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TROPICAL FORESTRY PAPERS. No. 13

Descriptions of Seed Sources and Collections for Provenances of *Pinus oocarpa*

Compiled by A. GREAVES

DEPARTMENT OF FORESTRY
COMMONWEALTH FORESTRY INSTITUTE
UNIVERSITY OF OXFORD
1979

DESCRIPTIONS OF SEED SOURCES AND COLLECTIONS FOR PROVENANCES OF *PINUS OOCARPA*

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Commonwealth Forestry Institute
University of Oxford

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Preface

Professor J.L. Harley, C.B.E., F.R.S.

The Commonwealth Forestry Institute's continuing programme of exploration and evaluation of the genetic resources of tropical tree species began with Pinus caribaea, which occurs naturally in the Bahamas, Cuba and the Central American lowlands. Tropical Forestry Papers Nos. 7 and 12 deal with this species. At higher and drier altitudes in Central America P. caribaea is associated with, and eventually replaced by Pinus oocarpa. P. oocarpa therefore appears to be useful species for extending the range of conditions in which plantations can be successfully established in other countries. The seed of the species is in increasing demand for plantation development, but many seed sources are untried and there is a need for range-wide provenance trials.

The Commonwealth Forestry Institute has responded to this need by expanding its programme to include P. oocarpa, with the assistance of funds donated by Commonwealth countries and projects financed by the Overseas Development Ministry. The scope of the work has been greatly widened by the cooperation of the Instituto Nacional de Investigaciones Forestales in making seed collections throughout the species' range in Mexico. Seed of 74 provenances of P. oocarpa has been collected and distributed for an international provenance trial in which 42 countries are participating. The maximum benefit will only be gained from this trial by further international cooperation through the exchange of information. It is hoped that this publication, which has been compiled to provide all collaborators in the project with full details of the provenance seed sources, will help in promoting such cooperation.

Acknowledgements

The author is grateful to his colleagues at the Commonwealth Forestry Institute for their advice and assistance during the preparation of this paper. Special thanks are due to Mr. G.E. Chaplin and Mr. H.B.L. Evans who assisted in the abstraction of data from local records in Central America. Particular mention is made of Mr. R.H. Kemp, now Forestry Adviser to the Overseas Development Ministry, who compiled much of the original data on which the site descriptions are based, and under whose direction and guidance many of the provenance collections were made. Grateful acknowledgement is also made of the typing services of Mrs. P.R. Taylor, Mrs. C.D. Taylor and Mrs. C. Styles, and the invaluable clerical assistance of Mrs. J. Steel.

Special reference is given to the cooperation and goodwill received from the forestry organisations of Nicaragua, Honduras, Guatemala, Belize and Mexico without which the provenance seed collections would not have been made.

TABLE OF CONTENTS

		Page
Preface (J.L. Harley)		i
1.0	Introduction	1
2.0	Botanical nomenclature	2
3.0	Geographical range	3
4.0	Climate	6
5.0	Soils, fire and vegetation	6
6.0	The natural stands	7
7.0	Provenance collections	
	7.1 General principles	7
	7.2 Seed collection	10
8.0	Site description	10
9.0	Seed storage and distribution	12
10.0	Provenance code numbers	13
11.0	INTFORPROV	13
12.0	The provenances distribution by the CFI; locations of seed collection sites and site descriptions	15
References		129

Tables

1	Parameters of the simple linear regression equations of mean monthly temperature over altitude for Guatemala	11
2	Parameters of the simple linear regression equations of mean monthly temperature over altitude for Honduras	11
3	Provenance seed collections of P. oocarpa made in Nicaragua	17
4	Provenance seed collections of P. oocarpa made in Honduras	18
5	Provenance seed collections of P. oocarpa made in Guatemala	19
6	Provenance seed collections of P. oocarpa made in Belize	20
7	Provenance seed collections of P. oocarpa made in Mexico	22

