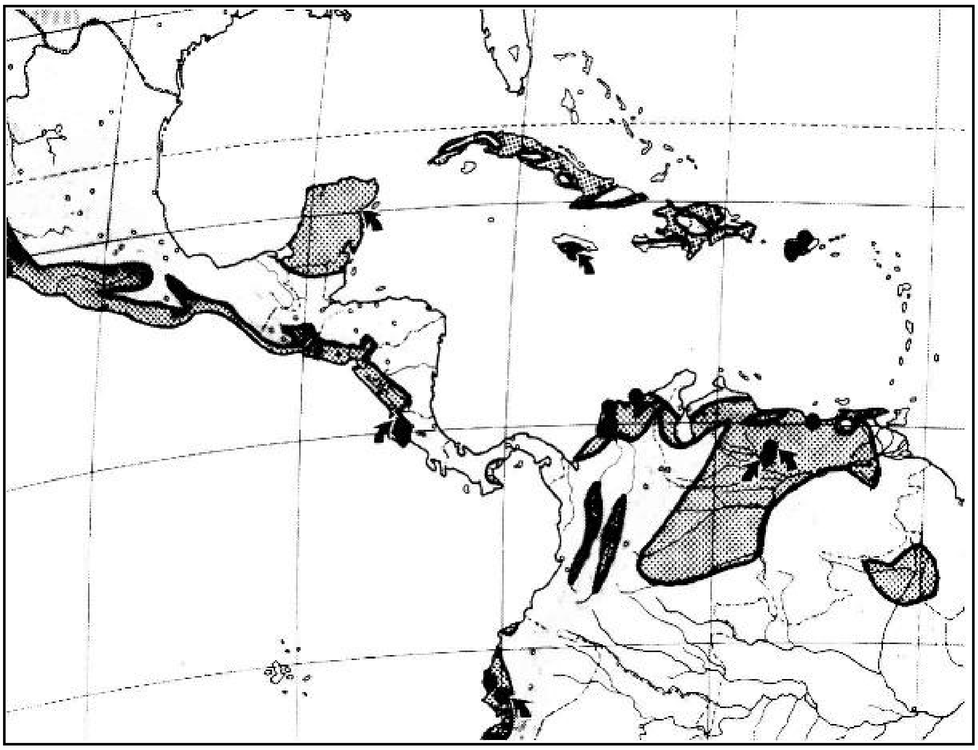


Fig. 4: **Distribution of dry forests in Central America, the Caribbean and northern South America .**
(Adapted from Gentry in: Bullock, Mooney & Medina, 1995).

2. Materials and methods

2.1 Data collecting

A transect running from the forest to the mangrove plains bordering the Shipstern Lagoon was established in January 1997. Prior to this, three theoretical transects had been chosen, based upon the variation in patterns observed on available satellite photographs. Unfortunately, none of these transects proved to be suitable in the field and had to be rejected for the following reasons:

a) the vegetation being in some places very low, mingled and/or thorny, the establishment of a transect in the field would have been extremely tedious. Furthermore, it would have implied a new track through the forest in the reserve and this understandably met with serious reservation from the reserve's management.
b) Numerous GPS positions would have been necessary to establish a transect properly and to pinpoint its exact position. Given that taking a GPS position within the forest is, even with the use of an antenna, a time-consuming operation, the establishment of an approx. 2 km long transect would have been far too difficult.

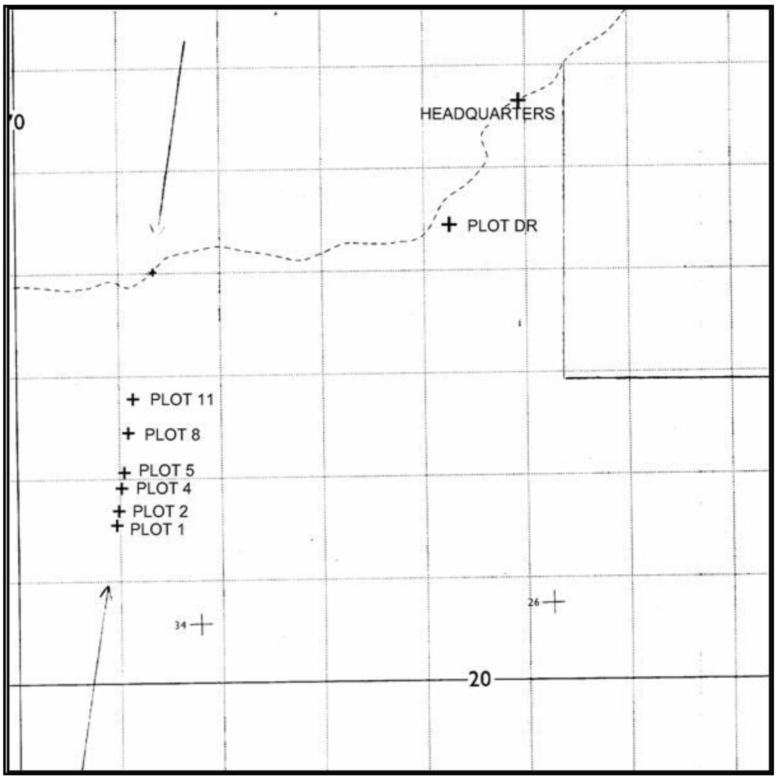
To put the transect along an existing trail would have been inappropriate with regard to the difficulty of random plot-setting along a not straight line. Thus it was decided, in the end, to follow the Western Survey Line, a perfectly straight track that, at the time, was opened to delimit the western boundary of Shipstern Nature Reserve.

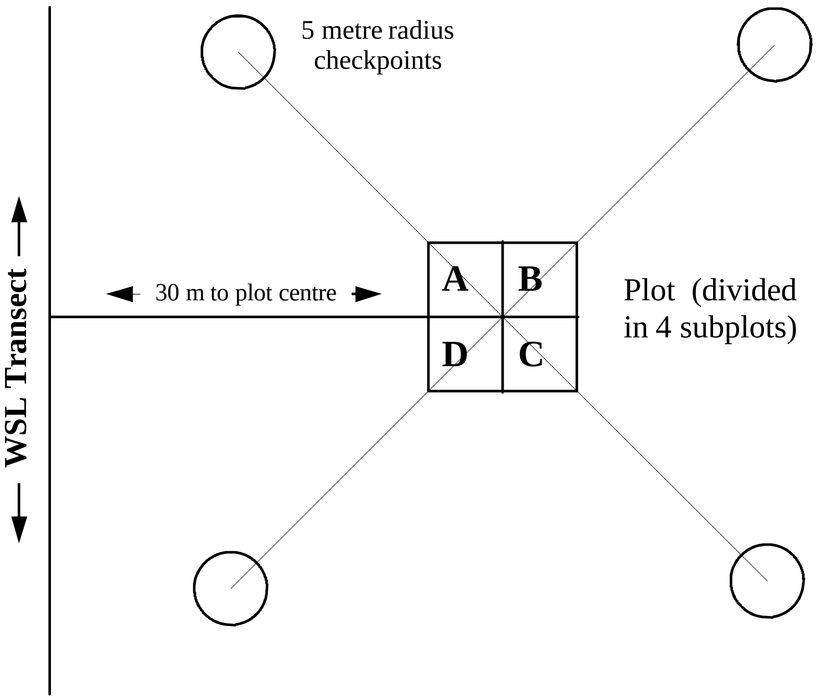
This survey line combines several advantages: first it is close to one of the earlier chosen theoretical transects. Secondly, it allows precise measurements in the field, important when it comes to identifying the location of plots.
The transect is 2625m long, with a total of 21 plots established every 125m. Plot 1 is situated in the mangrove savannah, whereas plot 21 is located near the main road Chunox-Sarteneja (see fig. 5: location of transect and New Trail plot, p. 15).

The centre of each plot is marked in the field, 30 m away from the survey line on its eastern side. The plots were put away from the survey line rather than adjacent to it to avoid possible human disturbance, such as removal of small trees during the cleaning of the trail.
Each plot measures 10m x 10m (i.e. 100m^2), and is divided in four 5m x 5m subplots to facilitate mapping and data collecting. The possibility of having larger plots was at first considered (i.e. 15m x 15 m = 225 m^2), but rejected considering that:

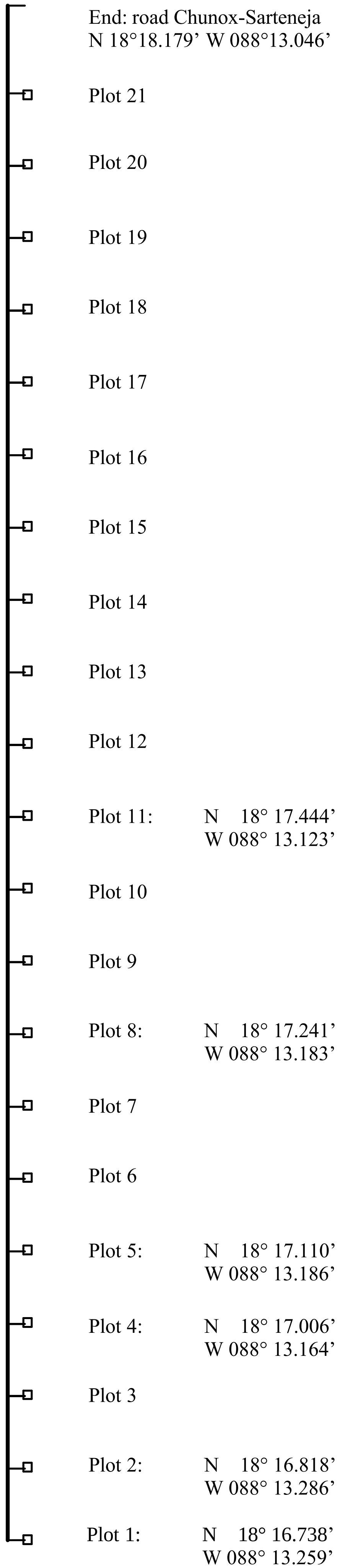
- the study of several plots representing various plant formations was preferable to the examination of only one or two larger areas. This is of special importance since the area is parcelled out into a mosaic of sometimes very small vegetation patterns.

Fig. 5: location of Western Survey Line Transect and New Trail plot DR.





Total length: 2625 m
No. of plots: 21
Distance between plots: 125m
Plot size: 10m x 10m
Plot surface: 100m^2



- Larger plots would probably not have produced further significant informations: a survey of the immediate surroundings (i.e. all species recorded in a 5m radius around points chosen 25 metres from the plot centre - see sketch), revealed no new species for the lower strata (except in the case of plots 4, 5, 11 and New Trail, where this reflected a change in vegetation patterns, or at least a clear transitional formation). For the higher strata, a few additional species were recorded (in the case of plot 11 and 8), whose absence inside the plots could simply be a coincidence.

- the plots, including the forested ones, contain very few specimens with a DBH (diametre at breast height) over 10 cm (this being the diametre normally used for trees to be taken into account in surveys, see Gentry (1995) for comments). The specimens finally retained (see section below) are so numerous that even with $100m^2$ areas, the collecting of data proved to be a time-consuming affair.

- The choice of much larger plots (e.g. hectare-size plots) and the taking into account of larger specimens (DBH = or >10cm) would very likely not have resulted in a better understanding of the vegetation since a) most of the area is dominated by low to very low vegetation and b) while the composition of the tree strata is already known to a certain degree.

In view of the available time, a somewhat subjective choice had to be made as to which plots should be studied first: those that clearly showed differences in their floristic composition and/or structure (thus potentially representing distinctive vegetation types) were given priority: plot 1, 2, 4, 5, 8 and 11.

The vegetation of each plot was mapped both horizontally and vertically. The following measurements were carried out:

- position of the trunk
- position of the crown, determined by two perpendicular diametres. The crown shape was reproduced as precisely as possible.
- trunk diametre at breast height, measured with a sliding ruler for trees less than DBH 13cm. The diametre was obtained by calculation based on the circonference in the case of trees with a DBH above 13cm. NB: for analyses' purposes, diameters recorded as being less than 1 cm were given the standard value of 1. Accordingly, standard basal area values given are 0.79 cm^2.
- height: the vegetation being moderately low in most plots, a 10m graduated pole was used to measure height. Height is understood here as being the distance separating the base of the tree to the top of its crown. Whenever necessary, the height of the first trunk fork was measured.

The choice as to what minimum DBH ought to be retained for the collection of data was difficult to make. Most studies in tropical forests, especially those dealing with forestry

sciences, use a minimum DBH of 10cm (Pfund, pers. comm.). This was not feasable in our case for the reasons cited above with regard to plot size. With a minimum DBH of 2.5 cm, a size often used in studies dealing with floristics (see Gentry in: Bullock et al., 1995), still only a marginal proportion of specimens would show in the overall data. Therefore, it was decided to take into consideration all plants with a minimum height of 1.5m. In the case of plots with lower vegetation types, all plants were included.
Vertical vegetation diagram were drawn, which included all trees of a 2m wide strip running parallel to the transect and through the centre of the plot (see fig. 5, p. 15). Plants were drawn schematically, but an effort was made to respect, whenever possible, their shape and form (growth type, phyllotaxy, etc.).

Herbarium specimens were taken threefold for each plant species encountered, including those plants that could not be related with certainty to an already collected or known species. Most plant material being sterile, identification was, at least at the family level, carried out in the field. As a matter of fact, litterature is now available which allows identification of tropical plant families - and sometimes even genera - by using only vegetative characters. As some vegetative characters (such as latex, odour of barkslash, odour of crushed leaves, innerbark structure, etc.) are often neglected during collection, it is an advantage to identify plants by using fresh material in the field.
Identification was carried out using KELLER (1996), GENTRY (1982, 1993), STANDLEY (1930, 1936), STANDLEY ET AL. (1958-1976), BROKAW ET AL. (1990), MCLEISH ET AL. (1995), HENDERSON ET AL. (1995), MAAS ET AL. (1993), TOMLINSON (1980, 1986), MEERMAN (1993a), DRESSLER ET AL. (1984), PENNINGTON & SARUKHAN (1968), HEYWOOD (1993) and BEETLE (1983). Nomenclature was based on MABBERLEY (1997) for family and genus levels, and the W^3 Tropicos database of the Missouri Botanical Garden was used to update nomenclature for species names.

Additionally to the Western Survey Line Transect, a plot was set out close to a recently opened track called the New Trail, to the southwest of the headquarters of the Shipstern Nature Reserve. It was created to demonstrate the possible existence of a very distinctive vegetation type, not covered by the transect on the Western Survey Line. The centre of the plot was chosen as objectively as possible, halfway in a vegetation type that showed clear differences with the other plots. The methodology used was identical to that of the Western Survey Line plots.

Once acquainted with the various vegetation types, their GPS positions were recorded along most of the trails. This information was gathered to facilitate mapping and comparison with existing photographs.

2.2 Analyses

Analyses, mostly on vegetation structure, were carried out whenever feasable with regard to the available data. Plot 2 and 4, because of their very low vegetation and obvious species composition and species dominancy were not included. As data were - statistically speaking - generally scarce, no complex analyses were attempted. Analyses thus concentrated on comparing various structural parameters such as:

- the frequency of a given species against its total basal area (i.e. the sum of basal areas of each specimen of the species in $cm^2/100m^2$).
- the density of a given species against its total basal area, when redundancy - because of the first parameter - does not occur
- the height in relation to the basal area, for each specimen of a given plot
- the frequency of basal area classes within a plot
- the frequency of height classes within a plot
- the height distribution within a plot
- a box plot analysis for all species with 2 or more specimens
- the total basal area (expressed in m^2/ha)
- the overall density (expressed in no. of ind./ha)

For two very common species, height was plotted against basal area, taking into account specimens from all plots.

A constraint clustering analysis (Legendre et al., 1985) with a connexity index of 0.7 and a probability p = 0.05 (0.01 in one case) was carried out on height data. Significant cluster limits were transfered to graphs dealing with height.

In some cases, the distribution and shape of crowns and how these interrelate have been discussed.

3. Results

Results obtained from the Western Survey Line and New Trail plots are presented in the following order:

1) Vertical diagrams
These diagrams each show a 10x2 m section of the plot, and provide an impression of the vertical structure of the vegetation. Every section runs parallel to the transect and through the centre of the plot. The numbers shown next to each specimen refer to the species list at the top of each diagram. The herbaceous strata, recorded in some cases, is not included in the vertical diagrams. Furthermore, some specimens were omitted when the degree of overlapping within the 10x2 m section did not allow a proper representation of all plants. These omissions are mentioned in the diagram.

2) Horizontal diagrams
The horizontal diagrams mapping the vegetation of each plot are organised in three different layers to facilitate their reading. The bottom layer shows the lower strata (1.5-5m), and is followed, in transparency, by the second (5-10 m) and third (10-15m) strata. Most plants are represented and numbered individually. Very frequent and/or locally abundant species are represented by a symbol and their height was measured and recorded as an average. All numbers refer to the data tables (see below).

3) Data tables
The first set of data tables show in the following order:
Specimen number - family - genus - species - height - DBH - date of collection - numbers collected and their location (in or outside plot) - herbaria where plants have been deposited (BLMP = Herbarium of the Forestry Department, Belmopan, Belize; CHET = Herbarium of the " Collegio de la Frontera Sur " (ECOSUR), Chetumal, Mexico; NE = herbarium of the University of Neuchâtel, Switzerland) - and last, means of identification.
N.B:

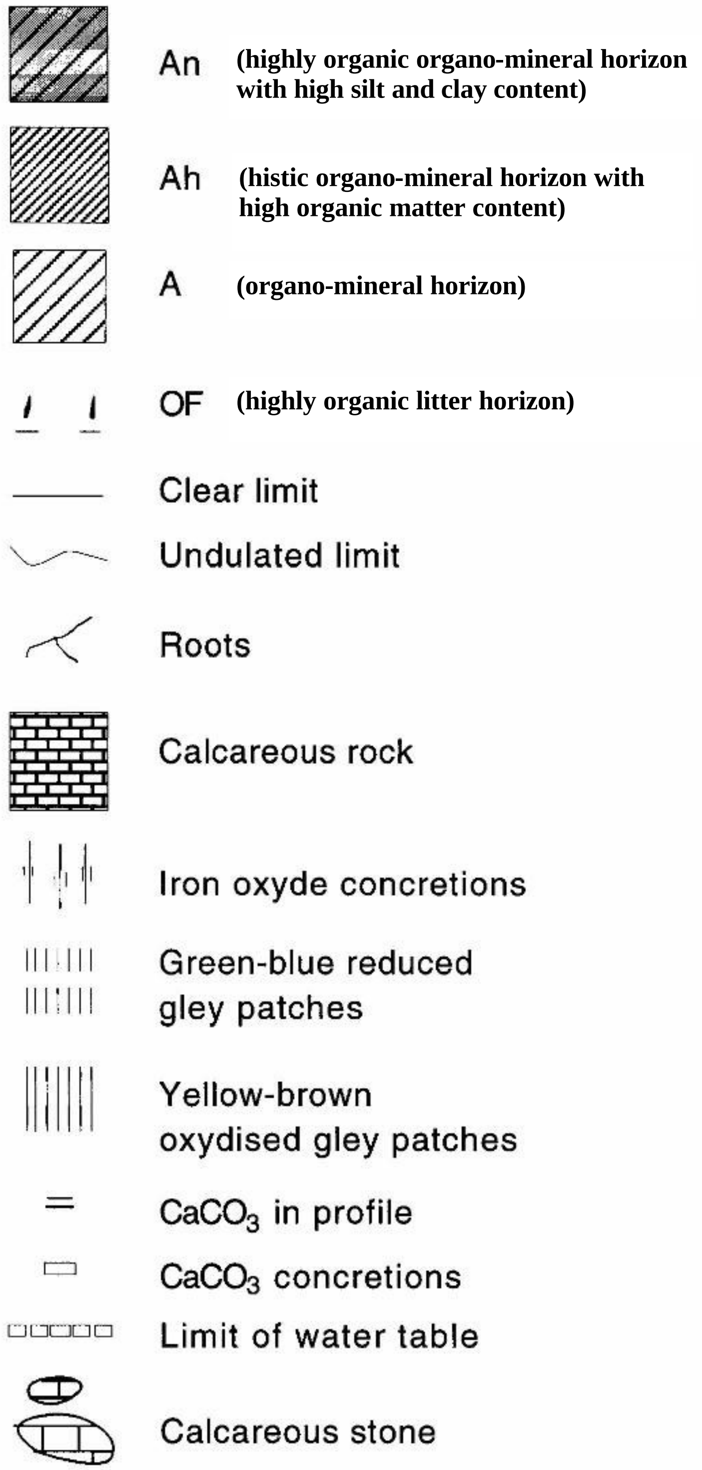
- "cf." placed before the family name means that the specimen has been compared to herbarium material, and matches the given taxon. Nevertheless, the sole use of vegetative characters does not allow an entirely positive identification.
- "cf." placed before the genus means that the family has been identified with certainty, but that doubts remain as to the identification of genus and species.
- "cf." placed before the species name means that the genus has been identified with certainty, but that doubts remain as to the identification of the species.
- "aff." placed before the species name means that the specimen has been identified with some certainty, but final confirmation can only be given with the help of fertile material.

The second data table summarises the overall data obtained for each species.

4) Graphs and other results

5) Soil profiles

5b) Legends of soil profiles



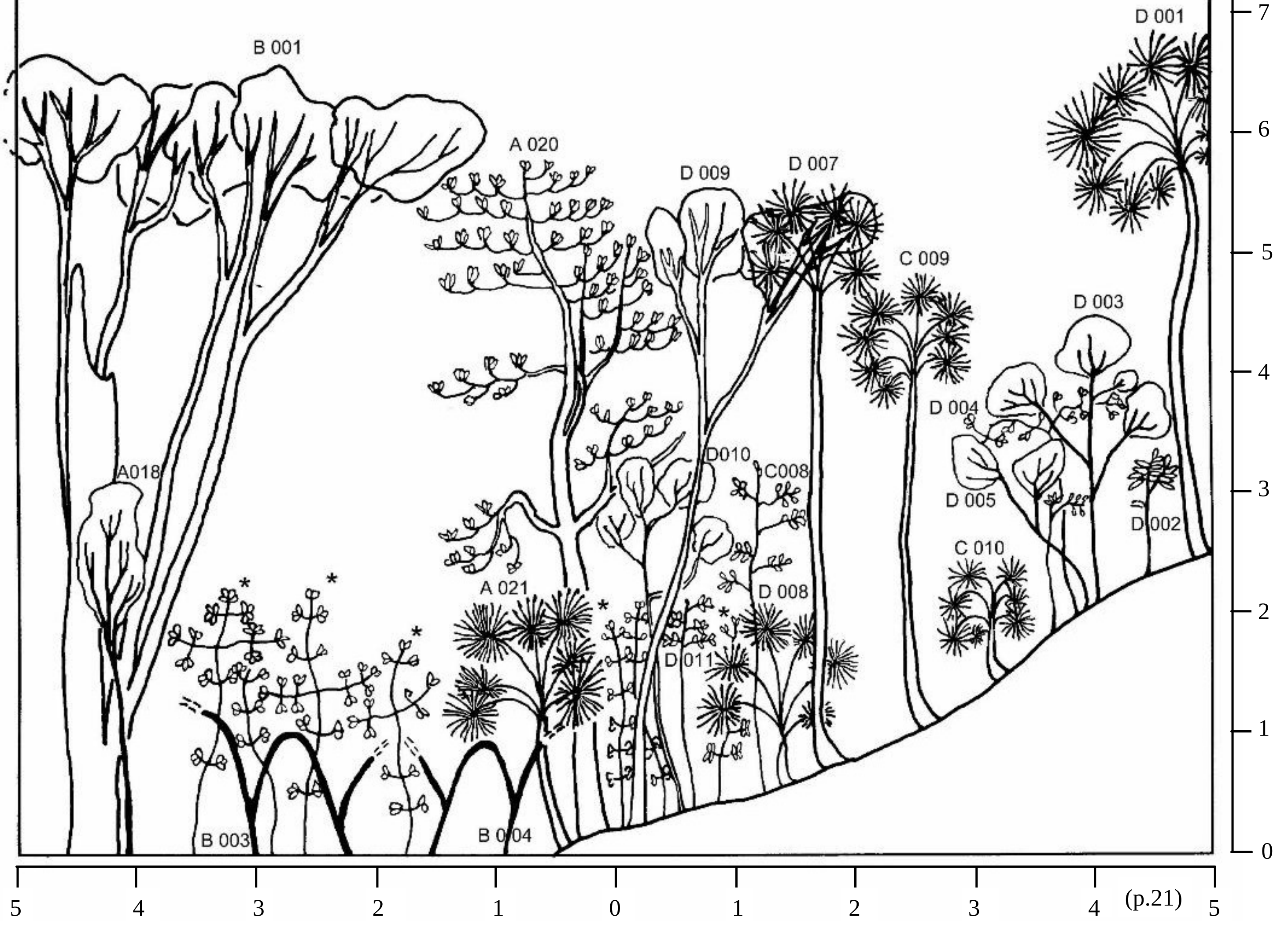
The Vegetation of Shipstern Nature Reserve
Western Survey Line Transect

Plot 1 N 18° 16.738' W 088° 13.259'

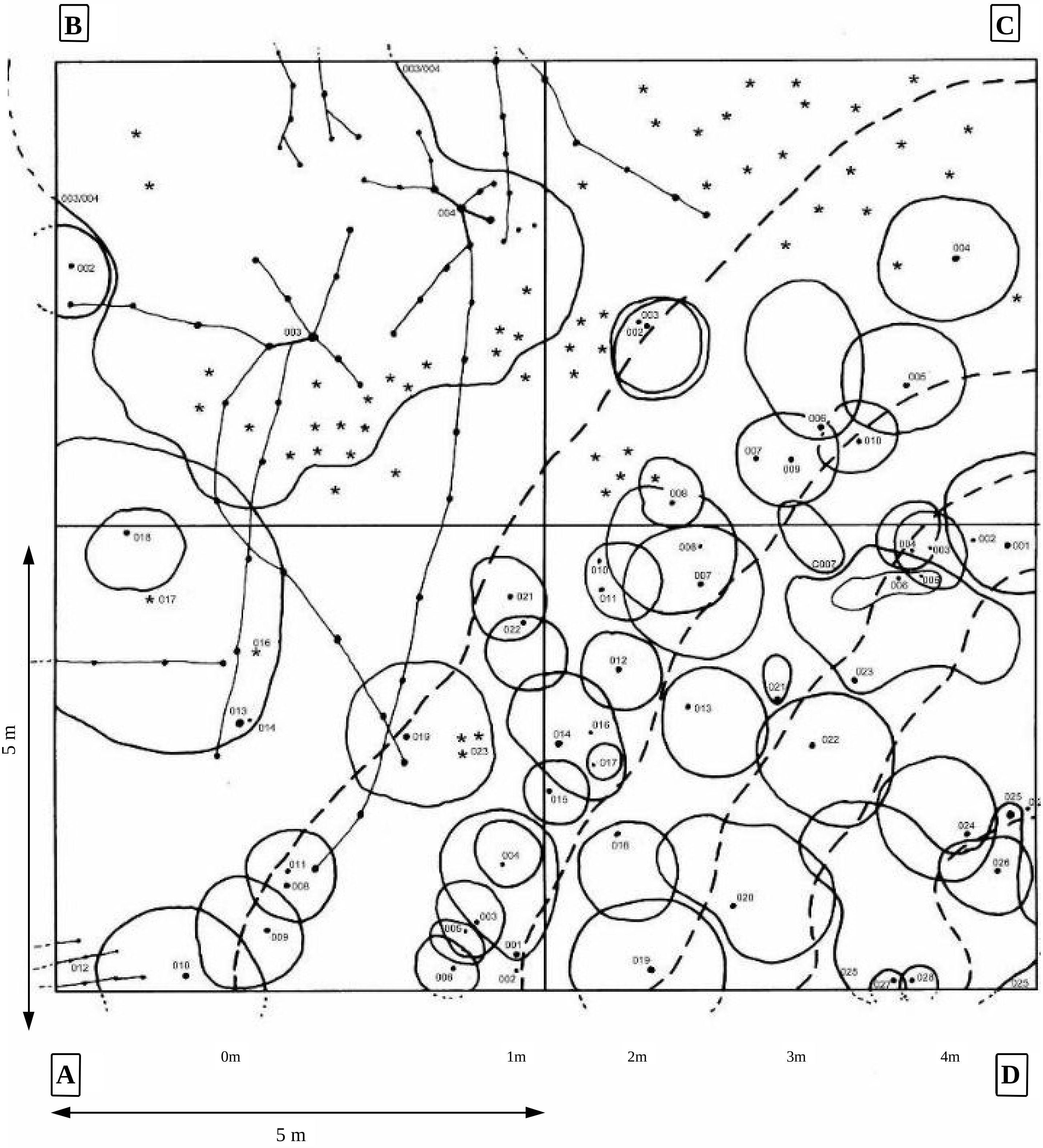
Vertical diagram (horizontal section: 10m x 2m, through centre, parallel to transect)

(m)

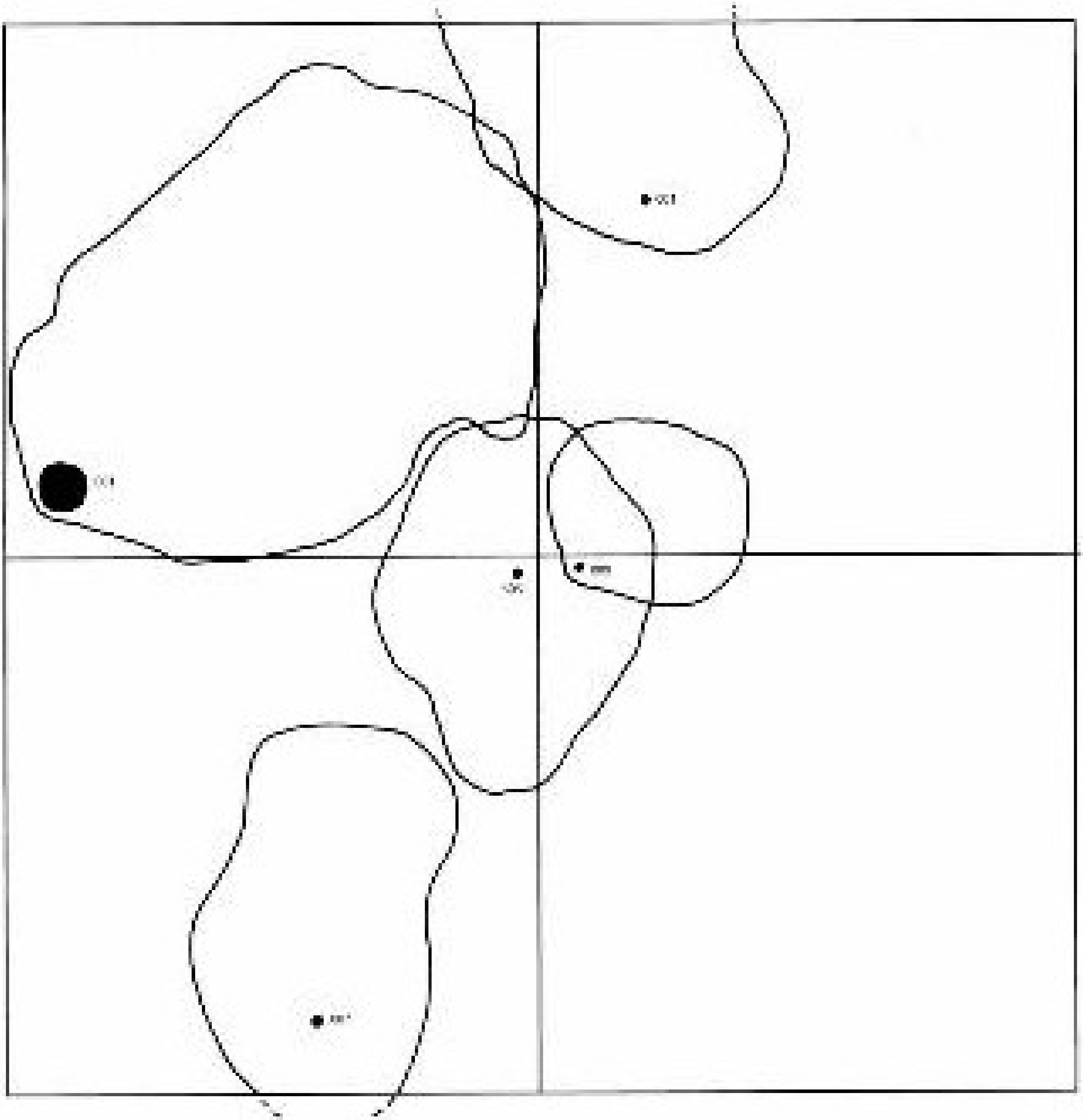
A018	= Apocynaceae? *Stemmadenia*?		A020	=	*Manilkara zapota*	(Sapot.)
A021	= *Thrinax* aff. *radiata*	(Palm.)	B001	=	*Laguncularia racemosa*	(Combr.)
B003/004	= *Rhizophora mangle*	(Rhiz.)	C008	=	*Laetia thamnia*	(Flacourt.)
C009/10,D001	= *Thrinax* aff. *radiata*	(Palm.)	D002	=	*Coccoloba* cf. *schiedeana*	(Polyg.)
D003	= *Sebastiana adenophora*	(Euphorb.)	D004	=	*Erythroxylum* aff. *areolatum*	(Erythrox.)
D005	= *Gymnopodium floribundum*	(Polyg.)	D007/8	=	*Thrinax* aff. *radiata*	(Palm.)



The Vegetation of Shipstern Nature Reserve
Western Survey Line Transect
Plot 1 N 18°16.738’ W 088° 13.259’
Horizontal diagram
First level, height 1.5m - 5m



Second level, height 5m - 10m



SHIPSTERN NATURE RESERVE VEGETATION SURVEY

PLOT 1 WESTERN SURVEY LINE TRANSECT

N 18°16.738' W 088° 13.259'

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb coll.	deposit	identification
PL1-A-001a	Euphorbiaceae	Sebastiana	adenophora	4.5	4.1				idem PL8-C-037a
PL1-A-002a	Ebenaceae	Diospyros	cuneata	1.7	1	27.05.97	1 x check	BLMP	idem PL8-A-008a
PL1-A-003a	Palmae	Thrinax	aff. radiata	1.6					idem PL8-A-011a
PL1-A-004a	Palmae	Thrinax	aff. radiata	1.5					idem PL8-A-011a
PL1-A-005a	Apocynaceae?	Stemmadenia?		2.5	1.2	27.05.97	3 x int.	BLMP/CHET/NE	Bernardi/Geneva BG
PL1-A-006a	Flacourtiaceae	Laetia	thamnia	2.5	1	27.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL1-A-007A	Sapotaceae	Manilkara	zapota	6.5	19.5				idem PL8-B-009A
PL1-A-008a	Palmae	Thrinax	aff. radiata	1.7					idem PL8-A-011a
PL1-A-009a	Palmae	Thrinax	aff. radiata	2.2					idem PL8-A-011a
PL1-A-010a	Sapotaceae	Manilkara	zapota	4	8				idem PL8-B-009A
PL1-A-011a	Ebenaceae	Diospyros	cuneata	1.8	<1				idem PL1-A-002a
PL1-A-012a	Rhizophoraceae	Rhizophora	mangle	2.5	3				unmistakable
PL1-A-013a	Apocynaceae?	Stemmadenia?		4.5	13.5				idem PL1-A-005a
PL1-A-014E	Orchidaceae	Myrmecophila	tibicinis						McLeish et al.
PL1-A-015a	Rhizophoraceae	Rhizophora	mangle	1.5					unmistakable
PL1-A-016H/a	Acanthaceae	Bravaisia	tubiflora	1.8	<1				idem PL11-A-010a
PL1-A-017H/a	Acanthaceae	Bravaisia	tubiflora	1.6	<1				idem PL11-A-010a
PL1-A-018a	Apocynaceae?	Stemmadenia?		3	2.4				idem PL1-A-005a
PL1-A-019a	Palmae	Thrinax	aff. radiata	3.5	6.5				idem PL8-A-011a
PL1-A-020A	Sapotaceae	Manilkara	zapota	5.5	14				idem PL8-B-009A
PL1-A-021a	Palmae	Thrinax	aff. radiata	2					idem PL8-A-011a
PL1-A-022a	Palmae	Thrinax	aff. radiata	3.5	6.5				idem PL8-A-011a
PL1-A-023H/a	Acanthaceae	Bravaisia	tubiflora	1.5	<1				idem PL11-A-010a
PL1-B-001A	Combretaceae	Laguncularia	racemosa	6.5	48	27.05.97	1 x check	BLMP	unmistakable
PL1-B-002a	Avicenniaceae	Avicennia	germinans	3.5	3.5	27.05.97	1 x check	BLMP	cf. chap. 8
PL1-B-003a	Rhizophoraceae	Rhizophora	mangle	3.5	9				unmistakable
PL1-B-004a	Rhizophoraceae	Rhizophora	mangle	3	8				unmistakable
PL1-C-001A	Sapotaceae	Manilkara	zapota	7	18				idem PL8-B-009A
PL1-C-002a	Palmae	Thrinax	aff. radiata	4	8				idem PL8-A-011a
PL1-C-003a	Palmae	Thrinax	aff. radiata	1.6					idem PL8-A-011a
PL1-C-004a	Palmae	Thrinax	aff. radiata	5	7				idem PL8-A-011a
PL1-C-005a	Palmae	Thrinax	aff. radiata	1.9					idem PL8-A-011a
PL1-C-006a	Capparidaceae	Capparis	cynophalloph	5	6.7	27.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL1-C-007	Apocynaceae?	Stemmadenia?		4	4				idem PL1-A-005a
PL1-C-008a	Flacourtiaceae	Laetia	thamnia	3	1.3				idem PL1-A-006a
PL1-C-009a	Palmae	Thrinax	aff. radiata	3.6	7.2				idem PL8-A-011a
PL1-C-010a	Palmae	Thrinax	aff. radiata	1.6					idem PL8-A-011a
PL1-D-001a	Palmae	Thrinax	aff. radiata	4	8.5				idem PL8-A-011a
PL1-D-002a	Polygonaceae	Coccoloba	cf. schiedeana	1.6	<1				idem PL8-A-014a
PL1-D-003a	Euphorbiaceae	Sebastiana	adenophora	2.5	1.5				idem PL8-C-037a
PL1-D-004a	Erythroxylaceae	Erythroxylum	aff. areolatum	1.8	<1	27.05.97	3 x int.	BLMP/CHET/NE	Fl. of Guatemala
PL1-D-005a	Polygonaceae	Gymnopodium	floribundum	1.6	<1				idem PLDR-B-001a
PL1-D-006a	Anacardiaceae	Metopium	brownei	1.5	<1				unmistakable
PL1-D-007a	Palmae	Thrinax	aff. radiata	4.5	7.8				idem PL8-A-011a
PL1-D-008a	Palmae	Thrinax	aff. radiata	1.6					idem PL8-A-011a
PL1-D-009A	Ebenaceae	Diospyros	cuneata	5.5	8	27.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL1-D-010a	Polygonaceae	Coccoloba	aff. reflexiflora	3	2				idem PL11-B-016a
PL1-D-011a	Flacourtiaceae	Laetia	thamnia	1.7	<1				idem PL1-A-006a
PL1-D-012a	Apocynaceae?	Stemmadenia?		3	2.4				idem PL1-A-005a
PL1-D-013a	Polygonaceae	Coccoloba	aff. reflexiflora	4	5.5				idem PL11-B-016a

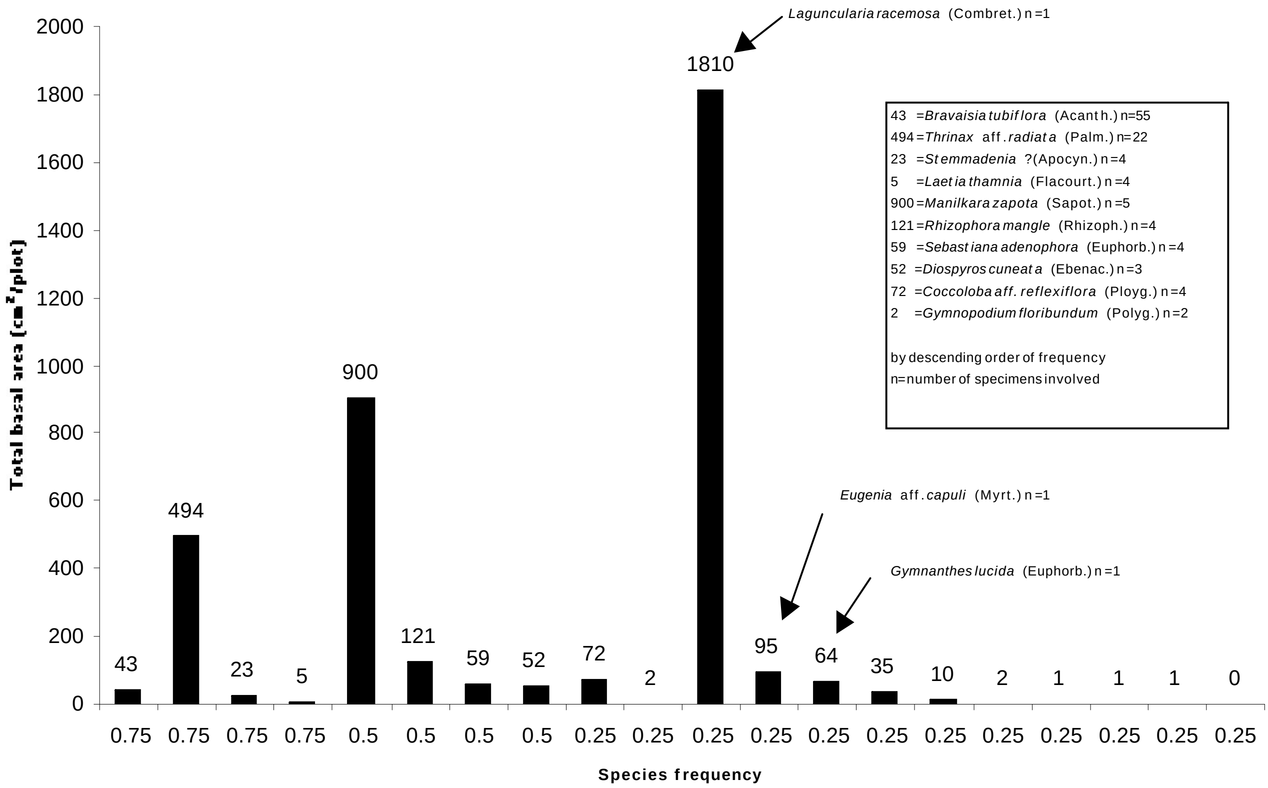
(Plot 1, cont'd)

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb coll.	deposit	identification
PL1-D-014a	Euphorbiaceae	Gymnanthes	lucida	4	9	27.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL1-D-015a	Palmae	Thrinax	aff. radiata	4	7.2				idem PL8-A-011a
PL1-D-016a	Euphorbiaceae	Sebastiana	adenophora	2	1.1				idem PL8-C-037a
PL1-D-017a	Flacourtiaceae	Laetia	thamnia	3	1.7				idem PL1-A-006a
PL1-D-018a	Palmae	Thrinax	aff. radiata	1.6					idem PL8-A-011a
PL1-D-019a	Palmae	Thrinax	aff. radiata	4	7.8				idem PL8-A-011a
PL1-D-020a	Euphorbiaceae	Sebastiana	adenophora	4.5	7.4				idem PL8-C-037a
PL1-D-021a	Polygonaceae	Gymnopodium	floribundum	1.6	<1				idem PLDR-B-001a
PL1-D-022a	Palmae	Thrinax	aff. radiata	3.5	7.1				idem PL8-A-011a
PL1-D-023a	Polygonaceae	Coccoloba	aff. reflexiflora	4.5	7.4				idem PL11-B-016a
PL1-D-024a	Palmae	Thrinax	aff. radiata	4	7.1				idem PL8-A-011a
PL1-D-025a	Myrtaceae	Eugenia	aff. capuli	4.5	11	27.05.97	3 x int. (fl.)	BLMP/CHET/NE	Herb. Chetumal
PL1-D-026a	Palmae	Thrinax	aff. radiata	2.5	5.8				idem PL8-A-011a
PL1-D-027a	Theophrastaceae	Jacquinia	sp. (aurantiac	2.2	1.6				idem PL8-C-026a
PL1-D-028a	Polygonaceae	Coccoloba	aff. reflexiflora	2	1.5				idem PL11-B-016a
PL1-D-029E	Orchidaceae	Myrmecophilus	tibicinus	0	0				idem PL1-A-014E
*	Acanthaceae	Bravaisia	tubiflora	av.1.75	av.1				unmistakable

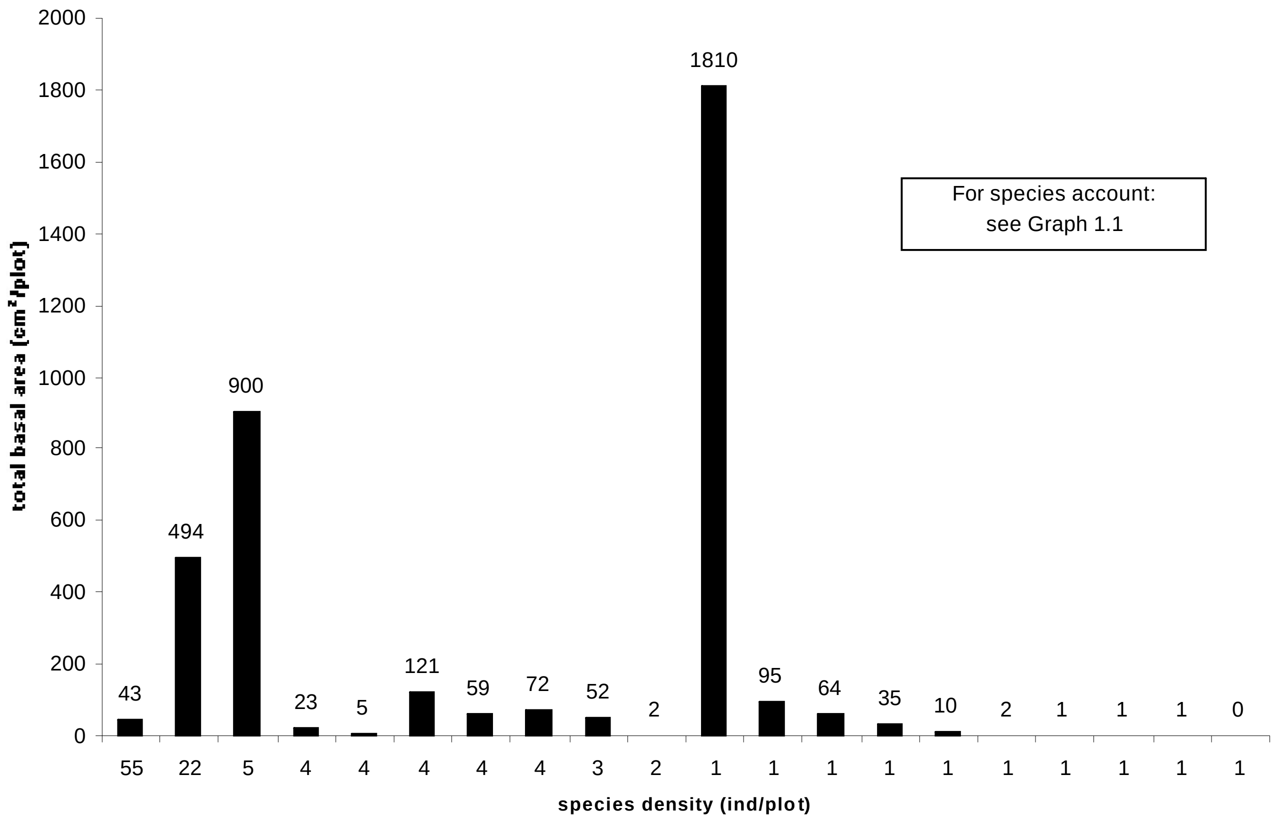
Plot 1: species data table

Family	**Genus**	**Species**	**Frequency**	**Density (ind./ha)**	**Total basal area ($cm^2/100m^2$)**
Acanthaceae	Bravaisia	tubiflora	0.75	55	43.45
Palmae	Thrinax	aff. radiata	0.75	22	494.46
Sapotaceae	Manilkara	zapota	0.5	5	900.47
Apocynaceae?	Stemmadenia?		0.75	4	22.74
Flacourtiaceae	Laetia	thamnia	0.75	4	5.18
Rhizophoraceae	Rhizophora	mangle	0.5	4	120.96
Euphorbiaceae	Sebastiana	adenophora	0.5	4	58.93
Polygonaceae	Coccoloba	aff. reflexiflora	0.25	4	71.68
Ebenaceae	Diospyros	cuneata	0.5	3	51.85
Polygonaceae	Gymnopodium	floribundum	0.25	2	1.58
Combretaceae	Laguncularia	racemosa	0.25	1	1809.56
Myrtaceae	Eugenia	aff. capuli	0.25	1	95.03
Euphorbiaceae	Gymnanthes	lucida	0.25	1	63.62
Capparidaceae	Capparis	cynophallophora	0.25	1	35.26
Avicenniaceae	Avicennia	germinans	0.25	1	9.62
Theophrastaceae	Jacquinia	aurantiaca	0.25	1	2.01
Anacardiaceae	Metopium	brownei	0.25	1	0.79
Erythroxylaceae	Erythroxylum	aff. areolatum	0.25	1	0.79
Polygonaceae	Coccoloba	cf. schiedeana	0.25	1	0.79
Orchidaceae	Myrmecophila	tibicinis	0.25	1	0

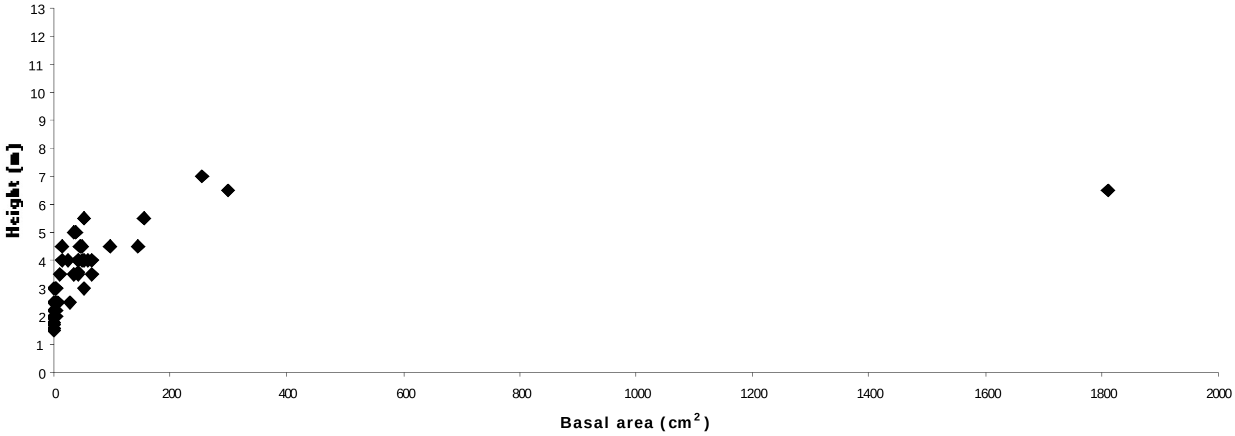
Graph 1.1 : frequency against total basal area



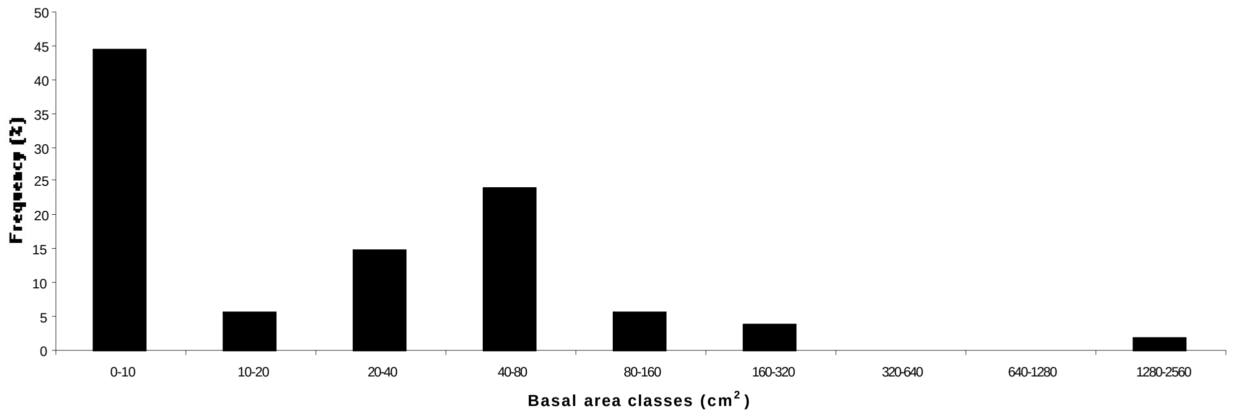
Graph 1.2 : density against basal area



Graph 1.3 : height against basal area

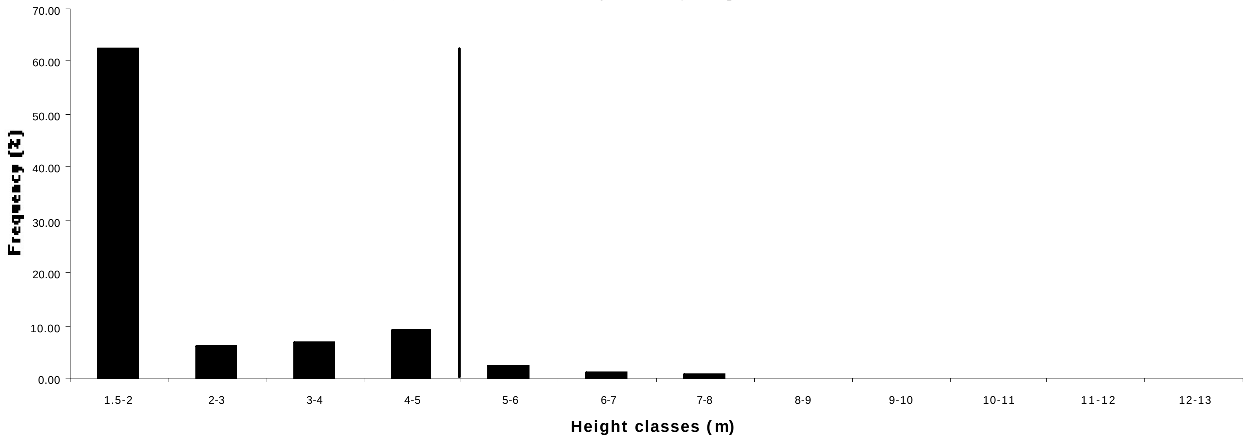


Graph 1.4 : frequency of basal area classes

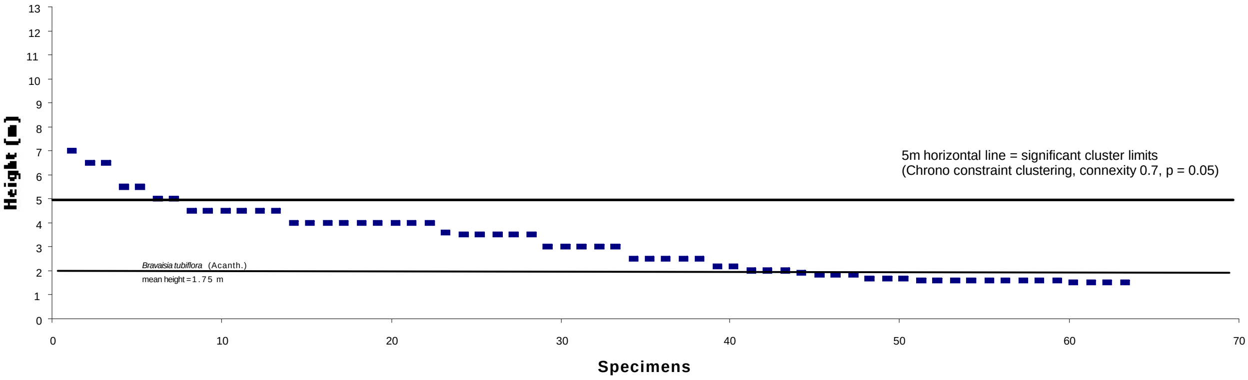


Graph 1.5 : frequency of height classes

Vertical line = significant cluster limit
(Chrono constraint clustering, connexity 0.7, p = 0.05

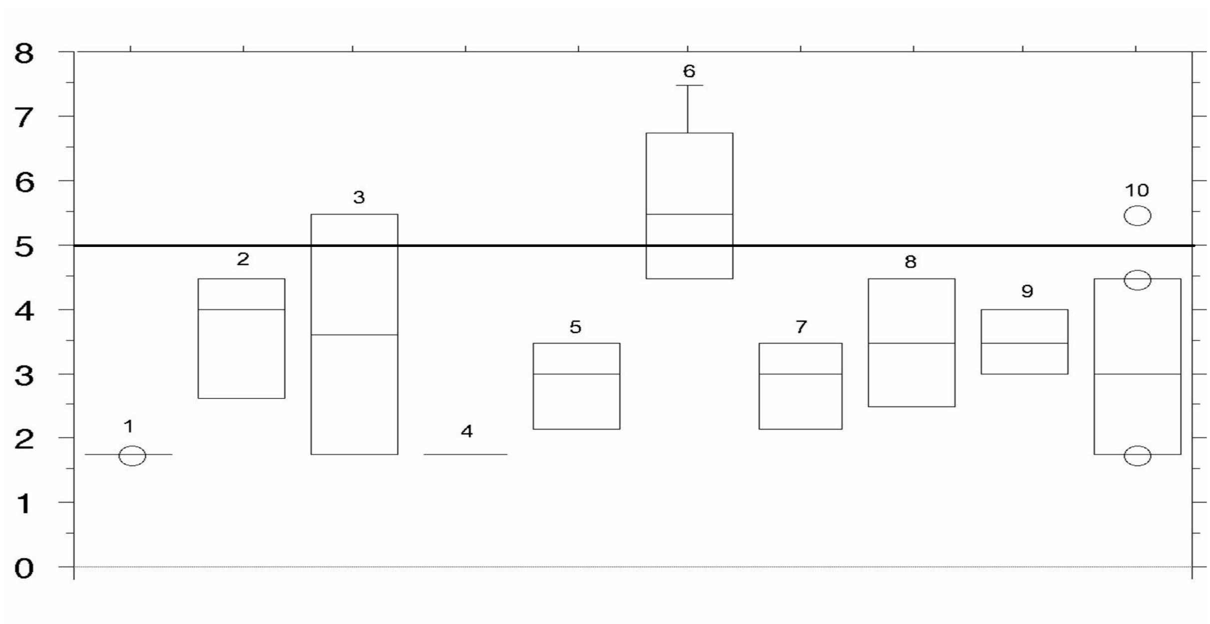


Graph 1.6 : height distribution (by descending order)



Graph 1.7: Box plot analysis

Horizontal lines = significant cluster limits
(Chrono constraint clustering, connexity 0.7, p = 0.05)

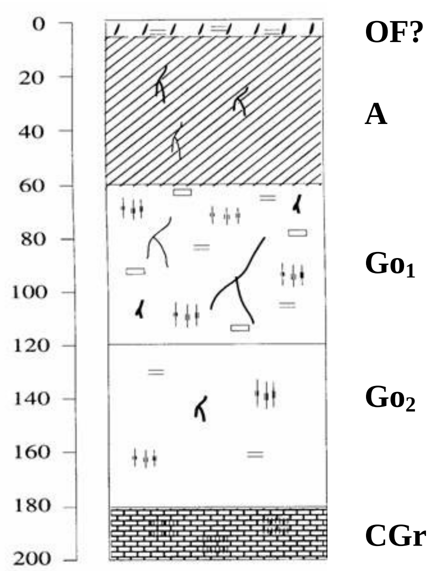


1: Bravaisia tubiflora
2: Coccoloba reflexiflora
3: Diospyros cuneata
4: Gymnopodium floribundum
5: Laetia thamnia
6: Manilkara zapota
7: Rhizophora mangle
8: Sebastiania adenophora
9: cf. Stemmadenia
10: Thrinax radiata

General Values:

Total basal area (all specimens above 1.5 m high): **37.88 m^2/ha**

Overall density (“): **11’700 ind./ha**

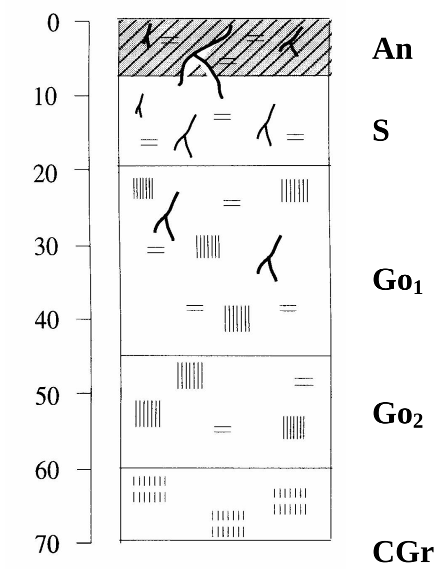


Soil Mitchell No.10/1993

Vegetation:	summit of forested island, mangrove plain, Thompson Trail, Shipstern N.R.
Type of soil:	deep organic gleyosol

Horizons:

OF:	highly organic litter horizon.
A:	organo-mineral horizon completely dry in March-April.
Go_1:	structural temporarily water-logged horizon, with iron oxyde concretions and organic matter.
Go_2:	+/- similar, less compact, drop in $CaCO_3$ levels
Cgr:	parent material, reduced gley, permanently water-logged.

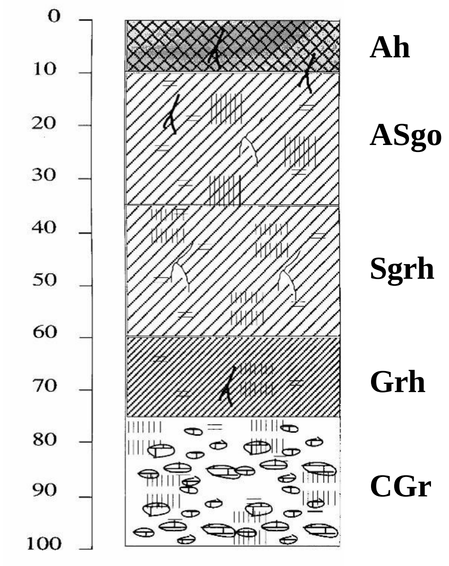


Soil Mitchell No.11/1993

Vegetation:	base of forested island, under Bravaisia tubiflora mangrove plain, Thompson Trail, Shipstern N.R.
Type of soil:	deep organic gleyosol

Horizons:

An:	highly organic organo-mineral horizon, with very high silt and clay content.
S:	structural horizon
Go_1:	structural temporarily water-logged horizon, with oxydised gley patches and organic matter.
Go_2:	+/- similar, less compact, drop in $CaCO_3$ levels
Cgr:	parent material, reduced gley, permanently water-logged.



Soil Mitchell No.12/1993

Vegetation:	mangrove belt around forested island, mangrove plain, Thompson Trail, Shipstern N.R.
Type of soil:	organic gleyosol

Horizons:

Ah:	histic organo-mineral horizon with high organic matter content.
ASgo:	transitional organo-mineral-structural horizon temporarily water-logged (oxydised gley patches).
Sgrh:	structural permanently water-logged horizon, with reduced gley patches and organic matter.
Grh:	+/- similar, higher organic matter content.
Cgr:	parent material, reduced gley, permanently water-logged.

Fig. 6: Soils supporting a forested island, mangrove plain, Thompson Trail, Shipstern N.R. (from Mitchell et al, 1993)

Soil Mitchell No.10/1993: results of analyses

Soil	Horizon	Loss on ignition	Organic matter (%)	Organic C	Total N	C/N	pH(H2O)	pH(KCl)	Total CaCO3%	HUE	VALUE	CHROMA	COLOUR
10	OF?	46.4	26.51	19.4	1.3		7.9	7.4	27	10YR	4	2	dark grey Br
10	A	24.5	14	2.6	0.2		8.3	8	83	10YR	5	2	grey Br
10	Go_1	19.6	11.2		0.04		8.4	8	88	10YR	5.5	3	pale Br-Br
10	Go_2	21.9	12.51	0.5	0.08		8.2	8	63	10YR	5.5	2	lig br Grey-br Grey
10	CGr	6.4	3.66	1.2	0.08		8.1	7.8	63	10YR	5.5	1	Grey

Soil Mitchell No.11/1993: results of analyses

Soil	Horizon	Loss on ignition	Organic matter (%)	Organic C	Total N	C/N	pH(H2O)	pH(KCl)	Total CaCO3%	HUE	VALUE	CHROMA	COLOUR
11	An	5.14	2.94	21.97			7.35	7.29	1.84	10YR	3	2	ver dark grey Br
11	S	4.58	2.62	7.97			7.75	7.54	31.9	10YR	3	2	ver dark grey Br
11	Go_1	2.95	1.68	4.24			7.89	7.48	64.88	2.5Y	6.5	1	lig Grey-Grey
11	Gc_2	4.51	2.58	3.05			7.93	7.5	54.8	2.5Y	4	1	dark Grey

Soil Mitchell No.12/1993: results of analyses

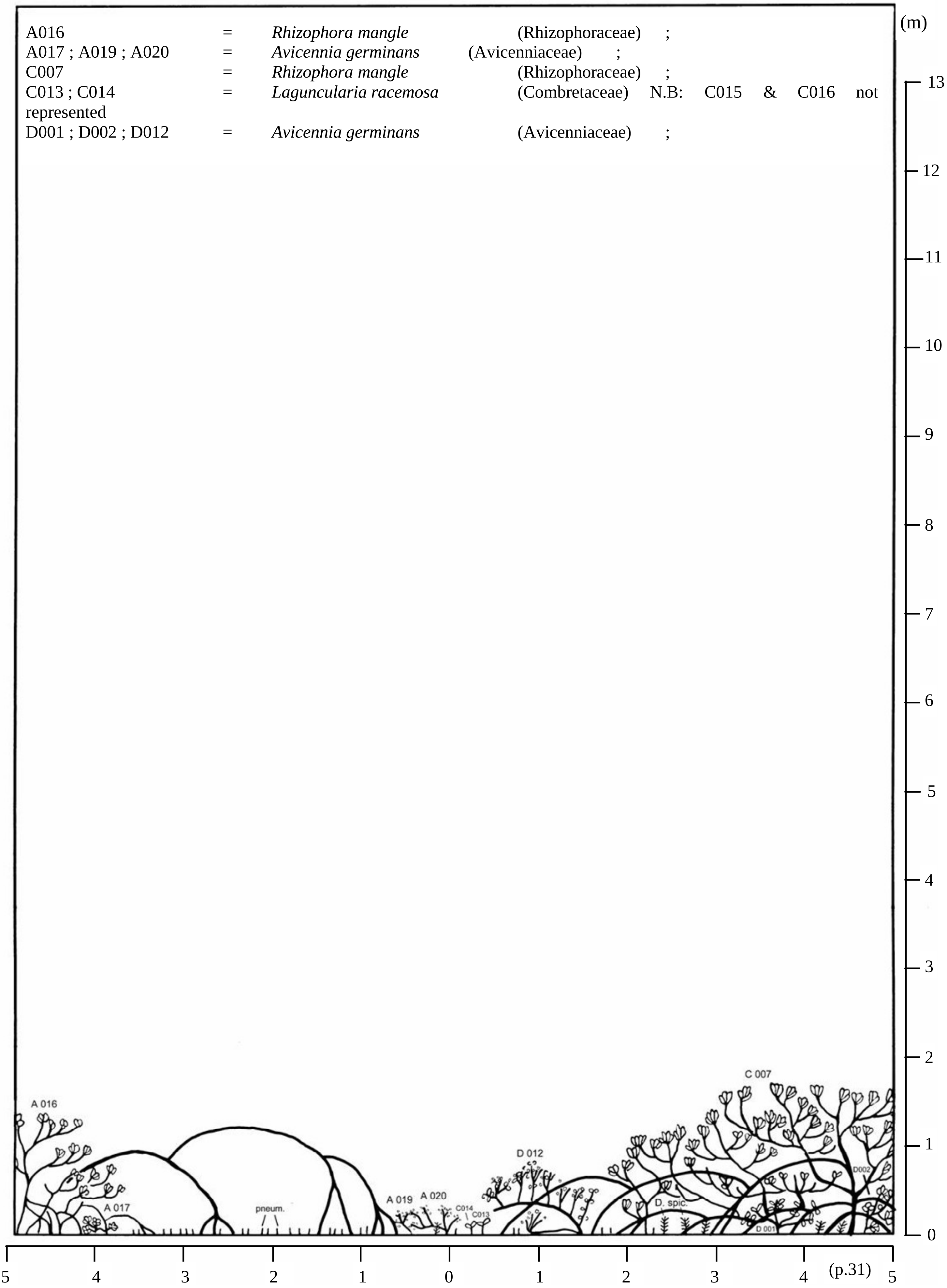
Soil	Horizon	Loss on ignition	Organic matter (%)	Organic C	Total N	C/N	pH(H2O)	pH(KCl)	Total CaCO3%	HUE	VALUE	CHROMA	COLOUR
12	Ah	8.76	5	30.86	1.72	17.9	6.73	6.42	0.65	10YR	2	2	very dark Br
12	Asgo	8.1	4.63	24.91	1.31	19	6.03	6	0.73	10YR	3	2	very dark grey Br
12	Sgrh	4.65	2.66	7.27	0.2	36	6.86	6.66	0.82	10YR	4	2	dark grey Br
12	Grh	4.6	2.63	25.23	0.63	40.4	7.4	7.3	3.43	10YR	2	2	very dark Br
12	CGr						7.81	7.62	71.69	10YR	6	1	Grey

Plot 2 N 18° 16.818’ W 088° 13.286’

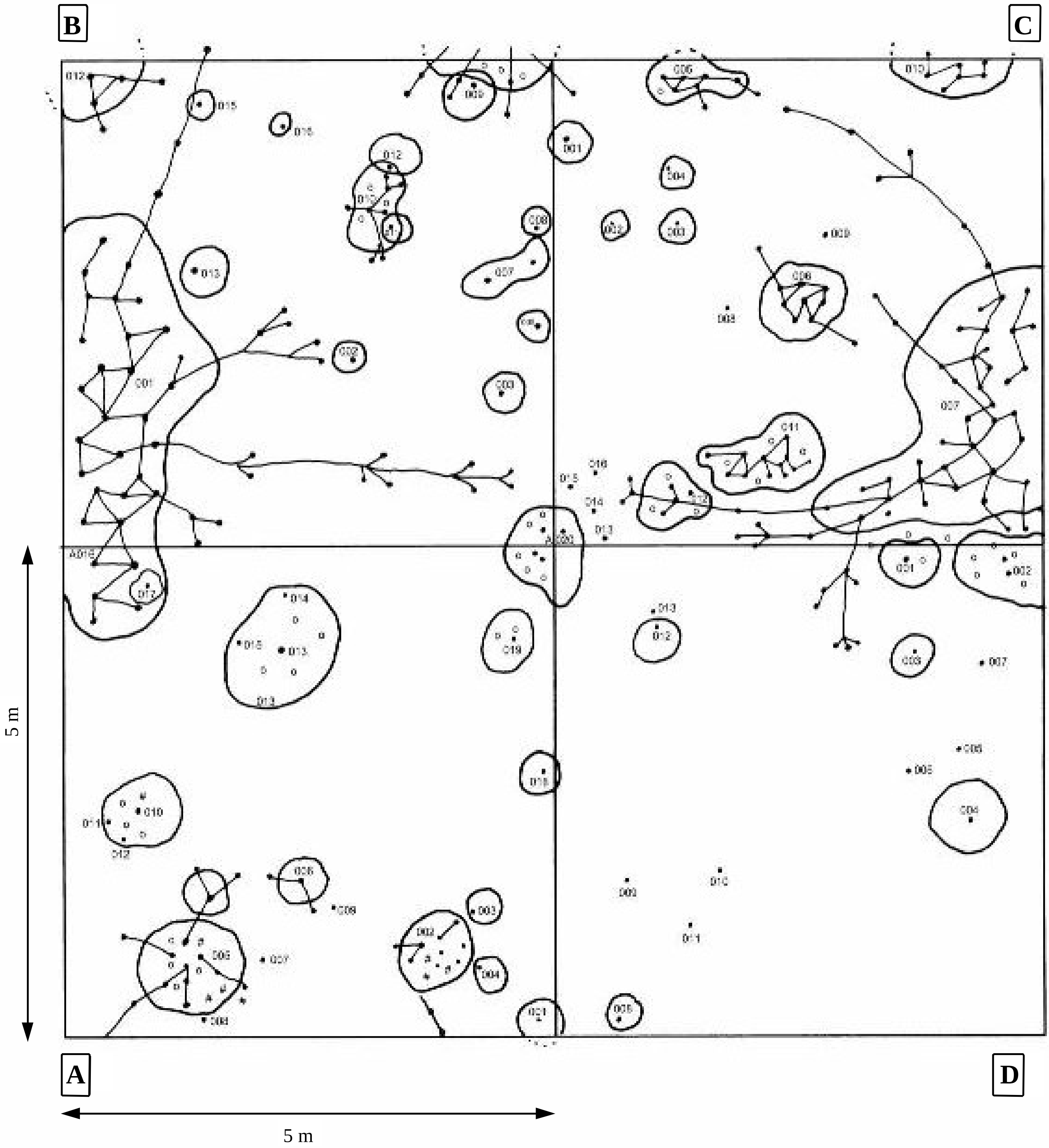
Vertical diagram (horizontal section: 10m x 2m, through centre, parallel to transect)

(m)

A016 = *Rhizophora mangle* (Rhizophoraceae) ;
A017 ; A019 ; A020 = *Avicennia germinans* (Avicenniaceae) ;
C007 = *Rhizophora mangle* (Rhizophoraceae) ;
C013 ; C014 = *Laguncularia racemosa* (Combretaceae) N.B: C015 & C016 not represented
D001 ; D002 ; D012 = *Avicennia germinans* (Avicenniaceae) ;



The Vegetation of Shipstern Nature Reserve
Western Survey Line Transect
Plot 2 N 18°16.818’ W 088° 13.286’
Horizontal diagram
Height 0m - 5m



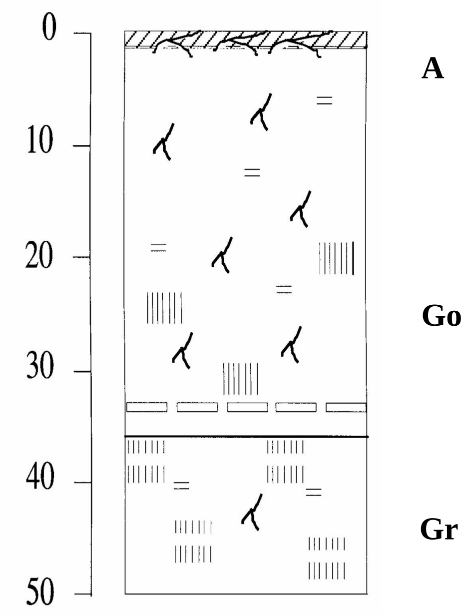
SHIPSTERN NATURE RESERVE VEGETATION SURVEY

PLOT 2 WESTERN SURVEY LINE TRANSECT

N 18°16.818. W 088°13.286'

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb collected	deposit	identification
o	Gramineae	Distichlis	spicata var. spicata	0.15		27.05.97	2 x int. 1 x ext.	BLMP/CHET/NE	Herb. Chetumal
#	Cyperaceae	Fimbristylis	spadicea	0.2		27.05.97	3 x ext.	BLMP/CHET/NE	Herb. Chetumal
PL2-A-001	Avicenniaceae	Avicennia	germinans	0.4					see appendix 2
PL2-A-002	Rhizophoraceae	Rhizophora	mangle	0.7					unmistakable
PL2-A-003	Avicenniaceae	Avicennia	germinans	0.4					
PL2-A-004	Avicenniaceae	Avicennia	germinans	0.3					
PL2-A-005	Rhizophoraceae	Rhizophora	mangle	1					
PL2-A-006	Rhizophoraceae	Rhizophora	mangle	0.9					
PL2-A-007	Combretaceae	Laguncularia	racemosa	0.3					unmistakable
PL2-A-008	Combretaceae	Laguncularia	racemosa	0.3					
PL2-A-009	Avicenniaceae	Avicennia	germinans	0.2					
PL2-A-010	Avicenniaceae	Avicennia	germinans	1					
PL2-A-011	Combretaceae	Laguncularia	racemosa	0.15					
PL2-A-012	Combretaceae	Laguncularia	racemosa	0.2					
PL2-A-013	Avicenniaceae	Avicennia	germinans	1.2					
PL2-A-014	Combretaceae	Laguncularia	racemosa	0.4					
PL2-A-015	Combretaceae	Laguncularia	racemosa	0.25					
PL2-A-016	Rhizophoraceae	Rhizophora	mangle	1.3					
PL2-A-017	Avicenniaceae	Avicennia	germinans	0.3					
PL2-A-018	Avicenniaceae	Avicennia	germinans	0.2					
PL2-A-019	Avicenniaceae	Avicennia	germinans	0.6					
PL2-A-020	Avicenniaceae	Avicennia	germinans	0.6					
PL2-B-001	Rhizophoraceae	Rhizophora	mangle	1.8					
PL2-B-002	Avicenniaceae	Avicennia	germinans	0.3					
PL2-B-003	Avicenniaceae	Avicennia	germinans	0.3					
PL2-B-004	Avicenniaceae	Avicennia	germinans	0.4					
PL2-B-005	Avicenniaceae	Avicennia	germinans	0.25					
PL2-B-006	Avicenniaceae	Avicennia	germinans	0.3					
PL2-B-007	Avicenniaceae	Avicennia	germinans	0.4					
PL2-B-008	Combretaceae	Laguncularia	racemosa	0.15					
PL2-B-009	Combretaceae	Laguncularia	racemosa	0.2					
PL2-B-010	Rhizophoraceae	Rhizophora	mangle	0.7					
PL2-B-011	Avicenniaceae	Avicennia	germinans	0.4					
PL2-B-012	Avicenniaceae	Avicennia	germinans	0.25					
PL2-B-013	Rhizophoraceae	Rhizophora	mangle	0.4					
PL2-B-014	Rhizophoraceae	Rhizophora	mangle	0.5					
PL2-B-015	Combretaceae	Laguncularia	racemosa	0.1					flowering!
PL2-C-001	Avicenniaceae	Avicennia	germinans	0.25					
PL2-C-002	Avicenniaceae	Avicennia	germinans	0.3					
PL2-C-003	Avicenniaceae	Avicennia	germinans	0.25					
PL2-C-004	Avicenniaceae	Avicennia	germinans	0.45					
PL2-C-005	Rhizophoraceae	Rhizophora	mangle	0.8					
PL2-C-006	Rhizophoraceae	Rhizophora	mangle	0.7					
PL2-C-007	Rhizophoraceae	Rhizophora	mangle	1.7					
PL2-C-008	Combretaceae	Laguncularia	racemosa	0.15					
PL2-C-009	Combretaceae	Laguncularia	racemosa	0.1					
PL2-C-010	Rhizophoraceae	Rhizophora	mangle	0.75					
PL2-C-011	Rhizophoraceae	Rhizophora	mangle	0.6					
PL2-C-012	Avicenniaceae	Avicennia	germinans	0.7					
PL2-C-013	Combretaceae	Laguncularia	racemosa	0.2					

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb collected	deposit	identification
PL2-C-014	Combretaceae	Laguncularia	racemosa	0.25					
PL2-C-015	Combretaceae	Laguncularia	racemosa	0.15					
PL2-C-016	Combretaceae	Laguncularia	racemosa	0.2					
PL2-D-001	Avicenniaceae	Avicennia	germinans	0.4					
PL2-D-002	Avicenniaceae	Avicennia	germinans	0.75					
PL2-D-003	Avicenniaceae	Avicennia	germinans	0.2					
PL2-D-004	Avicenniaceae	Avicennia	germinans	0.4					
PL2-D-005	Combretaceae	Laguncularia	racemosa	0.2					
PL2-D-006	Combretaceae	Laguncularia	racemosa	0.15					
PL2-D-007	Combretaceae	Laguncularia	racemosa	0.15					
PL2-D-008	Avicenniaceae	Avicennia	germinans	0.3					
PL2-D-009	Avicenniaceae	Avicennia	germinans	0.1					
PL2-D-010	Avicenniaceae	Avicennia	germinans	0.15					
PL2-D-011	Avicenniaceae	Avicennia	germinans	0.1					
PL2-D-012	Avicenniaceae	Avicennia	germinans	0.4					
PL2-D-013	Rhizophoraceae	Rhizophora	mangle	0.5					



Soil Mitchell No.13/1993

Vegetation: low red mangroves plain, soil with pneumatophores, Thompson Trail, Shipstern N.R., dry season

Type of soil: gleyosol

Horizons:

A: organo-mineral horizon, 1 cm thick. forms a crust in March-April.

Go: temporarily water-logged horizon, with oxydised gley patches.

Gr: reduced gley horizon, permanently water-logged.

Soil	Horizon	Loss on ignition	Organic matter (%)	Organic C	Total N	C/N	pH(H2O)	pH(KCl)	Total CaCO3%	HUE	VALUE	CHROMA	COLOUR
13	A	3.73	2.13	7.67	0.36	21.21	8.22	8.1	44.45	10YR	7	3	very pal Br
13	Go	1.61	0.92	9.41	0.1	95.93	8.13	7.84	75.59	10YR	8	3	very pal Br
13	Gr	0.96	0.55	10.83	0.06	172.95	8.17	8.09	88.81	10YR	8	2	very pal Br

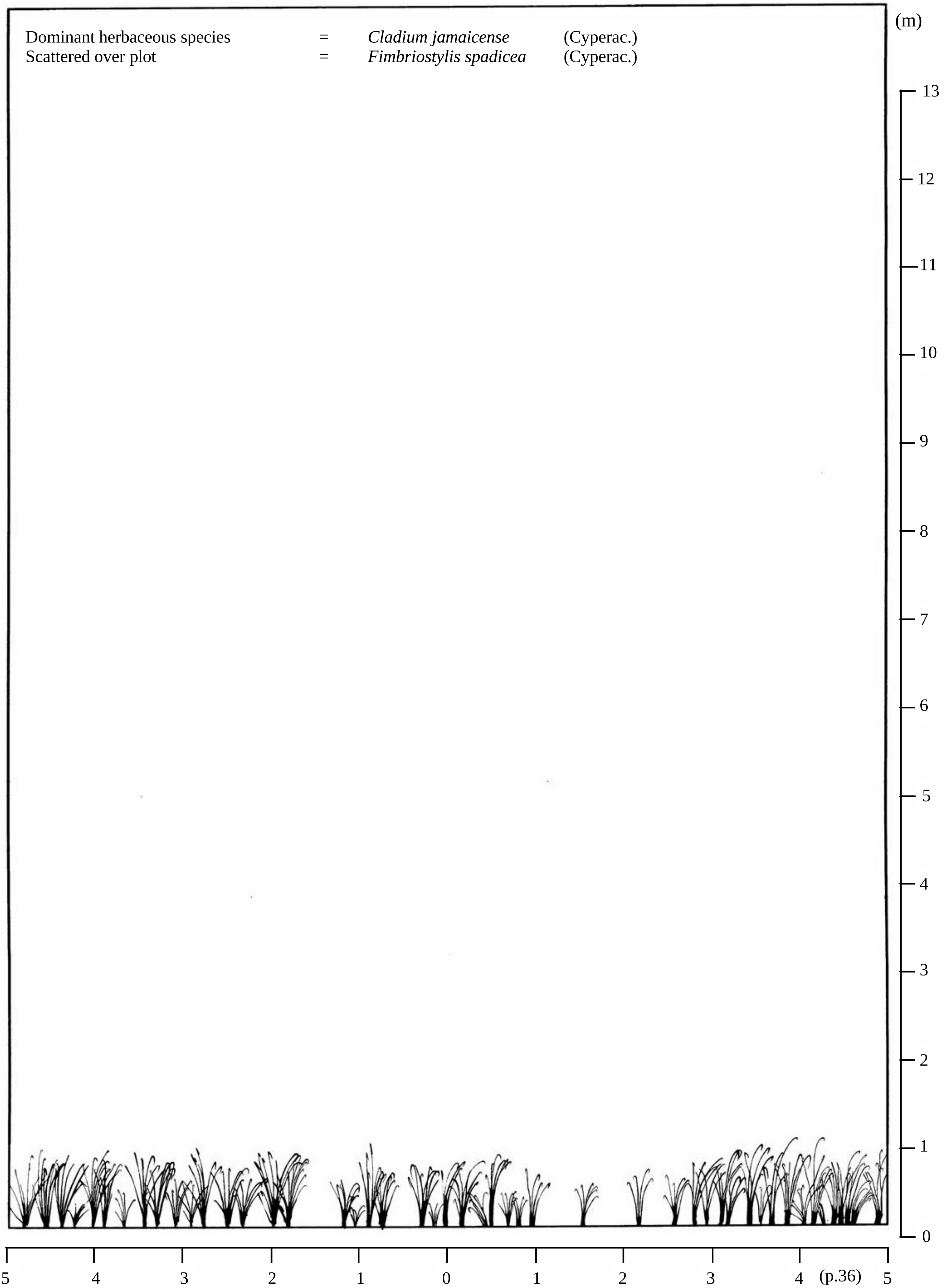
Fig. 7: Soil supporting a mangrove plain, with Rhizophora mangle and pneumatophores Thompson Trail, Shipstern N.R. (from Mitchell et al, 1993).

The Vegetation of Shipstern Nature Reserve
Western Survey Line Transect

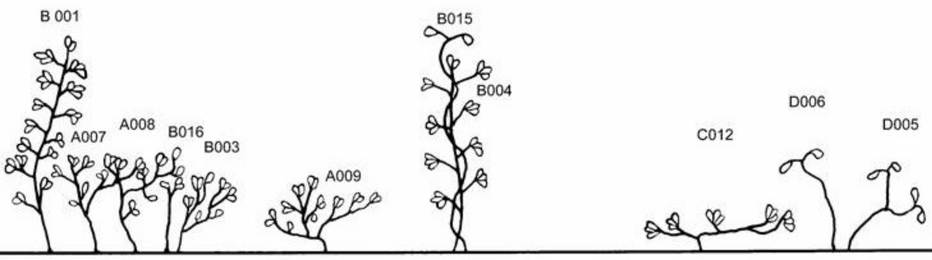
Plot 4 N 18° 17.006’ W 088° 13.164’

Vertical diagram (horizontal section: 10m x 2m, through centre, parallel to transect)

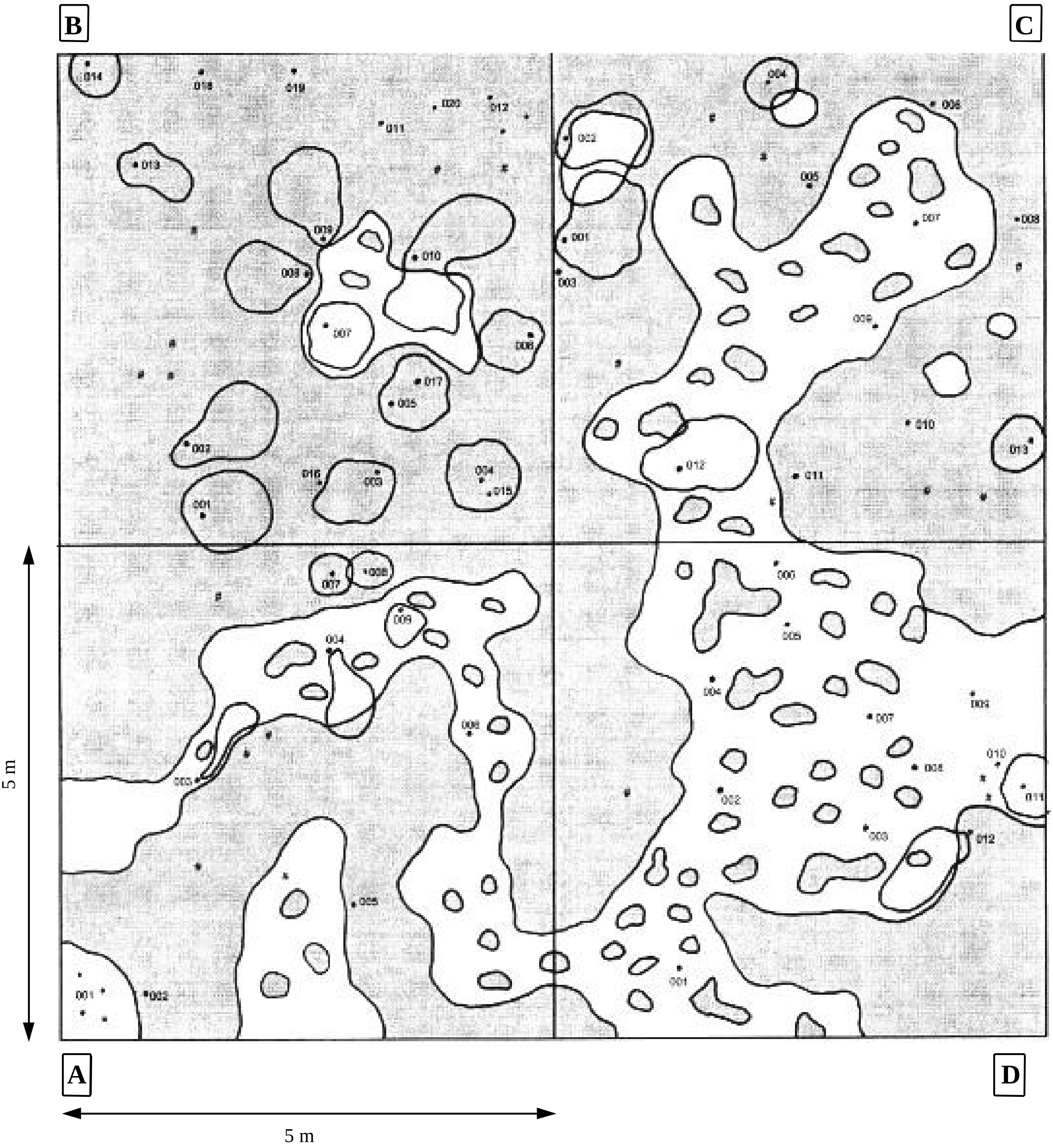
Dominant herbaceous species	=	*Cladium jamaicense*	(Cyperac.)
Scattered over plot	=	*Fimbriostylis spadicea*	(Cyperac.)



A007 ; B001 ; B003 ; B004 ; C012	=	*Conocarpus erectus*	(Combretaceae)
B016	=	*Solanum blodgettii*	(Solanaceae)
A008 ; D005 ; D006	=	*Rhabdadenia biflora*	(Apocynaceae)



The Vegetation of Shipstern Nature Reserve
Western Survey Line Transect
Plot 4   N 18°17.006’   W 088° 13.164’
Horizontal diagram
Height 0m - 5m

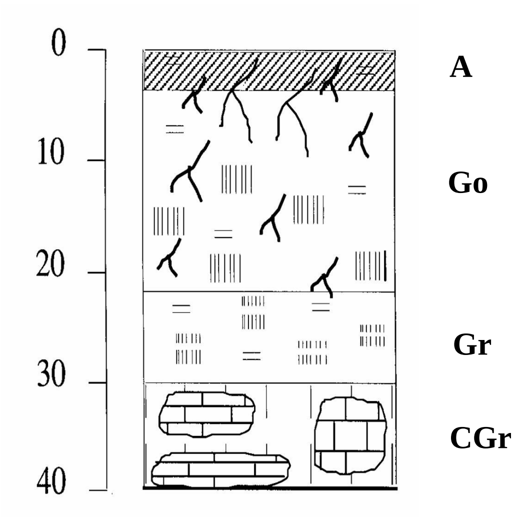


SHIPSTERN NATURE RESERVE VEGETATION SURVEY

PLOT 4 WESTERN SURVEY LINE TRANSECT

N 18°17.006' W 088° 13.164'

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb coll.	deposit	identification
PL4-A-001	Acanthaceae	Bravaisia	tubiflora	0.8					idem PL11-A-010a
PL4-A-002l	Apocynaceae	Rhabdadenia	biflora	0.8		26.01.97	3 x ext.	BLMP/CHET/NE	Tomlinson
PL4-A-003	Combretaceae	Conocarpus	erectus	0.3					unmistakable
PL4-A-004	Combretaceae	Conocarpus	erectus	0.9					
PL4-A-005l	Apocynaceae	Rhabdadenia	biflora	0.4					idem PL4-A-002l
PL4-A-006l	Apocynaceae	Rhabdadenia	biflora	0.5					idem PL4-A-002l
PL4-A-007	Combretaceae	Conocarpus	erectus	0.6					
PL4-A-008	Apocynaceae	Rhabdadenia	biflora	0.5					idem PL4-A-002l
PL4-A-009	Combretaceae	Conocarpus	erectus	0.3					
PL4-B-001	Combretaceae	Conocarpus	erectus	1.6	1.4				
PL4-B-002	Combretaceae	Conocarpus	erectus	1.4					
PL4-B-003	Combretaceae	Conocarpus	erectus	0.5					
PL4-B-004	Combretaceae	Conocarpus	erectus	1.3					
PL4-B-005	Combretaceae	Conocarpus	erectus	0.5					
PL4-B-006	Combretaceae	Conocarpus	erectus	1.3					
PL4-B-007	Combretaceae	Conocarpus	erectus	0.9					
PL4-B-008	Combretaceae	Conocarpus	erectus	0.7					
PL4-B-009	Combretaceae	Conocarpus	erectus	0.7					
PL4-B-010	Combretaceae	Conocarpus	erectus	0.6					
PL4-B-011	Combretaceae	Conocarpus	erectus	0.9					
PL4-B-012	Combretaceae	Conocarpus	erectus	0.9					
PL4-B-013	Combretaceae	Conocarpus	erectus	0.8					
PL4-B-014	Combretaceae	Conocarpus	erectus	0.6					
PL4-B-015	Apocynaceae	Rhabdadenia	biflora	1.3					
PL4-B-016	Solanaceae	Solanum	blodgettii	0.6		27.05.97	2 x ext.	BLMP/CHET	Fl. of Guatemala
PL4-B-017	Solanaceae	Solanum	blodgettii	0.7					idem PL4-B-016
PL4-C-001	Combretaceae	Conocarpus	erectus	1.3					
PL4-C-002	Combretaceae	Conocarpus	erectus	1					
PL4-C-003	Solanaceae	Solanum	blodgettii	0.8			1 x int.	NE	idem PL4-B-016
PL4-C-004	Combretaceae	Conocarpus	erectus	0.4					
PL4-C-005l	Apocynaceae	Rhabdadenia	biflora	0.5					idem PL4-A-002l
PL4-C-006l	Apocynaceae	Rhabdadenia	biflora	0.6					idem PL4-A-002l
PL4-C-007l	Apocynaceae	Rhabdadenia	biflora	0.5					idem PL4-A-002l
PL4-C-008l	Apocynaceae	Rhabdadenia	biflora	0.5					idem PL4-A-002l
PL4-C-009l	Apocynaceae	Rhabdadenia	biflora	0.6					idem PL4-A-002l
PL4-C-010l	Apocynaceae	Rhabdadenia	biflora	0.4					idem PL4-A-002l
PL4-C-011l	Apocynaceae	Rhabdadenia	biflora	0.6					idem PL4-A-002l
PL4-C-012	Combretaceae	Conocarpus	erectus	0.3					
PL4-C-013	Combretaceae	Conocarpus	erectus	0.4					
PL4-D-001l	Apocynaceae	Rhabdadenia	biflora	0.5					idem PL4-A-002l
PL4-D-002l	Apocynaceae	Rhabdadenia	biflora	0.6					idem PL4-A-002l
PL4-D-003l	Apocynaceae	Rhabdadenia	biflora	0.7					idem PL4-A-002l
PL4-D-004l	Apocynaceae	Rhabdadenia	biflora	0.5					idem PL4-A-002l
PL4-D-005l	Apocynaceae	Rhabdadenia	biflora	0.3					idem PL4-A-002l
PL4-D-006l	Apocynaceae	Rhabdadenia	biflora	0.6					idem PL4-A-002l
PL4-D-007l	Apocynaceae	Rhabdadenia	biflora	0.6					idem PL4-A-002l
PL4-D-008l	Apocynaceae	Rhabdadenia	biflora	0.5					idem PL4-A-002l
PL4-D-009l	Apocynaceae	Rhabdadenia	biflora	0.4					idem PL4-A-002l
PL4-D-010l	Apocynaceae	Rhabdadenia	biflora	0.5					idem PL4-A-002l
PL4-D-011	Combretaceae	Conocarpus	erectus	0.4					
PL4-D-012	Combretaceae	Conocarpus	erectus	0.3					
	Cyperaceae	Cladium	jamaicense	~0.55					idem PL11-C-016H
#	Cyperaceae	Fimbristylis	spadicea	~0.5					idem PL2



Soil Mitchell No.09/1993

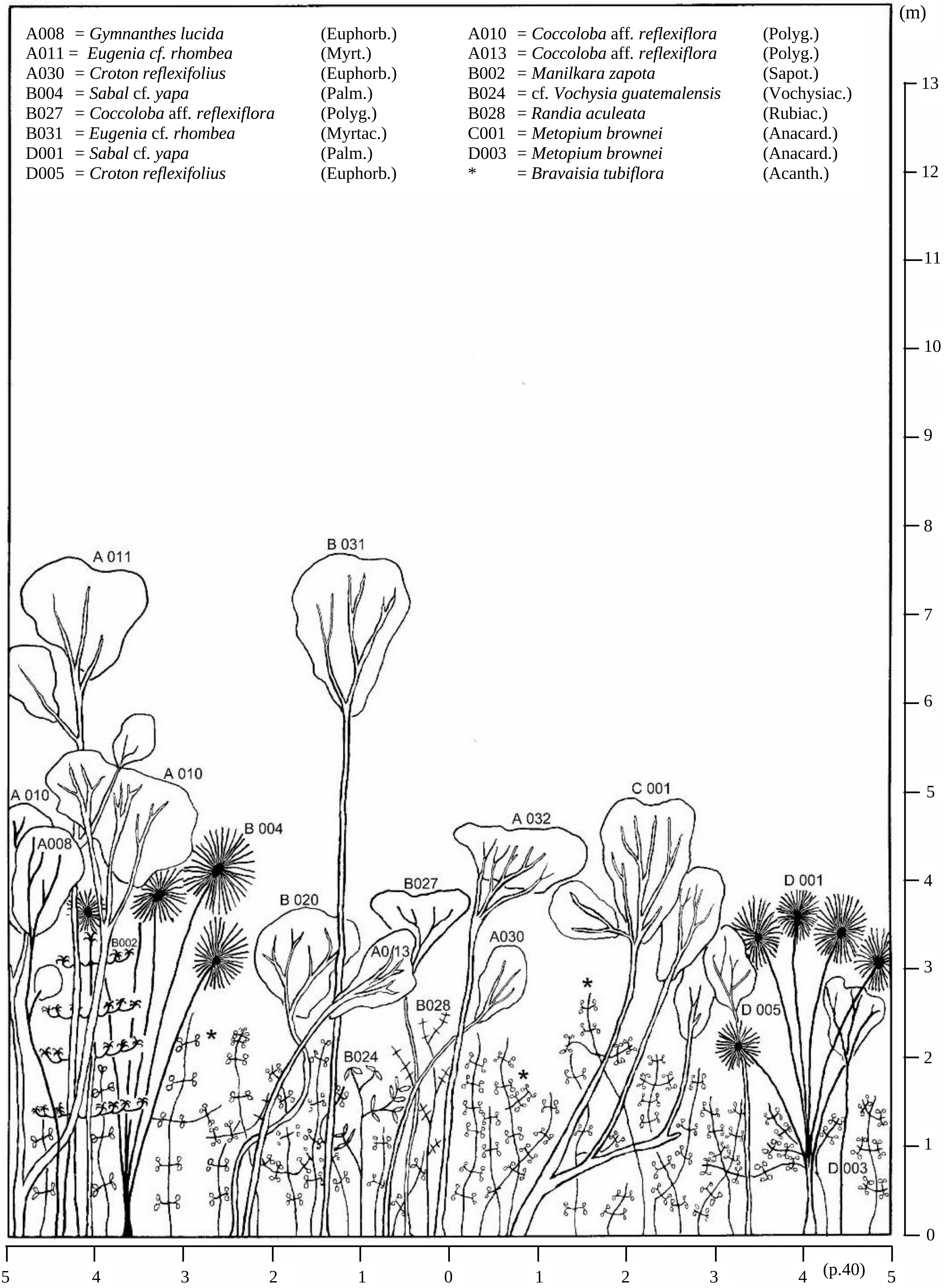
Vegetation:	herbaceous wetland with swordgrass and buttonwood Thompson Trail, Shipstern N.R., dry season
Type of soil:	gleyosol
Horizons:	
A:	organo-mineral horizon, 4 cm thick.
Go:	temporarily water-logged horizon, with oxydised gley patches.
Gr:	reduced gley horizon, permanently water-logged.
CGr:	parent material + reduced gley

Soil	Horizon	Loss on ignition	Organic matter (%)	Organic C	Total N	C/N	pH(H2O)	pH(KCl)	Total CaCO3%	HUE	VALUE	CHROMA	COLOUR
9	A	5.96	3.41	8.85	0.28	31.07	7.93	7.82	51.41	2.5Y	5.5	2	grey Br-lig br Grey
9	Go	3.6	2.06	7.27	0.08	87.68	8.15	7.72	60.86	2.5Y	7	3	pal Yel
9	Gr	1.74	1				8.32	7.63	18.64	10YR	6	4	lig yel Br
9	CGr	3.04	1.74				7.91	7.58	9.07	10YR	7	2	lig Grey

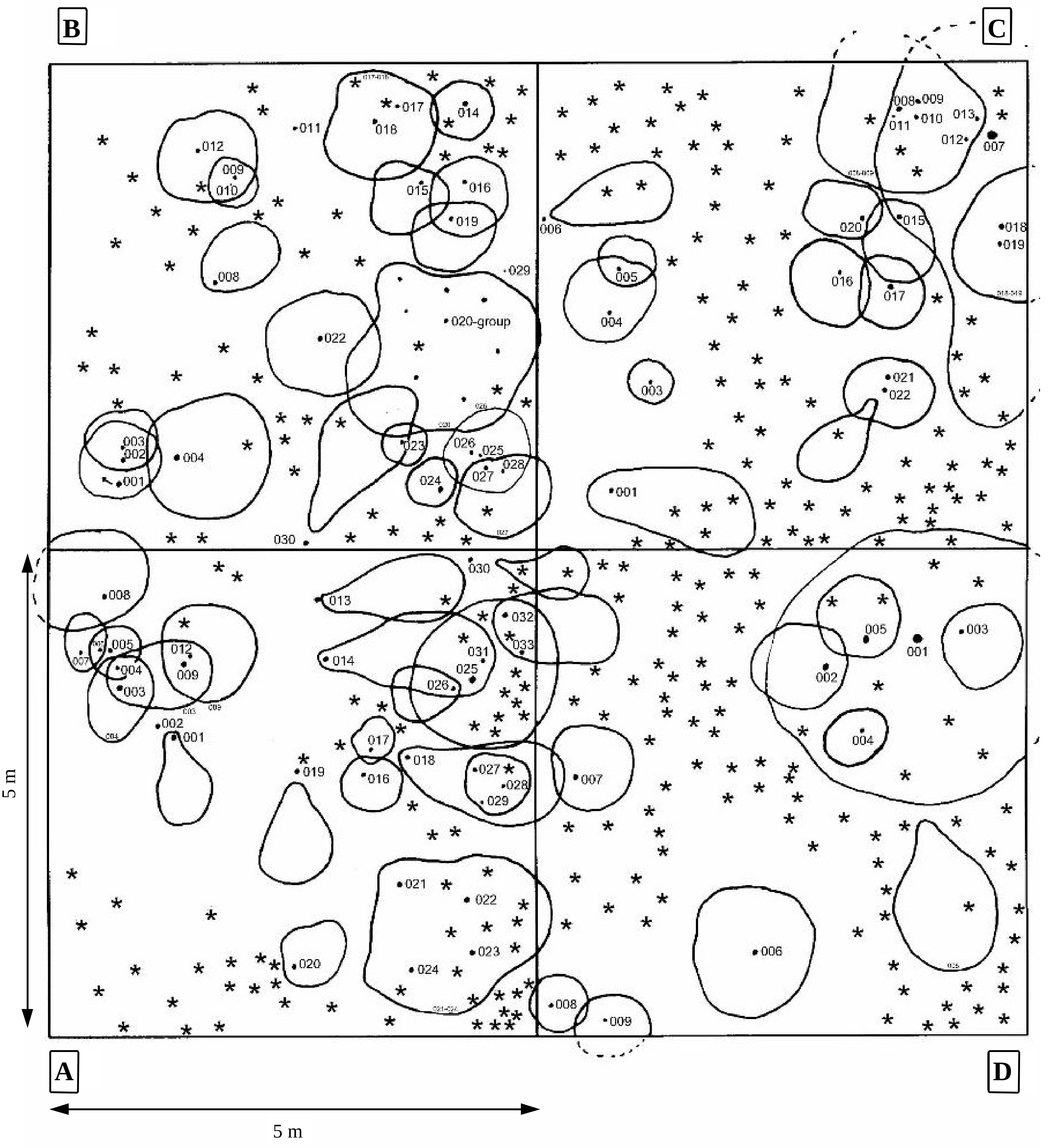
Fig. 8: Soil supporting a herbaceous wetland with swordgrass and buttonwood, Thompson Trail, Shipstern N.R. (from Mitchell et al, 1993).