Page

Appendices

I Specific names used in the site descriptions and their authorities 133

II Climodiagrams for the provenance seed collection sites 134

III Interpretation of the climodiagrams 135

IV Contents of the INTFORPROV computer files 136

Plates

1 Yucul, Nicaragua 137

2 San Rafael del Norte, Nicaragua 138

3 Dipilto, Nicaragua 139

4 Cerro el Bonete, Nicaragua 140

5 El Zamorano, Honduras 141

6 El Bucaral, Guatemala 142

7 El Pinalon, Guatemala 143

8 La Lagunilla, Guatemala 144

1.0 Introduction

The early trials with Pinus oocarpa Schiede as an exotic plantation species were discouraging. Most of the seeds were obtained from Mexico and tended to produce very crooked trees, as experienced in South Africa (Loock, 1950). However, the natural distribution of P. oocarpa covers a very wide range in Central America and Mexico. The history of exotic introductions has shown that there is usually genetic adaptations to local environments within the natural populations of a wide-ranging species (Callaham, 1964). Therefore the seed from some locations may produce better plantations than seed from others when grown in new conditions. Seed source (provenance) trials are necessary to determine which seed sources give the optimum results in different exotic environments.

In 1960 the FAO seminar on Tropical Pines in Mexico (INIF, 1962) stimulated a greater awareness of the potential role of tropical pines in afforestation schemes. One consequence was that some countries planted trials of P. oocarpa using seed from a few sources outside Mexico. Some of the provenances from the southern end of the species' range grew well, for example, in Uganda trees of Honduras Republic origin grew as well as, if not better than, Pinus caribaea Mor. which is also native to the Central American and Caribbean region (Greaves, 1976). The natural populations of both species are typically found growing on very infertile soils, but P. oocarpa occupies sites at higher altitudes with a more severe dry season than P. caribaea. P. oocarpa therefore appears to have the necessary genetic adaptation that will enable it to grow satisfactorily on degraded sites that are too high or too dry for the successful establishment of P. caribaea plantations, the kind of sites that many countries are anxious to bring into useful production.

This renewed interest in P. oocarpa arose at a time when there was a growing international awareness of the need to evaluate and conserve forest genetic resources. Work on P. caribaea by the Commonwealth Forestry Institute (CFI) had already commenced in 1963 in response to a request from the Eighth Commonwealth Forestry Conference for species and provenance studies, a course of action that was also recommended or endorsed by other international bodies (Greaves, 1978). In 1968 the first session of the FAO Panel of Experts on Forests Gene Resources drew up a list of species requiring attention and the priorities to be given to them in exploration and seed collection (FAO, 1969). P. oocarpa was placed in the highest priority category with the responsibility for the exploration of the Central American populations assigned to the CFI, and that for the Mexican populations to the Instituto Nacional de Investigaciones Forestales (INIF), Mexico.

In response to the need for intensive provenance studies the Central American Pine Provenance Research Project was initiated at the CFI in 1969 under a grant from the British Overseas Development Ministry, with additional financial support from the United Nations Organisation through the FAO Panel of Experts on Forest Gene Resources. The objectives of the project with regard to P. oocarpa are threefold:-

(i) To explore the natural populations of the species in Central America

(ii) To evaluate the relative performances in new environments of the full range of natural seed sources by means of an international provenance trial

(iii) To initiate measures to conserve the genetic material of the potentially valuable provenances, especially those for which the native seed sources are in danger of depletion or eradication

The distribution of seed by the CFI for the International Provenance Trial of Central American provenances commenced in 1971. Kemp (1973a) gives a full account of the background and aims of the project. Progress reports and summaries of the early results from the provenance trials are given by Kemp (1973b) and Greaves and Kemp (1978). Reports by individual collaborators in the programme have been compiled by Burley and Nikles (1973), Dyson and Greaves (1976), and Nikles, Burley and Barnes (1978). INIF has collected a range of provenances representative of the Mexican populations of P. oocarpa, also with financial assistance from the United Nations Organisation. The distribution of seed for the International Provenance Trial of Mexican provenances commenced early in 1979, with the coordination of the trials in Latin America supervised by INIF, and the trials in Africa and Asia coordinated by the CFI.

Although the CFI and INIF are the coordinating agencies for this programme it has always been the intention that the work should be conducted as an international cooperative effort. Over forty countries are now participating in the provenance trials, and only by pooling information can the results from these trials to be used to their greatest advantage. Most of the participating countries send the results of their periodic assessments to the CFI where they are continuously monitored to give up-to-date information on the performances of the different provenances.

At the same time individual countries continue to publish the results of their own trials and draw conclusions from them within the context of their environments and forest policies. Such results are enhanced if the countries concerned can easily and rapidly drawn on the pooled assessment data to compare their trial results with those from similar environments in other countries. A computerised information storage and retrieval system (INTFORPROV) has been developed to assist this process of international data exchange (see Section 11.0).

It is also recognised that researchers in this field will require information on the background to the provenance collections that is not compatible with computer storage. The purpose of this paper is to provide this information.

2.0 Botanical nomenclature

The botanical characteristics of typical P. oocarpa as originally identified by Schiede (1838) are as follows:-

Pinus oocarpa Schiede
Needles predominantly in fascicles of 5, but also 3, 4 and

(rarely) 6, 12-28 cm in length, up to 1.5 mm in width, spreading or held stiffly erect, often tufted at ends of branches, usually light shining green. Resin ducts 3-8, usually septal. Cones broadly ovoid or ovoid conic, scales opening widely, borne on stiff peduncles in groups of up to three.

Throughout its natural range P. oocarpa shows a wide variation in both the morphology of the tree and its botanical features, especially the size and shape of the mature cones and the properties of the foliage. This has resulted in the description of several different varieties, but invariably by taxonomists working independently in different areas. Inevitably confusion has arisen over the botanical nomenclature.

Styles (1976) presented a thorough review of the current nomenclature, leading to an examination of the status of Pinus oocarpa var. ochoterenai Martinez, the most commonly used varietal name in the species. This variety was first described in 1940 following studies of trees in Chiapas, Mexico, that are of distinctive and superior form to the typical P. oocarpa. In later years the name has tended to be applied without adequate scientific foundation to any better-formed P. oocarpa. Styles concludes that the trees in Chiapas should be referred to P. patula var. longipedunculata Loock ex Martinez. This applies only to the trees in Chiapas. Elsewhere the trees should still be named P. oocarpa but the varietal term ochoterenai should be discontinued.

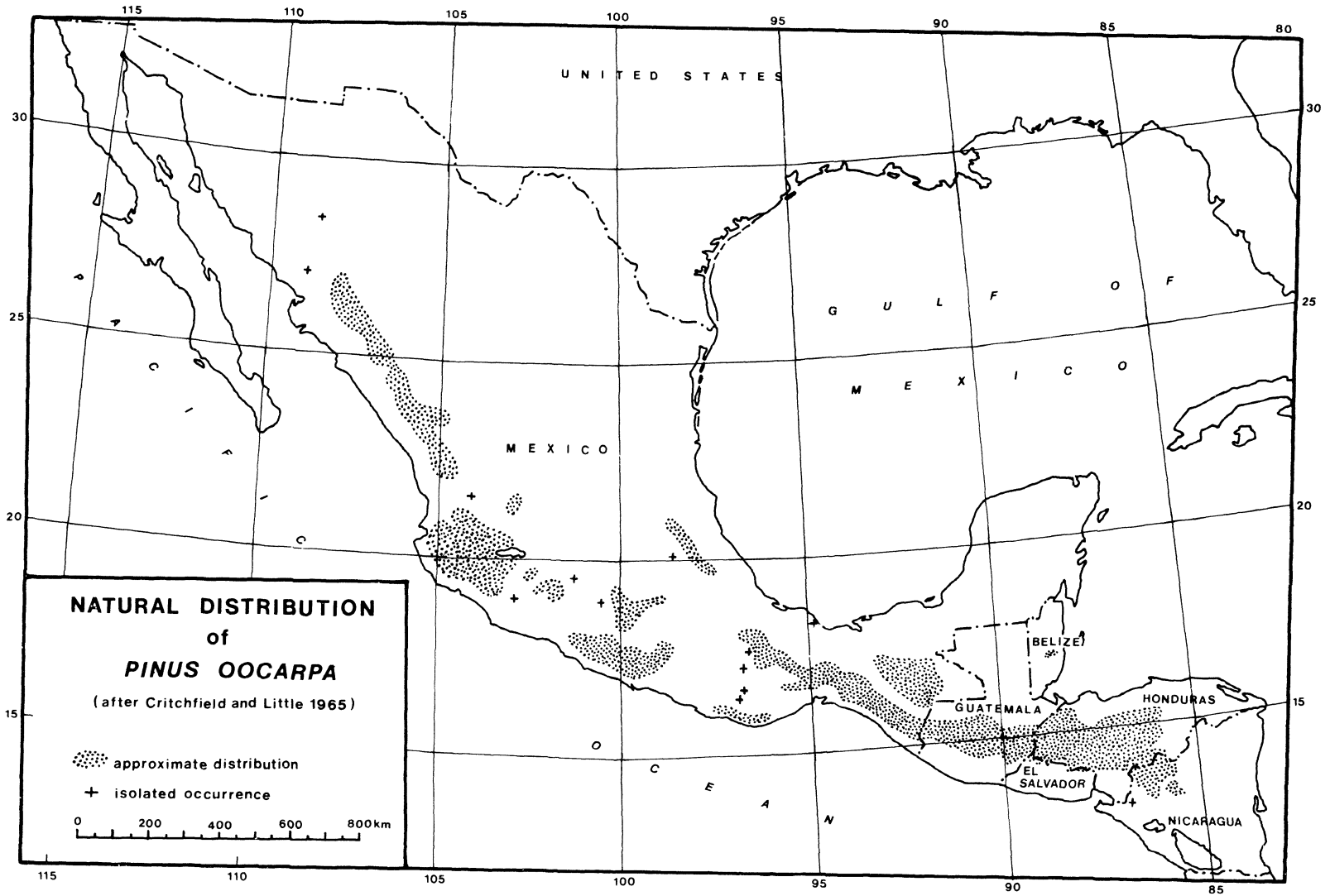
This illustrates the misconceptions that can arise when classifications are attempted before reference can be made to the full range of variation in a species. A range-wide systematic study of the botanical features of P. oocarpa is now in progress at the CFI which will undoubtedly establish a botanical classification for the species on a rational scientific basis, but until it has been completed the use of varietal names should be avoided.