The Vegetation of Shipstern Nature Reserve
Western Survey Line Transect

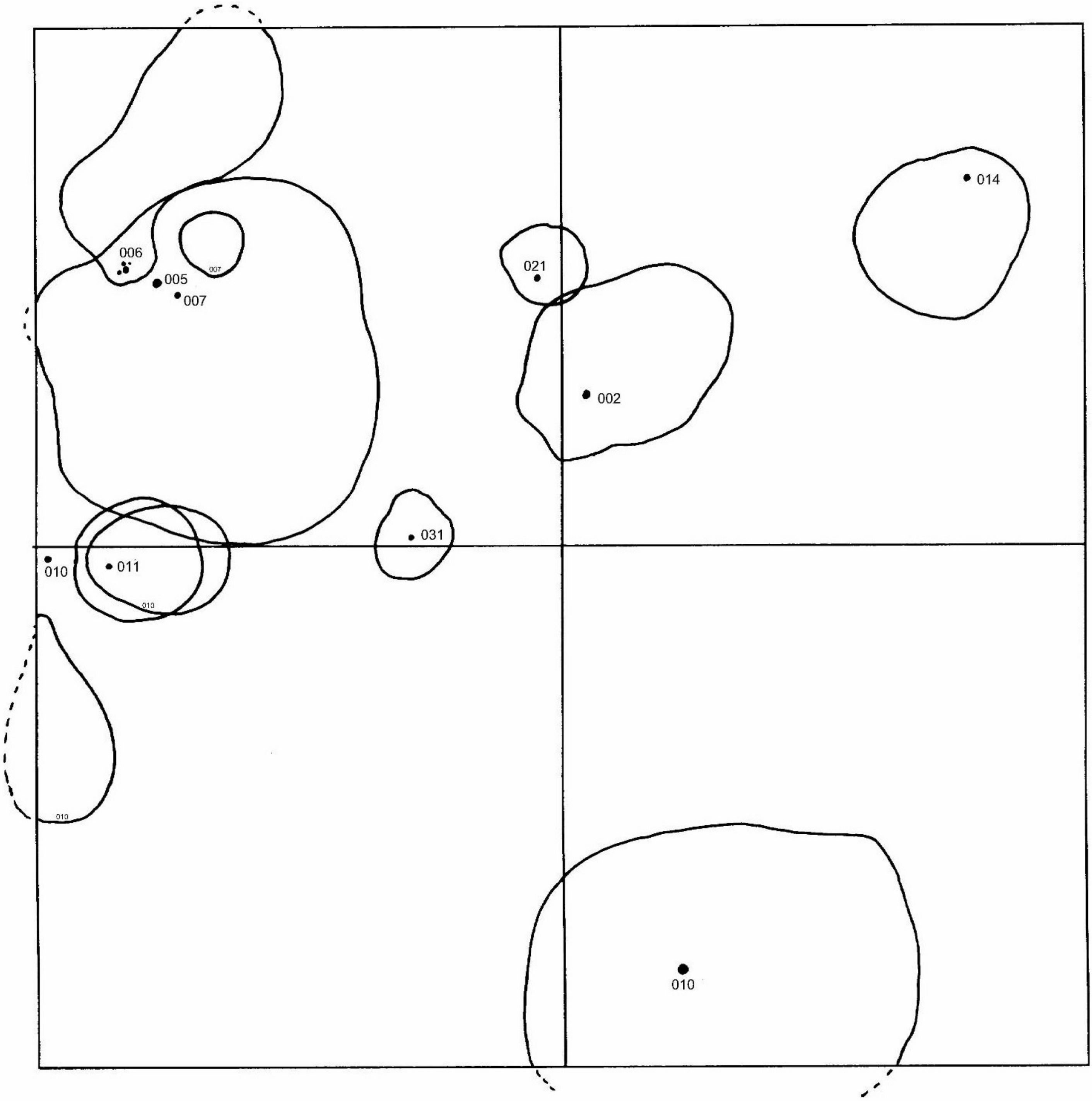
Plot 5 N 18° 17.110’ W 088° 13.186’
Vertical diagram (horizontal section: 10m x 2m, through centre, parallel to transect)



The Vegetation of Shipstern Nature Reserve
Western Survey Line Transect
Plot 5 N 18°17.110’ W 088° 13.186’
Horizontal diagram
First level, height 1.5m - 5m



Second level, height 5m - 10m



SHIPSTERN NATURE RESERVE VEGETATION SURVEY

PLOT 5 WESTERN SURVEY LINE TRANSECT

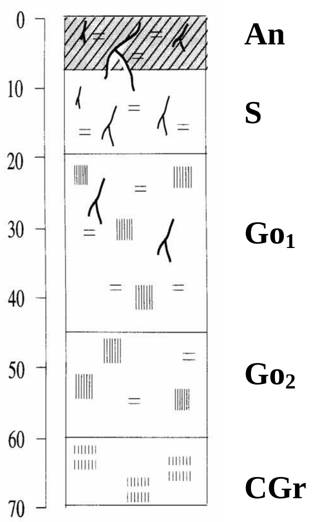
N 18°17.110' W 088° 13.186'

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb coll.	deposit	identification
*	Acanthaceae	Bravaisia	tubiflora	1.7	1				idem PL11
PL5-A-001a	Euphorbiaceae	Croton	reflexifolius	2	1.8				idem PL8-A-036a
PL5-A-002l	Rubiaceae	Morinda	royoc	2	<1				idem PLDR-A-002l
PL5-A-003a	Euphorbiaceae	Croton	reflexifolius	4	1.7				idem PL8-A-036a
PL5-A-004a	Euphorbiaceae	Croton	reflexifolius	4.5	3.5				idem PL8-A-036a
PL5-A-005a	cf. Olacaceae	cf. Schoepfia	obovata	4	1.2				idem PL5-C-006a
PL5-A-006a	Myrtaceae	Eugenia	cf. rhombea	2.5	1.3	22.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL5-A-007a	Myrtaceae	Eugenia	cf. rhombea	3.5	1.8				idem PL5-A-006a
PL5-A-008a	Euphorbiaceae	Gymnanthes	lucida	4.5	2.6				idem PL8-B-020a
PL5-A-009a	Palmae	Thrinax	aff. radiata	2.5					idem PL8-A-011a
PL5-A-010A	Polygonaceae	Coccoloba	aff. reflexiflora	5.5	7.2				idem PL11-B-005a
PL5-A-011A	Myrtaceae	Eugenia	cf. rhombea	7.5	9.4				idem PL5-A-006a
PL5-A-012a	Euphorbiaceae	Gymnanthes	lucida	1.5	<1				idem PL8-B-020a
PL5-A-013a	Polygonaceae	Coccoloba	aff. reflexiflora	3.5	3.3				idem PL11-B-005a
PL5-A-014a	Polygonaceae	Coccoloba	aff. reflexiflora	4.5	5.9				idem PL11-B-005a
PL5-A-015A	Myrtaceae	Eugenia	cf. rhombea	7.5	7.3				idem PL5-A-006a
PL5-A-016a	Rubiaceae	Randia	aculeata	3	1.2				idem PL8-A-031a
PL5-A-017a	Myrtaceae	Eugenia	cf. rhombea	3	1.1				idem PL5-A-006a
PL5-A-018a	Myrtaceae	Eugenia	acapulcensis	4.5	4.8				idem PL11-D-007a
PL5-A-019a	Myrtaceae	Eugenia	acapulcensis	3.5	3				idem PL11-D-007a
PL5-A-020a	Polygonaceae	Coccoloba	aff. reflexiflora	3	1.4				idem PL11-B-005a
PL5-A-021a	Polygonaceae	Coccoloba	aff. reflexiflora	4.5	6				idem PL11-B-005a
PL5-A-022a	Polygonaceae	Coccoloba	aff. reflexiflora	3	4				idem PL11-B-005a
PL5-A-023a	Polygonaceae	Coccoloba	aff. reflexiflora	3	3.7				idem PL11-B-005a
PL5-A-024a	Polygonaceae	Coccoloba	aff. reflexiflora	2.5	2.2				idem PL11-B-005a
PL5-A-025a	Palmae	Sabal	cf. yapa	4					see appendix 2
PL5-A-026a	Euphorbiaceae	Croton	reflexifolius	4.5	4.3				idem PL8-A-036a
PL5-A-027a	Polygonaceae	Coccoloba	aff. reflexiflora	2.5	1.7				idem PL11-B-005a
PL5-A-028a	Polygonaceae	Coccoloba	aff. reflexiflora	3	1.9				idem PL11-B-005a
PL5-A-029a	Polygonaceae	Coccoloba	aff. reflexiflora	3	2.3				idem PL11-B-005a
PL5-A-030a	Euphorbiaceae	Croton	reflexifolius	3.5	2.9				idem PL8-A-036a
PL5-A-031a	Papilionaceae	Gliricidia	sepium	1.5	<1				idem PL11-D-020a
PL5-A-032a	Euphorbiaceae	Croton	reflexifolius	4.5	4.1				idem PL8-A-036a
PL5-A-033a	Euphorbiaceae	Croton	reflexifolius	3	3.2				idem PL8-A-036a
PL5-B-001a	Polygonaceae	Coccoloba	aff. reflexiflora	2.5	3.9				idem PL11-B-005a
PL5-B-002a	Sapotaceae	Manilkara	zapota	3.5	2.6				idem PL8-B-009A
PL5-B-003a	Myrtaceae	Eugenia	cf. rhombea	3	<1				idem PL5-A-006a
PL5-B-004a	Palmae	Sabal	cf. yapa	4.5					see appendix 2
PL5-B-005A	Anacardiaceae	Metopium	brownei	7	19				unmistakable
PL5-B-006A	Flacourtiaceae	Samyda	yucatanensis	5.5	8.3				idem PLDR-C-018a
PL5-B-007A	Papilionaceae	Dalbergia	glabra	8	7.5	22.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL5-B-008a	Flacourtiaceae	Samyda	yucatanensis	4	4				idem PL5-B-006A
PL5-B-009a	Polygonaceae	Coccoloba	cf. schiedeana	2.5	<1				idem PL8-A-014a
PL5-B-010l	Rubiaceae	Morinda	royoc	3+	<1				idem PLDR-A-002l
PL5-B-011l	Smilacaceae	Smilax	aff. spinosa	4	<1	22.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL5-B-012a	Flacourtiaceae	Samyda	yucatanensis	3.5	2.1				idem PL5-A-006a
PL5-B-013A	Anacardiaceae	Metopium	brownei	6	11				
PL5-B-014a	Anacardiaceae	Spondias	mombin	5	2	22.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL5-B-015a	Anacardiaceae	Metopium	brownei	4.5	3.6				unmistakable
PL5-B-016a	Anacardiaceae	Metopium	brownei	4	3.4				

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb coll.	deposit	identification
PL5-B-017a	Rubiaceae	Randia	aculeata	3.5	2.8				idem PL8-A-031a
PL5-B-018a	Rubiaceae	Randia	aculeata	3.5	2.6				idem PL8-A-031a
PL5-B-019a	Myrtaceae	Eugenia	acapulcensis	5	4				idem PL11-D-007a
PL5-B-020a	Rubiaceae	Randia	aculeata	2.6	1.6				idem PL8-A-031a
PL5-B-021A	Euphorbiaceae	Croton	reflexifolius	5.5	7.8				idem PL8-A-036a
PL5-B-022a	Rubiaceae	Randia	aculeata	3	1.4				idem PL8-A-031a
PL5-B-023a	Ochnaceae	Ouratea	nitida	1.5	<1	23.05.97	1 x check		idem Ext-061-WSL6
PL5-B-024a	Vochysiaceae	cf. Vochysia	guatemalensis	2	1.2	22.05.97	3 x int.	BLMP/CHET/NE	Keller, Gentry
PL5-B-025l	Sapindaceae	Serjania	yucatanensis	3+	<1				idem PL8-A-033l
PL5-B-026a	Polygonaceae	Coccoloba	aff. reflexiflora	3.5	4.2				idem PL11-B-005a
PL5-B-027a	Polygonaceae	Coccoloba	aff. reflexiflora	4	5.6				idem PL11-B-005a
PL5-B-028a	Rubiaceae	Randia	aculeata	3	1.5				idem PL8-A-031a
PL5-B-029l	Convolvulaceae	Merremia	cf cissoides	3+	<1	22.05.97	2 x int.	BLMP/NE	Herb. Chetumal
PL5-B-030a	Polygonaceae	Coccoloba	aff. reflexiflora	3.5	8				idem PL11-B-005a
PL5-B-031A	Myrtaceae	Eugenia	cf. rhombea	7.5	7				idem PL5-A-011a
PL5-C-001a	Anacardiaceae	Metopium	brownei	4.5	7.5				unmistakable
PL5-C-002A	Palmae	Sabal	cf. yapa	5.5	21				see appendix 2
PL5-C-003a	Anacardiaceae	Metopium	brownei	3	1.4				unmistakable
PL5-C-004a	Myrtaceae	Eugenia	cf. rhombea	4.5	6.8				idem PL5-A-011a
PL5-C-005a	Polygonaceae	Coccoloba	aff. reflexiflora	3.5	1.7				idem PL11-B-005a
PL5-C-006a	cf. Olacaceae	cf. Schoepfia	obovata	2.5	1.3	22.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL5-C-007a	Palmae	Sabal	cf. yapa	4					see appendix 2
PL5-C-008a	Euphorbiaceae	Gymnanthes	lucida	3.5	2.1				idem PL8-B-031a
PL5-C-009a	Euphorbiaceae	Croton	reflexifolius	5	5.1				idem PL8-A-036a
PL5-C-010a	Euphorbiaceae	Croton	reflexifolius	5	4.8				idem PL8-A-036a
PL5-C-011l	Sapindaceae	Serjania	yucatanensis	4+	<1				idem PL8-A-033l
PL5-C-012a	Euphorbiaceae	Croton	reflexifolius	3.5	1.7				idem PL8-A-036a
PL5-C-013a	Euphorbiaceae	Croton	reflexifolius	4.5	3.6				idem PL8-A-036a
PL5-C-014A	Euphorbiaceae	Croton	reflexifolius	5.5	7				idem PL8-A-036a
PL5-C-015a	Euphorbiaceae	Croton	reflexifolius	5	5.8				idem PL8-A-036a
PL5-C-016a	Mimosaceae	Pithecellobium	aff. stevensonii	3.5	3.4	22.05.97	1 x int. ch	NE	idem PL8-A-005a?
PL5-C-017a	Sapotaceae	Manilkara	zapota	2.5	1.4				idem PL8-B-009A
PL5-C-018a	Euphorbiaceae	Croton	reflexifolius	5	7				idem PL8-A-036a
PL5-C-019a	Euphorbiaceae	Croton	reflexifolius	4.5	6.2				idem PL8-A-036a
PL5-C-020a	Palmae	Sabal	cf. yapa	2					see appendix 2
PL5-C-021a	Euphorbiaceae	Croton	reflexifolius	3.5	4.8				idem PL8-A-036a
PL5-C-022a	Myrtaceae	Eugenia	acapulcensis	2.5	1.9				idem PL11-D-007a
PL5-D-001a	Palmae	Sabal	cf. yapa	3.5					see appendix 2
PL5-D-002a	Euphorbiaceae	Croton	reflexifolius	4	3.9				idem PL8-A-036a
PL5-D-003a	Anacardiaceae	Metopium	brownei	3	3.8				unmistakable
PL5-D-004a	Erythroxylaceae	Erythroxylum	aff. areolatum	2.5	1.6	22.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL5-D-005a	Euphorbiaceae	Croton	reflexifolius	3.5	8.2				idem PL8-A-036a
PL5-D-006a	Euphorbiaceae	Croton	reflexifolius	4	5.3				idem PL8-A-036a
PL5-D-007a	Anacardiaceae	Metopium	brownei	3.5	3.9				unmistakable
PL5-D-008a	Apocynaceae	Cameraria	latifolia	2	<1				idem PL11-A-006a
PL5-D-009a	Mimosaceae	Acacia	collinsii	3	2.1				field ident.FBH
PL5-D-010A	Palmae	Sabal	cf. yapa	5.5	24.5				see appendix 2

Plot 5: species data table

Family	Genus	Species	Frequency	Density (ind./ha)	Total basal area (cm2/100m2)
Acanthaceae	Bravaisia	tubiflora	1	283	223.57
Euphorbiaceae	Croton	reflexifolius	1	20	394.05
Palmae	Sabal	cf. yapa	1	7	817.8
Polygonaceae	Coccoloba	aff. reflexiflor	0.75	16	245.77
Anacardiaceae	Metopium	brownei	0.75	8	466.83
Myrtaceae	Eugenia	cf. rhombea	0.75	8	191.66
Myrtaceae	Eugenia	acapulcensis	0.75	4	40.58
Rubiaceae	Randia	aculeata	0.5	6	17.92
Euphorbiaceae	Gymnanthes	lucida	0.5	3	5.7
Sapotaceae	Manilkara	zapota	0.5	2	6.85
cf. Olacaceae	cf. Schoepfia	obovata	0.5	2	2.46
Rubiaceae	Morinda	royoc	0.5	2	1.58
Sapindaceae	Serjania	yucatanensis	0.5	2	1.58
Flacourtiaceae	Samyda	yucatanensis	0.25	3	14.4
Papilionaceae	Dalbergia	glabra	0.25	1	44.18
Mimosaceae	Pithecellobium	aff. stevenso	0.25	1	9.08
Vochysiaceae	cf. Vochysia	guatemalens	0.25	1	3.59
Mimosaceae	Acacia	collinsii	0.25	1	3.46
Anacardiaceae	Spondias	mombin	0.25	1	3.14
Apocynaceae	Cameraria	latifolia	0.25	1	0.79
Convolvulacea	Merremia	cf cissoides	0.25	1	0.79
Erythroxylacea	Erythroxylum	aff. areolatum	0.25	1	0.79
Ochnaceae	Ouratea	nitida	0.25	1	0.79
Papilionaceae	Gliricidia	sepium	0.25	1	0.79
Polygonaceae	Coccoloba	cf. schiedean	0.25	1	0.79
Smilacaceae	Smilax	aff. spinosa	0.25	1	0.79
Palmae	Thrinax	aff. radiata	0.25	1	0



Soil Mitchell No.11/1993

Vegetation:

base of forested island, under Bravaisia tubiflora mangrove plain, Thompson Trail, Shipstern N.R.

Type of soil: deep organic gleyosol

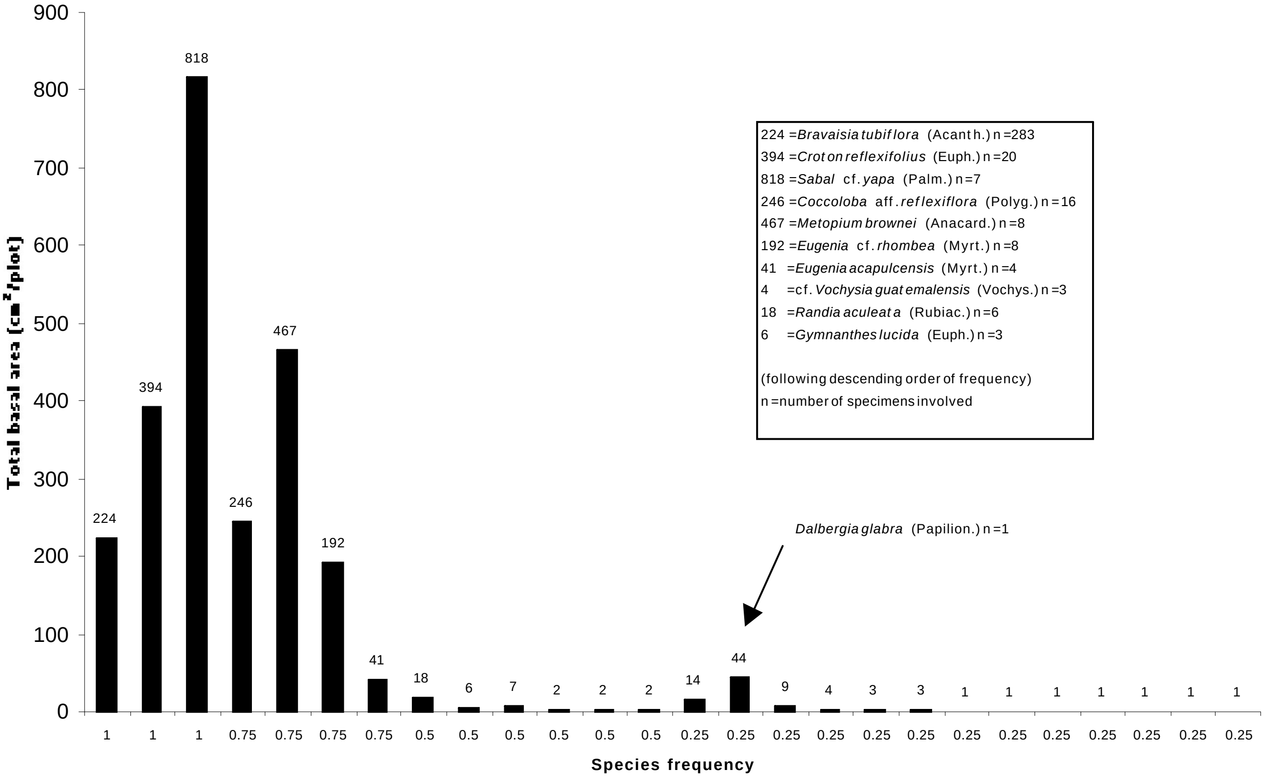
Horizons:

An: highly organic organo-mineral horizon, with very high silt and clay content.
S: structural horizon

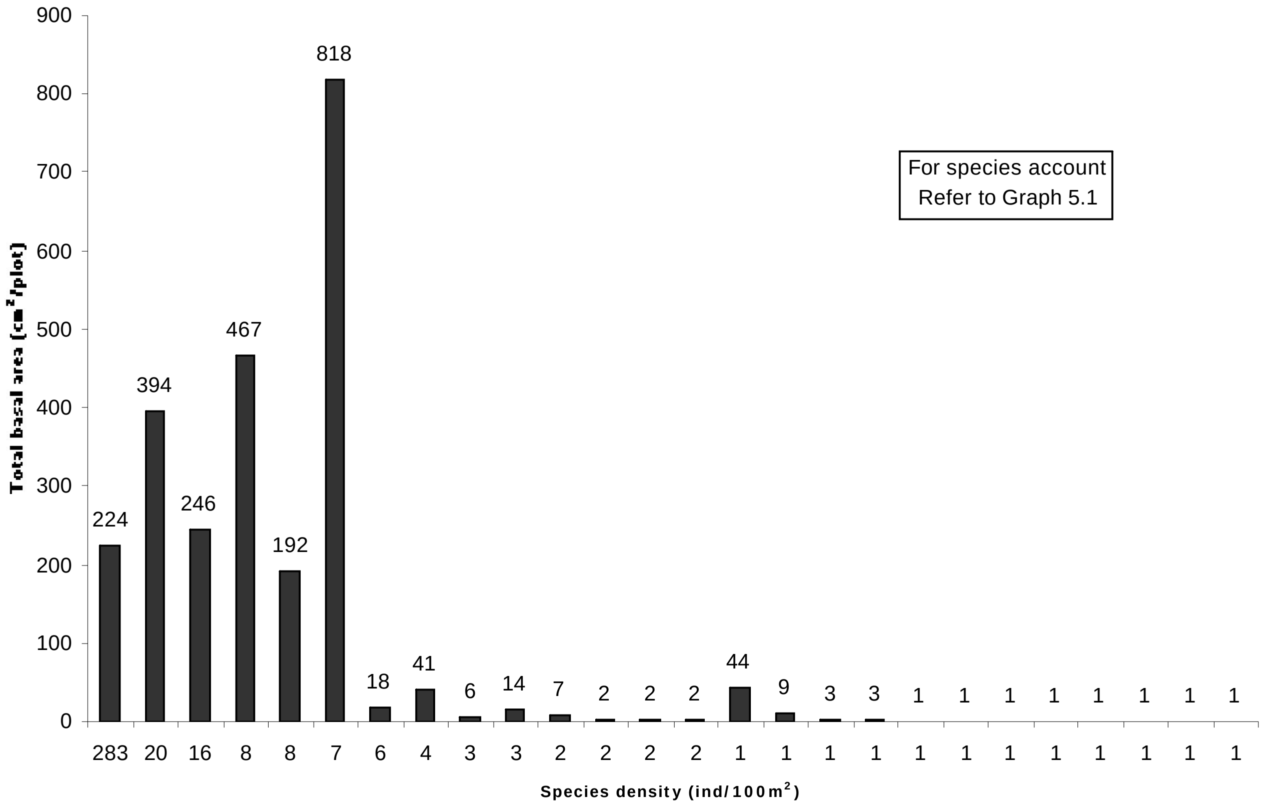
Go_1: structural temporarily water-logged horizon, with oxydised gley patches and organic matter.
Go_2: +/- similar, less compact, drop in $CaCO_3$ levels
Cgr: parent material, reduced gley, permanently water-logged.

Fig. 9: Soil under *Bravaisia tubiflora*-dominated vegetation. Soil of plot 5 is expected to be similar.

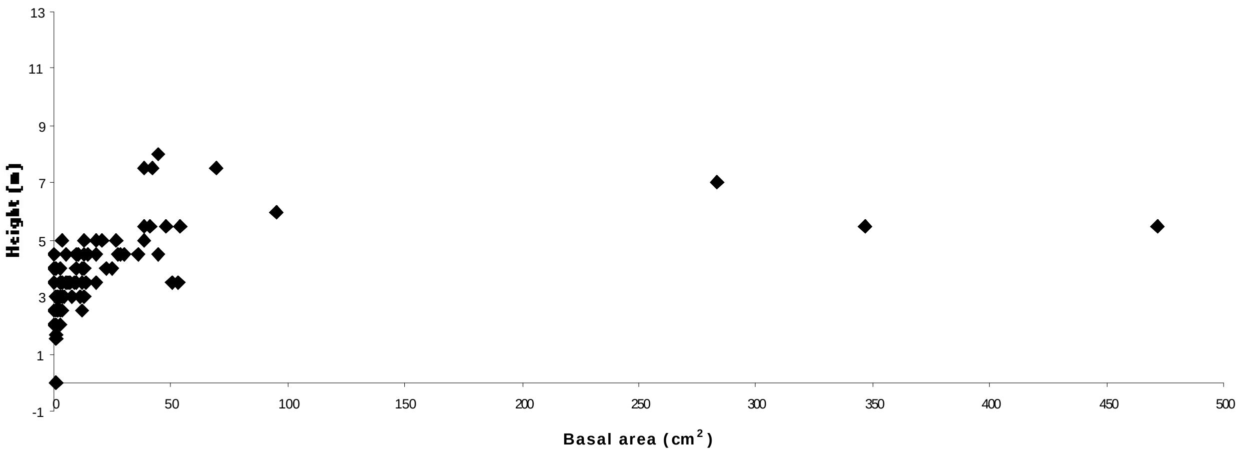
Graph 5.1 : frequency against total basal area



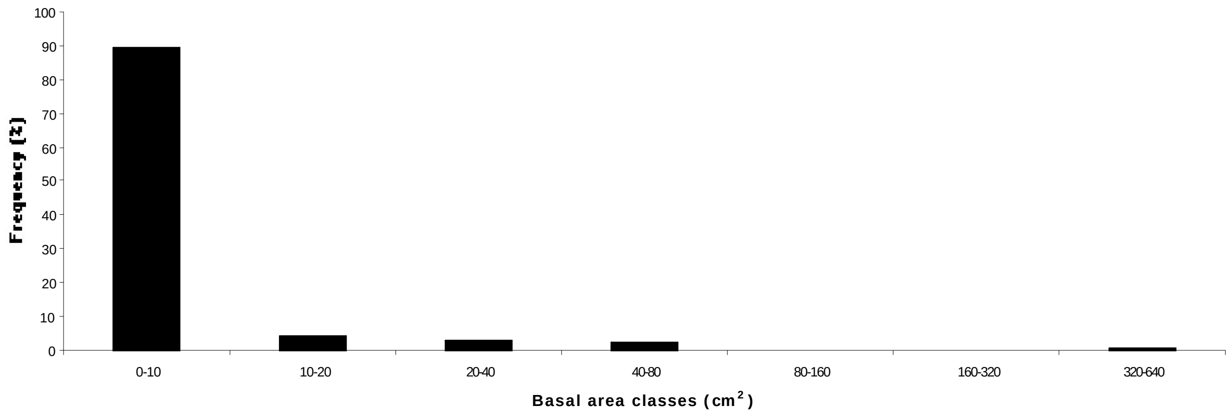
Graph 5.2 : density against total basal area



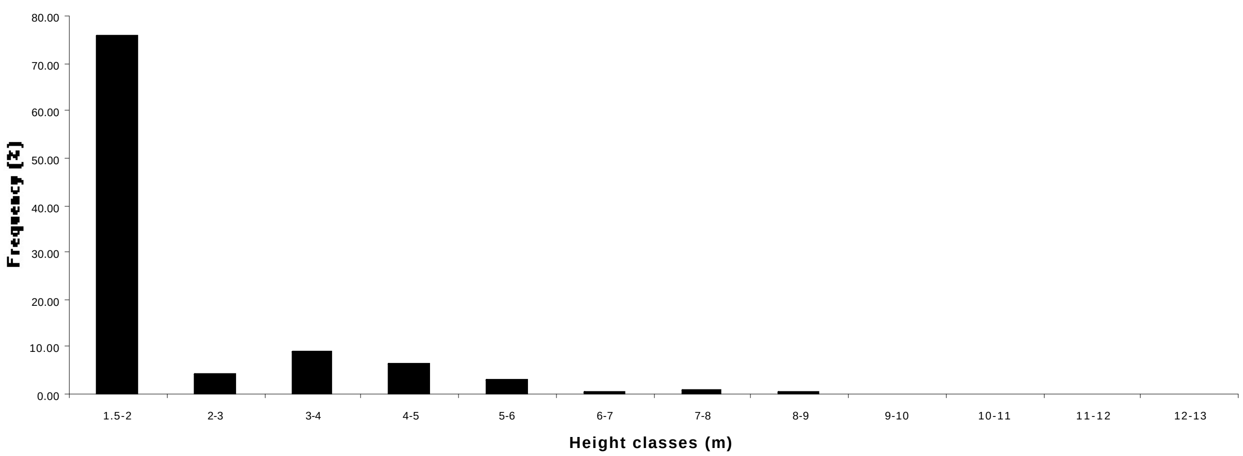
Graph 5.3 : height against basal area



Graph 5.4 : frequency of basal area classes

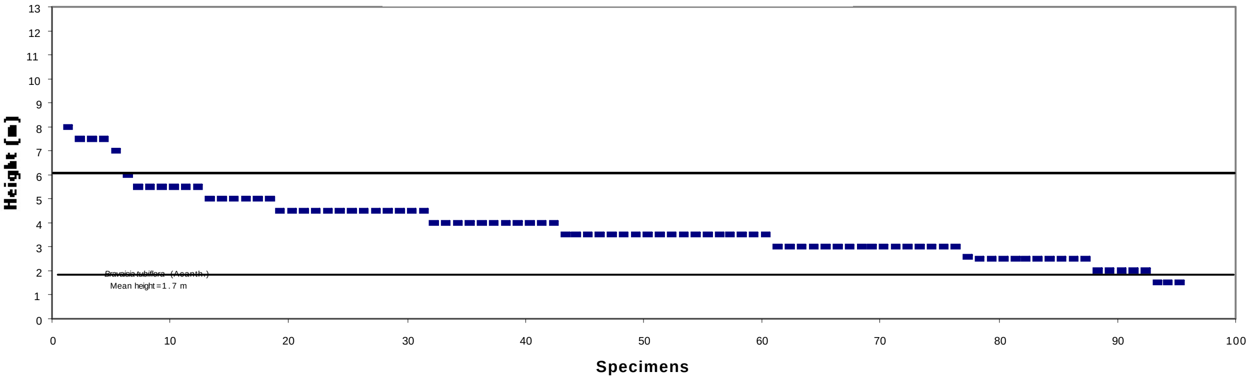


Graph 5.5 : frequency of height classes



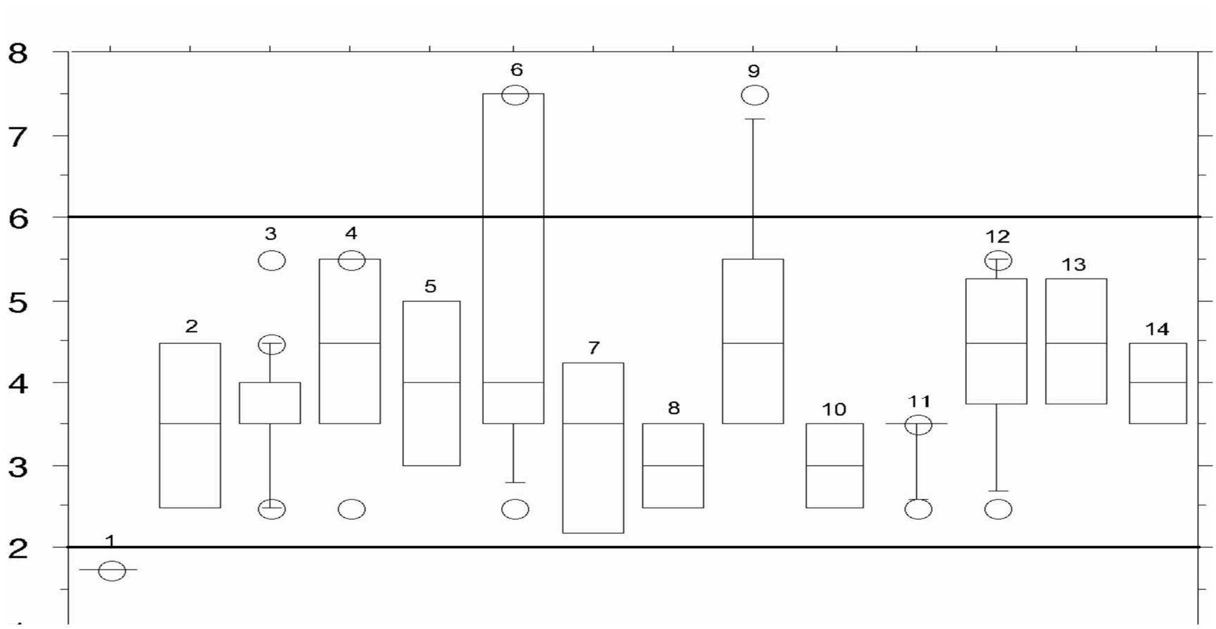
Graph 5.6: height distribution (by descending order)

Horizontal lines = significant cluster limits
(Chrono constraint clustering, connexity 0.7, p = 0.05)



Graph 5.7: Box plot analysis

Horizontal lines = significant cluster limits
(Chrono constraint clustering, connexity 0.7, p = 0.05)



1: Bravaisia tubiflora
2: cf. Schoepfia
3: Coccoloba reflexiflora
4: Croton reflexifolius
5: Eugenia acapulcensis
6: Eugenia rhombea
7: Gymnanthes lucida
8: Manilkara zapota
9: Metopium brownei
10: Morinda royoc
11: Randia aculeata
12:Sabal yapa
13: Samyda yucatanensis
14: Serjania yucatanensis

General Values:

Total basal area (all specimens above 1.5 m high): **25.00 m^2/ha**

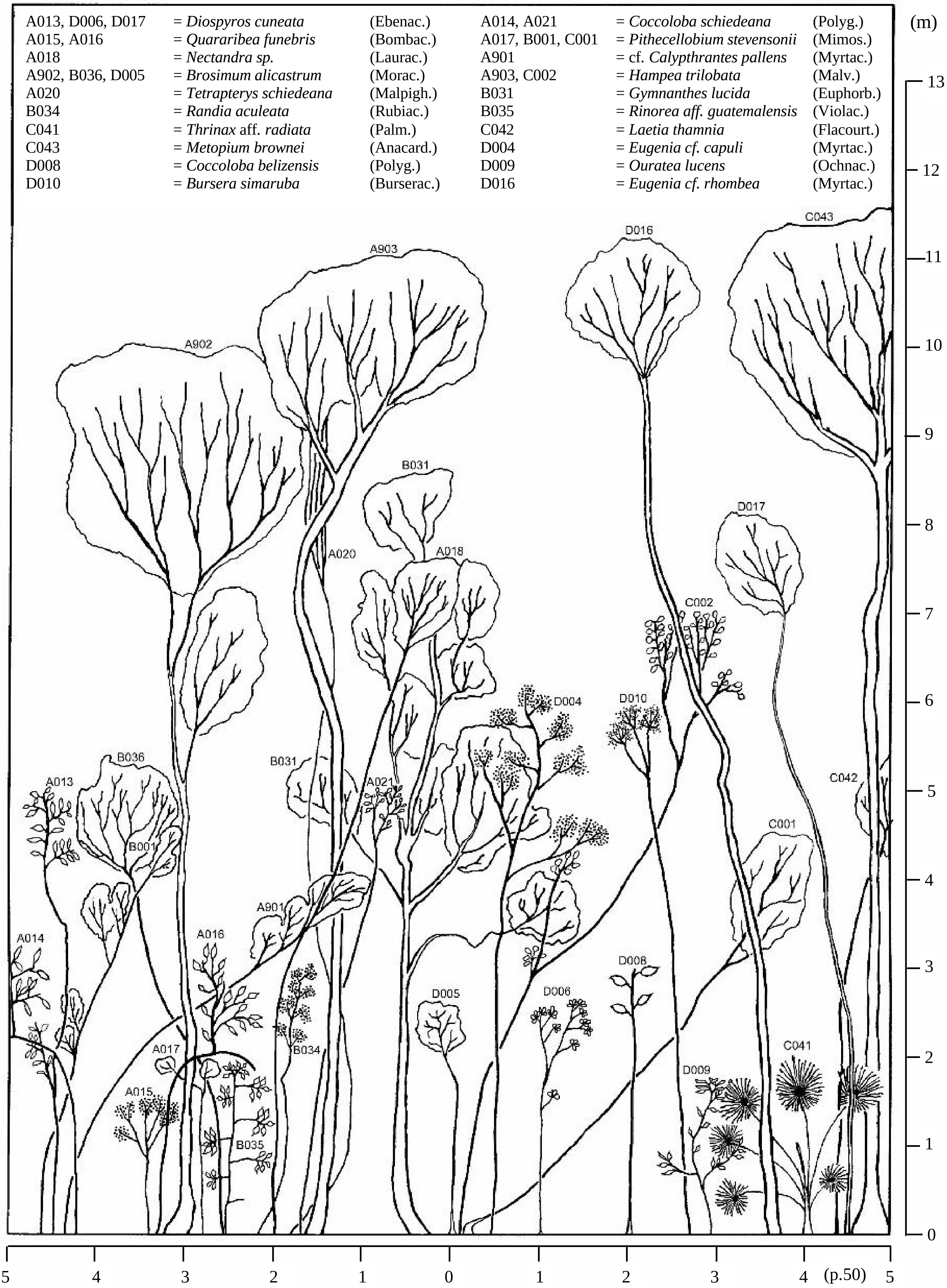
Overall density (“): **37’900 ind./ha**

The Vegetation of Shipstern Nature Reserve
Western Survey Line Transect

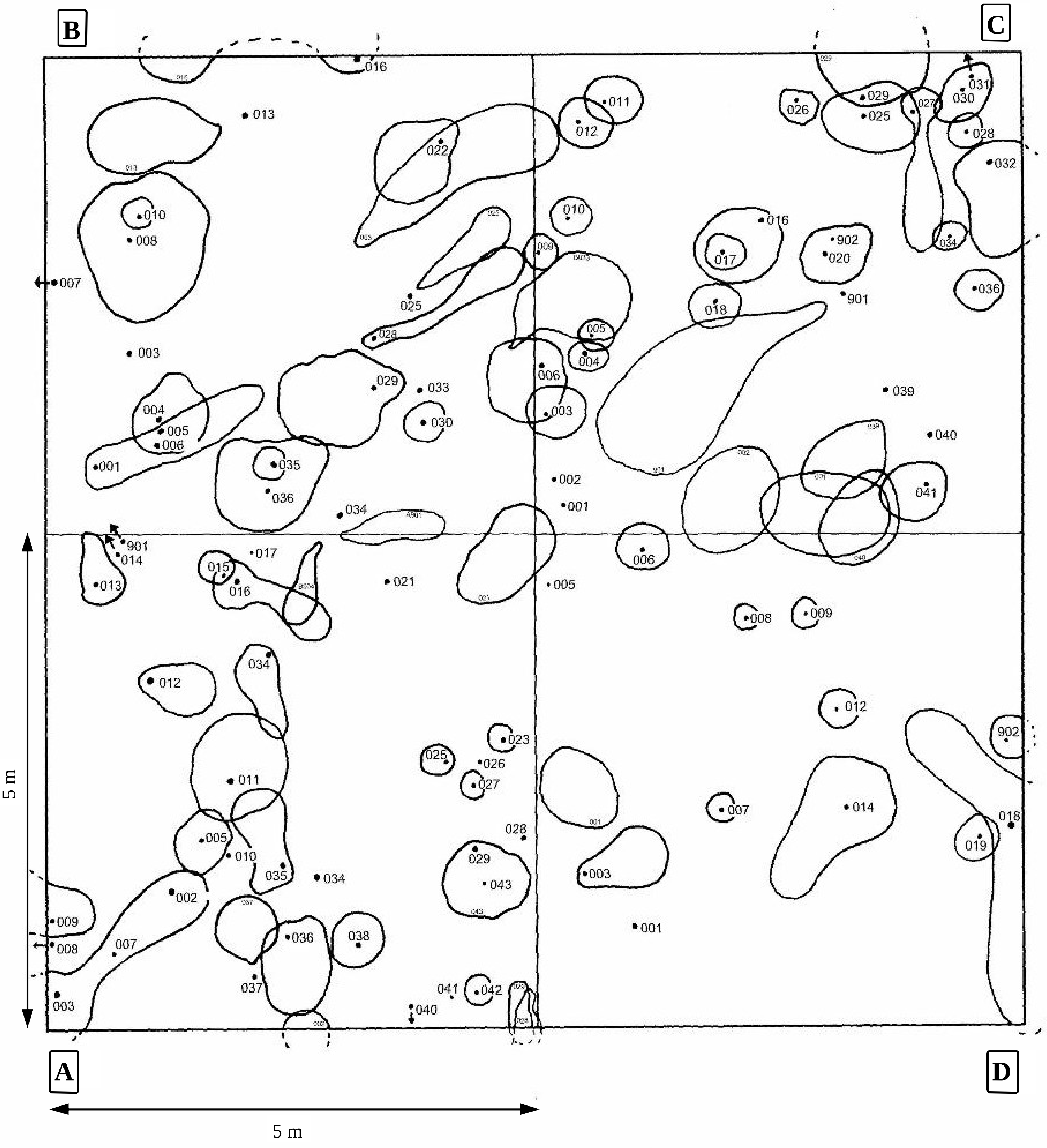
Plot 8   N 18° 17.241’ W 088° 13.183’

Vertical diagram   (horizontal section: 10m x 2m, through centre, parallel to transect)

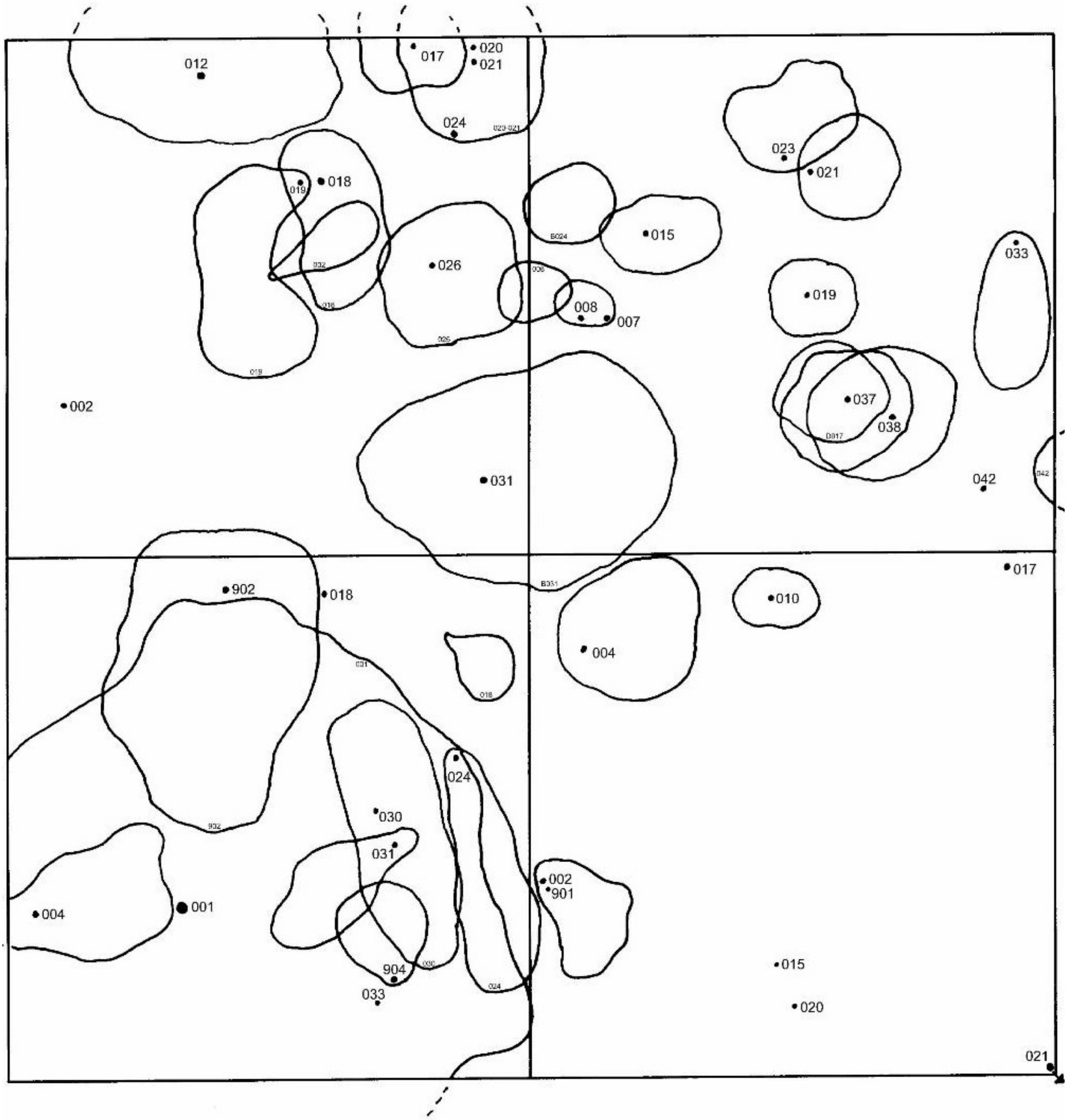
A013, D006, D017	= *Diospyros cuneata*	(Ebenac.)	A014, A021	= *Coccoloba schiedeana*	(Polyg.)
A015, A016	= *Quararibea funebris*	(Bombac.)	A017, B001, C001	= *Pithecellobium stevensonii*	(Mimos.)
A018	= *Nectandra sp.*	(Laurac.)	A901	= cf. *Calypthrantes pallens*	(Myrtac.)
A902, B036, D005	= *Brosimum alicastrum*	(Morac.)	A903, C002	= *Hampea trilobata*	(Malv.)
A020	= *Tetrapterys schiedeana*	(Malpigh.)	B031	= *Gymnanthes lucida*	(Euphorb.)
B034	= *Randia aculeata*	(Rubiac.)	B035	= *Rinorea aff. guatemalensis*	(Violac.)
C041	= *Thrinax* aff. *radiata*	(Palm.)	C042	= *Laetia thamnia*	(Flacourt.)
C043	= *Metopium brownei*	(Anacard.)	D004	= *Eugenia cf. capuli*	(Myrtac.)
D008	= *Coccoloba belizensis*	(Polyg.)	D009	= *Ouratea lucens*	(Ochnac.)
D010	= *Bursera simaruba*	(Burserac.)	D016	= *Eugenia cf. rhombea*	(Myrtac.)