3.0 Geographical range

The natural populations of P. oocarpa cover a range in latitude greater than fifteen degrees, whilst the range in longitude is slightly less than twenty two degrees. The most southerly limit of the species' range occurs to the south of Matagalpa in Nicaragua at 12° 45'N, 85° 51'W. The northern limit of the main range is in the north of Sinaloa State in Mexico at 27° 00'N, 108° 08'W, but there is an isolated occurrence farther north in the east of Sonora State at 28° 21'N, 108° 36'W.

The main distribution forms a discontinuous band, largely confined to the mountainous uplands running from north-west Nicaragua, through Honduras and northern El Salvador, the southern half of Guatemala, and the south and west of Mexico. There is a separate occurrence on the Mountain Pine Ridge in Belize.

In Nicaragua 150,000 ha is covered by upland pine forests (Taylor, 1963), of which about 90 percent is pure P. oocarpa. The largest continuous block occurs on the Sierra de Dipilto, along which lies the border between Honduras and Nicaragua. Smaller, scattered


115
110
105
100
95
90
85
80
30
25
20
15
UNITED STATES
MEXICO
G U L F O F M E X I C O
P A C I F I C O C E A N
BELIZE
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
NATURAL DISTRIBUTION
of
PINUS OOCARPA
(after Critchfield and Little 1965)
approximate distribution
isolated occurrence
0 200 400 600 800km

areas of the species are found to the south extending just beyond Matagalpa (Denevan, 1961).

Within Honduras there are, or were, 267,000 ha of extensive pure P. oocarpa forest (Le Cacheux et al., 1959), mostly concentrated in the centre of the country, in addition to wider areas with irregular cover.

The distribution of the species continues westwards, through southern Guatemala, into Mexico where it is widely distributed. It is found in the states of Sonora, Chihuahua, Sinaloa, Durango, Zacatecas, Jalisco, Nayarit, Michoacan, Mexico, Hidalgo, Morelos, Puebla, Guerrero, Oaxaca and Chiapas. In Mexico it is most common in the warmer sub-tropical to temperate zones of the southern regions.

In Belize, "The forest and flora of British Honduras" (Standley and Record, 1936) recorded P. oocarpa as occurring at Baker's Pine Ridge, a low-lying area 32 km north-west of Belize City. Hunt (1962) could find no confirmation of this. He concluded that since P. oocarpa is normally not found below 600 m the record must be in error.