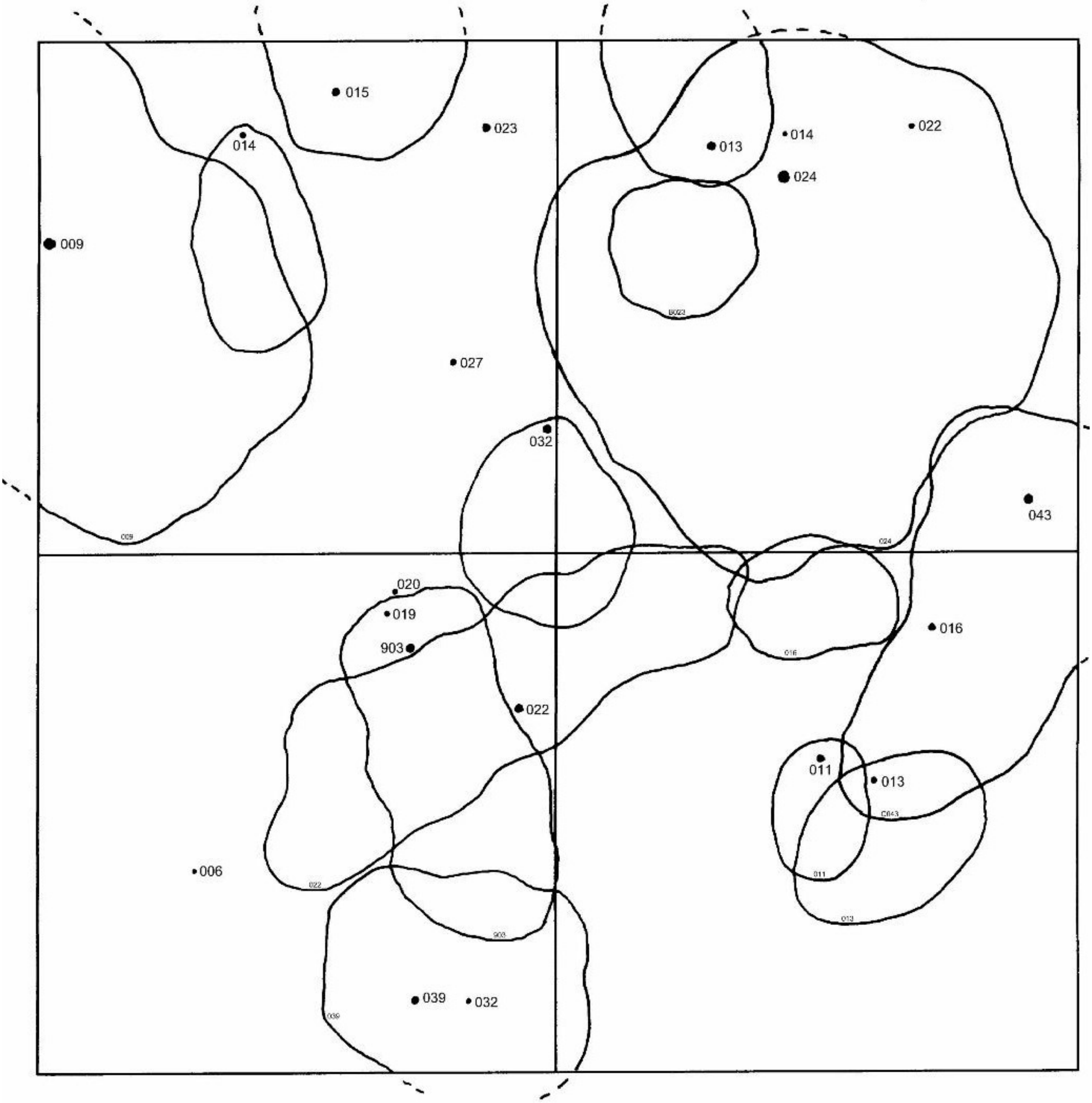
The Vegetation of Shipstern Nature Reserve
Western Survey Line Transect
Plot 8 N 18°17.241’ W 088° 13.183’
Horizontal diagram
First level, height 1.5m - 5m



Second level, height 5m - 10m



Third level, height 10m - 15m



SHIPSTERN NATURE RESERVE VEGETATION SURVEY

PLOT 8 WESTERN SURVEY LINE TRANSECT

N 18°17.241' W 088° 13.183'

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb collected	deposit	identification
PL8-A-001A	Palmae	Sabal	cf. yapa	8	21.5				see appendix 2
PL8-A-002a	Burseraceae	Protium	copal	5	2.8	17.02.97	3 x on A-038	BLMP/CHET/NE	Herb. Chetumal
PL8-A-003a	Moraceae	Brosimum	alicastrum	4	2.6	17.02.97	3 x	BLMP/CHET/NE	Herb. Chetumal
PL8-A-004A	Moraceae	Brosimum	alicastrum	5.5	4				
PL8-A-005a	Mimosaceae	Pithecellobium	stevensonii	5	2.7	17.02.97	2x int. 1x ext.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-006l	Malpighiaceae	Tetrapterys	cf. schiedeana	10+?	1.5	17.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-007a	Myrtaceae	Psidium	cf. sartorianorum	1.7	<1	17.02.97	2 x ext 1 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-008a	Ebenaceae	Diospyros	cf. cuneata	4.5	1.7	17.02.97	2 x ext 1 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-009a	Ochnaceae	Ouratea	lucens	2	<1	05.02.97	3x ext (fertile)	BLMP/CHET/NE	Herb. Chetumal
PL8-A-010a	Polygonaceae	Coccoloba	acapulcensis	4	2	17.02.97	3 x int.	BLMP/CHET/NE	Fl. of Guatemala
PL8-A-011a	Palmae	Thrinax	aff. radiata	1.6		17.02.97	3 x int.	BLMP/CHET/NE	see appendix 2
PL8-A-012a	Myrtaceae	Eugenia	cf. rhombea	3.5	2	13.04.97	2x int.	BLMP/NE	idem PL8-B-008a
PL8-A-013a	Ebenaceae	Diospyros	cf. cuneata	5	1.5				idem PL8-A-008a
PL8-A-014a	Polygonaceae	Coccoloba	schiedeana	3	3.3	17.02.97	3 x int.	BLMP/CHET/NE	Fl. of Guatemala
PL8-A-015a	Bombacaceae	Quararibea	cf. funebris	1.6	<1	19.02.97	3 x int.	BLMP/CHET/NE	Fl. of Guatemala
PL8-A-016a	Bombacaceae	Quararibea	cf. funebris	3	2				idem PL8-A-015a
PL8-A-901a	Myrtaceae	cf. Calyptranthes	pallens	4	2.3				idem PL8-A-043a
PL8-A-902A	Moraceae	Brosimum	alicastrum	10	7	19.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-017a	Mimosaceae	Pithecellobium	stevensonii	2	1.5				
PL8-A-018A	Lauraceae	Nectandra	sp.	7.5	3	19.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-019L	Malpighiaceae	Hiraea	obovata	10+	1.2	19.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-020l	Malpighiaceae	Tetrapterys	cf. schiedeana	10+	2.5				idem PL8-A-006l
PL8-A-021a	Polygonaceae	Coccoloba	schiedeana	5	2.5				idem PL8-A-014a
PL8-A-903A	Malvaceae	Hampea	trilobata	11	11				idem PL8-A-022A
PL8-A-022A	Malvaceae	Hampea	trilobata	11	12	19.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-023a	Polygonaceae	Coccoloba	schiedeana	5	2.5				idem PL8-A-014a
PL8-A-024A	Mimosaceae	Pithecellobium	stevensonii	6	2.8				idem PL8-A-005a
PL8-A-025a	Moraceae	Brosimum	alicastrum	2.4	<1				idem PL8-A-003a
PL8-A-026a		(alive but leafless)		3.5	2.3				
PL8-A-027a	Ochnaceae	Ouratea	lucens	2	<1				idem PL8-A-009a
PL8-A-028a	Polygonaceae	Coccoloba	browniana	4.5	2.5	17.02.97	2 x ext 1 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-029a	Rubiaceae	Randia	aculeata	4.5	2.3				idem PL8-A-031a
PL8-A-030A	Moraceae	Brosimum	alicastrum	7	5				idem PL8-A-003a
PL8-A-031A	Rubiaceae	Randia	aculeata	6	4	19.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-032l	Malpighiaceae	Hiraea	obovata	10+	<1				idem PL8-A-019l
PL8-A-033L	Sapindaceae	Serjania	yucatanensis	9+	5	19.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-034a	Polygonaceae	Coccoloba	schiedeana	5	3.2				idem PL8-A-014a
PL8-A-035a	Moraceae	Brosimum	alicastrum	4.5	3				idem PL8-A-003a
PL8-A-036a	Moraceae	Brosimum	alicastrum	3.5	2.2				idem PL8-A-003a
PL8-A-037a	Euphorbiaceae	Croton	reflexifolius	4	1.8	19.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-038a	Burseraceae	Protium	copal	5	3.5				idem PL8-A-002a
PL8-A-039A	Polygonaceae	Coccoloba	reflexiflora	12	12.5	19.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-A-904A	Polygonaceae	Coccoloba	reflexiflora	7.5	5.7				idem PL8-A-039A
PL8-A-040a	Lecythidaceae?Myristicaceae?			5	3.5	19.02.97	3 x int.	BLMP/CHET/NE	
PL8-A-041a		dead							
PL8-A-042a	Flacourtiaceae	Laetia	thamnia	3	2				idem PL8-C-042A
PL8-A-043a	Myrtaceae	cf. Calyptranthes	pallens	4.5	2.3	19.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-001a	Mimosaceae	Pithecellobium	stevensonii	4.5	2				idem PL8-A-005a
PL8-B-002a	Polygonaceae	Coccoloba	acapulcensis	5.5	4.5				idem PL8-A-010a
PL8-B-003a	Polygonaceae	Coccoloba	sp.?	5	3.2	28.02.97?			check herb.CH

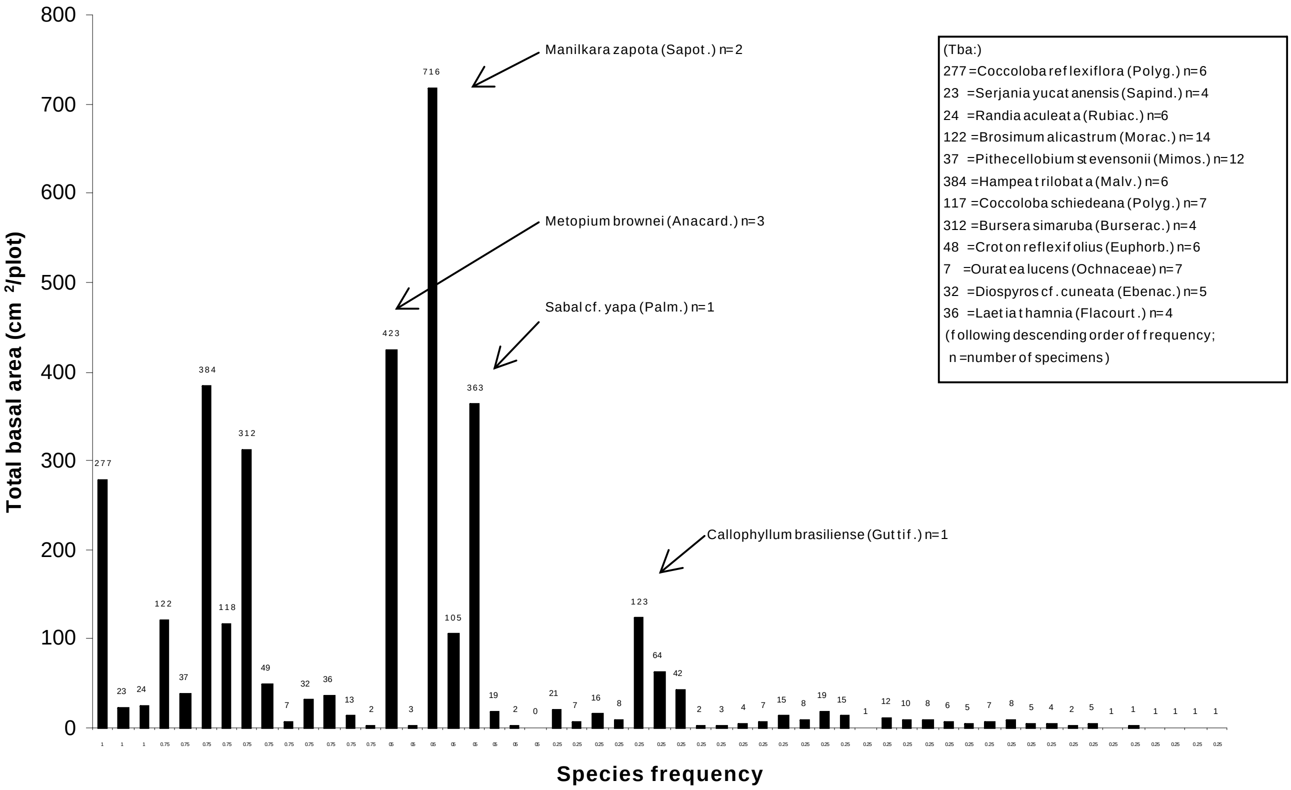
#	family	genus	species	height (m)	DBH (cm)	date coll.	nb collected	deposit	identification
PL8-B-004a	Moraceae	Brosimum	alicastrum	4.5	3				idem PL8-A-003a
PL8-B-005a	Moraceae	Brosimum	alicastrum	2.5	<1				idem PL8-A-003a
PL8-B-006a	Myrtaceae	Psidium	cf. sartorianorum	2	<1				idem PL8-A-007a
PL8-B-007a	Mimosaceae	Pithecellobium	stevensonii	1.9	<1				idem PL8-A-005a
PL8-B-008a	Myrtaceae	Eugenia	cf. rhombea	4.5	2.8	28.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-009A	Sapotaceae	Manilkara	zapota	11	21	28.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-010a	Lauraceae	Nectandra	aff. salicifolia	1.9	<1	28.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-012A	Burseraceae	Bursera	simaruba	10	10.5				unmistakable
PL8-B-013a	Caesalpiniaceae	Caesalpinia	gaumeri	3	1.6	28.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-014A	Guttiferae	Callophyllum	brasiliense	12	12.5	28.02.97	3 x int.	BLMP/CHET/NE	Fl. of Brit. Hond.
PL8-B-015A	Anacardiaceae	Metopium	brownei	12.5	15.6				unmistakable
PL8-B-016a	Euphorbiaceae	Croton	reflexifolius	4.5	3.5				idem PL8-A-037a
PL8-B-017A	Malvaceae	Hampea	trilobata	9.5	6.5	28.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-018A	Malvaceae	Hampea	trilobata	7	5.8				idem PL8-B-017A
PL8-B-019A	Lauraceae	Nectandra	aff. salicifolia	7	4.3				idem PL8-B-010a
PL8-B-020A	Euphorbiaceae	Gymnanthes	lucida	7	4.2	28.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-021A	Polygonaceae	Coccoloba	schiedeana	7.5	5.7				idem PL8-A-014a
PL8-B-022a	Mimosaceae	Pithecellobium	stevensonii	3	<1				idem PL8-A-005a
PL8-B-023A	Polygonaceae	Coccoloba	reflexiflora	12.5	7.2				idem PL8-A-039A
PL8-B-024A	Polygonaceae	Coccoloba	reflexiflora	8	5.9				idem PL8-A-039A
PL8-B-025a	Moraceae	Brosimum	alicastrum	1.8	2.1				idem PL8-A-003a
PL8-B-026A	Anacardiaceae	Metopium	brownei	8	6.3				unmistakable
PL8-B-027l	Sapindaceae	Serjania	yucatanensis	10+	1				idem PL8-A-033L
PL8-B-028a	Sapotaceae	Pouteria	campechiana	4.5	2.9	28.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-029a	Lauraceae	Nectandra	aff. salicifolia	2	<1	17.04.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-030a	Lauraceae	Nectandra	aff. salicifolia	2	2.5	28.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-031A	Euphorbiaceae	Gymnanthes	lucida	8.5	10.7	28.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-032A	Malvaceae	Hampea	trilobata	11	11.5				idem PL8-B-017A
PL8-B-033a	Moraceae	Brosimum	alicastrum	3.5	3.6				idem PL8-A-003a
PL8-B-034a	Rubiaceae	Randia	aculeata	3	1.7				idem PL8-A-031a
PL8-B-035a	Violaceae	Rinorea	aff. guatemalensis	2	<1	28.02.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-B-036a	Moraceae	Brosimum	alicastrum	5	3.2				idem PL8-A-003a
PL8-C-001a	Mimosaceae	Pithecellobium	stevensonii	4.5	2.6				idem PL8-A-005a
PL8-C-002a	Malvaceae	Hampea	trilobata	5	2				idem PL8-B-017A
PL8-C-003a	Ochnaceae	Ouratea	lucens	2	<1				idem PL8-A-009a
PL8-C-004a	Euphorbiaceae	Croton	reflexifolius	2.5	2.6				idem PL8-B-035 A
PL8-C-005a	Euphorbiaceae	Croton	reflexifolius	3.5	1.9				idem PL8-B-035 A
PL8-C-006a	Verbenaceae	Vitex	gaumeri	4.5	2.4	18.04.97	3 x ext. (fertile)	BLMP/CHET/NE	Fl. of Brit. Hond.
PL8-C-007A	?	uncollectable		7	4.3				
PL8-C-008A	?	leafless		10	7.3				
PL8-C-009a	Polygonaceae	Coccoloba	schiedeana	3.5	2.1				idem PL8-A-014a
PL8-C-010a	Mimosaceae	Pithecellobium	stevensonii	2	<1				idem PL8-A-005a
PL8-C-011a	Rubiaceae	Randia	aculeata	3	1.6				idem PL8-A-031a
PL8-C-012a	?Clusiaceae?			2.2	1	22.04.97	3 x int.	BLMP/CHET/NE	Keller, Gentry
PL8-C-013A	Polygonaceae	Coccoloba	schiedeana	12.5	8.9				uncollectable
PL8-C-014l	Bignoniaceae	Arrabidaea	japurensis	10+	1.6	28.04.97	2 x int.	BLMP/CHET/NE	Keller, Gentry
PL8-C-015A	Flacourtiaceae	Laetia	thamnia	6	3.9				idem PL8-C-042A
PL8-C-016a	Sapindaceae	Matayba	cf. oppositifolia	5	2.7	22.04.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-C-017a	Lauraceae	Nectandra	aff. coriacea	2.5	<1	22.04.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-C-018a	Euphorbiaceae	Gymnanthes	lucida	2.5	1				idem PL8-B-020a
PL8-C-019A	Polygonaceae	Coccoloba	reflexiflora	6.5	5.3				idem PL8-A-038A
PL8-C-020a	Ochnaceae	Ouratea	lucens	3	1.7				idem PL8-A-009a
PL8-C-021A	Sapindaceae	Exothea	diphylla	7	4.9	28.04.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-C-022l	Sapindaceae	Serjania	yucatanensis	10+	1.7				idem PL8-A-033l
PL8-C-023A	Euphorbiaceae	Croton	reflexifolius	6	4.3				idem PL8-A-037a

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb collected	deposit	identification
PL8-C-024A	Sapotaceae	Manilkara	zapota	13	21.7				idem PL8-B-009A
PL8-C-025a	Mimosaceae	Pithecellobium	stevensonii	4	2.1				idem PL8-A-005a
PL8-C-026a	Theophrastaceae	Jacquinia	aurantiaca	1.6	<1	22.04.97	3 x int.	BLMP/CHET/NE	see appendix 2
PL8-C-027a	Mimosaceae	Pithecellobium	stevensonii	2	1.3				idem PL8-A-005a
PL8-C-028a	Ochnaceae	Ouratea	lucens	1.5	<1				idem PL8-A-009a
PL8-C-029a	Mimosaceae	Pithecellobium	stevensonii	4.5	3				idem PL8-A-005a
PL8-C-030a	Mimosaceae	Pithecellobium	stevensonii	3	1.2				idem PL8-A-005a
PL8-C-031a	Rubiaceae	Randia	aculeata	4	1.8				idem PL8-A-031a
PL8-C-032a	Moraceae	Brosimum	alicastrum	3.5	2.2				idem PL8-A-003a
PL8-C-033A	Simaroubaceae	Simarouba	glauca	5.5	3.9	22.04.97	3 x int.	BLMP/CHET/NE	Keller, Fl.of BH
PL8-C-034a	Myrtaceae	Psidium	cf. sartorianorum	2.5	<1				idem PL8-A-007a
PL8-C-035a		dead							
PL8-C-036a	Malpighiaceae	Bunchosia	swartziana	2	<1	22.04.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-C-037A	Euphorbiaceae	Sebastiania	adenophora	7	3.2	08.05.97	3 x int.(fertile)	BLMP/CHET/NE	Herb. Chetumal
PL8-C-038A	Euphorbiaceae	Croton	reflexifolius	7	4.2				idem PL8-A-037a
PL8-C-039a	Ebenaceae	Diospyros	cf. cuneata	4	2				idem PL8-A-008a
PL8-C-040a	Celastraceae	Wimmeria	bartlettii	4.5	3.2	22.04.97	3 x int.	BLMP/CHET/NE	Keller
PL8-C-041a	Palmae	Thrinax	aff. radiata	2					idem PL8-A-011a
PL8-C-042A	Flacourtiaceae	Laetia	thamnia	6	3	22.04.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-C-043A	Anacardiaceae	Metopium	brownei	11.5	16				unmistakable
PL8-C-901a	Moraceae	Brosimum	alicastrum	1.8	<1				idem PL8-A-003a
PL8-C-902l	Rubiaceae	Morinda	royoc	3	<1				idem PLDR-A-002l
PL8-D-001a	Myrtaceae	Eugenia	cf. rhombea	3	2.3	23.04.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-D-002A	Flacourtiaceae	Laetia	thamnia	6.5	4.2				idem PL8-C-042A
PL8-D-003a	Lauraceae	Nectandra	aff. coriacea	2	<1				idem PL8-C-017a
PL8-D-901l	Papilionaceae	Machaerium	floribundum	6+	1	28.04.97	3 x int.	BLMP/CHET/NE	Keller, Gentry
PL8-D-004A	Myrtaceae	Eugenia	cf. capuli	6	4.3	28.04.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-D-005a	Moraceae	Brosimum	alicastrum	2.5	1.3				idem PL8-A-003a
PL8-D-006a	Ebenaceae	Diospyros	cf. cuneata	2.5	1.1				idem PL8-A-008a
PL8-D-007a	Rubiaceae	Guettarda	combsii	2.3	1.3	23.04.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-D-008a	Polygonaceae	Coccoloba	belizensis	3	2.6				unmistakable
PL8-D-009a	Ochnaceae	Ouratea	lucens	1.5	<1				idem PL8-A-009a
PL8-D-010A	Burseraceae	Bursera	simaruba	6	3.2				unmistakable
PL8-D-011A	Burseraceae	Bursera	simaruba	11	12.5				unmistakable
PL8-D-012a	Caesalpiniaceae	Bauhinia	jenningsii	3	1.6	28.04.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-D-013A	Burseraceae	Bursera	simaruba	10.5	11				unmistakable
PL8-D-014a	Ochnaceae	Ouratea	lucens	2.3	1.2				idem PL8-A-009a
PL8-D-015l	Sapindaceae	Serjania	yucatanensis	5+	1				idem PL8-A-033l
PL8-D-016A	Myrtaceae	Eugenia	cf. rhombea	11	9	28.04.97	3 x int.	BLMP/CHET/NE	Keller, Gentry, BH
PL8-D-017A	Ebenaceae	Diospyros	cf.cuneata	8	5.5	28.04.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL8-D-018a	Palmae	Sabal	cf. yapa	2.5					see appendix 2
PL8-D-019a	Rubiaceae	Randia	aculeata	2.5	1				idem PL8-A-029a
PL8-D-020l	Malpighiaceae	Hiraea	cf. obovata	5+	1.2				idem PL8-A-019l
PL8-D-021A	Polygonaceae	Coccoloba	reflexiflora	9.5	7				idem PL8-A-038A
PL8-D-902a	Caesalpiniaceae	Bauhinia	jenningsii	1.7	<1				idem PL8-D-012a

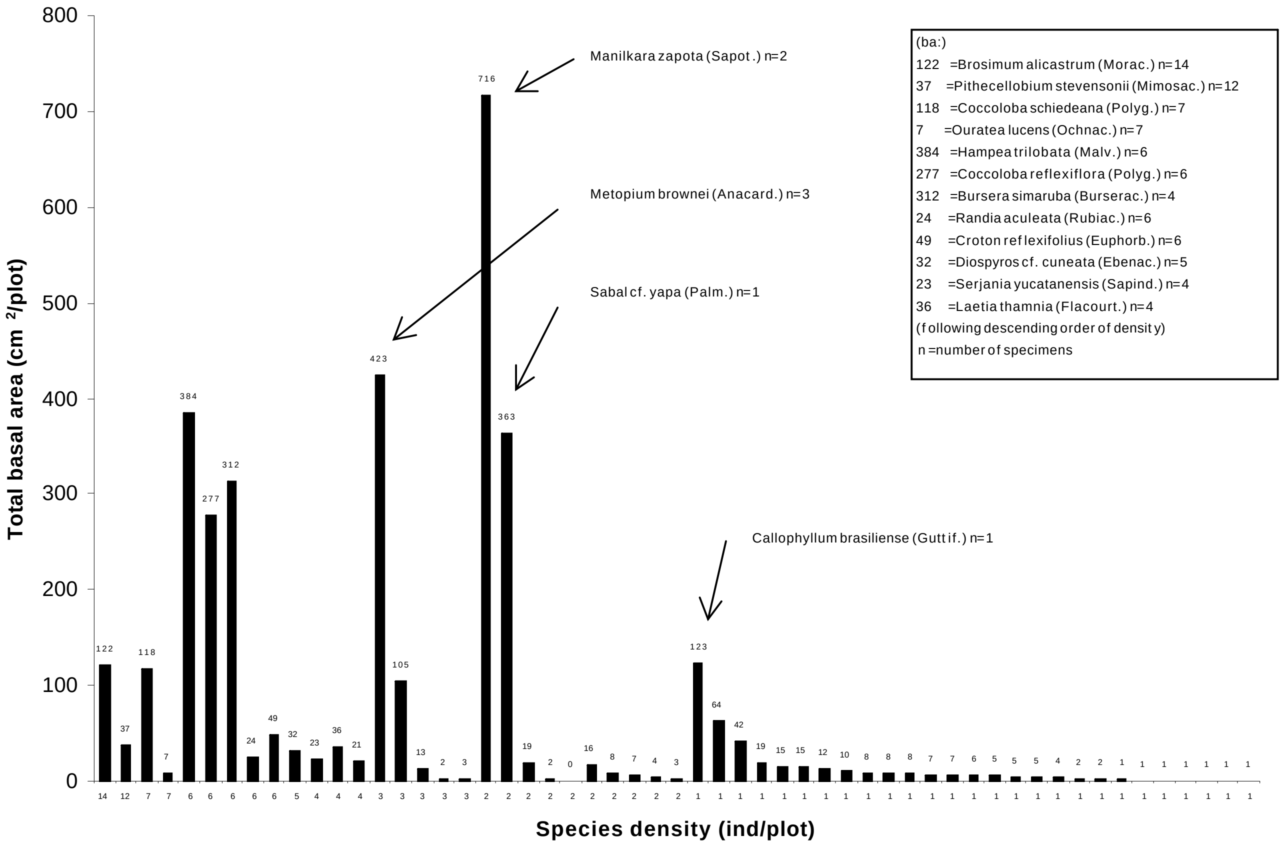
Plot 8: species data table

Family	Genus	Species	Frequency	Density	Total basal area
Moraceae	Brosimum	alicastrum	0.75	14	121.79
Mimosaceae	Pithecellobium	stevensonii	0.75	12	37.47
Polygonaceae	Coccoloba	schiedeana	0.75	7	117.6
Ochnaceae	Ouratea	lucens	0.75	7	7.35
Polygonaceae	Coccoloba	reflexiflora	1	6	276.84
Rubiaceae	Randia	aculeata	1	6	24.33
Malvaceae	Hampea	trilobata	0.75	6	384.17
Euphorbiaceae	Croton	reflexifolius	0.75	6	48.68
Ebenaceae	Diospyros	cf. cuneata	0.75	5	31.89
Sapindaceae	Serjania	yucatanensis	1	4	23.49
Burseraceae	Bursera	simaruba	0.75	4	312.38
Flacourtiaceae	Laetia	thamnia	0.75	4	36.01
Lauraceae	Nectandra	aff. salicifolia	0.25	4	21.01
Myrtaceae	Eugenia	cf. rhombea	0.75	3	13.45
Myrtaceae	Psidium	cf. sartorianorum	0.75	3	2.37
Anacardiaceae	Metopium	brownei	0.5	3	423.36
Euphorbiaceae	Gymnanthes	lucida	0.5	3	104.56
Malpighiaceae	Hiraea	obovata	0.5	3	3.05
Sapotaceae	Manilkara	zapota	0.5	2	716.2
Palmae	Sabal	cf. yapa	0.5	2	363.05
Polygonaceae	Coccoloba	acapulcensis	0.5	2	19.04
Lauraceae	Nectandra	aff. coriacea	0.5	2	1.58
Palmae	Thrinax	aff. radiata	0.5	2	0
Burseraceae	Protium	copal	0.25	2	15.78
Myrtaceae	cf. Calyptranthes	cf. pallens	0.25	2	8.3
Malpighiaceae	Tetrapterys	cf. schiedeana	0.25	2	6.68
Bombacaceae	Quararibea	cf. funebris	0.25	2	3.93
Caesalpiniaceae	Bauhinia	jenningsii	0.25	2	2.8
Guttiferae	Callophyllum	brasiliense	0.25	1	122.72
Monimiaceae?	Siparuna?		0.25	1	63.62
?	(alive but leafless)		0.25	1	41.85
Sapindaceae	Exothea	diphylla	0.25	1	18.86
?	uncollectable		0.25	1	14.52
Myrtaceae	Eugenia	cf. capuli	0.25	1	14.52
Simaroubaceae	Simarouba	glauca	0.25	1	11.95
Lecythidaceae?Myristicaceae?			0.25	1	9.62
Euphorbiaceae	Sebastiania	adenophora	0.25	1	8.04
Polygonaceae	Coccoloba	sp.?	0.25	1	8.04
Celastraceae	Wimmeria	bartlettii	0.25	1	8.04
Lauraceae	Nectandra	sp.	0.25	1	7.07
Sapotaceae	Pouteria	campechiana	0.25	1	6.61
Sapindaceae	Matayba	cf. oppositifolia	0.25	1	5.73
Polygonaceae	Coccoloba	belizensis	0.25	1	5.31
Polygonaceae	Coccoloba	browniana	0.25	1	4.91
Verbenaceae	Vitex	gaumeri	0.25	1	4.52
?	(alive but leafless)		0.25	1	4.15
Bignoniaceae	Arrabidaea	japurensis	0.25	1	2.01
Caesalpiniaceae	Caesalpinia	gaumeri	0.25	1	2.01
Rubiaceae	Guettarda	combsii	0.25	1	1.33
Papilionaceae	Machaerium	floribundum	0.25	1	0.79
Rubiaceae	Morinda	royoc	0.25	1	0.79
?Clusiaceae?			0.25	1	0.79
Malpighiaceae	Bunchosia	swartziana	0.25	1	0.79
Violaceae	Rinorea	aff. guatemalensis	0.25	1	0.79
Theophrastaceae	Jacquinia	aurantiaca	0.25	1	0.79

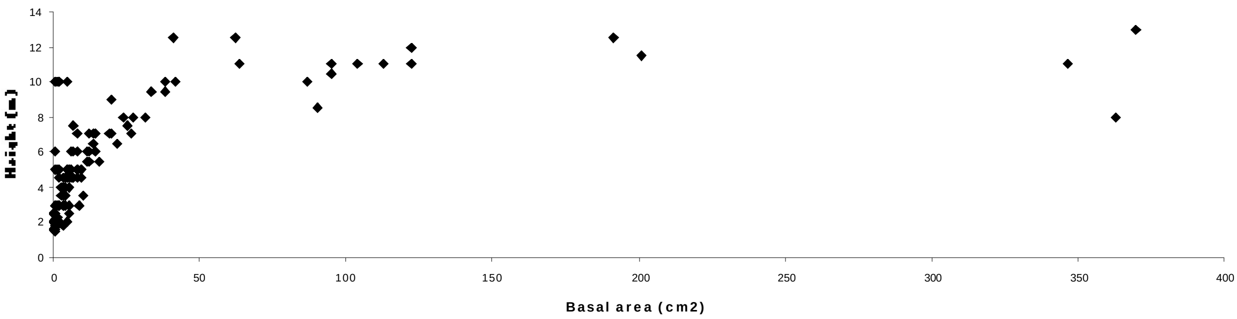
Graph 8.1 : frequency against total basal area



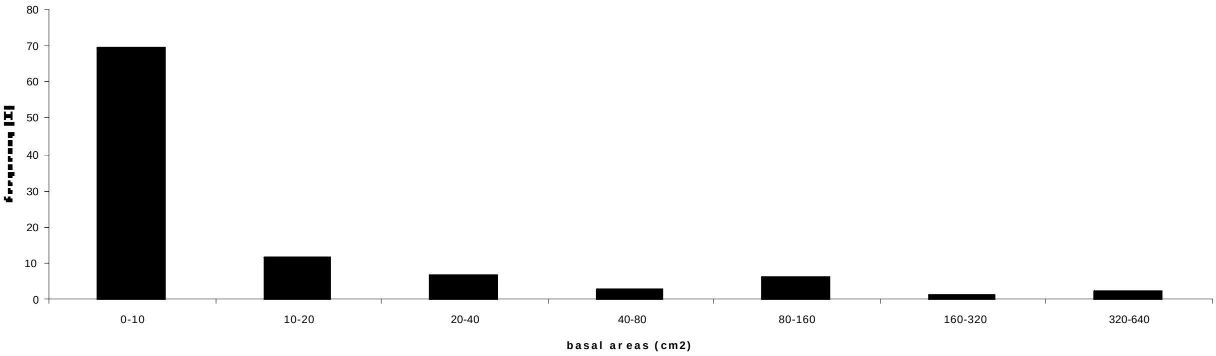
Graph 8.2 : density against total basal area



Graph 8.3 : height against basal area

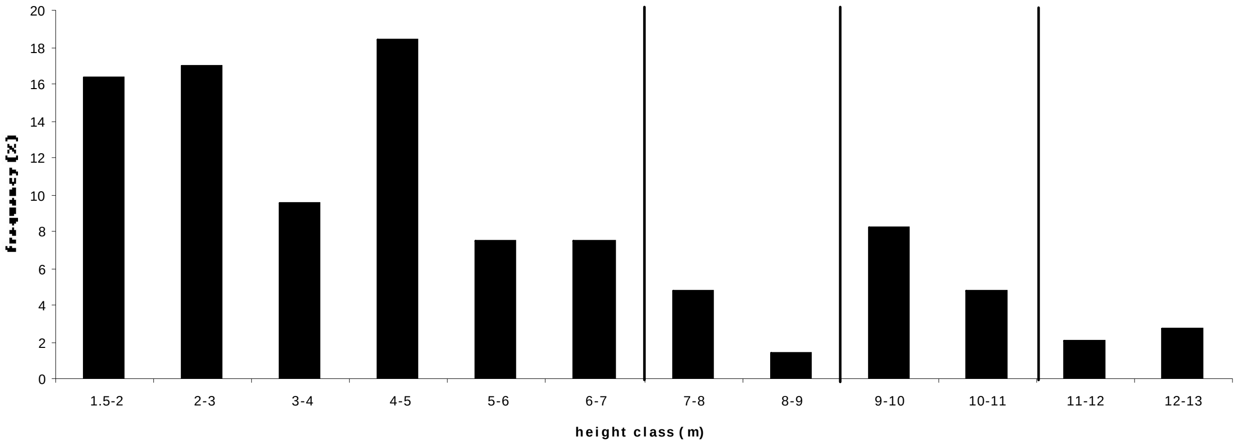


Graph 8.4 : frequency of basal area classes



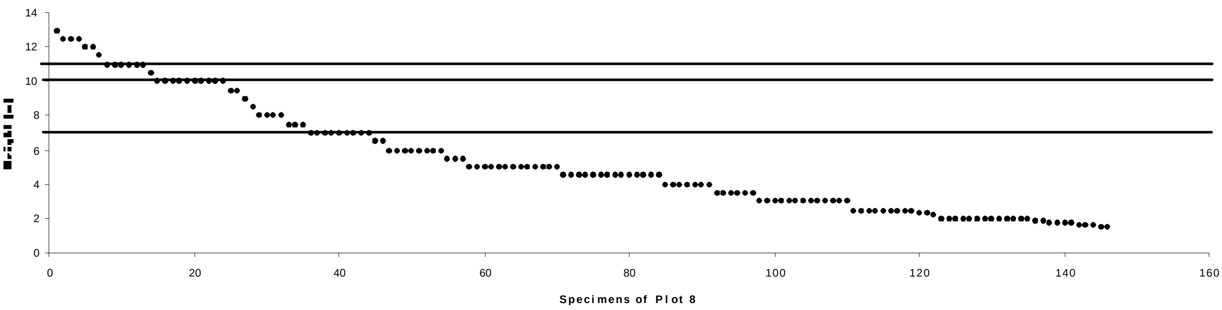
Graph 8.5 : frequency of height classes

N.B: vertical lines are significant cluster limits (Chrono constraint clustering, connexity = 0.7, p = 0.05)



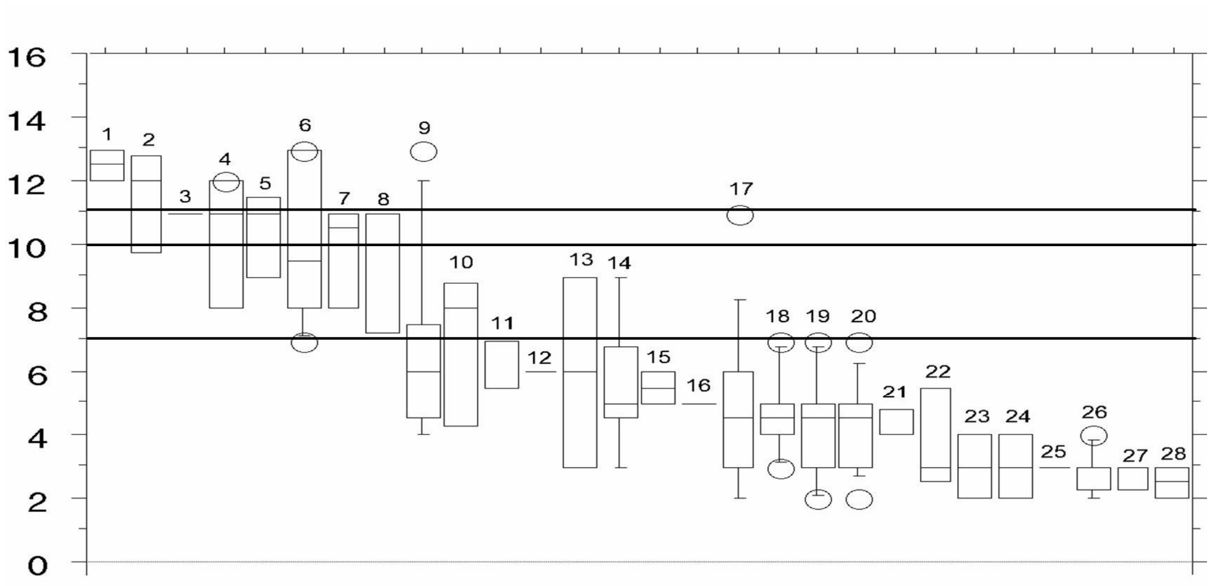
Graph 8.6 : height distribution (by descending order)

N.B: horizontal lines are significant cluster limits (Chrono constraint clustering, connexity = 0.7, p = 0.05)



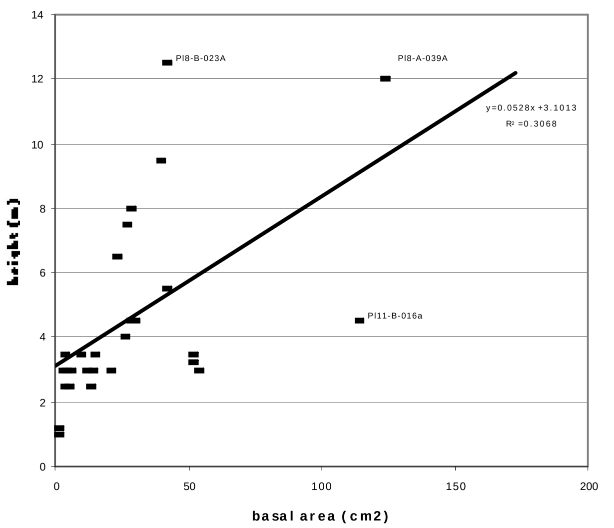
8.7: Box plot analysis

Horizontal lines are significant cluster limits
(Chrono constraint clustering, connexity 0.7, p = 0.05)

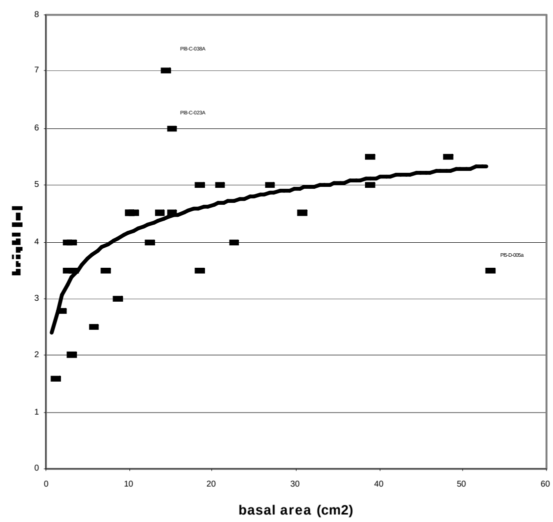


1: Manilkara zapota	2: Metopium brownei	3: Tetrapteris schiedeana	4: Hampea trilobata
5: Bursera simaruba	6: Coccoloba reflexiflora	7: Serjania yucatanensis	8: Hiraea obovata
9: Coccoloba schiedeana	10: Gymnathes lucida	11: Laetia thamnia	12: Protium copal
13: Sabal yapa	14: Diospyros cuneata	15: Coccoloba acapulcensis	16: Calypthrantes pallens
17: Brosimum alicastrum	18: Randia aculeata	19: Croton reflexifolius	20: Pithecellobium stevensonii
21: Eugenia rhombea	22: Nectandra salicifolia	23: Quararibea funebris	24: Bauhinia jenningsii
25: Nectandra coriacea	26: Ouratea lucens	27: Psidium sartorianum	28: Thrinax radiata

Graph 8.8: *Coccoloba* aff. *reflexiflora*
Height against basal area
(all plots considered)



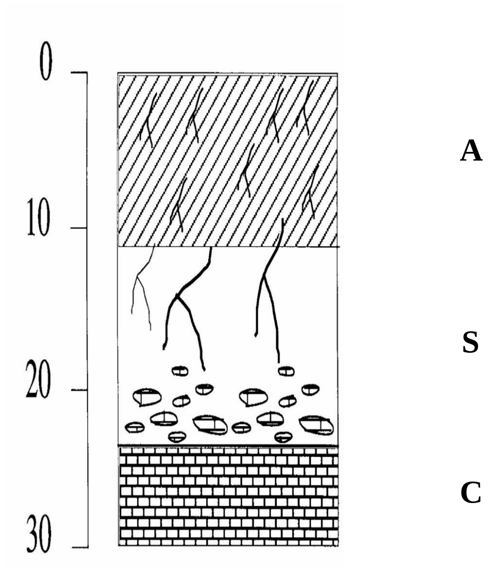
Graph 8.9 : *Croton reflexifolius*
Height against basal area
(all plots considered)



General Values:

Total basal area (all specimens above 1.5 m high) : **34.97 m^2/ha**

Overall density (all specimens above 1.5 m high) : **14'900 ind./ha**



Soil Bijleveld No. PL8.1/1998

Vegetation:

Soil of plot 8, subplot D, stoney area
Western Survey Line, Shipstern N.R.

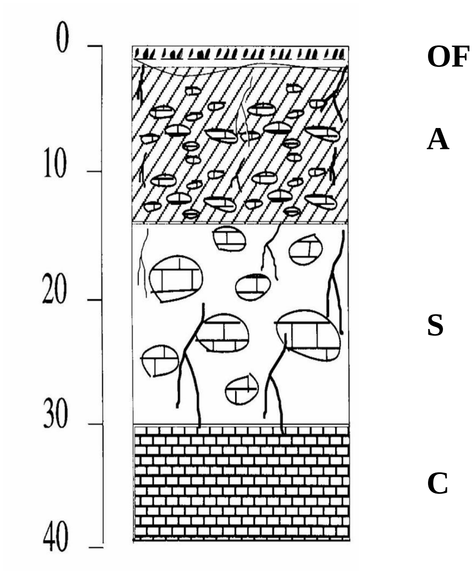
Type of soil: cf. chromic cambisol

Horizons:

A: organo-mineral horizon, somewhat clayey.

S: structural horizon, stoney at the base

C: Calcareous bedrock: Fe-rich chalk



Soil Bijleveld No. PL8.2/1998

Vegetation:

Soil of plot 8, subplot B, in a slightly sunken area
Western Survey Line, Shipstern N.R.

Type of soil: cf. chromic cambisol

Horizons:

OF: semi-decomposed litter horizon

A: organo-mineral horizon, somewhat clayey, many small stones.