The only confirmed occurrence of P. oocarpa in Belize is the population at Mountain Pine Ridge. The first authentic report of this was made by Luckhoff to the British Honduras Forest Department in February 1957. This was later confirmed by Hunt (1962) when the species was identified as Pinus oocarpa var. ochoterenai using Loock's key (Loock, 1950). As stated in the previous section, Styles (1976) has since shown that it is incorrect to apply this varietal name here and its use should be discontinued.

P. oocarpa is typically found at altitudes ranging from 600 to 2,400 m, but most of the distribution lies between 700 and 1,500 m (Prats-Llaurado, 1962). However, there are exceptions to this. Kemp (1973a) recorded a very atypical occurrence in Guatemala at 250 m and Gomez-Pompa (1973) referred to a population at 500 m in Mexico. The altitudinal limits of the species increases northwards. In Nicaragua it is found between 600 and 1,700 m (Taylor, 1963) but in southern Mexico it is very common between 1,500 m and 2,100 m where it frequently grows in association with Pinus leiophylla Schl. and Cham., Pinus lawsoni Roezl, Pinus pringlei Shaw, Pinus montezumae Lamb and Pinus michoacana var. cornutu Martinez (Loock, 1950).

At low elevations the species is commonly replaced by thorn scrub or grasslands in areas of low rainfall, or by mixed hardwoods in wetter regions. In many locations south of Mexico, particularly at the limits of its range closest to the Caribbean, it merges with P. caribaea, at elevations below 600-800 m, usually where the annual rainfall is over 1,500 mm. In these areas where both species are found growing in intimate mixtures some trees are found with morphological characteristics intermediate between the two. This has given rise to speculation that hybridisation occurs. However, there is, as yet, no confirmation of the existence of hybrids, in particular there has not been any proven success in synthesising the hybrid artificially.

At high elevations P. oocarpa is replaced by mixed hardwoods or high altitude pine species. In Nicaragua, Honduras and southern

Guatemala Pinus pseudostrobus Lindl. may occur above 1,200 m.

4.0 Climate

Throughouts its natural range P. oocarpa experiences a summer-rainfall winter-dry-season climate. The rains occur during the period April to November with two peaks, usually in June and September.

The mean annual rainfall probably lies within the 1,000-1,500 mm range over most of the species' distribution, but populations are known where the mean annual rainfall is as low as 700 mm and others where it exceeds 2,000 mm. There is generally a severe dry season of four to five months duration, longer in some places.

Mean annual temperatures fall within the range 13^{o}-23^{o}C with January being the coldest month and May the warmest. At the hottest sites the absolute maximum temperatures are about 40^{o}C. Overall the species can be regarded as not experiencing frost, but temperatures slightly below freezing occur very occasionally at some of the high altitude sites in Mexico.

5.0 Soils, fire and vegetation

The ground flora beneath P. oocarpa is usually dominated by grasses, especially the tall dense exotic grass Hyparrhenia rufa Stapf. These grasses rapidly dry out during the dry season and frequently burn. Ground fires, and the ability of the pines to survive them are a marked characteristic of P. oocarpa forests. Mature trees will survive fires with little harm, even though the foliage may be heavily scorched. The aerial parts of young trees are frequently killed, but they survive by sprouting from the base. This process of burning and sprouting may be repeated over several successive years until a break in the incidence of fire enables the trees to grow to a height at which they can survive.

Fire seems to play a vital ecological role in P. oocarpa forests. Successful seed germination only takes place on bare mineral soil and the seedlings will not tolerate dense shade. The species appears to be incapable of competing with broadleaf vegetation for a prolonged period without the aid of at least occasional fires. If fire is totally excluded the forest will probably revert to a broadleaf type.

In view of this evidence both Taylor (1963) and Denevan (1961) consider that these pine communities are fire-induced dis-climax. Further support to this theory is given by the fact that P. oocarpa is mostly found on infertile sandy soils, derived from materials of volcanic origin, with a high quartz content (Prats-Llanrado, 1962; and Taylor, 1963), the kind of soils on which hardwoods are most easily excluded.