S: structural horizon, stoney throughout

C: Calcareous bedrock: Fe-rich chalk

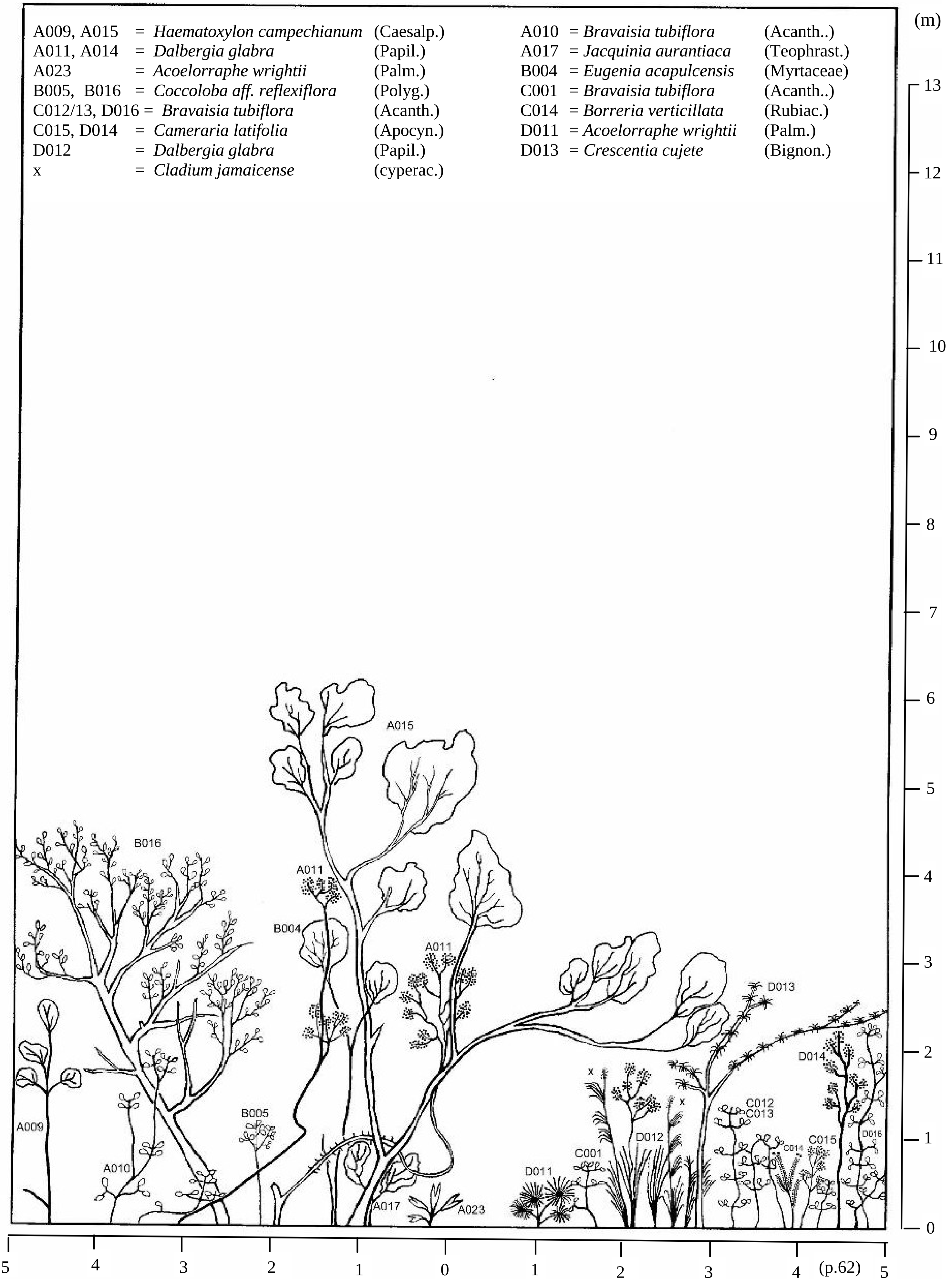
Fig. 10: Soils of plot 8, Western Survey Line Transect, Shipstern Nature Reserve

The Vegetation of Shipstern Nature Reserve
Western Survey Line Transect

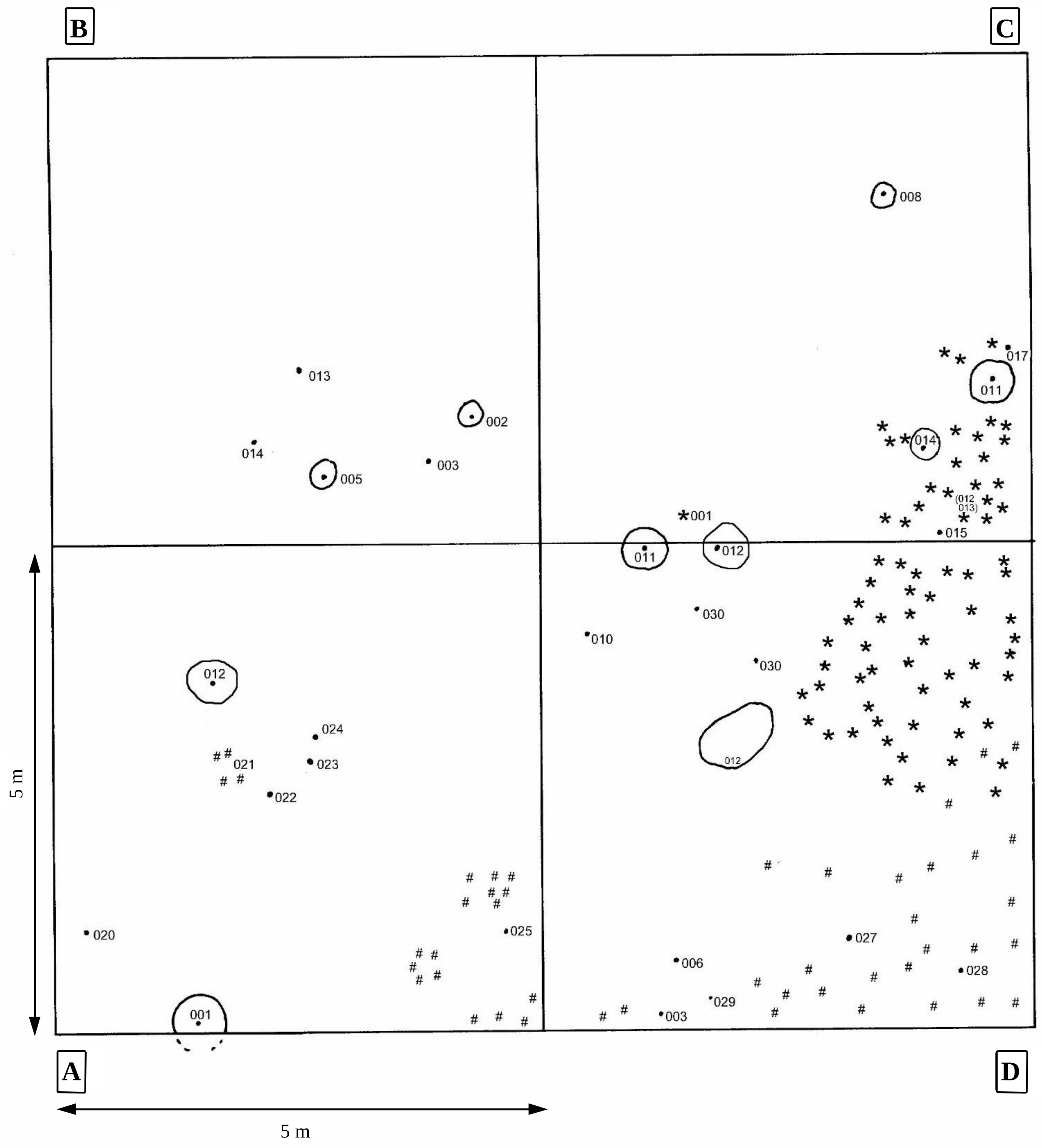
Plot 11 N 18° 17.444' W 088° 13.123'

Vertical diagram (horizontal section: 10m x 2m, through centre, parallel to transect)

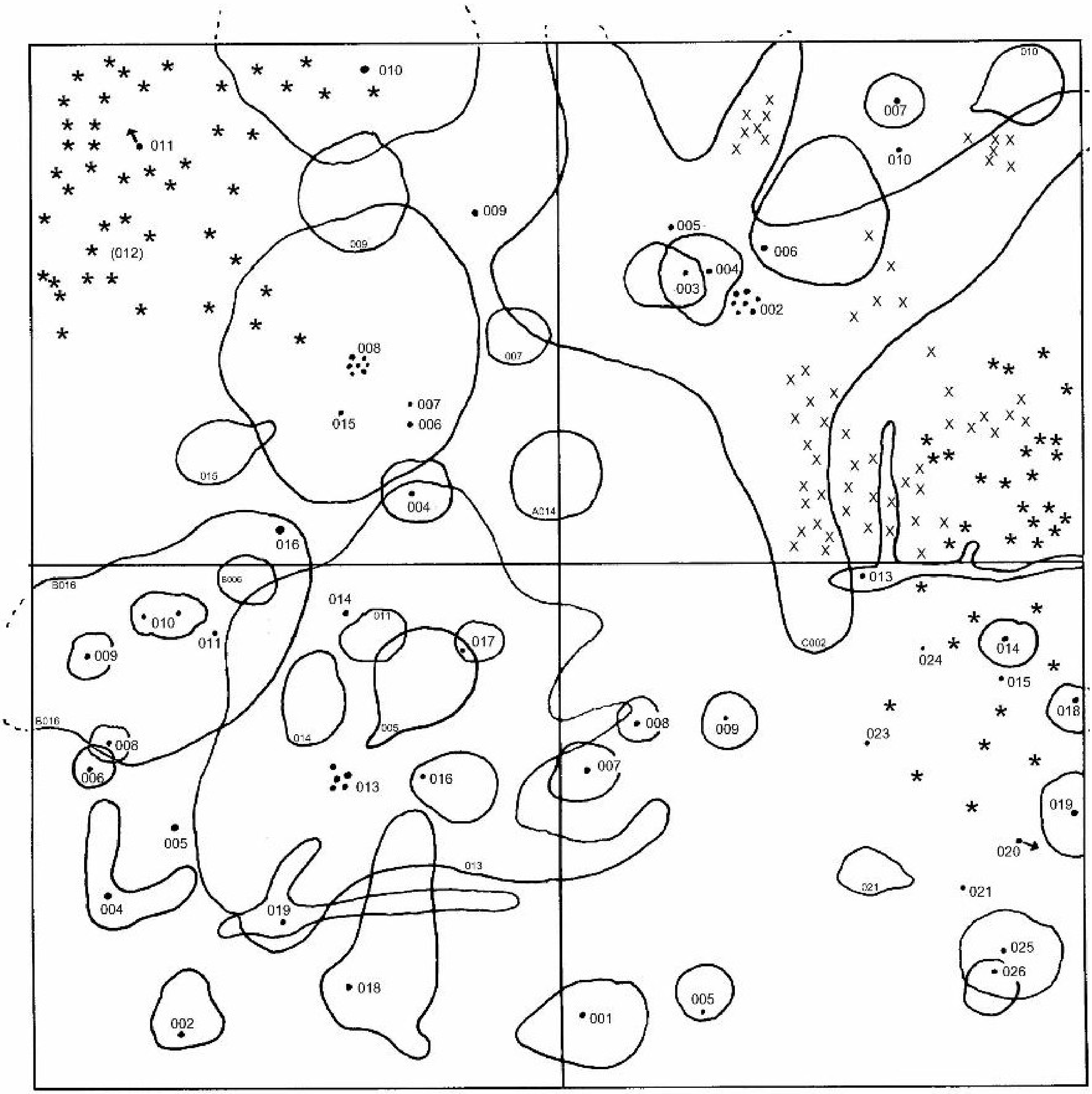
A009, A015	= *Haematoxylon campechianum*	(Caesalp.)	A010	= *Bravaisia tubiflora*	(Acanth..)
A011, A014	= *Dalbergia glabra*	(Papil.)	A017	= *Jacquinia aurantiaca*	(Teophrast.)
A023	= *Acoelorraphe wrightii*	(Palm.)	B004	= *Eugenia acapulcensis*	(Myrtaceae)
B005, B016	= *Coccoloba aff. reflexiflora*	(Polyg.)	C001	= *Bravaisia tubiflora*	(Acanth..)
C012/13, D016	= *Bravaisia tubiflora*	(Acanth.)	C014	= *Borreria verticillata*	(Rubiac.)
C015, D014	= *Cameraria latifolia*	(Apocyn.)	D011	= *Acoelorraphe wrightii*	(Palm.)
D012	= *Dalbergia glabra*	(Papil.)	D013	= *Crescentia cujete*	(Bignon.)
x	= *Cladium jamaicense*	(cyperac.)			



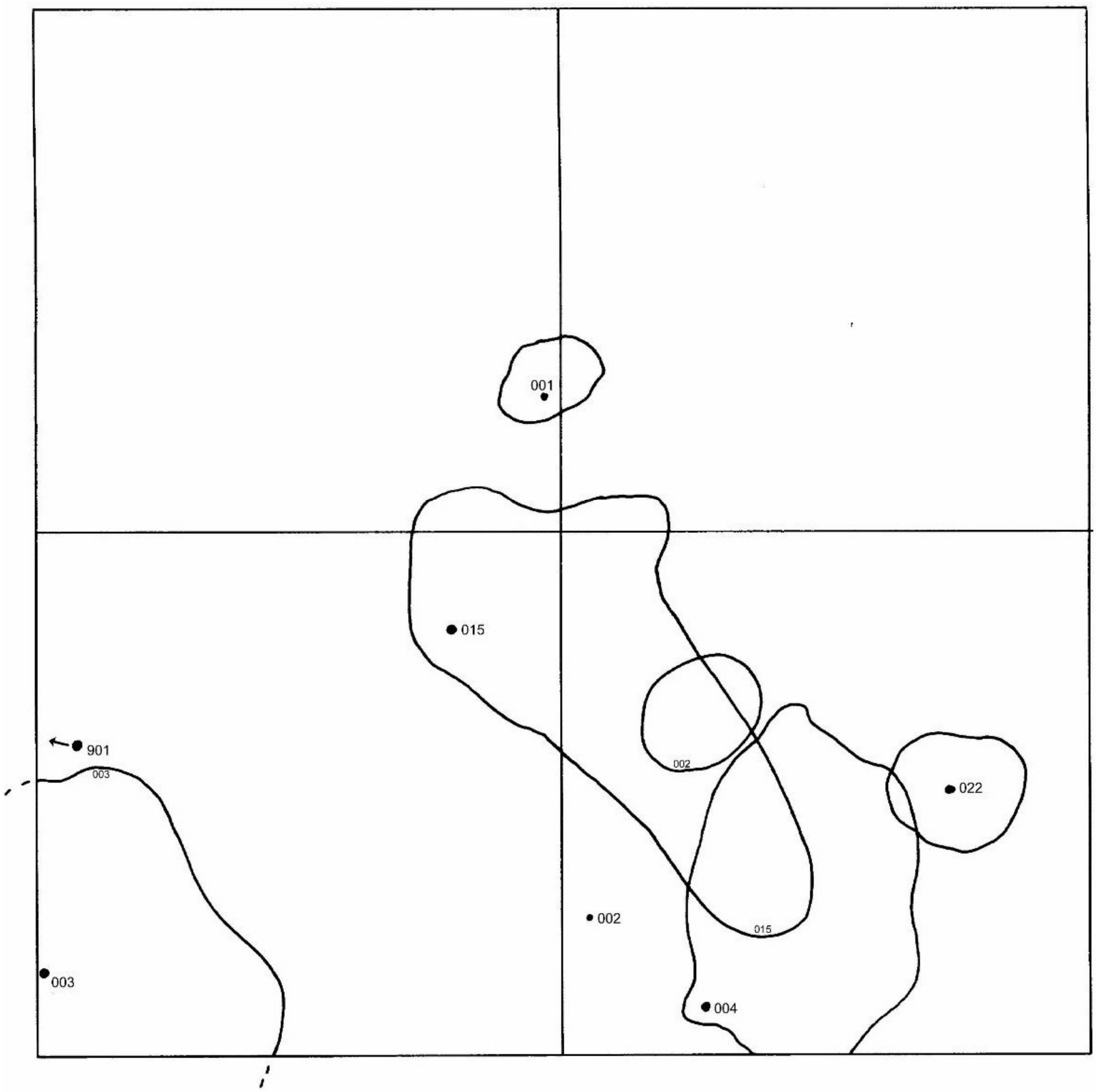
The Vegetation of Shipstern Nature Reserve
Western Survey Line Transect
Plot 11 N 18°17.444' W 088° 13.123'
Horizontal diagram
First level, height 0 m - 1.5 m



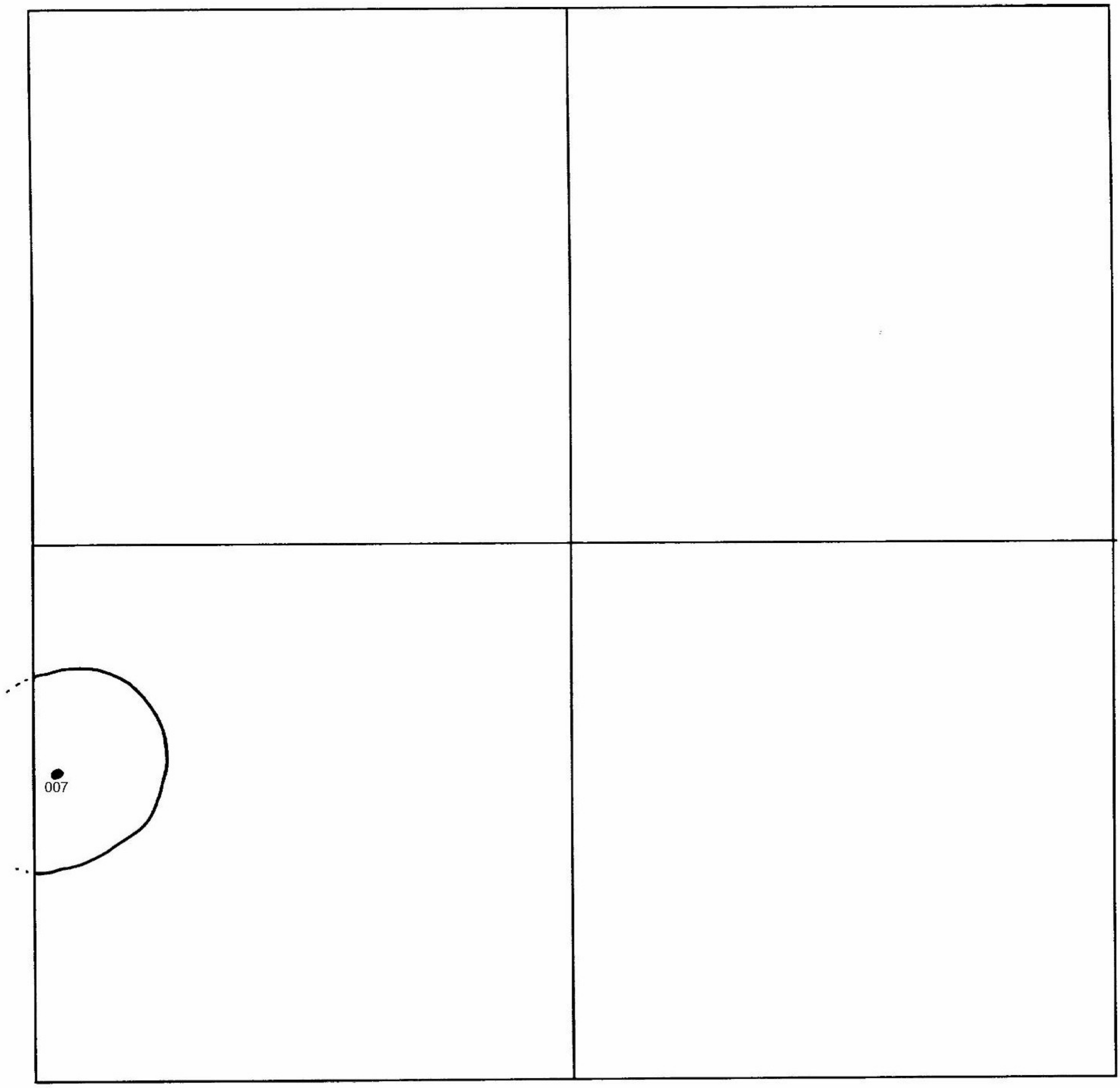
Second level, height 1.5 m - 5m



Third level, height 5m - 10m



Fourth level, height > 10m



SHIPSTERN NATURE RESERVE VEGETATION SURVEY

PLOT 11 WESTERN SURVEY LINE TRANSECT

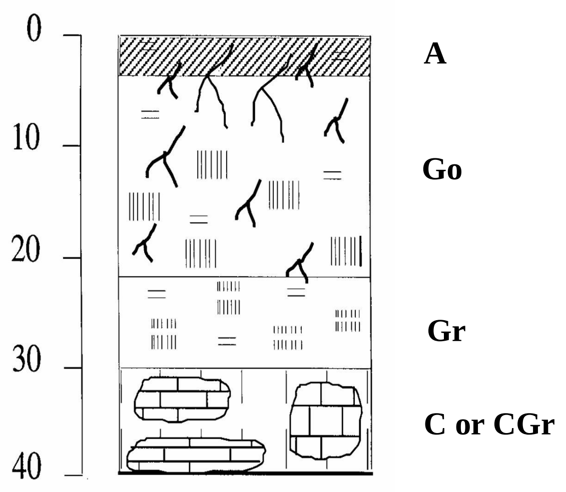
N 18°17.444' W 088° 13.123'

no.	family	genus	species	height (m)	DBH (cm)	date coll.	nb coll.	deposit	identification
#	Cyperaceae	Rhynchospora	floridensis	av. 0.25					
X	Cyperaceae	Cladium	jamaicense	av. 1.65					
*	Acanthaceae	Bravaisia	tubiflora	av. 1.1					
PL11-A-001a	Theophrastaceae	Jacquinia	aurantiaca	1.2		29.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-A-002a	Euphorbiaceae	Croton	reflexifolius	2.8	1.4	29.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-A-003A	Sapotaceae	Manilkara	zapota	5.5	6	29.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-A-004a	Bignoniaceae	Crescentia	cujete	3	2.9	29.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-A-005a	Papilionaceae	Dalbergia	glabra	3	3.8	29.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-A-006a	Apocynaceae	Cameraria	latifolia	4	2.5	29.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-A-007A	Apocynaceae	Cameraria	latifolia	11	11.2				idem PL11-A-006a
PL11-A-901A	Combretaceae	Conocarpus	erecta	5.5	7.4	29.01.97	3 x int.	BLMP/CHET/NE	Tomlinson
PL11-A-008a	Papilionaceae	Dalbergia	glabra	4	4.1				idem PL11-A-005a
PL11-A-009a	Caesalpiniaceae	Haematoxylon	campechianum	2.5	1	29.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-A-010a	Acanthaceae	Bravaisia	tubiflora	2	<1	29.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-A-011a	Papilionaceae	Dalbergia	glabra	4	3.6				idem PL11-A-005a
PL11-A-012a	Papilionaceae	Dalbergia	glabra	1					idem PL11-A-005a
PL11-A-013a	Papilionaceae	Dalbergia	glabra	3.5	5				idem PL11-A-005a
PL11-A-014a	Papilionaceae	Dalbergia	glabra	3	3.5				idem PL11-A-005a
PL11-A-015A	Caesalpiniaceae	Haematoxylon	campechianum	6	12.8				idem PL11-A-009a
PL11-A-016a	Papilionaceae	Dalbergia	glabra	3	1.8				idem PL11-A-005a
PL11-A-017a	Theophrastaceae	Jacquinia	aurantiaca	1.7	<1				idem PL11-A-001a
PL11-A-018a	Papilionaceae	Dalbergia	glabra	3	2.8				idem PL11-A-005a
PL11-A-019a	Bignoniaceae	Crescentia	cujete	4.5	5.1				idem PL11-A-004a
PL11-A-020h	Palmae	cf. Acoelorraphe	wrightii	0.3					idem PL11-C-011a
PL11-A-021h	Cyperaceae	Rhynchospora	floridensis	0.2		29.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-A-022h	Theophrastaceae	Jacquinia	aurantiaca	0.5					idem PL11-A-001a
PL11-A-023h	Palmae	Acoelorrhaphe	wrightii	0.3		29.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-A-024l	Rubiaceae	Morinda	royoc	0.8		29.01.97	1 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-A-025h	Caesalpiniaceae	Haematoxylon	campechianum	0.4					idem PL11-A-009a
PL11-A-026e	Bromeliaceae	Tillandsia	brachycaulos			29.01.97	2 x int.	BLMP/NE	Gentry
PL11-B-001A	Apocynaceae	Cameraria	latifolia	7	5.7				idem PL11-A-006a
PL11-B-002a	Theophrastaceae	Jacquinia	aurantiaca	1.2					idem PL11-A-001a
PL11-B-003a	Acanthaceae	Bravaisia	tubiflora	1.3					idem PL11-A-010a
PL11-B-004a	Myrtaceae	Eugenia	acapulcensis	4	3.5	30.01.97	3 x int.	BLMP/CHET/NE	Keller, Gentry
PL11-B-005a	Polygonaceae	Coccoloba	aff. reflexiflora??	1.2		30.01.97	3 x int.	BLMP/CHET/NE	?
PL11-B-006a	Papilionaceae	Dalbergia	glabra	3	2.8				idem PL11-A-005a
PL11-B-007a	Papilionaceae	Dalbergia	glabra	2	2.3				idem PL11-A-005a
PL11-B-008a	Malpighiaceae	Malpighia	lundellii	4	5	30.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-B-009a	Papilionaceae	Dalbergia	glabra	1.7	<1				idem PL11-A-005a
PL11-B-010a	Malpighiaceae	Malpighia	lundellii	4	4.6				idem PL11-B-008a
PL11-B-011a	Papilionaceae	Dalbergia	glabra	3	2.7				idem PL11-A-005a
PL11-B-012a	Acanthaceae	Bravaisia	tubiflora	1.7	<1				idem PL11-A-010a
PL11-B-013a	Theophrastaceae	Jacquinia	aurantiaca	0.7					idem PL11-A-001a
PL11-B-014a	Theophrastaceae	Jacquinia	aurantiaca	0.6					idem PL11-A-001a
PL11-B-015a	Papilionaceae	Dalbergia	glabra	3	3.1				idem PL11-A-005a
PL11-B-016a	Polygonaceae	Coccoloba	aff. reflexiflora	4.5	12	30.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-C-001a	Acanthaceae	Bravaisia	tubiflora	0.3					idem PL11-A-010a
PL11-C-002a	Papilionaceae	Dalbergia	glabra	3.8	4.7				idem PL11-A-005a
PL11-C-003a	Polygonaceae	Coccoloba	aff. reflexiflora	3	8.2				idem PL11-B-016a
PL11-C-004a	Polygonaceae	Coccoloba	aff. reflexiflora	3.2	8				idem PL11-B-016a

no.	family	genus	species	height (m)	DBH (cm)	date coll.	nb coll.	deposit	identification
PL11-C-005a	Papilionaceae	Dalbergia	glabra	1.5					idem PL11-A-005a
PL11-C-006a	Polygonaceae	Coccoloba	aff. reflexiflora	3	5				idem PL11-B-016a
PL11-C-007a	Theophrastaceae	Jacquinia	aurantiaca	1.7	<1				idem PL11-A-001a
PL11-C-008a	Polygonaceae	Coccoloba	aff. reflexiflora	1					idem PL11-B-016a
PL11-C-009a	Papilionaceae	Dalbergia	glabra	1.3					idem PL11-A-005a
PL11-C-010a	Papilionaceae	Dalbergia	glabra	2.1	1.8				idem PL11-A-005a
PL11-C-011a	Palmae	Acoelorraphe	wrightii	0.7		30.01.97	1 x int. 2 x	BLMP/CHET/NE	Herb. Chetumal
PL11-C-012a	Acanthaceae	Bravaisia	tubiflora	1.3					idem PL11-A-010a
PL11-C-013a	Acanthaceae	Bravaisia	tubiflora	1.2					idem PL11-A-010a
PL11-C-014H	Rubiaceae	Borreria	verticillata	0.8		30.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-C-015a	Apocynaceae	Cameraria	latifolia	0.7					idem PL11-A-006a
PL11-C-016H	Cyperaceae	Cladium	jamaicense	1.8	<1	30.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-C-017h	Cyperaceae	Rhynchospora	holoschoenoides	0.7		30.01.97	1x	BLMP	Herb. Chetumal
PL11-D-001a	Malpighiaceae	Byrsonima	bucidaefolia	1.7	<1	31.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-D-002A	Papilionaceae	Dalbergia	glabra	6	5.6				idem PL11-A-005a
PL11-D-003a	Apocynaceae	Cameraria	latifolia	1.4					idem PL11-A-006a
PL11-D-004A	Caesalpiniaceae	Haematoxylon	campechianum	7	10.2				idem PL11-A-009a
PL11-D-005a	Apocynaceae	Cameraria	latifolia	1.8	<1				idem PL11-A-006a
PL11-D-006a	Apocynaceae	Cameraria	latifolia	1.5					idem PL11-A-006a
PL11-D-007a	Myrtaceae	Eugenia	acapulcensis	2	1.2				idem PL11-B-004a
PL11-D-008a	Papilionaceae	Dalbergia	glabra	2.1	<1				idem PL11-A-005a
PL11-D-009a	Malpighiaceae	Malpighia	lundellii	2	1.3	31.01.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PL11-D-010a	Papilionaceae	Dalbergia	glabra	0.6					idem PL11-A-005a
PL11-D-011a	Palmae	Acoelorraphe	wrightii	0.5					idem PL11-C-011a
PL11-D-012a	Papilionaceae	Dalbergia	glabra	1.4					idem PL11-A-005a
PL11-D-013a	Bignoniaceae	Crescentia	cujete	3	3.2				idem PL11-A-004a
PL11-D-014a	Apocynaceae	Cameraria	latifolia	2.5	1.7				idem PL11-A-006a
PL11-D-015a	Papilionaceae	Dalbergia	glabra	2.1	<1				idem PL11-A-005a
PL11-D-016a	Acanthaceae	Bravaisia	tubiflora	2.4	<1				idem PL11-A-010a
PL11-D-017		dead							
PL11-D-018a	Theophrastaceae	Jacquinia	aurantiaca	2	1.2				idem PL11-A-001a
PL11-D-019a	Apocynaceae	Cameraria	latifolia	3	2.5				idem PL11-A-006a
PL11-D-020a	Papilionaceae	Gliricidia	sepium	5	3.5	31.01.97	3 x ext.	BLMP/CHET/NE	Herb. Chetumal
PL11-D-021a	Papilionaceae	Dalbergia	glabra	1.8	<1				idem PL11-A-005a
PL11-D-022A	Apocynaceae	Cameraria	latifolia	9	9.5				idem PL11-A-006a
PL11-D-023a	Papilionaceae	Dalbergia	glabra	2	1.4				idem PL11-A-005a
PL11-D-024a	Acanthaceae	Bravaisia	tubiflora	1.6	<1				idem PL11-A-010a
PL11-D-025a	Apocynaceae	Cameraria	latifolia	3.5	2.3				idem PL11-A-006a
PL11-D-026a	Theophrastaceae	Jacquinia	aurantiaca	1.8	<1				idem PL11-A-001a
PL11-D-027a	Myrtaceae	Eugenia	acapulcensis	1.1					idem PL11-B-004a
PL11-D-028a	Euphorbiaceae	Croton	reflexifolius	1.2					idem PL11-A-002a
PL11-D-029h	Palmae	Acoelorraphe	wrightii	0.2		31.01.97	3 x int.	BLMP/CHET/NE	idem PL11-A-020h
PL11-D-030h	Palmae	Acoelorraphe	wrightii	0.3					idem PL11-A-020h
PL11-D-031h	Cyperaceae	Rhynchospora	floridensis	0.25					idem PL11-A-021h

Plot 11: species data table

Family	Genus	Species	Frequency	Density (ind./ha)	Total basal area (cm2/100m2)
Acanthaceae	Bravaisia	tubiflora	1	37	29.23
Papilionaceae	Dalbergia	glabra	1	19	135.87
Apocynaceae	Cameraria	latifolia	0.75	9	211.95
Theophrastacea	Jacquinia	aurantiaca	0.75	4	3.5
Polygonaceae	Coccoloba	aff. reflexiflora	0.5	4	235.82
Caesalpiniaceae	Haematoxylon	campechianum	0.5	3	211.18
Malpighiaceae	Malpighia	lundellii	0.5	3	37.59
Bignoniaceae	Crescentia	cujete	0.5	3	35.08
Myrtaceae	Eugenia	acapulcensis	0.5	2	10.75
Combretaceae	Conocarpus	erecta	0.25	1	43.01
Sapotaceae	Manilkara	zapota	0.25	1	28.27
Papilionaceae	Gliricidia	sepium	0.25	1	9.62
Euphorbiaceae	Croton	reflexifolius	0.25	1	1.54
Malpighiaceae	Byrsonima	bucidaefolia	0.25	1	0.79



<u>Soil Mitchell No.09/1993 (as an example)</u>

Type of soil: gleyosol

Horizons:

A: organo-mineral horizon, varying depths thick.

Go: oxydised gley horizon, temporarily water-logged

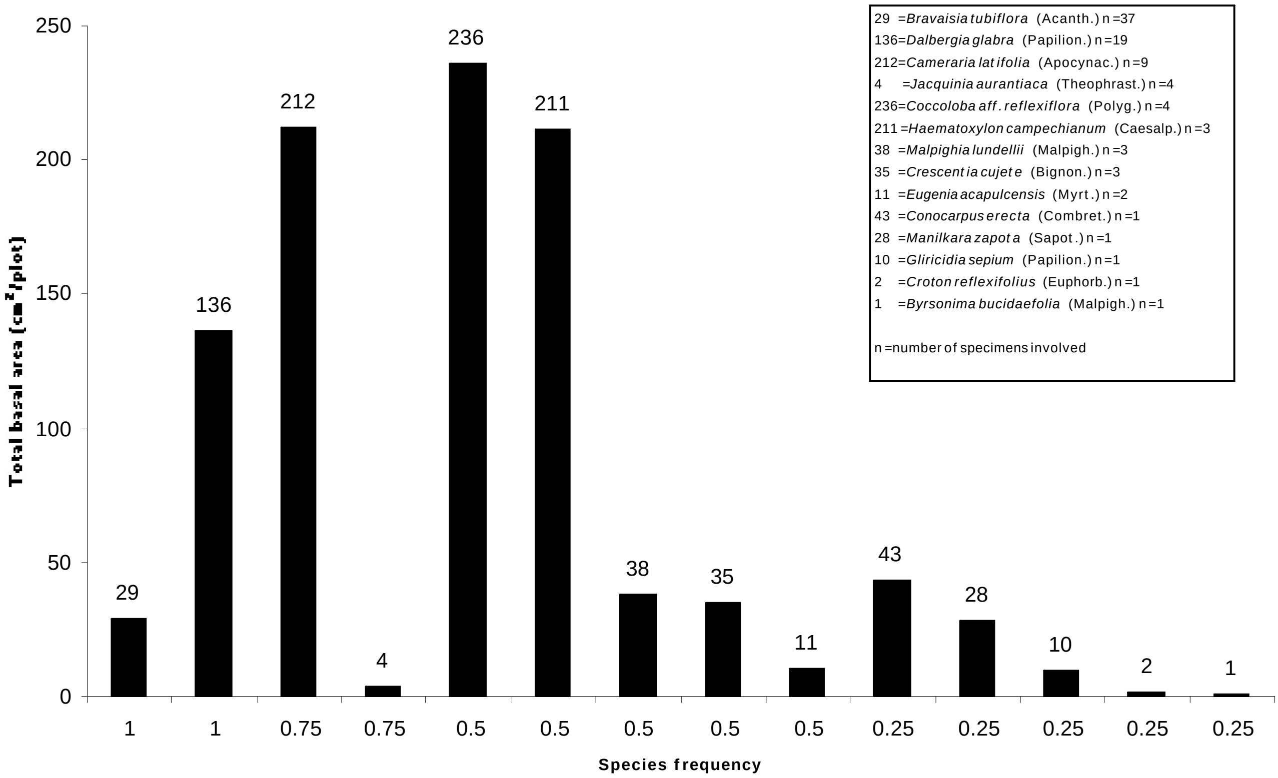
Gr: reduced gley horizon, permanently water-logged.

C or Cgr: parent material (gleyification possible)

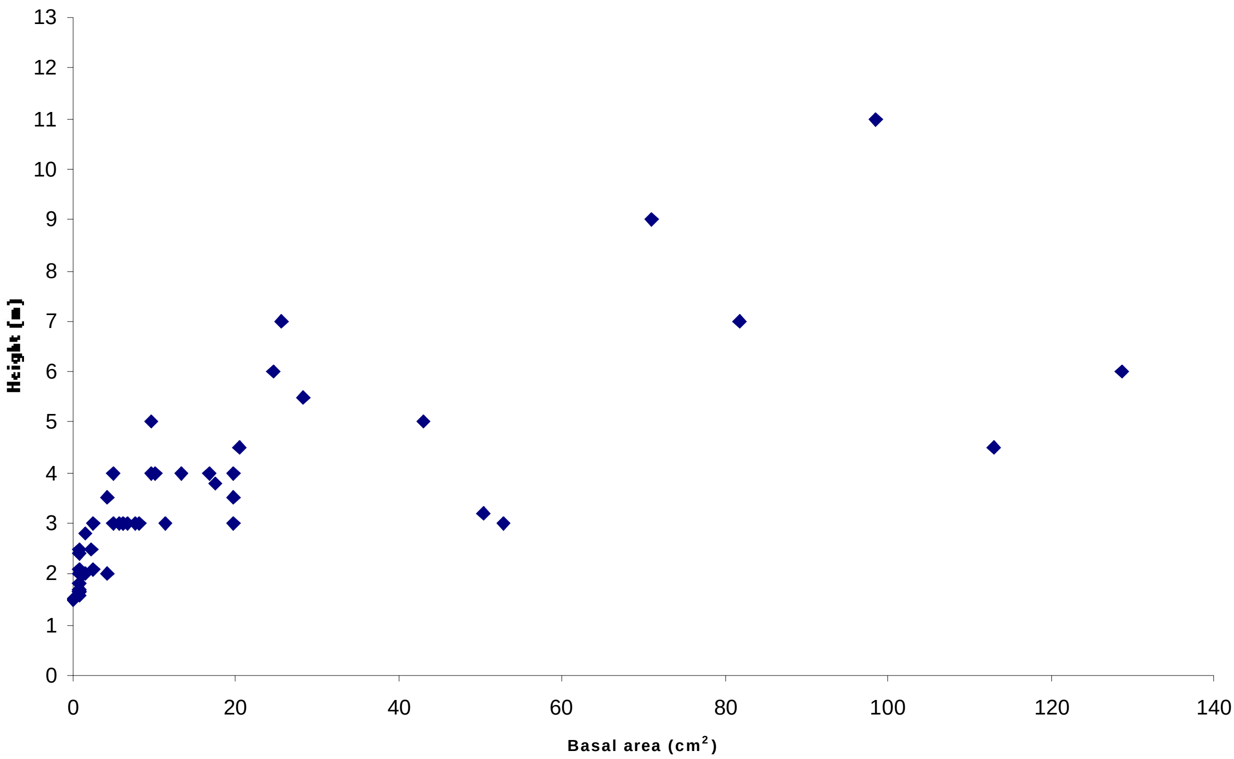
Fig. 11: general soil type that can be expected under temporarily inundated forests. Varying factors are undoubtedly soil depth, content of organic matter, fluctuation of water table, and, to a lesser degree, salinity.

Graph 11.1 : frequency against total basal area

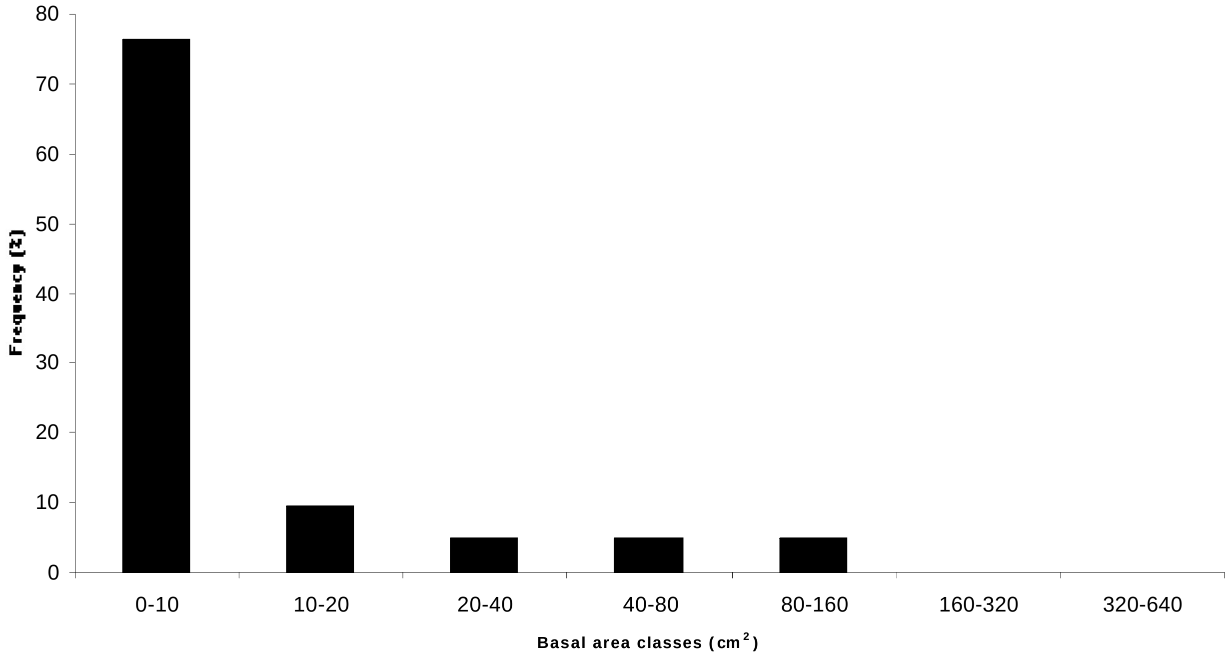
N.B: Graph based on density is equivalent



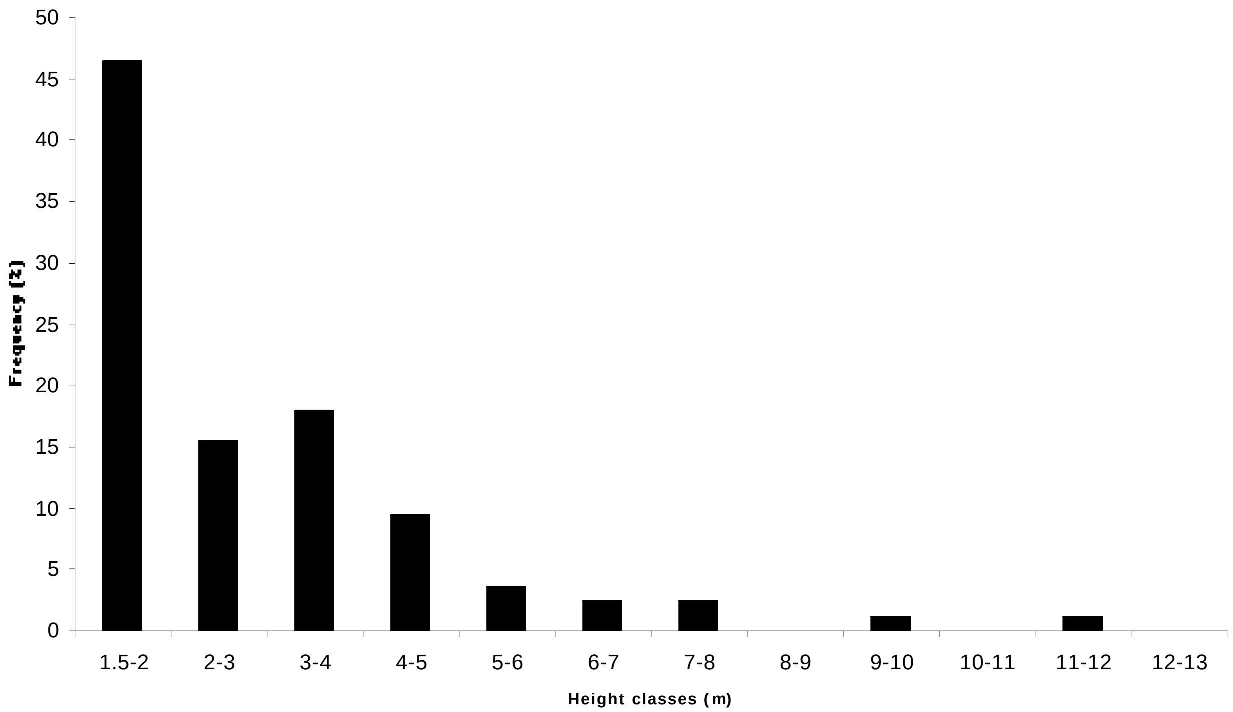
Graph 11.2 : height against basal area



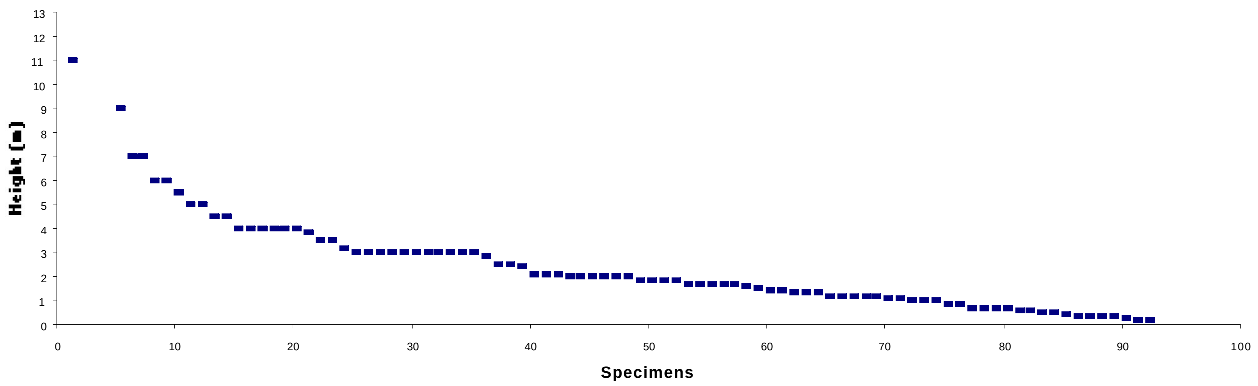
Graph 11.3 : frequency of basal area classes



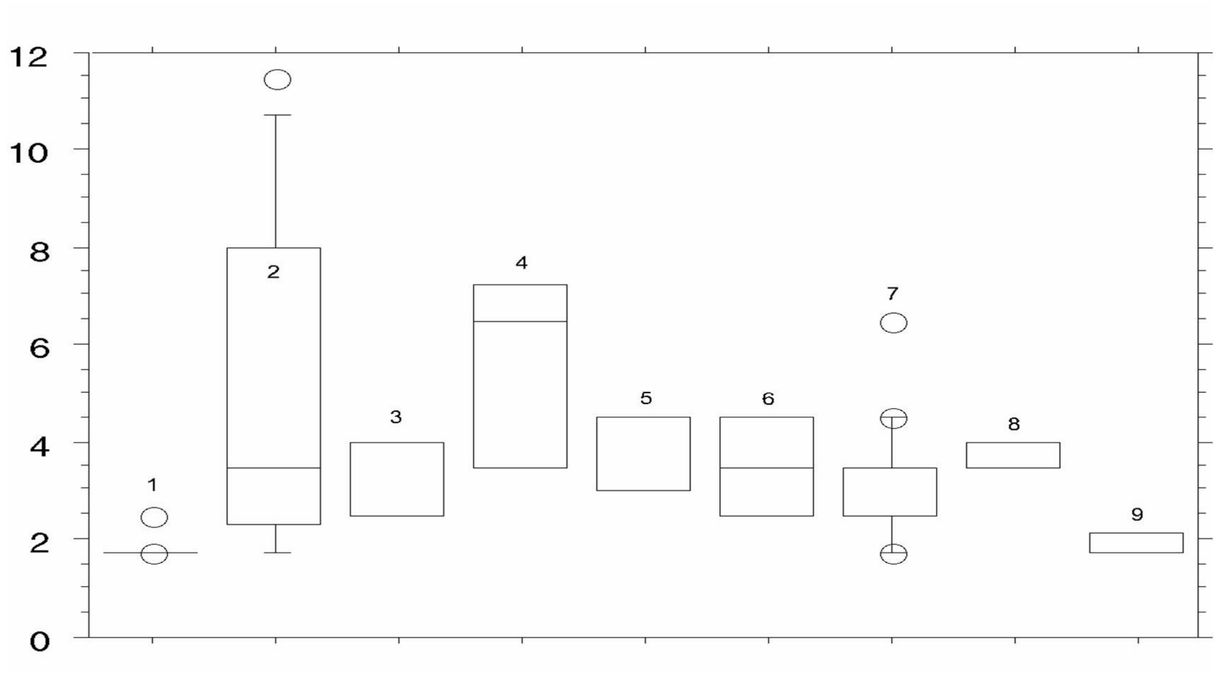
Graph 11.4: frequency of height classes



Graph 11.5 : height distribution (by descending order)



Graph 11.6 : Box plot analysis



1: Bravaisia tubiflora
2: Cameraria latifolia
3: Crescentia cujete
4: Haematoxylon campechianum
5: Malpighia lundellii
6: Eugenia acapulcensis
7: Dalbergia glabra
8: Coccoloba reflexiflora
9: Jacquinia aurantiaca

General Values:

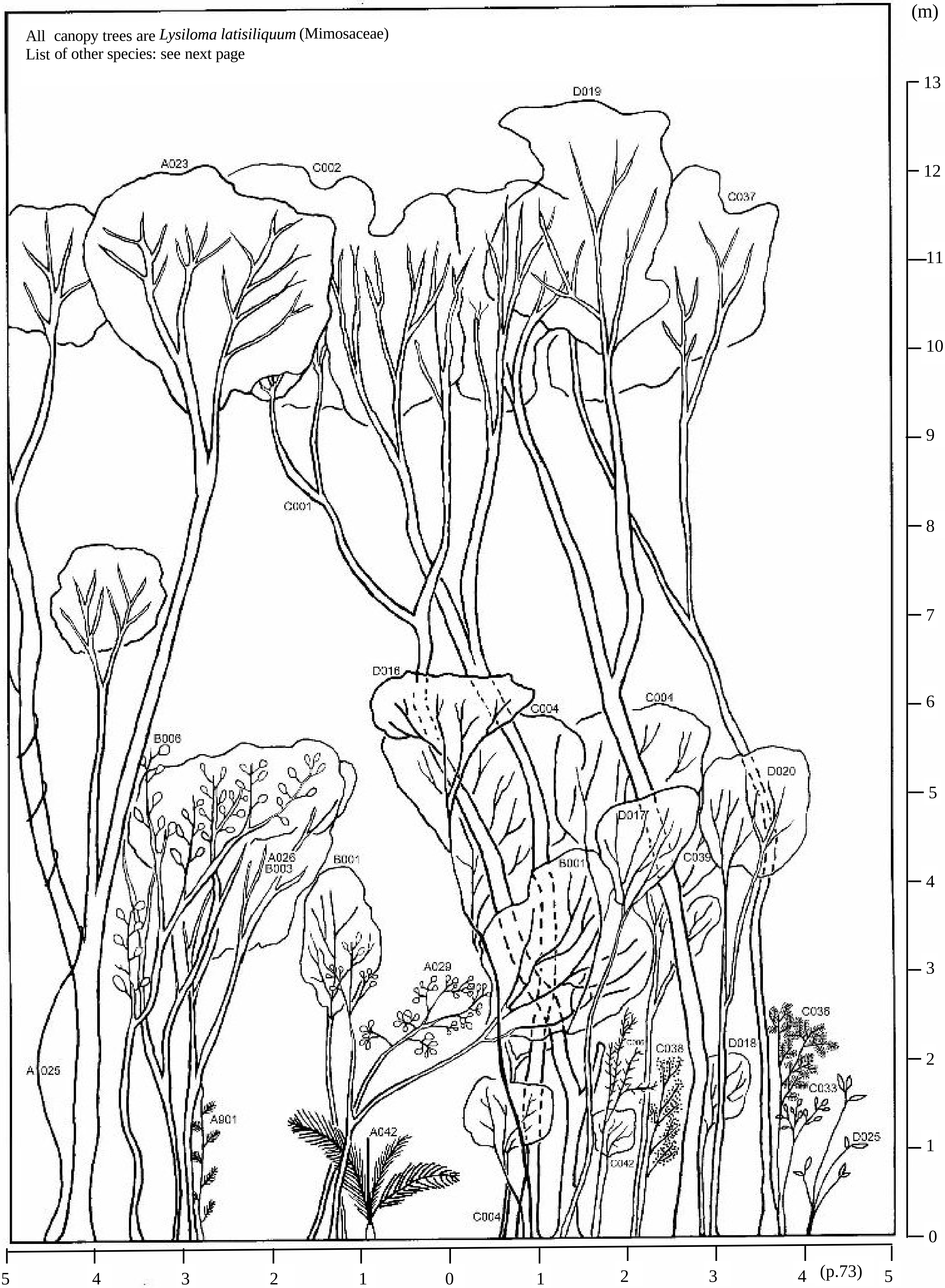
Total basal area (all specimens above 1.5 m high): **9.94 m^2/ha**

Overall density (all specimens above 1.5 m high): **8'900 ind./ha**

The Vegetation of Shipstern Nature Reserve
New Trail

Plot DR N 18° 18.419' W 088° 11.376'

Vertical diagram (horizontal section: 10m x 2m, through centre, parallel to transect)



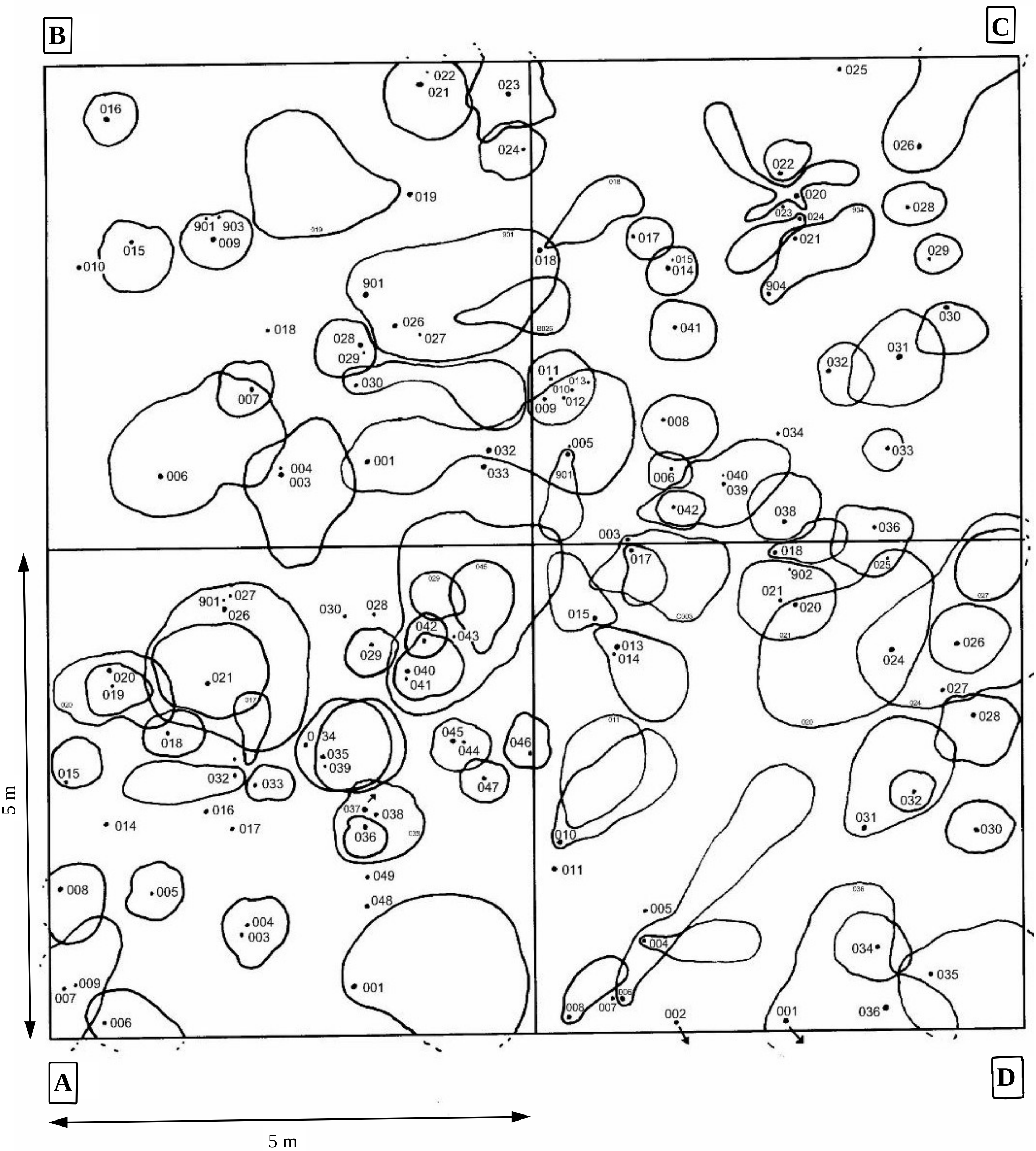
The Vegetation of Shipstern Nature Reserve
New Trail

Plot DR   N 18° 18.419’   W 088° 11.376’
Vertical diagram

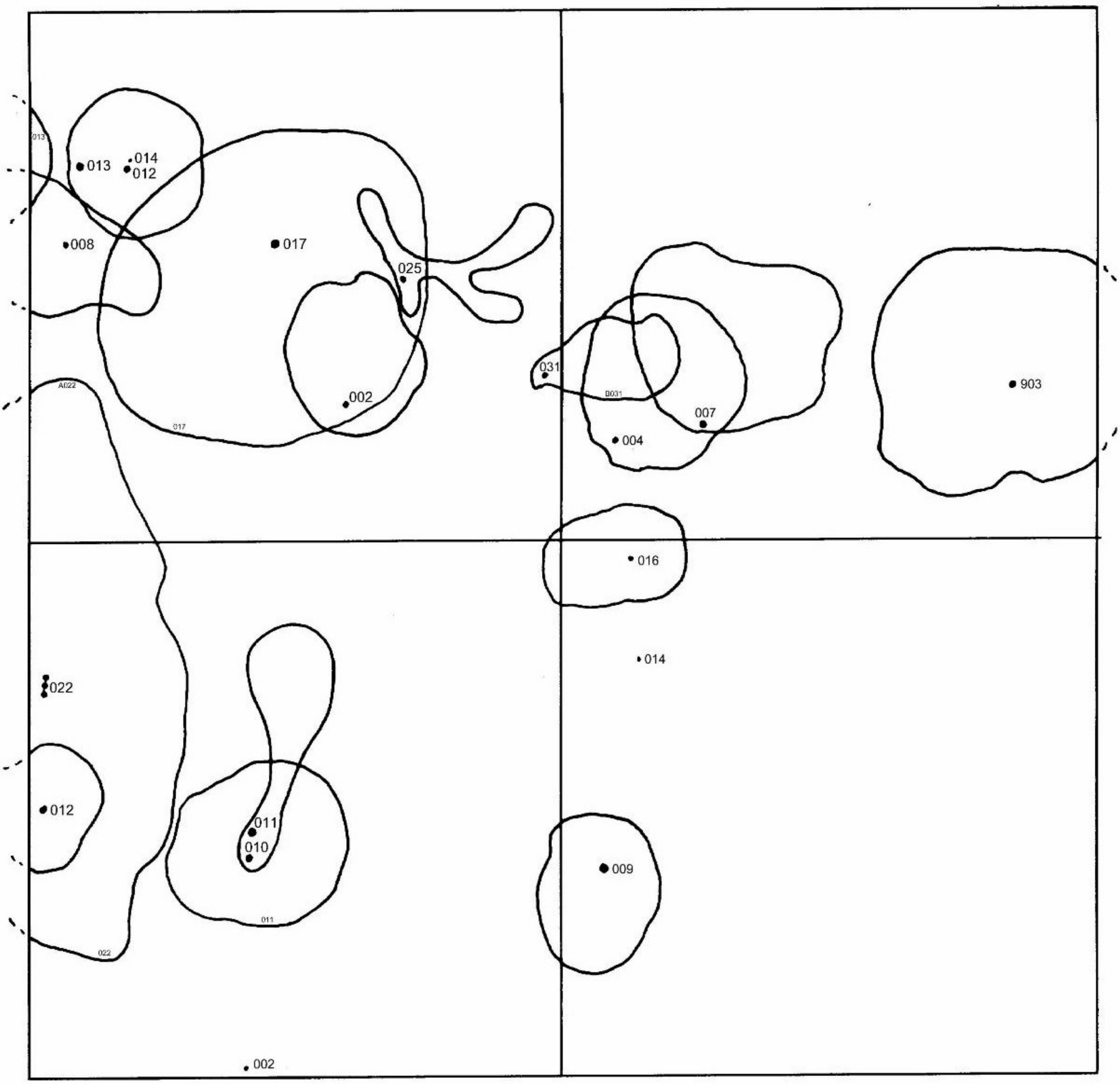
Species List:

A025:	*Arrabidea sp*? (Bignon.)	NB: died after storm of 23rd april1997
A026:	*Croton chichenensis*	(Euphorbiaceae)
B003:	“	
C039:	“	
A029:	*Sapranthus campechianus*	(Annonaceae)
A042:	*Pseudophoenix s. sargentii*	(Palmae)
A901:	*Serjania adiantoides*	(Sapindaceae)
B001:	*Gymnopodium floribundum*	(Polygonaceae)
B006:	*Jatropha gaumeri*	(Euphorbiaceae)
C004:	*Erythroxylum rotundifolium*	(Erythroxylaceae)
C006:	*Randia truncata*	(Rubiaceae)
C033:	*Myginda gaumeri*	(Celastraceae)
C036:	*Acacia collinsii*	(Mimosaceae)
C038:	*Malpighia lundellii*	(Malpighiaceae)
C042 :	*Eugenia sp.*	(Myrtaceae) NB: diff. from *E. buxifolia*
D018:	“	
D016:	*Samyda yucatanensis*	(Flacourtiaceae)
D017:	*Eugenia buxifolia*	(Myrtaceae)
D025:	*Pedilanthus deamii*	(Euphorbiaceae)
A023:	*Lysiloma latisiliquum*	(Mimosaceae)
C001:	“	
C002:	“	
C037:	“	
D019:	“	
D020:	“	

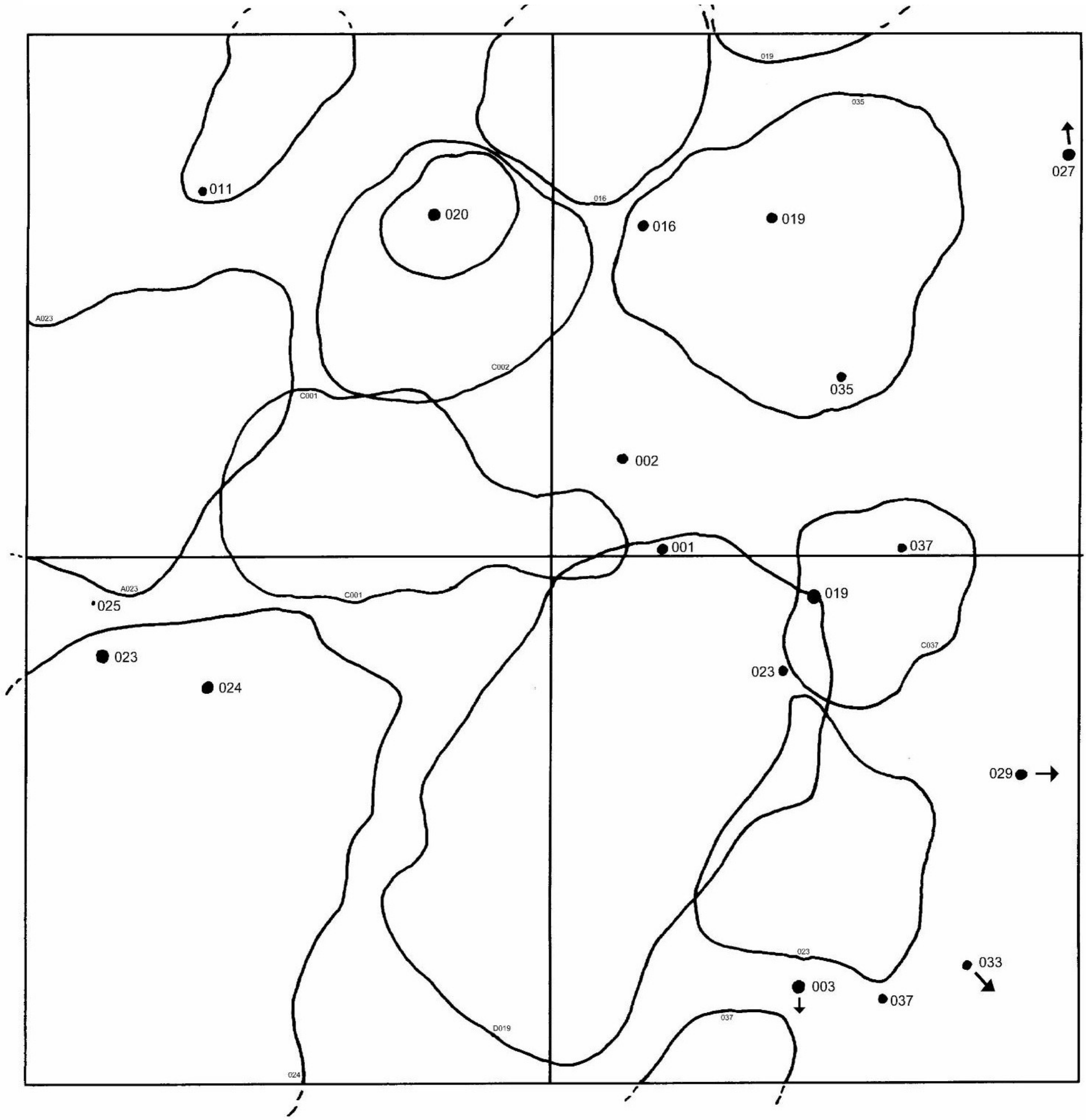
The Vegetation of Shipstern Nature Reserve
New Trail
Plot DR N 18°18.419’ W 088° 11.376’
Horizontal diagram
First level, height 1.5m - 5m



Second level, height 5m - 10m



Third level, height 10m - 15m



SHIPSTERN NATURE RESERVE VEGETATION SURVEY

PLOT DR NEW TRAIL PLOT

N 18°18.419' W 088° 11.376'

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb coll.	deposit	identification
PLDR-A-001a	Myrtaceae	Eugenia	cf. buxifolia	5	3.5	13.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-002l	Rubiaceae	Morinda	royoc	5+	<1	13.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-003a	Malpighiaceae	Bunchosia	cf. glandulosa	1.7	<1	13.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-004l	Rubiaceae	Morinda	royoc	1.5	<1				idem PLDR-A-002l
PLDR-A-005a	Rubiaceae	Randia	truncata	2.2	<1	01.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-006a	Euphorbiaceae	Croton	reflexifolius	1.6	<1				idem PL8-A-037a
PLDR-A-007a	Malpighiaceae	Bunchosia	swartziana	2.5	1				idem PL8-C-036a
PLDR-A-008a	Myrtaceae	Eugenia	cf. buxifolia	2	<1				idem PLDR-A-001a
PLDR-A-009l	Bignoniaceae	Arrabidaea	floribunda	2	<1	16.05.97	3 x int.	BLMP/CHET/NE	Keller, Gentry
PLDR-A-010A	Burseraceae	Bursera	simaruba	5.5	4.7				unmistakable
PLDR-A-011A	Burseraceae	Bursera	simaruba	6	6.3				unmistakable
PLDR-A-012A	Polygonaceae	Coccoloba	spicata	5.5	4.7	16.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-013E	Orchidaceae	Oncidium	ascendens						McLeish et al.
PLDR-A-014a	Sapotaceae	Sideroxylon	persimile	1.8	<1	07.06.97	1 x int. 2 x ext.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-015a	Malpighiaceae	Malpighia	lundellii	2.5	<1	16.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-016l		leafless							
PLDR-A-017a	Euphorbiaceae	Croton	chichenensis	3	1.5	04.03.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-018a	Annonaceae	Sapranthus	cf. campechianus	1.6	<1	16.05.97	2x int.	BLMP/NE	Herb. Chetumal
PLDR-A-019a	Rubiaceae	Randia	truncata	2	<1				idem PLDR-A-005a
PLDR-A-020a	Rubiaceae	Asemnanthe	pubescens	2.5	<1	16.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-021a	Myrtaceae	Eugenia	cf. buxifolia	4	1.3				idem PLDR-A-001a
PLDR-A-022A	Anacardiaceae	Metopium	brownei	8	7.5				unmistakable
PLDR-A-023A	Mimosaceae	Lysiloma	latisiliquum	11	17	07.04.97	3 x ext.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-024A	Mimosaceae	Lysiloma	latisiliquum	11.5	19				idem PLDR-A-023A
PLDR-A-025L		dead							
PLDR-A-026a	Euphorbiaceae	Croton	chichenensis	5	3.8				idem PLDR-A-017a
PLDR-A-027l	Bignoniaceae	Arrabidaea	floribunda	4+	<1				idem PLDR-A-009l
PLDR-A-901l	Sapindaceae	Serjania	adiantoides	1.6	<1	16.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-28l	Bignoniaceae	Arrabidaea	floribunda	4+	<1				idem PLDR-A-009l
PLDR-A-29a	Annonaceae	Sapranthus	cf. campechianus	3	1	16.05.97	3 x int.	BLMP/CHET/NE	idem PLDR-A-018a
PLDR-A-030l	Apocynaceae	Echites	yucatanensis	2.5	<1	16.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-031a	Myrtaceae	Eugenia	cf. buxifolia	1.6	<1				idem PLDR-A-001a
PLDR-A-032a	Euphorbiaceae	Croton	chichenensis	3.5	<1				idem PLDR-A-017a
PLDR-A-033a	Myrtaceae	Eugenia	cf. buxifolia	2	<1				idem PLDR-A-001a
PLDR-A-034a	Euphorbiaceae	Croton	chichenensis	4.5	2.2				idem PLDR-A-017a
PLDR-A-035a	Polygonaceae	Coccoloba	belizensis	5	4.5				unmistakable
PLDR-A-036a	Myrtaceae	Eugenia	cf. buxifolia	2	<1				idem PLDR-A-001a
PLDR-A-037a	Erythroxylaceae	Erythroxylum	rotundifolium	5	4.3				idem PLDR-C-004a
PLDR-A-038a	Noliniaceae	Beaucarnea	ameliae	2.5	2.5	16.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-039l	Bignoniaceae	Arrabidaea	sp.	2.3	<1				idem PLDR-A-009l
PLDR-A-040a	Euphorbiaceae	Jatropha	gaumeri	4	3.8	16.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-041a	Myrtaceae	Eugenia	sp.	2	1				idem PLDR-B-007a
PLDR-A-042a	Palmae	Pseudophoenix	s. sargentii	1.6					idem PLDR-B-017A
PLDR-A-043l	Apocynaceae	Echites	yucatanensis	1.7		06.03.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-044a	Polygonaceae	Neomillspaughia	emarginata	3	1	16.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-A-045a	Polygonaceae	Neomillspaughia	emarginata	4.5	3.8				idem PLDR-A-044a
PLDR-A-046a	Euphorbiaceae	Croton	chichenensis	2	1.2				idem PLDR-A-017a
PLDR-A-047a	Erythroxylaceae	Erythroxylum	rotundifolium	1.5	<1				idem PLDR-A-037a
PLDR-A-048l	Rubiaceae	Morinda	royoc	1.6	<1				idem PLDR-A-002l
PLDR-A-049l	Euphorbiaceae	Tragia	yucatanensis	1.6	0	16.05.97	1 x ext. 2 x int.	BLMP/CHET/NE	Herb. Chetumal

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb coll.	deposit	identification
PLDR-B-001a	Polygonaceae	Gymnopodium	floribundum	4	4	16.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-B-002A	Burseraceae	Bursera	simaruba	6	6.5				unmistakable
PLDR-B-003a	Euphorbiaceae	Croton	chichenensis	4	3.2				idem PLDR-A-017a
PLDR-B-004l	Araceae	Philodendron	sp.						dead (storm 23.4.97)
PLDR-B-005l	?	?	?						dead (storm 23.4.97)
PLDR-B-006a	Euphorbiaceae	Jatropha	gaumeri	5	5.5				idem PLDR-A-040a
PLDR-B-007a	Myrtaceae	Eugenia	sp.	2	1.9	16.05.97	3 x int.	BLMP/CHET/NE	see appendix 2
PLDR-B-008A	Polygonaceae	Coccoloba	spicata	6.5	5.5				idem PLDR-A-012A
PLDR-B-009a	Euphorbiaceae	Euphorbia	schlechtendalii	4.5	2.8	21.05.97	3 x ext.	BLMP/CHET/NE	Herb. Chetumal
PLDR-B-010l	Sapindaceae	Serjania	yucatanensis	3	<1				idem PL8-A-033l
PLDR-B-011A	Papilionaceae	Gliricidia	sepium	11	7.5				idem PL11-D-020a
PLDR-B-012A	Apocynaceae	Plumeria	obtusa	5.5	4.8	13.04.97	3 x ext.	BLMP/CHET/NE	Herb. Chetumal
PLDR-B-013A	Burseraceae	Bursera	simaruba	9	8.5				unmistakable
PLDR-B-014l	Araceae	Philodendron	hederaceum	5+	<1	16.05.97	2 x int.	BLMP/NE	Gentry
PLDR-B-015a	Myrtaceae	Eugenia	sp.	3.5	1.2				idem PLDR-B-007a
PLDR-B-016a	Myrtaceae	Eugenia	sp.	2	1.6				idem PLDR-B-007a
PLDR-B-017A	Palmae	Pseudophoenix	s.sargentii	6.5	13.5	07.06.97	3 x ext.	BLMP/CHET/NE	Henderson et al.
PLDR-B-018l	Araceae	Philodendron	sp.	3	<1				idem PLDR-B-014l
PLDR-B-019a	Myrtaceae	Eugenia	sp.	2.5	2.5				idem PLDR-B-007a
PLDR-B-020A	Anacardiaceae	Metopium	brownei	11	10				unmistakable
PLDR-B-021a	Myrtaceae	Eugenia	sp.	3	1.5				idem PLDR-B-007a
PLDR-B-022l	Rubiaceae	Morinda	royoc	2.5	<1				idem PLDR-A-002l
PLDR-B-023a	Polygonaceae	Coccoloba	spicata	3	2.5				idem PLDR-A-012A
PLDR-B-024a	Polygonaceae	Coccoloba	spicata	3	2.3				idem PLDR-A-012A
PLDR-B-025A/l	Rubiaceae	Hintonia	octomera	7.5	1.2	08.05.97	3 x ext.	BLMP/CHET/NE	Herb.Chetumal
PLDR-B-026a	Myrtaceae	Eugenia	sp.	1.5	<1				idem PLDR-B-007a
PLDR-B-027l	Rubiaceae	Morinda	royoc	1.7	<1				idem PLDR-A-002l
PLDR-B-901a	Euphorbiaceae	Jatropha	gaumeri	5	6.3				idem PLDR-A-040a
PLDR-B-028a	Myrtaceae	Eugenia	sp.	2	1.2				idem PLDR-B-007a
PLDR-B-029l	Rubiaceae	Morinda	royoc	4+	<1				idem PLDR-A-002l
PLDR-B-030a	Myrtaceae	Eugenia	sp.	4	3				idem PLDR-B-007a
PLDR-B-031A	Malpighiaceae	Malpighia	lundellii	5.5	4	23.05.97	3 x int.		idem PLDR-A-015a
PLDR-B-032l	Bignoniaceae	Arrabidaea	sp.	1.5	<1				idem PLDR-A-009l
PLDR-B-033l	Rubiaceae	Morinda	royoc	1.6	<1				idem PLDR-A-002l
PLDR-B-902l	Euphorbiaceae	Dalechampia	cf. scandens	3.5	<1				idem PLDR-C-034l
PLDR-B-903l	Dioscoreaceae	Dioscorea	sp.	2.8	<1				Gentry, Herb. Chet.
PLDR-C-001A	Mimosaceae	Lysiloma	latisiliquum	11	16.5				idem PLDR-A-023A
PLDR-C-002A	Mimosaceae	Lysiloma	latisiliquum	10.5	12.5				idem PLDR-A-023A
PLDR-C-003a	Myrtaceae	Eugenia	cf. buxifolia	3.5	2.1				idem PLDR-A-001a
PLDR-C-004A	Erythroxylaceae	Erythroxylum	rotundifolium	5.5	3.7	16.05.97	3 x int.		Herb.Chetumal
PLDR-C-005l	Rubiaceae	Morinda	royoc	4+	<1				idem PLDR-A-002l
PLDR-C-901a	Papilionaceae	Platymiscium	yucatanum	5	2	16.05.97	3 x int.		Herb.Chetumal
PLDR-C-006a	Rubiaceae	Randia	truncata	2.2	<1				idem PLDR-A-005a
PLDR-C-007A	Mimosaceae	Lysiloma	latisiliquum	8	9.8				idem PLDR-A-023A
PLDR-C-008a	Myrtaceae	Eugenia	cf. buxifolia	2.5	1.5				idem PLDR-A-001a
PLDR-C-009a	Malpighiaceae	Bunchosia	swartziana	2	1.5				idem PL8-C-036a
PLDR-C-010a/l	cf. Tiliaceae	Corchorus	siliquosus	2	<1				idem PLDR-C-025a/l
PLDR-C-011l	Sapindaceae	Serjania	adiantoides	2	<1				idem PLDR-A-901l
PLDR-C-012l	Rubiaceae	Morinda	royoc	2.2	<1				idem PLDR-A-002l
PLDR-C-013l	Sapindaceae	Serjania	yucatanensis	1.5	<1				idem PL8-A-033l
PLDR-C-014a	Myrtaceae	Eugenia	cf. buxifolia	1.6	<1				idem PLDR-A-001a
PLDR-C-015l	Rubiaceae	Morinda	royoc	1.7	<1				idem PLDR-A-002l
PLDR-C-016A	Mimosaceae	Lysiloma	latisiliquum	11	13.5				idem PLDR-A-023A
PLDR-C-017a/l	cf. Tiliaceae	Corchorus	siliquosus	1.7	<1				idem PLDR-C-025a/l
PLDR-C-018a	Flacourtiaceae	Samyda	yucatanensis	1.6	<1	02.05.97	3 x ext.	BLMP/CHET/NE	Herb. Chetumal

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb coll.	deposit	identification
PLDR-C-019A	Mimosaceae	Lysiloma	latisiliquum	10	12				idem PLDR-A-023A
PLDR-C-020a/l	Rubiaceae	Hintonia	octomera	1.6	<1				idem PLDR-B-025A/l
PLDR-C-021h/l	Gramineae	Lasiacis	cf. divaricata	3+	<1	16.05.97		BLMP/CHET/NE	Herb. Chetumal
PLDR-C-022a	Malvaceae	Hampea	trilobata	4	1.9	17.05.97	1 x int. (check)	BLMP	idem PL8-A-022a
PLDR-C-023h/l	Graminae	Lasiacis	cf. divaricata	3	<1				idem PLDR-C-021h/l
PLDR-C-024a	Euphorbiaceae	Sebastiana	adenophora	3.5	1.1	16.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-C-902a	Euphorbiaceae	Croton	flavens	1.7	<1	30.04.97	3 x ext.	BLMP/CHET/NE	Herb.Chetumal
PLDR-C-025a/l	Tiliaceae	Corchorus	siliquosus	1.6	<1	02.05.97	2 x int.(flowers)	BLMP/CHET/NE	Herb. Chetumal
PLDR-C-026a	Malpighiaceae	Bunchosia	swartziana	5	3.5				idem PL8-C-036a
PLDR-C-027A	Mimosaceae	Lysiloma	latisiliquum	12	15.4				idem PLDR-A-023A
PLDR-C-028a	Erythroxylaceae	Erythroxylum	rotundifolium	1.5	<1				idem PLDR-A-037a
PLDR-C-029a	Euphorbiaceae	Sebastiana	adenophora	2	<1				idem PLDR-C-024a
PLDR-C-030a	Erythroxylaceae	Erythroxylum	rotundifolium	1.6	<1				idem PLDR-A-037a
PLDR-C-031a	Euphorbiaceae	Croton	chichenensis	2	<1				idem PLDR-A-017a
PLDR-C-903A	Euphorbiaceae	Sebastiana	adenophora	5.5	6.5				idem PLDR-C-024a
PLDR-C-032a	Euphorbiaceae	Sebastiana	adenophora	2.5	<1	07.05.97	1 x int.(fruit)	BLMP	idem PLDR-C-024a
PLDR-C-033a	Celastraceae	Myginda	gaumeri	1.5	<1	05.07.97	3 x ext.	BLMP/CHET/NE	Herb. Chetumal
PLDR-C-034l	Euphorbiaceae	Dalechampia	cf. scandens	1.5	<1	17.05.97	2 x int.	BLMP/NE	Herb. Chetumal
PLDR-C-035A	Mimosaceae	Lysiloma	latisiliquum	11.5	14.5				idem PLDR-A-023A
PLDR-C-036a	Mimosaceae	Acacia	collinsii	2.5	2.6				field ident.FBH
PLDR-C-037A	Mimosaceae	Lysiloma	latisiliquum	11	12.5				idem PLDR-A-023A
PLDR-C-038a	Malpighiaceae	Malpighia	lundellii	1.8	<1				idem PLDR-A-015a
PLDR-C-039a	Euphorbiaceae	Croton	chichenensis	4.3	2.5				idem PLDR-A-017a
PLDR-C-040l	Rubiaceae	Morinda	royoc	3+	<1				idem PLDR-A-002l
PLDR-C-041a	Annonaceae	Sapranthus	cf. campechianus	3	1.2				idem PLDR-A-018a
PLDR-C-042a	Myrtaceae	Eugenia	sp.	1.5	<1				idem PLDR-B-007a
PLDR-C-904a	Malvaceae	Hampea	trilobata	4.5	4.2				idem PL8-A-022a
PLDR-D-001a	Euphorbiaceae	Croton	chichenensis	1.5					idem PLDR-A-017a
PLDR-D-002a	Euphorbiaceae	Croton	chichenensis	3.5	3.1				idem PLDR-A-017a
PLDR-D-003A	Mimosaceae	Lysiloma	latisiliquum	10.5	16				idem PLDR-A-023A
PLDR-D-004a	Euphorbiaceae	Croton	chichenensis	3	2				idem PLDR-A-017a
PLDR-D-005l	Rubiaceae	Morinda	royoc	3	<1				idem PLDR-A-002l
PLDR-D-006a	Euphorbiaceae	Croton	chichenensis	1.8	2				idem PLDR-A-017a
PLDR-D-007l	Rubiaceae	Morinda	royoc	2	<1				idem PLDR-A-002l
PLDR-D-008a	Papilionaceae	Lonchocarpus	cf. yucatanensis	1.6	<1	17.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-D-009A	Mimosaceae	Lysiloma	latisiliquum	6.5	11				idem PLDR-A-023A
PLDR-D-010a	Euphorbiaceae	Croton	chichenensis	4.5	3.7				idem PLDR-A-017a
PLDR-D-011a	Mimosaceae	Lysiloma	latisiliquum	5	6				idem PLDR-A-023A
PLDR-D-012l	Rubiaceae	Morinda	royoc	5+	<1				idem PLDR-A-002l
PLDR-D-013a	Theaceae	Ternstroemia	tepezapote	3	1.9	17.05.97	3 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-D-014l	Rubiaceae	Morinda	royoc	6	<1				idem PLDR-A-002l
PLDR-D-015a	Polygonaceae	Gymnopodium	floribundum	1.8	<1				idem PLDR-B-001a
PLDR-D-016A	Flacourtiaceae	Samyda	yucatanensis	6	3.3				idem PLDR-C-018a
PLDR-D-017a	Myrtaceae	Eugenia	cf. buxifolia	4.5	2				idem PLDR-A-008a
PLDR-D-018a	Myrtaceae	Eugenia	sp.	2	1.7				idem PLDR-B-007a
PLDR-D-019A	Mimosaceae	Lysiloma	latisiliquum	12	24				idem PLDR-A-023A
PLDR-D-020a	Mimosaceae	Lysiloma	latisiliquum	5	7.2				idem PLDR-A-023A
PLDR-D-021a	Myrtaceae	Eugenia	cf. buxifolia	4.5	3.1				idem PLDR-A-008a
PLDR-D-022l		dead							
PLDR-D-023A	Mimosaceae	Lysiloma	latisiliquum	10.5	9.7				idem PLDR-A-023A
PLDR-D-024a	Malpighiaceae	Bunchosia	swartziana	4.5	3.2				idem PL8-C-036a
PLDR-D-025H	Euphorbiaceae	Pedilanthus	deamii	1.5	<1	17.05.97	2 x ext.1 x int.	BLMP/CHET/NE	Herb. Chetumal
PLDR-D-026a	Myrtaceae	Eugenia	cf. buxifolia	2	<1				idem PLDR-A-008a
PLDR-D-027a	Myrtaceae	Eugenia	cf. buxifolia	3.5	2				idem PLDR-A-008a
PLDR-D-028a	Myrtaceae	Eugenia	cf. buxifolia	2.5	1.3				idem PLDR-A-008a

#	family	genus	species	height (m)	DBH (cm)	date coll.	nb coll.	deposit	identification
PLDR-D-029A	Mimosaceae	Lysiloma	latisiliquum	11	11				idem PLDR-A-023A
PLDR-D-030a	Myrtaceae	Eugenia	cf. buxifolia	1.7	<1				idem PLDR-A-008a
PLDR-D-031a	Euphorbiaceae	Croton	chichenensis	4.5	2.8				idem PLDR-A-017a
PLDR-D-032a	Myrtaceae	Eugenia	cf. buxifolia	1.7	<1				idem PLDR-A-008a
PLDR-D-033A	Mimosaceae	Lysiloma	latisiliquum	10.5	9.2				idem PLDR-A-023A
PLDR-D-034a	Myrtaceae	Eugenia	cf. buxifolia	2.5	1.1				idem PLDR-A-008a
PLDR-D-035a	Myrtaceae	Eugenia	cf. buxifolia	3	1.5				idem PLDR-A-008a
PLDR-D-036a	Euphorbiaceae	Croton	chichenensis	5	3.5				idem PLDR-A-017a
PLDR-D-037A	Mimosaceae	Lysiloma	latisiliquum	11	9.3				idem PLDR-A-023A
PLDR-D-902h/l	Bignoniaceae	Macfadyena	unguis-cati	1.5	<1	17.05.97	3 x int.		Herb. Chetumal

Lower stratum

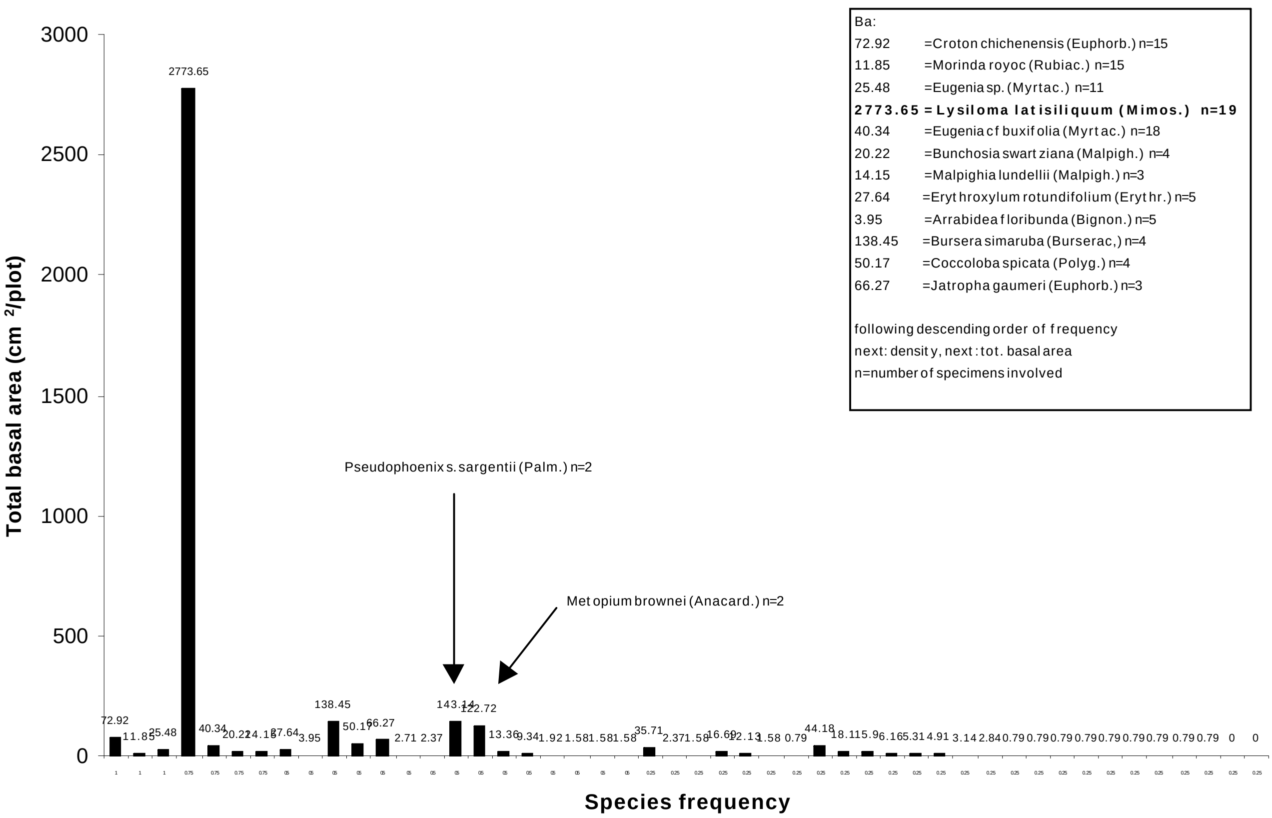
<1.5 m

	Orchidaceae	Encyclia	belizensis	belizensis
	Rubiaceae	Morinda	royoc	
	Zamiaceae	Zamia	lodigesii	
	Myrtaceae	Eugenia	buxifolia	
	Myrtaceae	Eugenia	sp.	
	Rubiaceae	Asemnanthe	pubescens	
	Euphorbiaceae	Pedilanthus	deamii	
	Theaceae	Ternstroemia	tepezapote	
	Graminae	cf ID Chetumal		

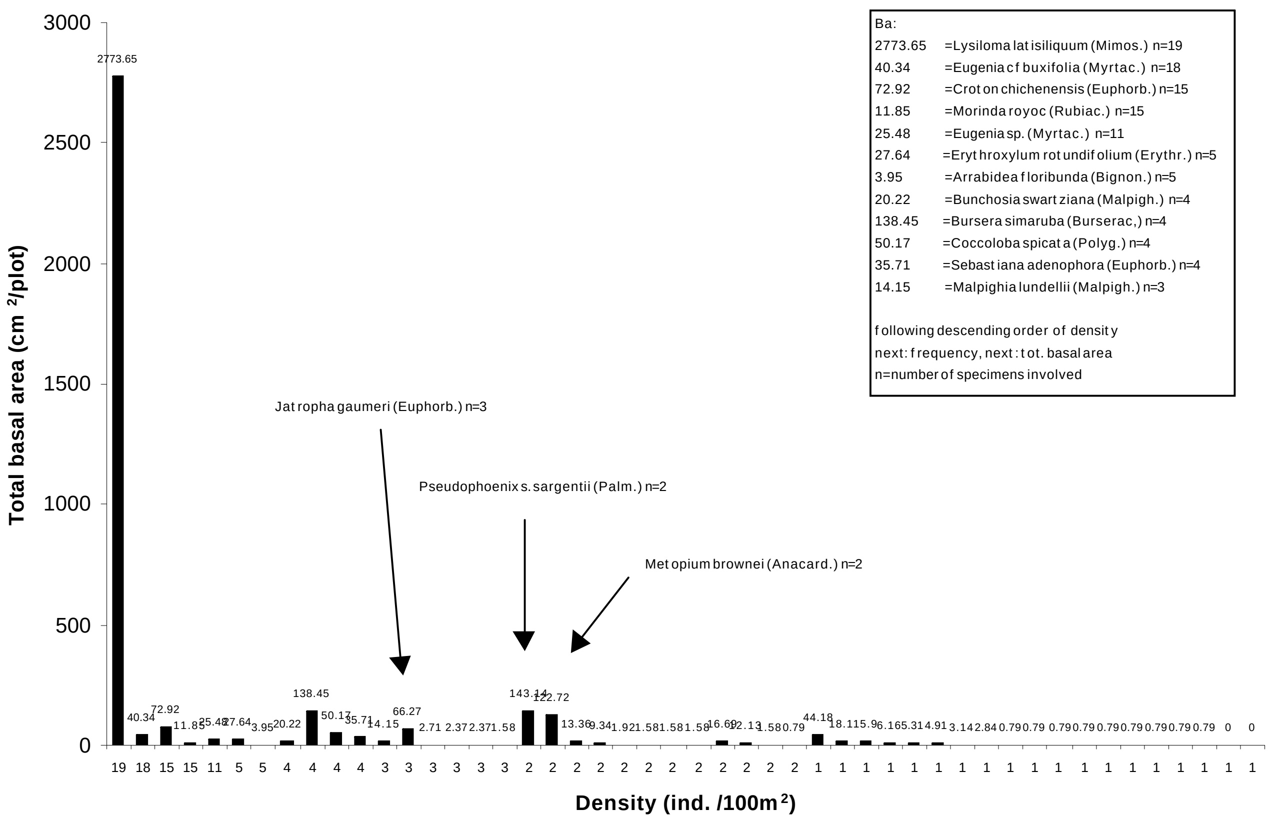
Plot DR: species data table

Family	Genus	Species	Frequency	Density (ind./ha)	Total basal area (cm2/100m2)
Mimosaceae	Lysiloma	latisiliquum	0.75	19	2773.65
Myrtaceae	Eugenia	cf. buxifolia	0.75	18	40.34
Euphorbiaceae	Croton	chichenensis	1	15	72.92
Rubiaceae	Morinda	royoc	1	15	11.85
Myrtaceae	Eugenia	sp.	1	11	25.48
Erythroxylaceae	Erythroxylum	rotundifolium	0.5	5	27.64
Bignoniaceae	Arrabidaea	sp.	0.5	5	3.95
Malpighiaceae	Bunchosia	swartziana	0.75	4	20.22
Burseraceae	Bursera	simaruba	0.5	4	138.45
Polygonaceae	Coccoloba	spicata	0.5	4	50.17
Euphorbiaceae	Sebastiana	adenophora	0.25	4	35.71
Malpighiaceae	Malpighia	lundellii	0.75	3	14.15
Euphorbiaceae	Jatropha	gaumeri	0.5	3	66.27
Annonaceae	Sapranthus	cf. campechianus	0.5	3	2.71
Rubiaceae	Randia	truncata	0.5	3	2.37
Tiliaceae	Corchorus	cf.siliquosus	0.25	3	2.37
Araceae	Philodendron	sp.	0.25	3	1.58
Palmae	Pseudophoenix	s. sargentii	0.5	2	143.14
Anacardiaceae	Metopium	brownei	0.5	2	122.72
Polygonaceae	Gymnopodium	floribundum	0.5	2	13.36
Flacourtiaceae	Samyda	yucatanensis	0.5	2	9.34
Rubiaceae	Hintonia	octomera	0.5	2	1.92
Euphorbiaceae	Dalechampia	cf. scandens	0.5	2	1.58
Sapindaceae	Serjania	adiantoides	0.5	2	1.58
Sapindaceae	Serjania	yucatanensis	0.5	2	1.58
Malvaceae	Hampea	trilobata	0.25	2	16.69
Polygonaceae	Neomillspaughia	emarginata	0.25	2	12.13
Graminae	Lasiacis	cf. divaricata	0.25	2	1.58
Apocynaceae	Echites	yucatanensis	0.25	2	0.79
Papilionaceae	Gliricidia	sepium	0.25	1	44.18
Apocynaceae	Plumeria	obtusa	0.25	1	18.1
Polygonaceae	Coccoloba	belizensis	0.25	1	15.9
Euphorbiaceae	Euphorbia	schlechtendalii	0.25	1	6.16
Mimosaceae	Acacia	collinsii	0.25	1	5.31
Noliniaceae	Beaucarnea	ameliae	0.25	1	4.91
Papilionaceae	Platymiscium	yucatanum	0.25	1	3.14
Theaceae	Ternstroemia	tepezapote	0.25	1	2.84
Bignoniaceae	Macfadyena	unguis-cati	0.25	1	0.79
Celastraceae	Myginda	gaumeri	0.25	1	0.79
Dioscoreaceae	Dioscorea	sp.	0.25	1	0.79
Euphorbiaceae	Croton	reflexifolius	0.25	1	0.79
Euphorbiaceae	Croton	flavens	0.25	1	0.79
Euphorbiaceae	Pedilanthus	deamii	0.25	1	0.79
Malpighiaceae	Bunchosia	cf. glandulosa	0.25	1	0.79
Papilionaceae	Lonchocarpus	cf. yucatanensis	0.25	1	0.79
Rubiaceae	Asemnanthe	pubescens	0.25	1	0.79
Sapotaceae	Sideroxylon	persimile	0.25	1	0.79
Euphorbiaceae	Tragia	yucatanensis	0.25	1	0
Orchidaceae	Oncidium	ascendens	0.25	1	0

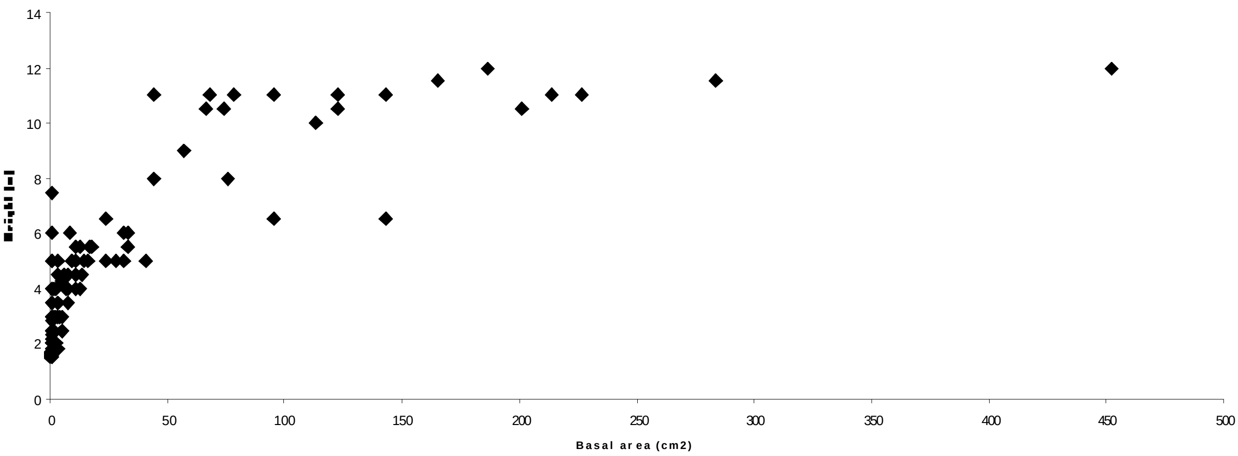
Graph DR.1: frequency against total basal area



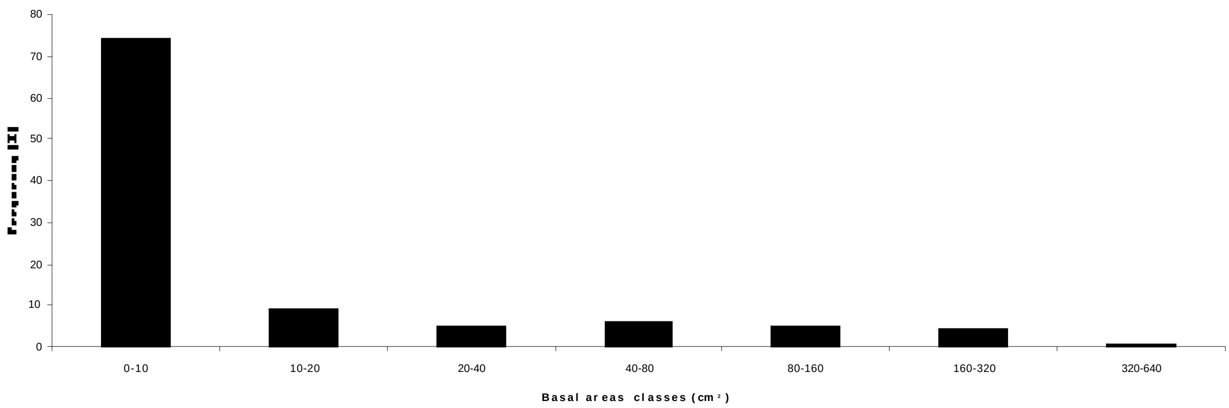
Graph DR.2: density against total basal area



Graph DR.3 :   height against basal area

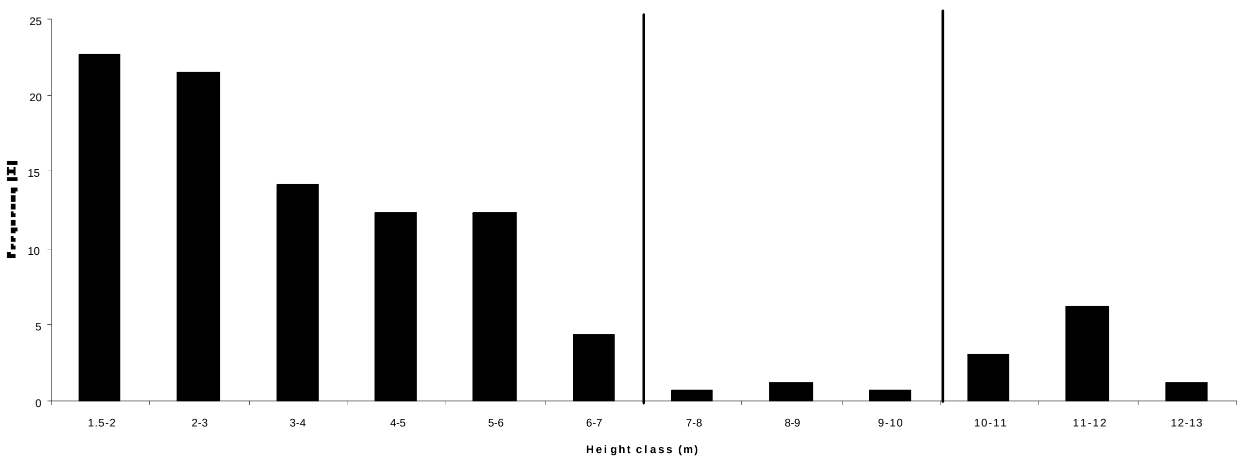


Graph DR.4 : frequency of basal area classes



Graph DR.5 : frequency of height classes

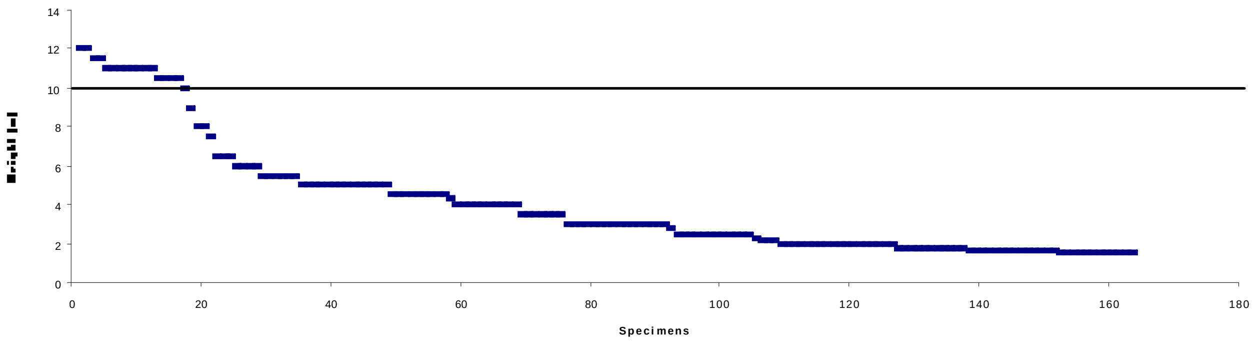
Vertical lines are significant cluster limits (Chrono constraint clustering, connexity 0.7, p =0.01)



Graph DR.6 : height distribution (by descending order)

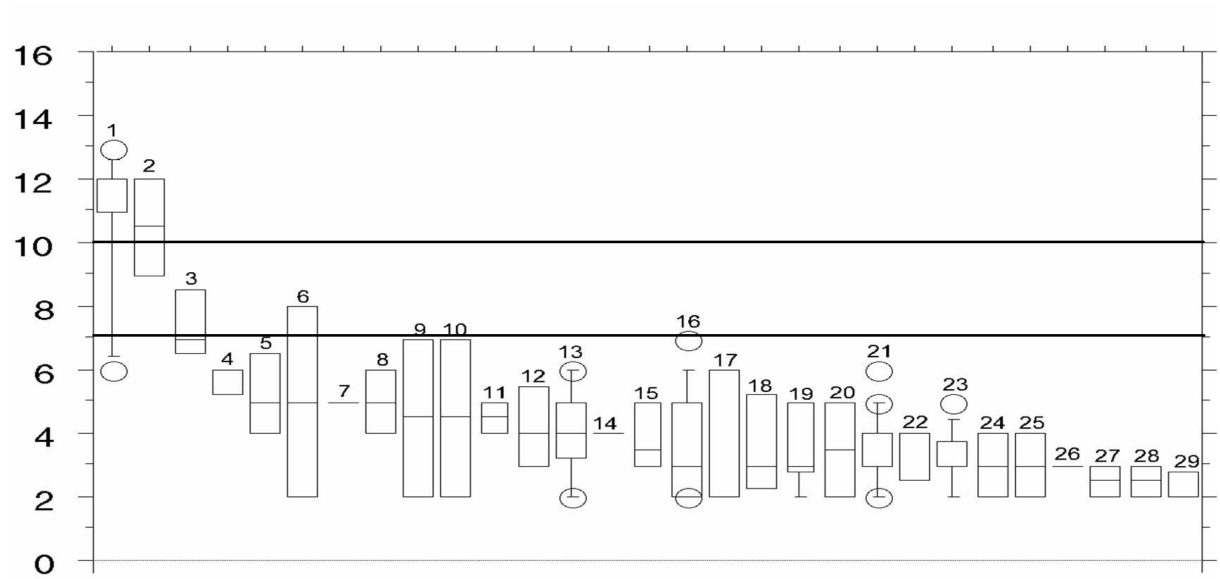
Horizontal lines are significant cluster limits

(Chrono constraint clustering, connexity = 0.7, p = 0.05)



Graph DR.7: Box plot analysis

Horizontal lines = significant cluster limits
(Chrono constraint clustering, connexity 0.7, p = 0.05)

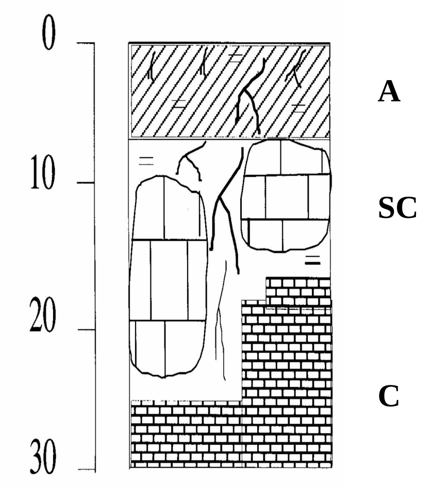


1: Lysiloma latisiliquum
2: Metopium brownei
3: Bursera simaruba
4: Jatropha gaumeri
5: Coccoloba spicata
6: Hintonia octomera
7: Hampea trilobata
8: Philodendron hederaceum
9: Pseudophoenix s. sargentii
10: Samyda yucatanensis
11: Neomillspaughia emarginata
12: Bunchosia swartziana
13: Croton chichenensis
14: Lasiacis divaricata
15: Sebastiania adenophora
16: Morinda royoc
17: Erythroxylum rotundifolium
18: Malpighia lundellii
19: Arrabidaea floribunda
20: Gymnopodium floribundum
21: Eugenia buxifolia
22: Sapranthus campechianus
23: Eugenia sp.
24: Dalechampia scandens
25: Serjania yucatanensis
26: Randia truncata
27: Echites yucatanensis
28: Serjania adiantoides
29: Corchorus siliquosus

General Values:

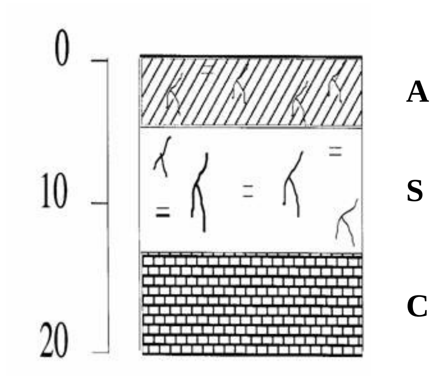
Total basal area (all specimens above 1.5 m high): **37.23 m2/ha**

Overall density (all specimens above 1.5 m high): **16’500 ind./ha**



Soil Mitchell No.18/1993

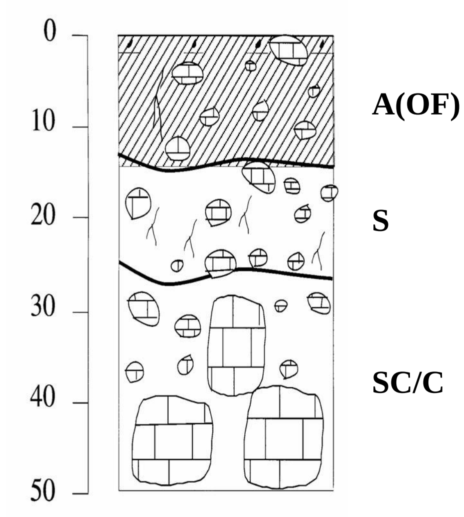
Vegetation:	semi-deciduous low forest with numerous *Lysiloma latisiliquum*, Thompson Trail, Shipstern N.R. **N.B: soil Bijleveld DR/1998 is identical**, except for large boulders that reach the surface.
Type of soil:	leptosol
Horizons:	
A:	organo-mineral horizon, very organic; extremely dry dry from March to May.
SC:	structural horizon, between large boulders very clayey, light brown
C:	karst limestone.



Soil Mitchell No.17/1993

Vegetation:	low temporarily inundated area with *Agave angustifolia*, Thompson Trail, Shipstern N.R.
Type of soil:	shallow cambisol ? Cryptogley?
Horizons:	
A:	organo-mineral horizon
S:	structural horizon
C:	bedrock: hard limestone (karst?)

G horizons expected, but not encountered.



Soil Mitchell No.16/1993

Vegetation:	semi-deciduous medium-sized forest, Thompson Trail, Shipstern N.R.
Type of soil:	Cambisol on karst limestone?
Horizons:	
A(OF):	organo-mineral horizon with patches of burried litter with fungi.
S:	structural horizon
C:	bedrock: karst limestone?

Fig. 12: Soils of semi-deciduous medium-sized/low forests and temporarily inundated areas with *Agave angustifolia*, Thompson Trail/New Trail, Shipstern N.R. (from Mitchell et al, 1993)

Soil	Horizon	Loss on ignition	Organic matter (%)	Organic C	Total N	C/N	pH(H2O)	pH(KCl)	Total CaCO3%	HUE	VALUE	CHROMA	COLOUR
16	A(OF)	2.85	1.63	10.73	0.66	16.33	7.66	7.17	31.29	10YR	3	2	very dark grey Br
16	S	2.22	1.27	11.02	0.27	41.52	7.74	7.49	70.89	7.5YR	5	3	Br

Soil	Horizon	Loss on ignition	Organic matter (%)	Organic C	Total N	C/N	pH(H2O)	pH(KCl)	Total CaCO3%	HUE	VALUE	CHROMA	COLOUR
17	A	4	2.28				7.39	6.43	0.12	2.5Y	5	2	grey Br
17	S	3	1.72				7.27	5.98	1.59	2.5Y	6	4	lig yel Br

Soil	Horizon	Loss on ignition	Organic matter (%)	Organic C	Total N	C/N	pH(H2O)	pH(KCl)	Total CaCO3%	HUE	VALUE	CHROMA	COLOUR
18	A			7.89	0.8		7.5	6.9	0	10YR	3	2	very dark grey Br
18	SC			2.41	0.3		7.7	6.6	0	10YR	5	4	yel Br

Fig. 12: (continued) tables of soil analyses

4 Discussion

4.1 General floristic and structural aspects.

4.1.1. Western Survey Line Plot 1

Before looking at the vertical structure of the vegetation of plot 1, a few elements of its topography should be discussed. Plot 1 is situated on a raised island roughly 30 m in diameter. The island itself is isolated within the mangal flat (see plot 2 for details on this pattern). WALDREN (1985) recognised two types of islands: the first similar to the one in plot 1, the other being a type of flat, stoney area slightly raised 10-20cm above the mangal flat. These flat islands were probably formed on outcrops of limestone coral where organic material could accumulate. According to WALDREN (1985), their vegetation is composed of *Laguncularia racemosa* (Combretaceae), with carpets of *Batis maritima* (Batidaceae): However, the species composition of these islands appears to vary greatly in relation to soil depth and elevation above the mangal flat.

The island of plot 1 is astonishly high compared to its diameter, and has a sunken middle, a characteristic also observed by WALDREN (op. cit.). It is approximately 4 metres in height at the highest point. The origin of these raised islands is unclear: they either result from a natural process, when a flat raised island slowly becomes an elevated one, or their origin is antropogenic. Human activity in the area can be traced back to the Mayan epoch, with as witnesses the numerous "sacbe" roads on the mangrove savannah, the raised terraces within the forest and the numerous house mounds and temples around Sarteneja. MITCHELL et al. (1993) while opening a soil profile (Mitchell No.10/1993) on a raised island on the eastern survey line, found numerous pottery remains, charcoal and tortoise eggshells between 90 and 150 cm. The probable origin is to be found in a combination of natural evolution and usage by Man.

No soil profiles were opened by the author while carrying out this study. However, soils of plot 1 are not expected to differ much from those described by MITCHELL et al. (see fig. 6, p. 29), as both islands support the same vegetation. The latter are discussed hereafter:

The soil on the summit of the island (Mitchell No. 10/1993) is very deep and composed of five horizons. The first is a semi-decomposed litter horizon (OF). The organo-mineral horizon (A) is deep (50 cm) and the gleyified horizon can be separated in two horizons: the first (Go_1) harbours more roots and is more compact than the second (Go_2). The latter, however, is much poorer in $CaCO_3$. The deepest horizon (CGr) is a calcareous parent material, in the form of a reduced gley. The two Go horizons with patches of oxydised gley indicate the maximum level reached by the water table during the wet season. At the time the profile was opened, the first 70cm of soil were absolutely dry. It is interesting to compare this soil with the soil profile Mitchell No.11/1993, located at the foot of the island, under

Bravaisia tubiflora: it is also composed of five horizons, but the top one (An) is organic with a large amount of silt and clay, while the second is a structural horizon (S). The water table is much closer to the surface during the rainy season (Go at - 20cm). The last soil profile (Mitchell No.12/1993) is found under the mangrove belt around the island. Organic material is present throughout the profile until the CGr horizon. The maximal depth of the water table is at 35 cm. This soil is water-saturated during most of the year.

The distribution and vertical organisation of the vegetation is related to the distribution of the soils which are themselves related to topography. The vertical diagram shows that mangroves on the flat parts of the plot eventually develop into a low forest. Since data of plot 1 have been analysed as one unit without taking into account the topography, the results obtained should be treated with caution: structural parameters, in fact, cover various vegetation patterns. This bias is demonstrated in graph 1.1: *Rhizophora mangle* has a low frequency within the plot because the low inundated part of the plot represent less than half the higher parts, whereas the species is actually dominant within the mangrove belt. Similarly, *Bravaisia tubiflora* appears to be frequent and abundant throughout the plot, while it is actually confined to the foot of the raised island. Sampling methods should probably have been adapted to topography to provide a correct account of structural parameters and species distribution. However, some elements of the latter can still be deducted from the horizontal diagrams:

- *Bravaisia tubiflora* is confined to the foot of the raised island, where it finds optimal growth conditions (possibly a combination of the availability sufficient nutrients and moisture).
- The structure of the vegetation is more complex on the lower parts of the island, since the largest trees (apart from the mangroves) grow along the lowest elevation line (see 2nd level, p. 22).
- The density of specimens is at its highest along the same topographic line.
- Overlapping of crowns tends to cease with elevation.
- The red mangroves (*Rhizophora mangle*) are better developed in the immediate vicinity of the island than on the flats, which is understandable because of the additional input of organic material and differences in soils (see plot 2 for details).

The high density and structure diversity along the first topographic line may, as in the case of *Bravaisia*, be explained by the fact that optimal growth conditions for several species are found there. Similarly, the less complex structure and crown distribution may be the result of the increasing dominancy of *Thrinax radiata*. The latter is, after from *Bravaisia tubiflora*, the most frequent species on the plot and contributes with 13% to the overall biomass (25% if *Laguncularia racemosa* isnot considred). However, if vegetation patterns were to be looked at separately, this percentage would be undoubtedly higher.

Graph 1.3 and 1.4 illustrate the impressive gap that exists between *Laguncularia racemosa* and the rest of the vegetation, with regard to basal areas. Since its trunk is broken and only some parts of the tree survive, it is not higher than other large trees of the plot (compare graph 1.4 and 1.5). This gap shows a discordance in the structure of the vegetation, the origin of which is to be found in its history, as in plot DR (see p.112). This tree is without doubt a survivor of the 1955 hurricane, and, consequently, the mangrove belt around this raised island can be expected to increase in height noticeably within the next decades, accompagnied by an increase in basal area.

Graph 1.5 is also biased by the presence of *Bravaisia tubiflora*. The only significant limit (Chrono constraint clustering, limit at 5m) is shown on the graph, and forms the canopy of the vegetation. The bias is corrected in graph 1.6 where *Bravaisia* is represented only by a line (which is not a significant cluster limit), and where the distribution of heights progresses regularly. This is also obvious in the box plot where the optima of species is distributed evenly between 2 and 5 m.

The general values are those to be treated with greatest care as they do not result from a single vegetation type. The density of the low forest on the elevated parts of the island is much lower (approx 5'500/ha) if *Bravaisia tubiflora* and the mangroves are excluded, while the large specimen of *Laguncularia* strongly biasses the basal area value if the plot is considered as a whole (N.B: in the case where the latter is omitted, a corrected total basal area of 20m^2/ha is obtained). The usefulness of giving such values per hectare for a pattern that rarely exceeds 1/4 of a hectare is questionable.

With regard to floristic composition, all species of plot 1 occur in other plots except for two species: an unindentified species of *Stemmadenia* (Apocynaceae) and *Capparis cynophallophora* (Capparidaceae). As in structural aspects, floristic elements need to be compared separately:

- the mangrove belt, although very different in structure, is floristically similar to plot 2. *Conocarpus erectus* was not sampled in the plot, but occurs elsewhere in the belt. The latter also contains the herbaceous species of plot 2, but in the outskirts only.
- *Bravaisia tubiflora* occurs as a species indicating transition from marsh to forest, forming a narrow belt. (see plot 5 for details).
- the forest growing on the raised island is similar to a community growing on stabilised dunes described by ESPEJEL (1986) in Sian Ka'an, Quintana Roo, Mexico. The community occurs on the highest dunes (up to 5m) 20 to 100m from the sea. However, only some floristic elements (the genus *Capparis* and the dominant *Thrinax radiata*) and the topography actually concur with plot 1. Furthermore, *Capparis cynophallophora* belongs to the low semi-deciduous forest, *Erythroxylum areolatum* to temporarily inundated low forests and most others to the semi-evergreen medium-sized forest type (Tellez & Sousa, 1982; Duran, 1985; Olmsted & Duran, 1990). This impedes a proper classification of the pattern. The topography-induced variation in soils is clearly important enough to allow species of various ecological backgrounds to establish. This blend of species has been observed by OLMSTED & DURAN (1983, 1990) in natural formations called "petenes", islands of vegetation located within coastal marshes and mangrove flats of the Yucatan Peninsula. According to these authors, the vegetation on these "islands" cannot really be considered as a distinct pattern, since the composition of species depends on ecological factors present within each "peten". Furthermore, the distance between these islands and other vegetation types may play a major role in the presence or absence of various species.

With regard to the above mentioned elements, the following description could well be retained: "low *Thrinax radiata*-dominated forest on small isolated islands rising above the discontinuous dwarf mangal".

Further studies are indispensable to understand the origin, the prevailing ecological factors, and the relationship between soils, height and vegetation patterns of all island types within the area.

Fig. 13: **Plot 1: a view into the *Thrinax radiata*-dominated forest on a small isolated island rising above the dwarf mangal.**

4.1.2 Western survey Line Plot 2

The vegetation pattern which includes plot no.2 is locally known as savannah, mangrove savannah or scrub mangrove. Some of these names may also refer to the belts of vegetation that form transitional patterns between the forest and the areas surrounding the lagoon (see Plot no 4). The composition of plot no.2 is dominated by species which are, in a limited sense, true mangroves, since they are restricted to intertidal communities. Thus, if the term mangrove is used to describe constituant species of a community, the word « mangal » can be used to describe the community itself, as proposed by MACNAE (1968, in: Tomlinson, 1986). Consequently, « mangal » describes a plant community that contains true mangroves , the latter being adapted to very precise ecological conditions such as tides or salinity levels. These true mangroves are, therefore, intrinsic elements of the community. Elements which are not mangroves s.s. but intermix in mangals of transitional areas are referred to as « mangal associates ».

Plot no.2 is part of a very large vegetation pattern dominating the open formations from the forested areas towards the Shipstern Lagoon (see also vegetation map p. 119). The dominant species is red mangrove (*Rhizophora mangle*, Rhizophoraceae), followed by species such as white mangrove (*Laguncularia racemosa*, Combretaceae), black mangrove (*Avicennia germinans*, Avicenniaceae), grasses and sedges. The largest specimens of red mangrove never exceed 2 metres in height, with an average of approx. one metre high. They are mostly grouped in patches, the largest specimens being in the centre. These patches of red mangroves are generally associated with slight depressions that sometimes harbour permanent pools of water during the dry season. Some organic material may also accumulate in these depressions. Most of this vegetation pattern is discontinuous, with large patches of ground being completely bare of vegetation. These patches sometimes bear mats of halophytic algae. The upper 3-5 cm of the soil tends to crack during the extremes of the dry season,but the moisture level rises again as one goes deeper, until the soil is saturated with water (at a depth of max. 30 cm). From August to November-December, the area of dwarf mangroves is inundated by 5-20 cm of water. The soil supporting this vegetation type is shown in fig. 7 (p. 34, Mitchell No. 13/1993): its structure is relatively simple, with a very thin organo-mineral horizon (1cm) followed by a relatively large oxydised gley horizon. The reduced gley is to be found at -35cm. Interestingly, the profile has been opened at the time when the water table was close to its lowest level. The structure below the bare flats is not really a soil, but rather a polyphasic substrate composed of layers of hard crusts, water-logged gravels, etc.

Although exceptions exist, there is a certain level of organisation within the pattern: for example, grass and sedge species such as *Distichlis spicata* var. *spicata* (Gramineae) and *Fimbristylis spadicea* (Cyperaceae) are always found growing under shrubs, mostly red and black mangroves. However, these species are not found in the centre of red mangrove patches, possibly because of a decrease in light level or a too long period of inundation. TOMLINSON (1986) considers these grasses and sedges to be mangal associates since they penetrate open mangals from adjacent fresh to saline wetlands. Consequently, they are not found in strict mangrove communities, but only occur in transitional areas. Further prospecting within the dwarf mangrove flats would be instrumental in discovering whether these herbaceous species disappear before the higher red mangrove formations close to the lagoon are reached.

Black and white mangroves are also common, but only in dwarf form. Their growth is obviously impeded by harsh ecological conditions, preventing an optimal development. Furthermore, these species develop best when growing within or at the edge of red mangrove patches (see for example: D001, D002 & D0012: *Avicennia germinans*): potential limiting factors for these species may thus be the low levels of edaphic nutrients and the fluctuation of moisture levels within the upper layers of the soil during the dry season, the latter impeding the establishment of propagules.

Species such as *Batis maritima* (Batidaceae) and *Salicornia perennis* (Chenopodiaceae) are sometimes found within this pattern, although they tend to be more common on the seeward side of the flats, i.e. towards Shipstern Lagoon.

In view of the above, the saline flat with dwarf mangroves of Shipstern Nature Reserve can be regarded as a true mangal, and have, consequently, not much in common with a tropical savannah. However, the reasons for their strange structure and spatial organisation are still not completely understood. Certain ecological factors must render this habitat somewhat marginal for the establishment of mangroves. The existence of bare ground devoid of mangroves proves that extremes are reached where no plant species is able to establish itself. This has been observed by other authors: SEMENIUK (1983) in his study on mangroves in Northern Australia found that in marginal habitats where levels of rainfall and run-off are low, extremes in ground water salinities provoked extensive salt flats devoid of mangroves. RICO-GRAY (1982), in his studies on the mangroves of the Northeastern Yucatan Peninsula, encountered the same dwarfism in red mangroves. According to him, the phenomenon is due to the high salinity and droughtess in the upper soil-layers during the dry season. Furthermore, the extreme temperatures (above 50°C) reached by the undeep waters covering these mangrove plains during the wet season possibly also play a major role in determining the growth potential of the vegetation. In the Everglades of Florida, large areas of patchy red mangroves combined with areas of bare ground are also common (see Olmsted in Tomlinson, 1986). The phenomenon is thus not limited to the Shipstern area.

Consequently, the main factors determining the presence of the saline flats with sparse mangroves include:

- edaphic factors: the area where this vegetation pattern occurs coincides with the Corozal Saline Swamp land system (see King et al., 1992), consisting of shallow and recent calcareous marl with mud, over Pleistocene limestones. The soils, when resting directly on old coral, are part of the Turneffe Suite - Shipstern Subsuite, which are mostly very undeep (less than 10 cm) and poorly horizonated. When deeper and more permanently inundated, these soils are classified within the gleys of the Ycacos Subsuite. Sometimes soils do not even develop (below bare flats), because droughtness (and possibly other factors within the texture of the substrate) creates hard crusts that impede the establishment of vegetation and consequently also pedogenesis .

- salinity: the coastal flats of the Shipstern area have been reported as highly saline by some authors (Hartshorn et al., 1984; Davis, 1943; Zisman in King et al., 1992). This high level of salinity is due to the fact that the area lacks large rivers that increase the input of freshwater in the system. This input is further limited by the low to very low rainfall. However, high salinity cannot be the only limiting factor since *Rhizophora mangle* is better developped than *Avicennia germinans*, the latter being a more salt tolerant species.

- evapotranspiration: the prolonged period of dryness combined with wind dessication results in unfavorable growth conditions during a large part of the year (January to July). This dryness has also direct consequences with regard to the accumulation of salt, and probably also on the salt excretion capacity of the mangroves species present: consequently growth conditions are certainly very close to the extremes tolerated by most species.

This list of factors is clearly not exhaustive. As a matter of fact, interrelationships within mangal ecosystems are so complex that it is extremely difficult to know which factors affect any of the elements of the ecosystem (see Tomlinson (1986) for examples). It would therefore be interesting to carry out a comparative study between the well-developped red mangrove communities along the lagoon and their dwarf counterparts on the flats, focussing primarily on environmental factors, together with a transect systematically investigating the relationship between mangal to back-mangal communities and the soils on which they rest.

To conclude, this vegetation pattern could be designated as a « discontinuous dwarf mangal interrupted by bare salt flats ».

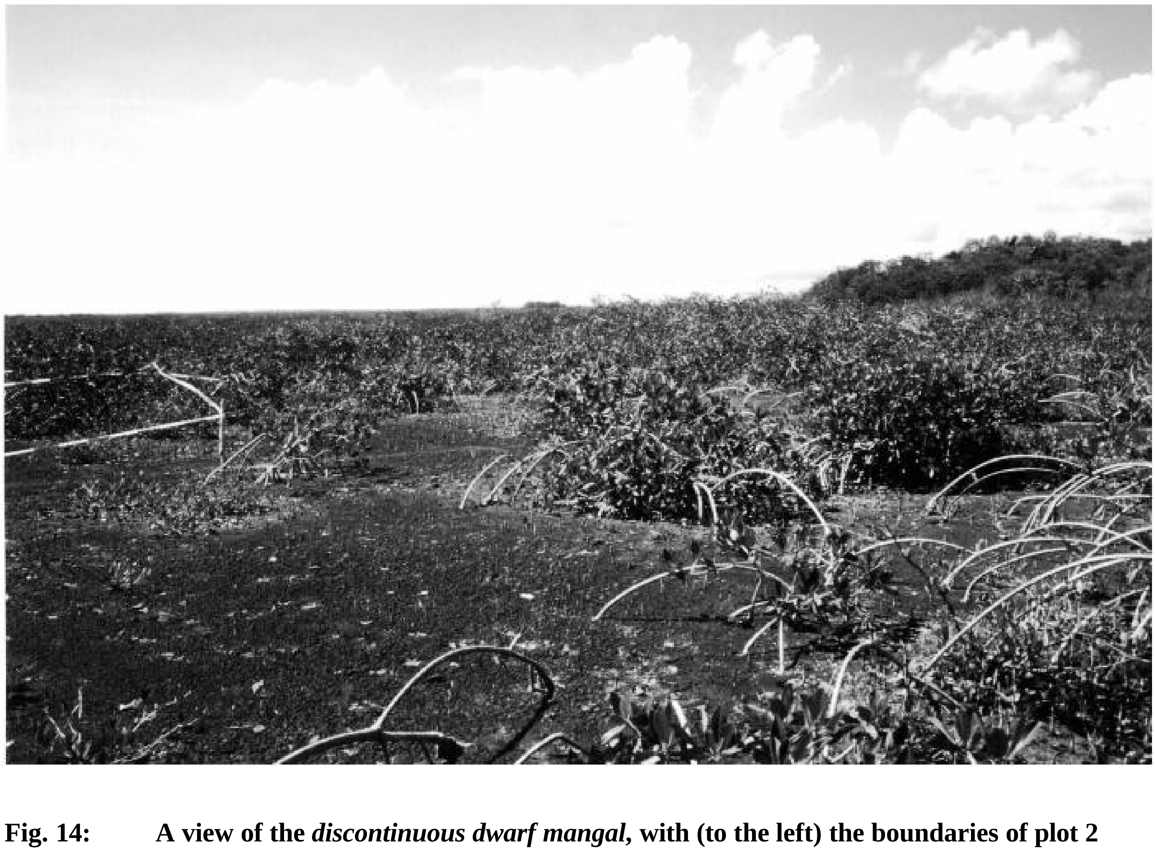


Fig. 14: A view of the *discontinuous dwarf mangal*, with (to the left) the boundaries of plot 2

4.1.3 Western Survey Line Plot 4

Plot no 4 is part of a vegetation pattern with a distinct location on the Western Survey Line. Prospections on the Eastern Survey Line, the Thompson Trail and the end of the Main Trail showed that its position in relation to other patterns does no vary, but the surface it covers does: it may be approx. 100 m wide (Eastern Survey Line) or close to absent (Main Trail), then recognisable only by the presence of a few specimens of typical species.

Unfortunately, the vegetation pattern which includes plot no. 4 is not the first transitional belt between the mangal flats as illustrated by plot no 2 and the forested areas. A small vegetation belt with a dominancy of *Distichlis spicata* var. *spicata* under red mangroves, with the rare occurrence of buttonwood (*Conocarpus erectus*, Combretaceae), was missed by the transect. This pattern is constantly present between the forest and the mangal flats, and varies in importance. It is included in the overall vegetation picture of Shipstern Nature Reserve (see part 4.2).

The vegetation of plot no.4 is dominated by the sedge *Cladium jamaicense* (Cyperaceae), which grows as much in closed patterns as in tussocks. According to GUNDERSON (1994, in: Rejmankova et al., 1996) this tussock growth formation depends on the mean annual level of the water table. Within plot 4, the first elevated elements appear as low outcrops of limestone. *Conocarpus erectus* is chiefly associated with these outcrops, possibly because this slight elevation (5-15 cm) separates it from the water table (and consequently also the high degree of salinity), and enables the species to establish itself. As a matter of fact, differences in relief as slight as 5 cm have been known to influence species composition (Tomlinson, 1986). Nevertheless, the accumulation of organic material is probably also an important factor inducing the establishment of this species. *Solanum blodgettii* (Solanaceae) is a common species in thishabitat as well, and seems to favour the same conditions as *Conocarpus erectus*. It is also found in good numbers around Sarteneja, where it occupies various disturbed mangrove habitats. *Fimbristylis spadicea* (Cyperaceae) is scattered over the plot, but does not seem to follow any particular distribution pattern. *Bravaisia tubiflora* (Acanthaceae), growing on a raised part of subplot A, belongs to another vegetation pattern. (see plot 5 for details)

The soil below areas where *Cladium jamaicense* occurs (Mitchell No.9/1993) is not very different from the soil of the mangal flats (see fig. 8, p.39). The first horizon (A, organo-mineral) is thicker, but only slightly so. The profile is shallower but the proportionally, the horizons and the minimum/maximum height of the water table is not really different. The edaphic factor that possibly varies and induces the occurrence of different species is, according to WALDREN (1985), probably salinity.

The occurrence of *Cladium jamaicense* as a transitional belt has been mentioned for the Biosphere Reserve of Sian Ka'an (Olmsted, Lopez Ornat & Duran Garcia, 1983**)**, where it grows

around isolated islands of vegetation. Height is low and scattered specimens of *Eleocharis* and *Sagittaria* occur. *Conocarpus erectus* is present as isolated shrubs.
Cladium jamaicense is a species reported to form pure stands, whilst its distribution depends much on water levels and duration of inundation. STEWART (1974) mentions that *C. jamaicense* is the dominant grass community in the Everglades. It is also abundant in Sian Ka'an. OLMSTED et al. (1980) found the species to be growing well on nutrient-limited soils, and consequently also on marls with very limited organic material. Cover, density and growth form seem to be directly related to edaphic factors, although they are not always related to each other. REJMANKOVA (1996) found that *C. jamaicense* is a species most apt to resist to prolonged periods of dessication. On the other hand, it does not tolerate high water, contrary to *Eleocharis* species.

Within Shipstern Nature Reserve, *C. jamaicense* occurs in another vegetation type next to the one discussed in this subchapter: a pattern found within the forest (see plot 11 for development), where *C. jamaicense* grows in association with the palm *Acoelorraphe whrightii*. In the latter case, it develops into large, robust plants, often reaching 2 metres in height, because the soil is peaty and saturated with fresh to slightly brackish water. This distribution corroborates with results obtained by REJMANKOVA (1996) in other areas of Northern Belize and Yucatan: *C. jamaicense* communities range from short, attenuate and sparse plants on soils consisting of marl with some peat and medium salinity to large and dense communities on peaty soils with fresh water. It is interesting to note that in both cases, varying ecological conditions determine growth forms, whereas a common one, i.e. height and periodicity of water table, determines the capacity for the species to establish itself.

With regard to the above, this vegetation type could be designated as a "*Cladium jamaicense*-dominated herbaceous wetland on marl of medium salinity", transitional to a "*Distichlis spicata*-dominated pre-mangal belt".

N.B: it should be mentioned here that in research dealing with the vegetation of Shipstern Nature Reserve, a certain degree of confusion existed in the identification of grasses and sedges. An in-depth study concentrating solely on the ecology, systematics and distribution of Cyperaceae, Gramineae and Juncaceae would greatly benefit their unclear status.

Fig. 15: **A view of the *Distichlis spicata - Rhizophora mangle* belt, between the dwarf mangal and the *Cladium jamaicense* herbaceous wetland.**

Fig. 16: **A view of the *Cladium jamaicense* (Cyperaceae) herbaceous wetland. The low shrubs are *Conocarpus erectus* (Combretaceae) and *Solanum blodgettii* (Solanaceae).**

4.1.4 Western Survey Line Plot 5

The problem in understanding the species composition of plot 5 is similar to the one encountered in the case of plot 1. This structure, however, is quite simple: plot 5 supports a low forest over a swampy organic soil, which only briefly dries out during the months of March to April. Vegetation is very dense, and emergent trees occasionally occur, but do not exceed 8 m in height.

A few interesting elements are detailed out by graph 5.1 and 5.2:

- Species with the highest density and frequency are also those contributing most to the overall biomass. This has not been observed in other plots.

- *Bravaisia tubiflora* is, as in plot 1, the species with the highest number of individuals. However, in plot 5 it is distributed over the entire area and is, consequently, a dominant species (see plot 1 for comparison). The horizontal diagrams show that this species tends to grow in areas where light is available sufficiently (compare densities in subplot B and in the upper half of subplot A with the rest of the plot).

- *Sabal* cf. *yapa*, among the most frequent species, is the largest biomass contributor. However, the large total basal area is only due to 2 individuals (C001 & D010).

Graph 5.3 shows the high density of specimens below 5m with a low basal area (below 50cm^2). The 3 specimens with high basal areas are *Metopium brownei* (1) and *Sabal* cf. *yapa* (2). This low basal area if most specimens is better represented by graph 5.4, where the disproportion between classes is obvious. This graph can be compared to graph 1.4 (plot 1), where the higher basal area classes are much better represented. Both plots support a low 5m high forest, but with different structures).

Graph 5.5 and 5.6 give an idea of height distribution. Two significant limits where defined by the Chrono constraint clustering: one at 2 metres and one at 6 metres. The first concurs with the upper limit of the dominant *Bravaisia tubiflora*, and the second can be regarded as the upper level of the vegetation. Graph 5.7 shows that most species find themselves within the 6 meter limit, except for two species with occasional emergents (*Eugenia* cf. *rhombea* and *Metopium brownei*).

The general values in this case are interesting: the total basal area for the plot is slightly higher than the corrected basal area of plot 1 (20m^2/ha - see plot 1 for details), but the density of specimens contributing to that basal area is more than 3 times as high. The vegetation is thus either young and not yet fully developed, or it is influenced by ecological factors limiting the growth of trees. The latter possibility is more plausible as a) the vegetation is found on soils that are water-saturated for most of the year and inundated at the peak of the rainy season and b) this vegetation type is always located between forest (s.l.) and the *Cladium jamaicense*-dominated herbaceous wetlands (see plot 4).

Floristically, plot 5 is somewhat related to the medium-sized semi-evergreen forest of plot 8. However, some species are found only in plot 5 (*Ouratea nitida*, cf *Vochysia guatemalensis*, cf. *Schoepfia obovata*), whereas some occur also in plot 11 (*Eugenia acapulcensis*, *Cameraria latifolia*, *Dalbergia glabra*) and are, therefore, related to inundated forests (see plot 11 for details). Its species composition is thus of mixed origin. Ecological conditions must be such that only those species (from either vegetation type) with some resistance to any environmental extreme (inundation, salinity and/or drought) can develop. Actually, the composition of species observed in plot 5 is quite similar to that of plot 1, in the sense that many ecological conditions prevail and allow species of various origin to establish themselves. OLMSTED & DURAN (1983) discuss the vegetation of forest islands ("petenes") in the Yucatan Peninsula (see plot 1 for details). In some cases, the vegetation is composed of a mixture of ecologically different species, but with *Bravaisia tubiflora* as the dominant species in the shrub layer: a situation similar to what has been found in plot 5. Unfortunately, soils were not studied within this vegetation type. However, they are expected to be similar to soil No.11/1993 (see fig. 6, p. 29), albeit possibly deeper.

Within Shipstern Nature Reserve, a transitional zone dominated by *Bravaisia tubiflora* is always present before the wetlands are reached. At the end of the Main Trail, this transitional zone is very similar to the one on plot 5, which is not surprising as they are approx. 500m away from each other. Another *Bravaisia tubiflora* transitional zone is situated at the end of the Thompson Trail, just after a large patch of semi-deciduous low forest (see plot DR for details about the latter). Interestingly, the vegetation higher than *Bravaisia tubiflora* contsists, in that zone of many large *Thrinax radiata* with a higher canopy than in plots. In fact, the general appearance is very similar to the interior of some forest islands of the mangrove flat (see also plot 1). The same *Bravaisia tubiflora* transitional zone with a high proportion of *Thrinax radiata* is also to be found at the end of the Eastern survey line, where it follows an extensive stand of black and red mangroves of medium height. (N.B: curiously, small isolated 1-2m high hillocks of coral limestone within this mangrove forest support stands *of Pseudophoenix s. sargentii* and *Coccothrinax argentata* mixed with other species of drier habitats. This again demonstrates the importance of elevation and edaphic factors in the distribution of vegetation types).

With regard to the above elements, it is proposed that this vegetation type be given a general name since species composition is variable, with *Bravaisia tubiflora* (when dominant), retained as a descriptor. The name proposed is thus:

"*Bravaisia tubiflora*-dominated zone, transitional to open wetlands".

The use of "open wetlands" is preferred to the use of more precise vegetation type names (see plot 4), since a) some vegetation types in successional patterns do not always occur (for ex. the *Cladium jamaicense* herbaceous wetland at the end of the Main Trail) and b) this transitional zone is sometimes found within forested areas bordering more permanent bodies of water (see plot 11).

Further studies may concentrate on the ecological micro-gradients occuring within these transitional zones, in order to better understand the distribution of species.

Fig. 17: **Plot 5 - Bravaisia tubiflora-dominated zone, transitional to open wetlands.**

4.1.5 Western Survey Line Plot 8

Soils:

Two soil profiles below plot 8 were briefly described during this study (see fig. 10, p.60): both are *Chromic Cambisols* (FAO/UNESCO). The soil of subplot B (Bijleveld No.8.1/1998) lies in an area where stones occasionally appear, whereas the one of subplot D (Bijleveld No. 8.2/1998) lies in a very slightly sunken area. Consequently, stones come close to the surface in the first case, whereas they hardly reach the half of the subsoil in the second case. In both cases, the subsoil or structural horizon is made of fairly compact red clays. The soil of subplot B possesses a second whitish litter-horizon (OF) which is composed of semi-decomposed litter with a high percentage of fungi. The bedrock is composed of a soft red chalk, which is less permeable than many other calcareaous substrates (C. Egger, pers.comm.).

Structural aspects:

The contribution of each species of plot 8 to the vertical structure of the forest is highlighted by graphs 8.1 and 8.2. Only three of the most frequent species participate to some degree in the overall biomass of the forest (*Coccoloba reflexiflora*, *Bursera simaruba* and *Hampea trilobata*), being canopy species. The others, although frequent, represent only 0.2 - 7% of the total basal area. Of the latter, at least one (*Brosimum alicastrum*) can, potentially, develop into large trees (Standley, 1936). Curiously, within Shipstern Nature Reserve, it has never been found to form a large canopy or as an emergent tree. The species may thus be impeded in its development by edaphic or climatic factors. The other frequent species with low contribution to the total basal area are mostly shrubs or small trees (Standley,1936; Standley et al., 1958-1976; see also Graph 8.7). Three species are distinctly dominant with regard to their biomass (*Manilkara zapota* by 20%, *Metopium brownei* by 12%, and *Sabal* cf. *yapa* by 10%), although their number of specimens is limited. *Callophyllum brasiliense* (Santa Maria) is a species that should undoubtedly be linked to the three previous ones, i.e. as an important biomass contributor, since it potentially develops into large canopy or emergent trees of commercial value. Since most valuable species have been taken out of the area in the early 1980's, it is probably not as frequent as it should be. The same remark is valid for *Swietenia macrophylla* (Mahogany) and *Cordia dodecandra* (Siricote).

Graph 8.3 gives an idea as to the distribution of basal areas in relation to height. If lower specimens, i.e. from 1.5 to 7 metres can be expected to have limited basal areas, it is interesting to note that most trees ranging from 8 to 12.5 metres have basal areas that do not exceed 125 cm^2. This is further highlighted by graph 8.4, where 70% of all basal areas are below 10 cm^2. Thereafter, the frequency of other basal area classes is declining rapidly.

Height distribution is illustrated by graph 8.5 and 6. The height distribution curve of graph 8.6 shows a sudden drop between 10 and 7 metres. This drop can also be seen in graph 8.5. A constraint clustering resulted in three significant limits (7m, 10m, 11m). The first cluster of specimens can be regarded as a shrub and small tree strata (1.5 - 7m), the second as a gap (the few specimens present do not connect to either of the other groups; 7 - 10m), the third as the canopy (10 -11m) and the last one as emergents. However significant the cluster limits may be, this interpretation should be considered with some care since: a) the amount of data available may not be sufficient and b) errors, even small, in the measurement of heights could bias the results significantly.

Graph 8.7 gives an idea of the height span of each species. For example, *Gymnanthes lucida* and *sabal* cf. *yapa* are evenly distributed from 3-9 metres, whereas some other species are confined either to the canopy (2, 3, 4, 5 and 7) or to the shrub layer (23-26), results that are in line with existent literature. Nevertheless, these results should be treated with some care due to the scarcity of data.

Height against basal area was tested again in the case of *Coccoloba reflexiflora and Croton reflexifolius* (two very common species in the Reserve), combining data from all plots (see graphs 8.8 and 8.9). In the case of *Coccoloba reflexiflora*, height increases together with the basal area, the species developing into large trees. Interestingly, the high specimens with low basal areas (PL8-B-023A and PL8-A-039A) occur in the forest of plot 8, whereas the small specimen (4.5m) with a fairly large basal area occurs in an open habitat (Plot 11, see that section). Competition and light availability undoubtedly play a major role in this difference in their development. In the case of *Croton reflexifolius*, height tends to stabilise while basal area increases, which means that the species is, at its optimum, a large shrub or a small tree. This is corroborated by Standley (1936; 1958-1976). Again, the largest specimens with a relatively low basal area are found in Plot 8, while the one with an important basal area (PL5-D-005) is found in a more open habitat.

Some interesting features can be observed in the horizontal and vertical diagrams: the crowns of several specimens, especially those within the first five metres, are located away from their trunk base (see A 901, A024, C001, C002, B002, etc.). Vectors from trunk-base to crowns are often placed on a N/NE to-S/SW line. This is particularly obvious on the vertical diagram, where North is to the left of the illustration. This characteristic is not surprising since violent winds mostly come from the North or the North-East (on the 23rd of April 1997, a fairly heavy northern wind blew in from Chetumal Bay and passed precisely over the reserve headquarters. It lasted for only two hours but the damage was impressive: thirteen trees 4-7m in height were knocked down on the reserve headquarters. On the following day, substantial damage was noticed on several plots. Especially plot DR suffered, where several

vines were destroyed by the storm.
The density (all specimens above 1.5 m) obtained for Plot 8 is 14'900 ind./ha. OLMSTED & DURAN (1990) obtained the following densities for a semi-evergreen medium-sized forest (see below) in the Biosphere Reserve of Sian Ka'an (all specimens equal or above DBH 2cm):

- mature forest: 1600 ind./ha
- young forest: 14'000 ind./ha

The forest on plot 8, if the same DBH class is considered, has a density of 9'200 ind./ha. This gives an indication on its degree of maturity, although many environmental factors, such as drought and soil depth, undoubtedly influence density.

The total basal area of all specimens above 1.5m combined is 34.97 m^2/ha. VALIENTE-BANUET (1984) obtained 38.75 m2 for a medium-sized semi-deciduous forest of the Tamaulipas region in Mexico. MEAVE DE CASTILLO (1983) obtained 41.45 m2/ha in a high evergreen forest of Chiapas. KELLY et.al (1988) obtained an average of 32 m2/ha in a Jamaican medium-sized forest over limestone (considering all trees > DBH 3cm). These data would indicate that the total basal area for the forest on plot 8 is on the low side, but this can be explained by the fact that the forest is still young and immature in structure. P.Walker (pers. comm) followed the evolution of some trees in the past decade, and observed that they were still growing at a high rate. Eventually, the canopy of this forest will reach a height of 20-25m.

Floristics:

The sampling of the forest on plot 8 produced 51 species, belonging to 42 genera in 27 families. Of the specimens collected, 4 proved to be completely unidentifiable (even at the family level), either because they were leafless when collecting took place or because of the absence of fertile material. One specimen was uncollectable, while of two only the genus could be identified, as there was no obvious similarity to the available herbarium material.

The survey of the immediate surroundings of plot 8 (see materials & methods) revealed 2 further species in the higher strata (> 10m): *Piscidia piscipula* (Papilionaceae) and *Ficus sp.* (Moraceae). Within the shrub and small tree layer, no additional species were encountered. Other plots with similar vegetation (nos. 9, 10, 13, 14 and 20) were checked with regard to their species composition. Due to lack of time, only specimens above DBH 10cm within a 5 metres radius from the plot centre, were identified. Species absent from plot 8 but occuring on these plots are: *Dendropanax sp.* (Araliaceae), *Swartzia cubensis* (Papilionaceae), *Lonchocarpus castilloi* (Papilionaceae) and *Swietenia macrophylla* (Meliaceae). In view of the limited sampling, it is not possible to say whether these additional species are missing in plot 8 as a result of sampling methods. As the forest on plot 14 and 20 is somewhat higher (canopy at 15 $^{+}$/- 1m), it can be expected that the soils of these two plots are deeper than the one of plot 8. This edaphic factor may affect both canopy height and the presence/absence of some species, but does not necessarily mean a change of vegetation type.

The 12 most common species on plot 8 (see also graphs 8.1 and 8.2) are:

- *Brosimum alicastrum* (Moraceae)
- *Pithecellobium stevensonii* (Mimosaceae)
- *Coccoloba schiedeana* (Polygonaceae)
- *Ouratea lucens* (Ochnaceae)
- *Hampea trilobata* (Malvaceae)
- *Coccoloba reflexiflora* (Polygonaceae)
- *Bursera simaruba* (Burseraceae)
- *Randia aculeata* (Rubiaceae)
- *Croton reflexifolius* (Euphorbiaceae)
- *Diospyros cuneata* (Ebenaceae)
- *Serjania yucatanensis* (Sapindaceae)
- *Laetia thamnia* (Flacourtiaceae)

The canopy (see graph 8.7) is mainly composed of *Metopium brownei* (Anacardiaceae), *Coccoloba reflexiflora*, *Bursera simaruba* and *Hampea trilobata. Manilkara zapota* is an emergent tree.Typical understory trees are *Randia aculeata*, *Croton reflexifolius*, *Pithecellobium stevensonii*, *Ouratea lucens* and *Bauhinia jenningsii.* These species are characteristic of this forest type and are frequently encountred in Shipstern Nature Reserve.

To correlate the association of species found on plot 8 to forest types cited in the available literature is somewhat problematic. The nomenclature of forest types is very confusing and authors have, over the years, often developed their own nomenclature. Unfortunately, these do not always correlate. The designation of forest associations can also vary from one country to another, e.g. between Mexico and Belize. Furthermore, nomenclature is based on either structure, climate or species composition, or a combination of these. To circumvent this difficulty, a comparison of plot 8 with the description of forest types by various authors is carried out hereafter.

The oldest available forest classification for Belize is the one given by STANLEY (1936), which was originally based on a classification by STEVENSON (in: Oliphant, N.J.: Forestry in British Honduras (1929), in: Stanley). The closest type cited is known as "intermediate forest", divided in three forest types one of which is "characterised by the frequent occurrence of *Sabal sp.*, *Achras* (=*Manilkara*) *zapota*, *Metopium brownei* and *Lucuma* *belizensis*". This characterization is, however, very general, since the species cited are widespread and occuring in many different types of forest.

On the vegetation map of Northern Belize (Wright,1959), the forests North of Shipstern Lagoon are all classified under pattern 1, designated as "deciduous seasonal forests, 50-70ft. (16-23m) high, on limestone, dominated by *Manilkara zapota-Swietenia macrophylla*, with abundant *Simarouba glauca*, *Lonchocarpus sp*., *Pithecellobium sp*., *Inga sp*., *Bursera simaruba*, *Vitex gaumeri*, *Coccoloba sp*., *Cupania sp*. and *Guettarda combsii*." According to STANLEY (1936), these forests are found on shallow red brown or black clays over chalk which has a marked indurated layer. They are furthermore associated to areas where rainfall is low (50-60 inches(1250-1500mm)/year), with a pronounced dry season with less than 2 inches (50mm) of monthly rainfall.

The classification of WRIGHT was revised by IREMONGER & BROKAW (1994), who completed data for many forest types. Pattern 1 in WRIGHT remained unchanged but for two elements:

- the denomination changed into " Lowland moist evergreen seasonal broadleaf forest over limestone: Northeastern variant, with a more Yucatecan element."
- Typical species cited are: *Alseis yucatanensis* (Rubiaceae), *Pouteria reticulata* (= *P. campechiana* in this case?), and *Vitex cuylenii* (= *V. gaumeri* in this case?) for the canopy, and the palms *Cryosophila argentea* (= *C. stauracantha*) and *Desmoncus sp.* (= *D. orthacanthos*) for the understory. Cited as typical Yucatecan elements in the northern extreme range of this forest type are: *Beaucarnea ameliae* (Noliniaceae), *Dracaena americana* (Dracaenaceae*)*, *Pseudophoenix sargentii* (Palmae) and *Yucca elephantipes* (Agavaceae).

This new definition deserves a few remarks:

- *Cryosophila stauracantha* is rare in the northern part of Shipstern Reserve. Two isolated specimens were found near plot 20. It is more common approx. 10 km to the South-West, near the Xo-Pol Ponds (the isolated 600 ha-parcel belonging to the reserve).
- *Beaucarnea ameliae* and *Pseudophoenix sargentii* are found in Shipstern Nature Reserve, but do not belong to this forest type. The forest type harbouring these species has been mapped by IREMONGER & BROKAW, and subsequently received the designation of "Lowland broadleaf moist semi-evergreen scrub forest". For some unexplained reason, the two species were not included (see plot DR for further details).
- *Dracaena americana* has so far never been found in the reserve. One specimen is known to have been collected between Chunox and Sarteneja (G. Davidse, 1987, Missouri BG). The species is mentioned for the high semi-evergreen forests of Quintana Roo, Mexico (Tellez & Sousa, 1982).

- *Yucca elephantipes* is planted as an ornamental in most villages because the flowers are used for local pastries. It is not mentioned as a wild species, neither for Northern Belize, nor for Quintana Roo.

The various forest types of Quintana Roo are described by MIRANDA (1963), TELLEZ & SOUSA (1982) with extensive species lists, and OLMSTED & DURAN (1990). The latter offers a good overall picture of the vegetation of the Biosphere Reserve of Sian Ka'an (Quintana Roo, Mexico) to which our area is closest.

Four forest types are defined:

- "Selva alta subperennifolia" or high semi-evergreen forest
- "Selva mediana subperennifolia" or medium-sized semi-evergreen forest
- "Selva mediana subcaducifolia" or medium-sized semi-deciduous forest
- "Selva baja caducifolia" or low deciduous forest

(N.B: semi-evergreen: 25-50% of the trees leafless during dry season (March to May);
semi-deciduous: 50-75% of the trees leafless during dry season;
deciduous: over 75% of the trees leafless during dry season).

The first two types are related to the Sapote-Mahogany forests of the northern and western parts of Belize, former British Honduras, as described by WRIGHT (1959). The latter's subtypes 1 and 1a designated as "16-23 m high deciduous seasonal forests on limestone" correspond to the mexican "selva mediana subperennifolia". The "selva alta subperennifolia" corresponds to Wright's series 2, i.e. the 23-33m high deciduous seasonal forests on limestone, to be found in Western Belize. near the border with Guatemala.

The differentiation of these forests on a floristic basis is more delicate, since dominant species are common to most of these forest types. Consequently, they are characterised by the presence or absence of various species with different physiological response to edaphic factors and/or rainfall. These forest types are very much intermingled in Quintana Roo, sometimes even in an area with no variation in rainfall (Olmsted & Duran, 1990). In such cases, the mosaic of vegetation patterns is mostly due to edaphic factors.

The most common species for the medium-sized semi-evergreen forests are *Vitex gaumeri, Bursera simaruba, Caesalpinia gaumeri, Gymnanthes lucida* and *Manilkara zapota*. Differential species for this association are: *Brosimum alicastrum, Talisia olivaeformis, Pouteria unilocularis* and *Nectandra coriacea*. All these species are found on plot 8, except *Talisia olivaeformis,* which was encountered outside the plot, and *Pouteria unilocularis,* which was not collected in Shipstern Reserve but could be present. Other species (present in or around plot 8) that distinguish the medium-sized semi-evergreen forest from the semi-deciduous one include: *Cedrela odorata, Dendropanax arboreus, Nectandra salicifolia, Pouteria campechiana, Protium copal, Quararibea funebris, Sabal yapa, Swartzia cubensis* and *Tetrapteris schiedeana*. TELLEZ & SOUSA (1982) encountered a total of 120 species of trees and shrubs within the medium-sized semi-evergreen forest. The average number of species found at each of their study sites was 42 species (min. 32 - max. 57). This is an indication that the area sampled in our case offers a fair picture of the forest species composition.

It can be conclude that this forest type may not so much be the northeastern variant of a "Lowland moist evergreen seasonal broadleaf forest over limestone, with a more Yucatecan element", as described by IREMONGER & BROKAW, but rather the southernmost distribution of a Yucatecan semi-evergreen seasonal forest.

Fig. 18: the medium sized semi evergreen forest of plot 8, with a ribbon indicating the boundary of the plot.

4.1.6 Western Survey Line Plot 11

The structure of the vegetation of plot 11 is heterogenous: some areas are quite open, allowing the existence of certain species (see below), whereas others are quite impenetrable, due to the growth forms of other species. The vertical diagram (p.61) illustrates this heterogeneity in structure well: to the left of the diagram (subplot A&B), the vegetation is composed of small to medium-sized trees, whereas the right side shows low shrubs and large herbaceous species.

The immediate surroundings of plot 11 deserve some description: the whole area in front of plot 11 (i.e. to the East) is a low marsh forest, gradually extending into an open wetland with large waterbodies. Soils are very dark and organic, and are saturated with water most of the year, except during the driest months. After heavy rains, the area is inundated. A few metres to the West of subplot A&D, the ground rises and a low forest (4-5m), structurally homogenous, appears. DBH of trees is low (2-5 cm), but density is high. Species of Myrtaceae dominate. To the left of subplots A&B (North), a few large specimens of Buttonwood (*Conocarpus erectus*) are found, to which PL-11-A901 is linked. A large patch of *Accoelorraphe wrightii* (Palmae) is found 5 metres East of subplot B and C. To the right side of subplot C&D, the vegetation develops into a discontinuous *Bravaisia tubiflora*-dominated transitional zone, leading to an open area with an almost permanent waterbody in its centre.

Soils have not been described for this plot, but marsh forests are reported to grow on marl soils (Gleyosols) with various degrees of organic matter (see expected soil profile, 3.1.6).

The entire height of the vegetation (i.e. 0-11m) of plot 11 was mapped to highlight the distribution of some species. However, analyses were carried out in the same way as in the other plots. Subplot A contains mostly trees and shrubs, whereas in open areas of the other subplots, species such as *Cladium jamaicense* (Cyperaceae) and *Bravaisia tubiflora* occur. The two species, although living close together, grow in distinct patches. *Rhynchospora floridensis* (Cyperaceae) occurs only close to the Myrtaceal forest to the West of the plot and does not seem to extend into the plot.

"Species frequency and density" against "basal area" result in the same graph: *Bravaisia tubiflora*, as in plot 1 and 5, is the species with the highest number of individuals, although it is not dominant in this case. Its contribution to the total basal area is, as in other plots, relatively low. The 4 species with high basal areas are all trees, except *Dalbergia glabra* ("Muc" in Yucatec Maya), which mostly grows as a trailing shrub. Height is distributed evenly up to 7 metres (significant Chrono constraint clustering limit), with occasional larger trees above that level. A significant limit also exists at 2m due to the high numbers of *Bravaisia tubiflora*. These limits have, however, not been included within the graphs. As a matter of fact, they are probably not representative for the plot as a whole, since the structure is not homogenous. General values show that the total basal area for the plot is low (10 m^2/

ha), which is not surprising considering the many shrub and herbaceous elements. Accordingly, density is low since the habitat is much more open that the surrounding forests. The interpretation of species composition is delicate, as the latter is directly related to the structure and general heterogeneity of the plot. The number of species on plot 11 is relatively low compared to other plots. However, several species were not, or only rarely, encountered elsewhere. These were:

- *Dalbergia glabra*	(Papilionaceae)	1 specimen on Pl.5
- *Haematoxylon campechianum*	(Caesalpiniaceae.)	
- *Accoelorraphe wrightii*	(Palmae)	
- *Cameraria latifolia*	(Apocynaceae)	1 specimen on Pl.5
- *Crescentia cujete*	(Bignoniaceae.)	

The main problem in interpreting plot 11 lies in the fact that the first three of these species are indicators of a recognised plant community, described in detail by OLMSTED & DURAN (1986). The latter carried out a in-depth research in the low periodically inundated forests of the biosphere reserve of Sian Ka'an in neighbouring Quintana Roo, Mexico. They divided these forests into five plant communities:

- Tasistal (Tasiste marsh)
  A palm marsh dominated by the palm *Accoelorraphe wrightii* (Tasiste), with *large Cladium jamaicense* (Cyperaceae), and shrub species as *Erythroxylum areolatum* and *Malpighia lundellii*. Soils below these marshes are reported to be marls with little organic material.

- Mucal (Muc marsh)
  A low, intricate forest or thicket dominated by *Dalbergia glabra* (Muc), with a maximum height of 5 m. Other species include *Cameraria latifolia* and *Malpighia lundellii*. Soils are marls mixed with organic material.

- Bucidal
  This community is dominated by *Bucida spinosa* (Combretaceae), a species never found in the other communities. Soil identical to the one under Mucal.

- Tintal (Tinta Marsh)
  A community dominated by *Haematoxylon campechianum* (Tinta, Caesalp.) and *Byrsonima bucidaefolia* (Malpigh.). Soils are organic.

- Pucteal
  A community dominated by *Bucida buceras* (Pucte, Combretaceae). Soils are also organic.

A gradient of elevation and duration of inundation follows the above sequence, the Tasistal

being close to permanently inundated and the Pucteal only occasionally so and never for long periods of time.
OLMSTED & DURAN (1986) report that very often, these five communities grow in a complicated mosaic. With regard to species composition, the Mucal, Tintal, Bucidal and Pucteal can be considered as being four distinct variants of the low periodically inundated forest, whereas the Tasistal is considered as an independant vegetation type. The four variants are determined by ecological factors such as periodicity of inundation and, to a lesser degree, soil types. OLMSTED & DURAN (1986) mention that in the area of the Bacalar Lagoon, in southern Quintana Roo, Mexico, the low periodically inundated forest consists of only two types: one with *Dalbergia glabra* and *Haematoxylon campechianum*, and the other with *Bucida buceras.* As this area is relatively close to the Shipstern Nature Reserve, the situation in the latter may very well be similar. With regard to the distribution of these variants within the Shipstern Nature Reserve, the following was observed:

- The Tasistal is often found on marl, together with species such as *Erythroxylum areolatum*, *Eugenia acapulcensis* and *Jacquinia aurantiaca*. However, the core area of these Tasistals is always composed of a pure stand of *Accoelorraphe wrightii*, with a higher proportion of organic material. Water is always close to the surface, even in the driest periods of the year. Almost pure stands of *A. wrightii* are also found within the forest, and one is crossed by the Western Survey Line (just before plot 19). Accompanying species are less numerous: occasional specimens of *Crescentia cujete* occur, and ground vegetation is mainly composed of sedges (Cyperaceae), *Borreria verticillata* (Rubiaceae) and *Eustoma exaltatum* (Gentianaceae). The latter species is typical for periodically inundated areas (S.Wohlhauser, pers. comm.). *Cladium jamaicense* is only present in those Tasistals located close to the areas transitional to mangrove communities or wetlands.

- Pure stands of *Dalbergia glabra* are rare along the Western survey line. The species is fairly common along the main road going through the reserve, where it grows in periodically inundated parts of the roadside. The Mucal variant may, however, be more common within unexplored parts of the low semi-deciduous forest. Further investigation is needed.

- *Bucida spinosa* has neither been reported nor collected in Shipstern Reserve as yet. It is not expected to occur, since it was not reported for the very southern part of Quintana Roo (see above).

- The Tintal variant is found along the Western Survey Line (between plot 10 and 11), wherein some very large specimens of *Haematoxylon campechianum* occur. However, the patch is small, with a diameter less than a 100m.

- One large specimen of *Bucida buceras* occurs on the Botanical Trail, not far from the Reserve Headquarters. However, the best stand of Pucteal is to be found around the Xo-

Pol Ponds, in the smaller satellite area of the Reserve.

The vegetation of plot 11 is thus a variant of the low periodically inundated forest composed of both *Dalbergia glabra* and *Haematoxylon campechianum* (as described for the southern regions of Quintana Roo). Some *Accoelorraphe wrightii* occur, as marginal elements of the Tasistal located close-by to the East of the plot. *Bravaisia tubiflora* can be considered either as a side-species of the Tintal, or, considering its high density to the South of the plot, as the appearing element of a *Bravaisia tubiflora*-dominated transitional zone (see plot 5).

Although three variants can be distinguished individually in the Shipstern Nature Reserve, the low periodically inundated forest is best considered as one unit, since its components are small areas composed into a complicated mosaic. The Tasistal, however, should be regarded as a separate type of vegetation..

Therefore, plot 11 is to be described as a "low periodically inundated forest", located close to a "Tasistal".

Fig. 19: the low temporarily inundated forest of plot 11.

Fig. 20: low temporarily inundated forest with, to the back, a palm grove (Tasistal) of *Accoelorraphe wrightii*.

4.1.7 New Trail Plot DR

Soils:

The soil under lying plot DR was briefly examined by the present author, and a soil under similar vegetation was described by Mitchell et al (1993, Mitchell No.18/1993, see fig. 12, p.85). In both profiles, rocks are abundant and become massive with depth. In soil No. DR/1998, large boulders reach the surface. The A horizon is in both cases very dark, organic, and clayey. Most roots are found within this layer, although some large ones reach the subsoil. The latter (SC), located between large boulders of limestone, is very clayey and light-brown. The bedrock is found at approx. 20cm and is made of karstic and porous limestone (C. Egger, pers. comm.). When opened on 27 January 1998, the soil was saturated with water, but is known to dry out completely between March and May. Both soils are similar to those described by TELLEZ & SOUSA (1982) under low semi-decidous forests (i.e. black, stoney, clayey, 10cm deep, water-saturated soils). They match the *Leptosols* (FAO/UNESCO) or *Rendolls* (USDA) of the *Remate Subsuite*, as described in KING ET AL. (1992).

Structural aspects:

The vertical distribution and presence of each species of plot DR is clearly different from that of plot 8, as seen in graphs DR.1 and 2. These differences in structure are also related to a very different species composition (see below). The biomass of the plot is dominated by one species, *Lysiloma latisiliquum* (Mimosaceae), which covers 74 % of the total basal area. This species has the highest number of individuals, but is not the most evenly distributed (frequ. = .75). Further observations within the same area showed that *Lysiloma latisiliquum* tends to grow in large patches. Thus, subplot DR-B contains no representatives of this species, while larger specimens of other species are present (see B011, B017 and B020 on the horizontal diagram (3rd level), the crowns of which form part of the canopy of the subplot).
Other tree species found on the plot include *Metopium brownei* and *Bursera simaruba*. The palm *Pseudophoenix s. sargentii* contributes to a certain degree to the overall biomass (3.8%) because it develops relatively thick trunks. However, it rarely exceeds 8 metres in height. The two tree species cited above are by far not as frequent and numerous as *Lysiloma latisiliquum*. Other frequent species in high numbers include *Eugenia buxifolia*, *Eugenia sp.* and *Croton chichenensis*. The latter are large bushes which may develop into small trees (Standley et al. 1958-1976).

Graph DR.3 shows the same characteristic, from another angle: all specimens above 10 metres, which contribute significantly to the total basal area, are *Lysiloma latisiliquum*, except for one *Metopium brownei* (PLDR-B-020) and one *Gliricidia sepium* (PLDR-B-011). Most other specimens have basal areas not exceeding 50 cm^2, with the exception of *Pseudophoenix*, as noted before.

Graph DR.4 shows the frequency of basal area classes. The difference between the bulk of specimens with basal areas below 10 cm^2 and the other classes is impressive. The same tendancy is to be found in plot 8, apart from the fact that Plot DR contains more specimens within the higher basal area classes (such as 160-320 cm^2).

Graph DR.5 and DR.6 are of particular interest: the decrease in the frequency of height classes seems to be regular up to the 9-10m class, followed by a sudden increase in specimens within the next classes. A gap is thus present between 7 and 10 metres, both limits being admitted by the Chrono constraint clustering. This gap shows itself in graph DR.6 by a very sudden drop in height distribution. As seen before, all trees of 10 metres or more in height (except B020) belong to Lysiloma latisiliquum. It would be tempting to interpretate this structure as being similar to that of Plot 8. However, the importance of the gap and the fact that the canopy is almost monospecific lead to other conclusions: a temptative explanation for this divergent structure is given at the end of the chapter.

Graph DR.7 shows the vertical distribution of the most common species. It is interesting to see that *Lysiloma latisiliquum* , although belonging mostly to the higher trees, is also present below the 7 metres limit, but there its frequency and numbers decreases drastically (only one specimen below 7m). Differences between the other species are less evident. Nevertheless, *Bursera simaruba* and *Metopium brownei* are species that seem to develop as canopy trees, whereas *Jatropha gaumeri*, *Coccoloba spicata* and *Samyda yucatanensis* may potentially do so.

The total basal area for this plot is 37.23 m^2/ha, with all specimens above 1.5m being taken into consideration. This result is very close to what VALIENTE-BANUET (1984) obtained for medium-sized to low subcaducifolious forests of Yucatan (38.75 m^2/ha).
The higher density of specimens in this plot compared to the density of plot 8 is not surprising since the vegetation is composed mostly of low trees and shrubs.

Floristics:

48 species were collected or identified on plot DR, of which 9 are also found on plot 8. Two specimens were identified only to the genus level. The survey of the immediate surroundings revealed further species such as *Sideroxylon persimile* (Sapotaceae), *Chamaedorea seifrizzi* (Palmae) and *Guettarda elliptica* (Rubiaceae).

Within plot DR, the 12 most frequent species are:

Croton chichenensis	(Euphorbiaceae)
Morinda royoc	(Rubiaceae)
Eugenia sp.	(Myrtaceae)
Lysiloma latisiliquum	(Mimosaceae)

Eugenia buxifolia	(Myrtaceae)
Bunchosia swartziana	(Malpighiaceae)
Malpighia lundellii	(Malpighiaceae)
Erythroxylum rotundifolium	(Erythroxylaceae)
Arrabidaea floribunda	(Bignonaceae)
Bursera simaruba	(Burseraceae)
Coccoloba spicata	(Polygonaceae)
Jatropha gaumeri	(Euphorbiaceae)

The linking of this vegetation pattern to a known forest type is less problematic than in the case of Plot 8. As a matter of fact, plot DR contains several species that are differential for the low semi-deciduous forest with *Pseudophoenix s. sargentii* as described by OLMSTED & DURAN (1990) and DURAN (1986). The latter carried out an extensive study of this type of forest in the Biosphere Reserve of Sian Ka'an , Quintana Roo, Mexico.
As seen before in the discussion of plot 8, the medium-sized to low semi-deciduous forests of Yucatan mainly differ from the medium-sized semi-evergreen forest by the absence of a certain number of species, the most important one being *Brosimum alicastrum*. However, the semi-deciduous forests harbour a few species that typify them. These are *Ceiba aesculifolia* (replaced further South by the much larger *Ceiba pentandra*) *Coccothrinax argentata* (=*C. readii*), *Diphysa carthagenensis*, *Erythroxylum rotundifolium*, *Gymnopodium floribundum*, *Hintonia octomera*, *Lysiloma latisiliquum* (when found in abundant numbers, fide OLMSTED& DURAN), *Neomillspaughia emarginata*, *Plumeria obtusa*, *Eugenia buxifolia* and other *Eugenia species*, *Randia truncata* and *Beaucarnea ameliae*. The first four species are not found in plot DR, but were collected in the immediate vicinity of the reserve headquarters . The other species are all present on Plot DR .

N.B: only 4 specimens of *Coccothrinax argentata* have been located so far, one of which was luckily located along the Botanical Trail of the reserve. This scarcity is probably due to the fact that Shipstern Nature Reserve is doubtlessly the southernmost extension of its distribution in the Yucatan Peninsula.

Pseudophoenix s. sargentii was first discovered in the reserve by MEERMAN (1993a). Before being properly identified, these palms were considered to be small specimens of *Roystonea oleracea*, a common palm in the wetter areas of Belize. However, the two species are very dissimilar, especially with regard to their crown shafts. *Pseudophoenix sargentii* has a very patchy distribution throughout the Yucatan Peninsula like, logically, the low semi-deciduous forest related to the species (see conclusion for details).

DURAN (1986), in studying this particular type of vegetation, discovered that the occurrence of the *Pseudophoenix*-forest is not determined by climatic factors since it is often found in a mosaic, mixed with either semi-deciduous or semi-evergreen forests. Consequently, its occurrence must be due to a conjunction of several factors: soils, influence of salt through the aquifer and by windspray, and/or wind. However, the *Pseudophoenix*-forest is always the second vegetation type going from sea to land, between mangrove communities and medium-sized forest, be it semideciduous or semi-evergreen.

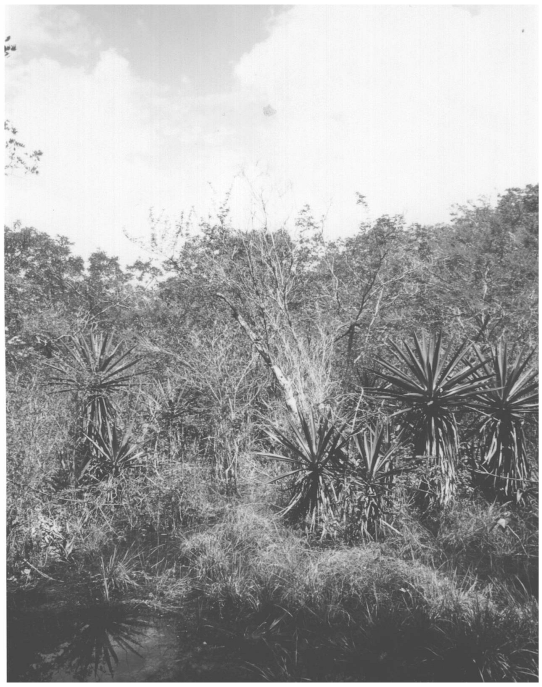


Fig. 21: Inundated clearing in the low semi-deciduous forest, with *Agave angustifolia* in the foreground.

With regard to species composition, the forest of plot DR is very similar to the forest described by DURAN, since 75 % of the species are common to both. Species found in plot DR that lack in Duran's list (*Samyda yucatanensis*, *Lonchocarpus yucatanensis*, *Platymiscium yucatanum*, *Coccoloba belizensis*, *Ternstroemia tepezapote*, *Randia truncata* among others) belong either to the semi-deciduous or the semi-evergreen medium-sized forests. Their presence in plot DR confirms the fact that these vegetation patterns are not well delimited and that in a given area, a mosaic of patterns is often encountered. The *Euphorbia sp.* mentioned by DURAN is very probably *E. schlechtendalii*.

Some species of plot DR are not cited in DURAN, possibly because of differences in sampling methods. *Agave angustifolia* (Agavaceae), a species mentioned for the low semi-deciduous forest by other authors (Olmsted & Duran, 1990; Tellez & Sousa, 1982). It is fairly common within Shipstern Nature Reserve and grows in open clearings throughout the *Pseudophoenix*-forest. Mitchell et al. (1993) described the soil under this vegetation type (see soil Mitchell No. 17/1993, fig. 12, p.85). The bedrock in this particular case is very hard and may not develop karst systems. Some gleyification was expected in this soil since the habitat is well inundated during the rainy season, but none was detected (Mitchell, pers. comm.).
Other species typical for these open areas are *Croton flavens* and *C. malvavisciifolius*.

Floristically, especially with regard to genera, the medium-sized and low semi-deciduous forests of this part of Yucatan belong to the tropical dry forests (fide Gentry, 1995). However, they are not so much induced by climatic factors as by edaphic factors. Climatically induced dry forests occur in the Northern part of the Yucatan Penisula (Thien et al., 1982) and are, with regard to floristics and structure, quite similar to those of Quintana Roo and northern Belize. The occurence of dry forests due to edaphic factors has been observed in various parts of the american tropics, in Yucatan, Puerto Rico, Jamaica, Trinidad etc. (see Murphy & Lugo (1995) for a review, Richards (1952) for examples).

In the case of plot DR, two more questions remain with regard to its forest: - why is the canopy mono-specific? And -why is there such a large gap between the said canopy and the vegetation below?

The answer to the first question undoubtedly lies in the history of the vegetation. Hurricane Janet (1955, see introduction) completely flattened the forests North of Shipstern Lagoon, whereas the fires that followed destroyed any remaining vegetation. It is not difficult, then, to imagine the harsh ecological conditions that must have prevailed thereafter: open burnt-out areas exposed to a very high degree of solar radiation, creating conditions undoubtedly too extreme and thus unsuitable for the seedlings of most species. *Lysiloma latisiliquum* may have been, at the time, the first species able to colonise these over-disturbed habitats. After some time, other species must have taken advantage of the shade provided by the newly established *Lysiloma* trees, and slowly the old vegetation pattern has been building up again.

This brings an answer to the second question: if the *Lysiloma*-dominated canopy is considered as being the first element of two or more successional vegetation patterns, then the "climax" would encompass all species found below the 7m limit. (N.B: the term "climax" is used here with some care since these forest may never have sufficient time to develop into a proper climax, due to the repeated occurrence of hurricanes). The hypothesis above is plausible, since:

a) all *Lysiloma* trees in the canopy are approximately of the same age
b) height hierarchy is developing between the species found below 7m
c) *Lysiloma latisiliquum* is still present below 7 m but not as a dominant species.

However, this *Lysiloma*-dominated forest is, as a vegetation pattern, not different from the low semi-deciduous *Pseudophoenix*-forest described by Duran (1986). It may nevertheless be considered as a structural variant resulting from destruction by hurricanes, expected to disappear within a few decades and to be replaced by the *Pseudophoenix*-low semi-deciduous forest.

In conclusion, some information about the distribution of the semi-deciduous medium-sized and low forests should be given. Black and white photographs of the area taken in March 1988 by the Royal Air Force show a conspicuous patch of vegetation which much differs from the forest where plot 8 is located (see map p.119). Within this patch, however, it is difficult to differenciate elements since these are numerous and create a complicated mosaic.

Field observations by the author show that the following elements occur within the patch:

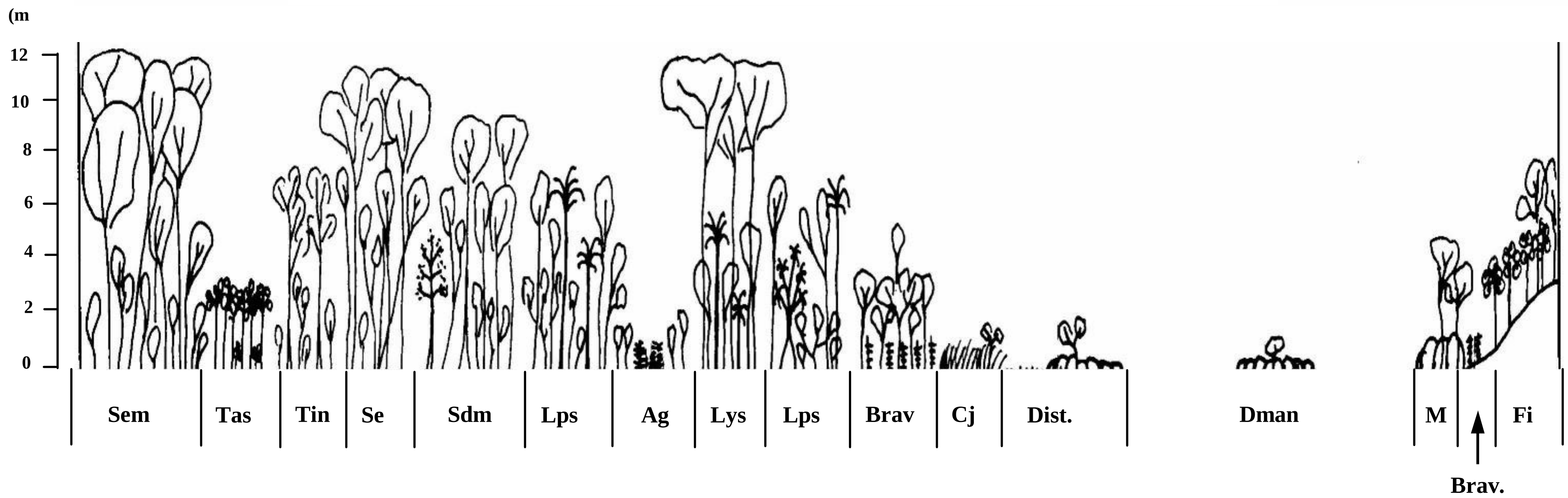
- low semi-deciduous *Pseudophoenix*-forest (canopy range: 6-10m)
- Lysiloma-dominated *Pseudophoenix*-forest (canopy at 10-13m, monospecific)
- temporarily inundated areas with *Eugenia* species and *Hyperbaena winzerlingii* (canopy 4-7m)
- temporarily inundated open areas with *Agave angustifolia* and *Croton malvaviscifolius*
- temporarily inundated semi-open areas with *Jacquinia aurantiaca*, *Eugenia acapulcensis* and *Erythroxylum areolatum*
- *Acoelorraphe wrightii* marshes (canopy 3-4m, see plot 11 for details)
- Medium-sized semi-deciduous forests (canopy 10-13m).

The first two vegetation types are being found mostly along the New Trail, the next four along the Thompson Trail and the last one around the Reserve's headquarters. Very large specimens of *Beaucarnea ameliae* can be found near the end of Thompson Trail (see below).

Fig. 22: Low semi-deciduous forest dominated by *Lysiloma latisiliquum* (Mimosaceae)

Fig. 23: A large specimen of *Beaucarnea ameliae* (Nolinaceae)

4.2 Vegetation distribution in relation to environmental factors



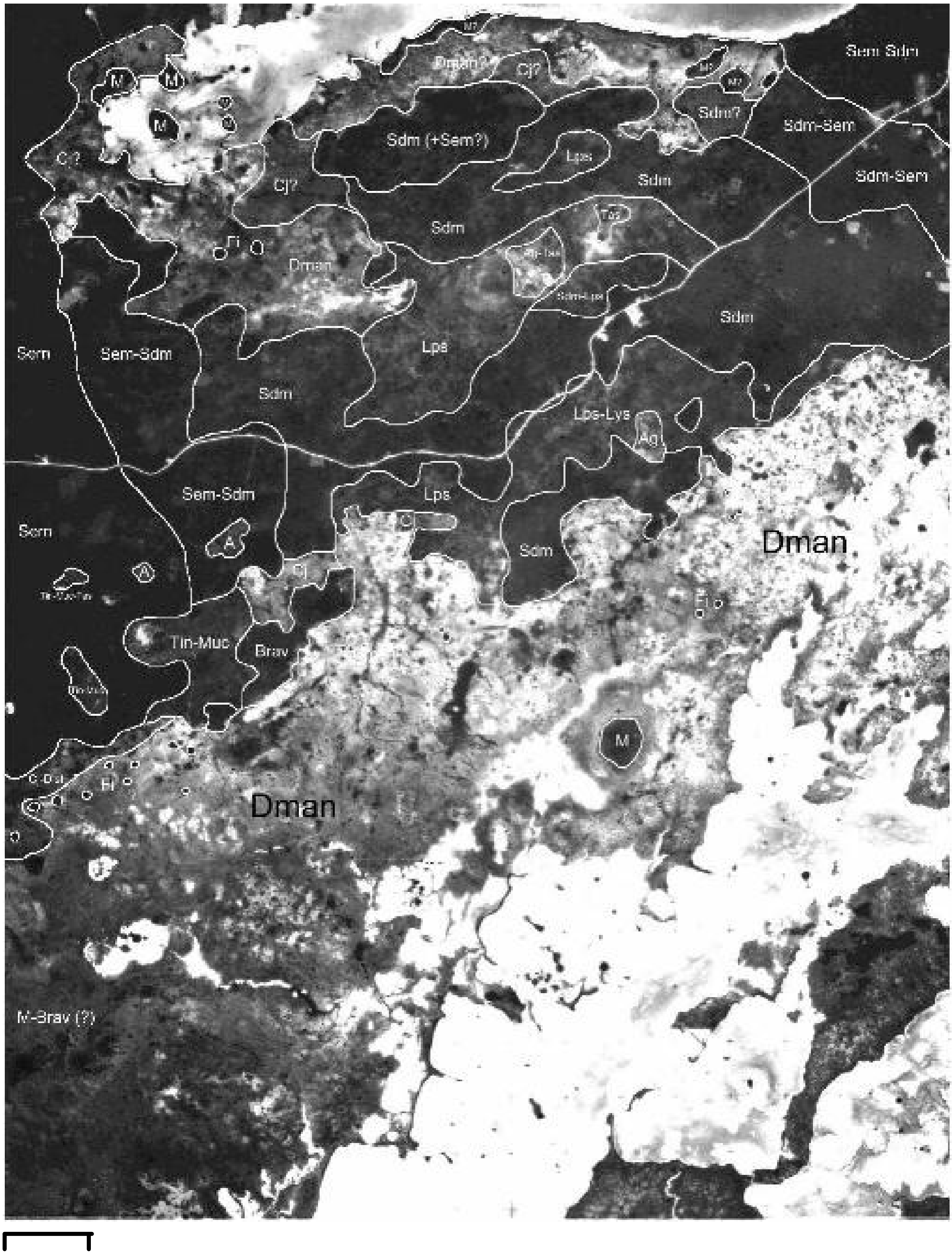
Legends to diagram and map (4.3)

Sem: semi-evergreen medium-sized forest
Tas: Tasistal
Tin: Tintal (Mucal is not represented)
Sdm: semi-deciduous medium-sized forest
Lps: low *Pseudophoenix*-forest
Ag: *Agave angustifolia*-clearing
Lys: Lysiloma-dominated low s.-d. forest
Brav: *Bravaisia*-dominated zone
Cj: *Cladium jamaicense* herb.wetland
Dist: *Distichlis-Rhizophora* belt
Dman: discontinuous dwarf mangal
M: Mangroves
Fi: forested island
A: agriculture

	Sem	Tas	Tin	Sdm	Lps	Aga	Lys	Brav	Cj	Dist	Dman	M	Fi
Soil(s)	chromic cambisols	gleysols	gleysols (organic?)	Cambisols?	Leptosols	Cambisols (gleyified?)	Leptosols	gleysols histosols?	gleysols	gleysols	gleysols or polyphasic substrate	Gleysols	Histosols/ gleysols
Parent material	Fe-rich chalks	limestone	limestone	karstic limestone	very karstic limestone	hard limestone?	very karstic limestone	quaternary deposits?	quaternary deposits?	quaternary deposits?	quaternary deposits?	quaternary deposits?	fragmented limestone
Hydrous conditions in soil during dry season	?	saturated	moist	?	very dry	dry	very dry	moist	moist-saturated	saturated	saturated	saturated	very dry topsoil)
rainy season	?	+15 to 20cm	0 to +10cm	?	saturated	+5 to 10cm	saturated	saturated	0 to +5cm	+5 to 10cm	+10 to 30cm	+15 to 20cm	moist-saturated
Approx. elevation above sea level	1-2m	0-0.7m(?)	0.5-1m(?)	1-2m	0.7-1m	0-0.7m(?)	0.7-1m	0.3-0.7m	0.3-0.5m	~0.3m	~0.2m	~0.2m	2-4m
Salinity in profile	none	low?	low?	none	low	low	low?	low-medium	medium	medium-high	high	high	low-none (top) medium (bottom)

4.3 Vegetation Map of Shipstern Nature Reserve

N.B: Abbreviations refer to the legends of the distribution diagram (4.2). An abbreviation followed by a question mark means that a vegetation type was not identified in the field, but is expected to occur.



1 km

5. Conclusion

The present study aims at a better understanding of the vegetation of Shipstern Nature Reserve. Some elements of its flora, unique for Belize, were previously described by MEERMAN (1993b), but the clarification of the exact extent and nature of vegetation types within the reserve was never attempted. In the past, the terminology used remained relatively vague, although the Yucatecan characteristics of the vegetation had been, to some degree, recognised.
Although further research is needed, the relationship between edaphic factors and vegetation was defined for most vegetation types. Because the destruction caused by hurricane Janet (1955) was almost total, the vegetation of Shipstern Nature Reserve can be considered to be 43 years old. Most vegetation types are still developing, and have not yet reached a structural climax. In one case, a very obvious successional process has been identified.

The vegetation types listed hereafter were identified and described during the course of this study. The nomenclature used was translated and/or adapted from OLMSTED AND DURAN (1990), which in turn originally based on MIRANDA (1963). It is used by many authors working on the vegetation of the Yucatan Peninsula, to the North of Belize. This nomenclature is more or less similar to the one used by WRIGHT et al. (1959), as it uses the same structural and phenological parameters.

Yucatecan medium-sized semi-evergreen forest (map legend: Sem)

This forest type is found close to the western border of Shipstern Nature Reserve and in the Xo-Pol area to the West which also belongs to the Reserve. It corresponds to type 1 in Wright (1959), albeit showing signs of transitioning due to the progressive decrease in palm species. This type of forest once extended over the whole of the Corozal district, but since the extension of sugar cane fields, it is now confined to the northeastern part of Corozal District. With the increase in agricultural activities and large scale logging, the future of this forest type in Belize is very much put to the question. Shipstern Nature Reserve is the only area in Belize protecting this forest type, but the extent within its boundaries is limited (see map p.119). The establishment of Freshwater Creek Forest Reserve (to the Southwest of Shipstern N.R.) as an effectively protected area would ensure the protection of some more of this forest type.

Yucatecan medium-sized semi-deciduous forest: (map legend: Sdm)

This forest type has, as yet, only been described in and around the Shipstern Nature Reserve. It may have existed to the North of Belize, near the border with Mexico, but as virtually all forests have been cleared in that area, this is difficult to ascertain. Patches probably occur along the coast between Sarteneja and Chunox, but these have not been located as yet.
Tracks of this forest type exist within the reserve, but on a whole, its extent is very limited. Areas including this vegetation type to the North and the East of the reserve, definitely deserve more protection.

Low semi-deciduous Pseudophoenix s. sargentii-forest (map legend: Lps & Lys)

This forest type is found only in and near Shipstern Nature Reserve and is therefore absolutely unique for mainland Belize. The area covered is very limited and nearly half of it is, luckily, found within the boundaries of Shipstern Nature Reserve. This forest type is also found in the Bacalar Chico National Park and Marine Reserve (A. Samos, pers. com.) on Ambergris Caye 30 km to the East, but here its extent is unknown. The *Pseudophoenix*-forest appears therefore to be very rare in Belize. Additionally it has a patchy distribution on the Yucatan Peninsula. Apart from Shipstern NR and Bacalar Chico, it is found near Tulum (the largest area), within the Sian Ka'an Biosphere Reserve, near Cancun and, finally, as a small patch near Merida. All these areas with *Pseudophoenix*-forests are relatively small, with the exception of the Tulum area.
Without doubt, quite a few of the species collected in the *Pseudophoenix*-forest will be first mentions for Belize. This is not surprising in view of the absence of previous collecting in the area and the very limited extent of this forest type.
With regard to future conservation efforts in the area, the low deciduous forest North of Shipstern Nature Reserve deserve the highest conservation priority. As a matter of fact the population of many plant species are extremely small and may not be any longer viable if encroachment upon this forest type occurs.

Low periodically inundated forests (Map legend: Tin, Muc & Tas)

This vegetation type can be divided in 3 interrelated types: Mucal (dominated by *Dalbergia glabra*, Papilionaceae), Tintal (dominated by *Haematoxylon campechianum*, Caesalpiniaceae) and Pucteal (dominated by *Bucida buceras*, Combretaceae). These subtypes grow, however, in a complicated mosaic and are rarely well-defined. Their presence is related to edaphic factors, among which the level of the water table plays a dominant role.

In addition, Tasistals (*Accoelorraphe wrightii* palm-groves) also constitue a distinct type of marsh forest, always well delimited within the reserve. However, their generally small size impedes a proper localisation on aerial and satellite photographs.

***Cladium jamaicense*-dominated herbaceous wetlands** (map legend: Cj)

This belt of vegetation occurs between forested areas and mangal flats, but its importance varies. Between this herbaceous wetland and the mangal flats a *Distichlis spicata-Rhizophora mangle* belt exists in most places.

Discontinuous dwarf mangal interrupted by bare salt flats (map legend: Dman)

This extensive vegetation type is dominant within the Shipstern Nature Reserve. It is dotted with small forested islands, where ecological gradients allow the establishment of various vegetation types, from mangroves to dry-forest related vegetation. These mangal flats are present around Shipstern Lagoon and along the coast below the Shipstern Nature Reserve.

The present study has shown that Shipstern Nature Reserve harbours at least three vegetation types worthy and in need of protection. The medium-sized semi-evergreen forest is confined to northern Belize, and the last reasonably large tracks are found in the northeastern corner of the Corozal District, in and around Shipstern Nature Reserve. The medium-sized semi-deciduous forest is probably very rare in Belize, if it occurs at all outside the reserve. The low semi-deciduous *Pseudophoenix*-forest is absolutely unique for mainland Belize. Further studies are needed to determine whether the fauna shows a similar degree of uniqueness.

The intrinsic conservation value of the Shipstern Nature Reserve is, in the context of habitat conservation in Belize, very high. The reserve contributes to the protection of the *Pseudophoenix sargentii*-forest, which is uncommon to rare on the Yucatan Peninsula. It is hoped for that all those involved in the conservation of nature in Belize, from Ngo's to Government Ministries, will undertake and support all efforts to conserve this unique natural environment.

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8. checklist of the flora of Shipstern Nature Reserve

NB: species marked with an * are mentioned by Meerman (1993b), but have not been collected nor identified for the reserve by the author. The nomenclature used by Meerman was updated.

ACANTHACEAE

**Aphelandra sp.*
**Blechum brownei* Juss
Bravaisia tubiflora Hemsl.
**Ruellia malacosperma* Greenm.
**Ruellia nudiflora* (Engelm. & A. Gray) Urb.

ANACARDIACEAE

Metopium brownei (Jacq.) Urb.
Spondias mombin L.
**Spondias purpurea* L.

ANNONACEAE

**Guatteria amplifolia* Triana & Planch.
Sapranthus cf. *campechianus* (Kunth) Standl.
**Xylopia frutescens* Aubl.

APOCYNACEAE

Cameraria latifolia L.
Echites yucatanensis Millsp. ex Standl.
**Lacmellea edulis* Kartsen
Plumeria obtusa L.
**Prestonia mexicana* A. DC.
Rhabdadenia biflora (Jacq.) Müll.-Arg.
Tabernaemontana chrysocarpa Blake
Thevetia gaumeri Hensl.
Urechites andrieuxii Muell.-Arg

ARACEAE

Philodendron hederaceum (Jacq.) Schott

ARALIACEAE

Dendropanax sp.

ARISTOLOCHIACEAE

**Aristolochia maxima* Jacq.
**Aristolochia pilosa* Kunth

ASCLEPIADACEAE

**Asclepias curassavica* L.

BATACEAE

**Batis maritima* L.

BIGNONIACEAE

Arrabidaea floribunda (Kunth) Loes.
Arrabidaea japurensis (DC) Bureau & Schum.
**Arrabidaea lundellii Standl.*
Ceratophytum tetragonolobum (Sarg) Sprag & Sandw.
Clytostoma mayanum Standl.
Crescentia cujete L.
Cydista diversifolia HBK
Macfadyena unguis-cati (L.) A.-H. Gentry
Pleonotoma diversifolium (Humb., Bonpl. & Kunth) Bureau & K. Schum
Tabebuia chrysantha (Jacqu.) G. Nicholson

BOMBACACEAE

**Bombax ellipticum* Kunth
Ceiba aesculifolia (Kunth) Btirtten & Baker f.
Quararibea funebris (La Llave) Vicher

BORAGINACEAE

Cordia dodecandra DC
**Cordia sebestena* L.

BROMELIACEAE

**Aechmea sp.*
**Aechmea magdalenae* (André) André ex Baker

BURSERACEAE

Bursera simaruba (L.) Sarg.
Protium copal (Schltr. & Cham.) Engl.

CACTACEAE

**Cereus pentagonus* (L.) Haw.
Selenicereus sp.

CAESALPINIACEAE

Bauhinia divarica L.
**Bauhinia glabra* Jacq.
Bauhinia jenningsii P. Wilson
Caesalpinia gaumeri Greenm.
**Cassia emarginata* L.
**Cassia leiophylla* Vogel
**Cassia undulata* Benth.
**Cassia occidentalis* L.
**Cassia stenocarpa* Vogel
**Cassia petensis* (Britton & Rose) Standl.
Haematoxylon campechianum L.

CELASTRACEAE

Elaedendron xylocarpum (Vent.) DC
Rhacoma gaumeri (Loes.) Standl.
Wimmeria bartlettii Lundell

CHENOPODIACEAE

Salicornia perennis Mill.

CHRYSOBALANACEAE

**Chrysobalanus icaco* L.

CLUSIACEAE

**Clusia sp.*

COMBRETACEAE

Bucida buceras L.
Conocarpus erecta L.
Conocarpus erecta var sericea DC

COMMELINACEAE

**Callisia repens* (Jacq.) L.
**Rhoeo discolor* (L'Hér.) Hance ex Walp.

COMPOSITAE

**Bidens pilosa* L.
**Bidens squarrosa* Kunth
Eupatorium albicante Sh. Bip.
**Mikania cordifolia* (L.f) Willd.
Tuberostylis rhizophorae Steetz.

CONVOLVULACEAE

Evonimus linifolius L.
**Ipomoea alba* L.
**Ipomoea sinuata* Ortega
**Ipomoea violacea* L.
**Quamoclit coccinea* (L.) Moench
Merremia cf. *cissoides* (Lam.) Hallier f.

CYPERACEAE

Cladium jamaicensis Crantz
**Eleocharis geniculata* (L.) Roem. & Schult.
Fimbristylis spadicea (L.) Vahl
Rhynchospora floridensis Griseb.

DIOSCOREACEAE

Dioscorea sp.

EBENACEAE

Diospyros cf. *cuneata* Standl.
Diospyros cf. *verae-crucis* Standl.

ERYTHROXYLACEAE

Erythroxylum aff. *areolatum* L.
Erythroxylum rotundifolium Lunan

EUPHORBIACEAE

**Chamaesyce prostrata* (Aiton) Small
Croton chichenensis Lundell
Croton flavens L.
Croton malvavisciifolius Millsp.
Croton reflexifolius Kunth.
Dalechampia scandens L.
Euphorbia schlechtendalii Boiss.
Gymnanthes lucida Sw.
Jathropha gaumeri Greenm.
Jathropha urens L.
Pedilanthus deamii Millsp.
**Plukenetia angustifolia* Standl.
**Poinsettia cyathophora* (Murray) Klotzsch & Garcke
Phyllanthus mocinianus Baillon
Sebastiania adenophora Pax & K. Hoffm.
Tragia yucatanensis Millsp.

FLACOURTIACEAE

Laetia thamnia L.
Samyda yucatanensis Standl.
Zuelania guidonia (Sw.) Britton & Millsp.

GENTIANACEAE

Eustoma exaltatum (L.) Salisb.
Voyria parasitica (Schltdl. & Cham.) Ruyters & Maas

GRAMINEAE

Lasiacis divaricata (L.) Hitchc.
Olyra sp.

GUTTIFERAE

Callophyllum brasiliense Cambess.

HIPPOCRATEACEAE

**Hemiangium excelsum* (Kunth) A.C. SM.
**Strychnos panamensis* Seem.

LAURACEAE

Nectandra coriacea (Sw.) Griseb.
Nectandra aff. salicifolia (Kunth.) Nees
Nectandra sp.

LILIACEAE

* *Hymenocallis latifolia* (Herb.) M. Roem.

LORANTHACEAE

**Phoradendron robustissimum* Eichler
**Psittacanthus calyculatus* (DC) G. Don.

MALPIGHIACEAE

Bunchosia cf. glandulosa (Cav.) DC
Bunchosia swartziana Griseb.
Byrsonima bucidaefolia Standl.
Dicella sp.
Heteropteris sp.
Hiraea obovata (Kunth.) Nied.
Malpighia lundellii C.V. Morton
Malpighia punicifolia L.
Stigmaphyllon ellipticum (HBK) Juss.
Tetrapterys cf. *schiedeana* Schltdl. & Cham.

MALVACEAE

**Gossypium hirsutum* L.
Hampea trilobata Standl.
Hibiscus clypeatus L.
Malvaviscus arboreus Cav.
**Sida acuta* Burm. f.

MELIACEAE

Cedrela odorata L.
Swietenia macrophylla King

MENISPERMACEAE

Hyperbaena winzerlingii Standl.
Cissampelos pareira L.

MIMOSACEAE

Acacia collinsii Saff.
Acacia dolichostachya Blake
Acacia gaumeri Blake
Enterolobium cyclocarpum (Jacq.) Griseb
**Leucaena leucocephala* (Lam.) de Wit
Lysiloma latisiliquum (L.) Benth.
Mimosa hemiendyta Rose & Robinson ex Rose
Mimosa pudica L.
**Pithecellobium erythrocarpum* Standl.
Pithecellobium keyense Britton ex Locher
Pithecellobium platylobum (Spreng) Urban
Pithecellobium stevensonii (Standl.) Standl. & Steyerm.

MORACEAE

Brosimum alicastrum Sw.
Cecropia peltata L.
**Chlorophora tinctoria* (L.) Gaudich. ex Benth. in Benth. & Hook.f.
**Ficus hemsleyana* Standl.
**Ficus laevigata* Vahl
Ficus lapathifolia (Liebm.) Miq.

Ficus popenoei Standl.
Ficus sp.

MYRICACEAE

Myrica cerifera L.

MYRTACEAE

Calyptranthes cf. *pallens* Griesb.
Eugenia acapulcensis Stend.
Eugenia buxifolia (Sw.) Willd
Eugenia cf. capuli (Schltdl. & Cham) O. Berg
Eugenia cf. *rhombea* (O.Berg) Krug & Berg
Eugenia sp.
Psidium cf. sartorianum (O. Berg) Nied.
Psidium schippii Standl.

NOLINACEAE

Beaucarnea ameliae Lundell

OCHNACEAE

Ouratea lucens (Kunth.) Engl.
Ouratea nitida (sw.) Engl.

OLACACEAE

cf. Schoepfia obovata C. Wright
**Ximenia americana* L.

ORCHIDACEAE

**Brassavola nodosa* (L.) Lindl.
**Catasetum integerrimum* Hook.
Encyclia belizensis belizensis (Rchb.f.) Schltr
**Epidendrum nocturnum* Jacq.
**Habenaria sp.*
Myrmecophila tibicinis (Batem ex. Lindl) Rolfe
Oncidium ascendens Lindl.
**Oncidium sphacelatum* Lindl.
**Polystachia sp.*
**Psygmorchis pusilla* (L.) Dodson & Dressler
Vanilla planifolia G. Jackson

PALMAE

Attalea cohune Mart.
Acoelorraphe wrightii (Griseb. & H. Wendl.) H. Wendl ex Becc.
**Acrocomia aculeata* (Jacq.) Lodd. ex Mart.
Chamaedorea seifrizzi Burret
Coccothrinax argentata Lodd ex Schult & Schult
Cryosophila stauracantha (Heynold) R. Evans
Desmoncus orthacanthos Mart.
Pseudophoenix s. sargentii H. Wendl. ex Sarg.
Sabal cf. *yapa* C. Wright
Thrinax aff. *radiata* Lodd. ex Schult. & Schult. f.

PAPAVERACEAE

Argemone mexicana L.

PAPILIONACEAE

Andira inermis (W.Wright) Kunth ex DC.
Dalbergia glabra (Mill.) Standl.
Desmodium sp.
Diphysa carthagenensis Jacq.
Erythrina standleyana Krukoff
Gliricidia sepium (Jacq.) Kunth ex Walp
Lonchocarpus castilloi Standl.
Lonchocarpus cf. *yucatanensis* Piltier
Lonchocarpus rugosus Benth.
Machaerium floribundum Benth.
Mucuna pruriens (L. in Stickman) DC.
Piscidia piscipula (L.) Sarg.
Platymiscium yucatanum Standl.
Sesbania emerus (Aubl.) Urb.
Sophora tomentosa L.

PASSIFLORACEAE

Passiflora biflora Lam.
Passiflora foetida L.
Passiflora rovirosae Killip
Passiflora serratifolia L.
Passiflora xiikzodz J.M. Macdougal

PIPERACEAE

Piper auritum Kunth in H.B.K.
Piper sp.

POLYGALACEAE

Securidaca diversifolia (L.) S.F. Blake

POLYGONACEAE

Coccoloba acapulcensis Standl.
Coccoloba belizensis Standl.
Coccoloba browniana Standl.
Coccoloba reflexiflora Standl.
Coccoloba schiedeana Lindau
Coccoloba spicata Lundell
Coccoloba sp.
Gymnopodium floribundum Rolfe
Neomillspaughia emarginata (Gross) Blake

POLYPODIACEAE

Acrostichum aureum L.
Pteridium caudatum (L.) Maxon

RHIZOPHORACEAE

Cassipourea guianensis Aubl.
Rhizophora mangle L.

RUBIACEAE

Asemnanthe pubescens Hook. f.
Guettarda combsii Urb.
Guettarda elliptica Sw.
Hamelia patens Jacq.
Hintonia octomera (Hemsl.) Bullock
Morinda royoc L.
Psychotria nervosa cf. var. *nervosa* Sw.
Randia aculeata L.
Randia armata (Swartz) DC
Randia truncata Greenm. & C.H. Thomps

RUTACEAE

**Esenbeckia pentaphyla* (Macfad.) Griseb.
Peltostigma ptelioides (Hook) Walp.
Picramnia sp.
**Zanthoxylum caribaeum* Lam.

SAPINDACEAE

Allophyllus sp.
Cupania dentata DC.
Exothea diphylla (Standl.) Lundell
Matayba cf. *oppositifolia* (A. Rich.) Britton
Serjania adiantoides Radlk.
Serjania yucatanensis Standl.
Talisia oliviformis (Kunth) Radlk.

SAPOTACEAE

Chrysophyllum oliviforme L.
**Dipholis salicifolia* (L.) A. DC.
Manilkara zapota (L.) P. Royen
Pouteria campechiana (Kunth.) Baehni
**Pouteria mammosa* (L.) Cronquist
Sideroxylon americanum (Miller) Pennington
Sideroxylon persimile (Hensl.) T.D. Penn.

SIMAROUBACEAE

Simarouba glauca DC

SMILACACEAE

Smilax aff. *spinosa* Mill.
Smilax cumaneusis Willd.
Smilax sp.

SOLANACEAE

Solanum blodgettii Chapm.

STERCULARIACEAE

**Guazuma ulmifolia* Lam.
**Helicteres guazumifolia* Kunth

THEACEAE

Ternstroemia tepezapote Schltdl. & Cham.

THEOPHRASTACEAE

Jacquinia aurantiaca Aiton

TILIACEAE

Corchorus siliquosus L.

TURNERACEAE

**Turnera ulmifolia* L.

TYPHACEAE

Typha domingensis Pers.

ULMACEAE

Trema micrantha (L.) Blume

URTICACEAE

**Pilea microphylla* (L.) Liebm.

VERBENACEAE

Citharexylum hirtellum Standl.
Lantana camara L.
Petrea volubilis L.
**Priva lappulacea* (L.) Pers.
**Stachytarpheta jamaicensis* (L.) Vahl
**Stachytarpheta sp.*
Vitex gaumeri Greenm.

VIOLACEAE

Rinorea aff.*guatemalensis* (S. Watson) Bartlett.

VITACEAE

Cissus gossypiifolia Standl.
**Vitis tiliifolia* Humb. & Bonpl. ex Roehm. & Schult.

VOCHYSIACEAE

cf. *Vochysia guatemalensis* Don. Sm.