Denevan (1961), after studying the upland pine forests in Nicaragua, concluded that " ..... the degree of disturbance of site and frequency of fire necessary to establish and sustain a tropical or sub-tropical stand of shade-intolerant pine is greatest in areas with rich and deep soils, basic parent materials, and with high average temperatures and high precipitation; and is less in areas with poor

soils, acidic parent materials, low rainfall, and especially with increasingly lower temperatures. Because man is the main disturbing element in the environment, the prescence of pines on a given site can in part be related to the extent and nature of man's activities on the site".

6.0 The natural stands

Throughout much of its range P. oocarpa has been subject to prolonged exploitation as a source of timber. Until recently there has been little effective consideration given to regeneration, and this, combined with the frequent occurrence of ground fires, has resulted in extensive degradation of the forest. Understandably exploitation has been greatest in the vicinity of population centres and road networks. Many once extensive stands have been reduced to scattered relic trees of poor form.

This degradation of the forests has been accelerated by a widespread preference for conditions suitable for cattle grazing following the exploitation of virgin stands, rather than the maintenance of a forest cover. The grass Hyparrhenia rufa was introduced to create a more luxuriant grass cover than that of native species, and it has spread throughout many forest areas. Its dense cover has decreased the ease with which natural seeding can occur and, on drying out during the dry season, it increases the fire hazard thus further reducing the likelihood of natural regeneration survival.

Despite these hazards to the forests, many full-stocked stands can be found, although they are not always easily accessible, a fact which assists their preservation. Thus in Honduras dense mature stands are mostly found in the Department of Olancho and the Orica region (FAO, 1968). Where conditions conducive to the establishment of natural regeneration do exist the re-growth is usually prolific. Dense pole-stage stands are found throughout the range of the species but they are often of limited extent

In recent years there has been a growing awareness of the sustained contribution that the forests can make to the local and national economics and of the protection they afford to the soil. This has resulted in the enactment of legislation which has done much to reduce over-exploitation and ensure the adequate regeneration of a forest cover. However, the P. oocarpa genetic resource has undoubtedly been seriously eroded and there is a pressing need to evaluate the remaining stands and conserve the potentially valuable seed sources.

7.0 Provenance collections

7.1 General principles

The term 'provenance' refers to the source of seed or to the plants derived from that source. A provenance is a defined geographical location. It is not a broad region. In this study the greatest importance has been attached to giving the precise locations of provenance seed collections by reference to local landscape features as well as by latitude, longitude and altitude.

In undertaking provenance trials it is assumed that the species under study has genetic adaptations to local environments, and the greater the range of environments covered by the species, the greater is the possible range of adaptations. Indications of the amount and pattern of genetic variability in the natural populations may be inferred from differing anatomical, biochemical, morphological and physiological traits. Callaham (1964) advised that provenance studies should start with a comprehensive summary of the available information on genetic and environmental variability within the range of the species. If sufficient information is available it is possible to classify the populations prior to seed collection, and then to work within this framework thus ensuring that the full range of variation is adequately covered. Unfortunately, such comprehensive information seldom exists at the start of a provenance study, and this was the case with P. oocarpa at the beginning of the project. A great deal of data were available on the variation of the environment, but earlier studies which might throw some light on the genetic variation were not sufficiently extensive to enable conclusions to be drawn about the whole range. Moreover the time and effort needed to acquire this additional information prior to starting on the provenance collections would have conflicted with one of the main objectives of the work, that is conservation of useful provenances before they are irretrievably lost through depletion of the forests.

In these circumstances it is possible only to determine the degree of environmental variation, assume the existence of parallel genetic adaptations, and make provenance collections accordingly. It could be assumed that a genetic adaptation has arisen in response to every unique combination of environmental factors, i.e. ecotypic variation. This implies a discontinuous or discrete pattern of variation. However, the environment has a graded variation and for those populations of a species which are not widely separated there probably exists a parallel graded genetic variation, i.e. clinal variation.

The provenance sampling scheme for P. oocarpa assumed that there is a combination of both clinal and ecotypic variation. Seed collection sites were selected to cover the full range of latitude and altitude of the more or less continuous populations which make up the greatest part of the P. oocarpa forests in Central America. This was on the assumption that there is clinal variation in response to the variation in day-length, rainfall and temperature. There is a possibility that the variation among those populations which are separate from the main mass of the distribution (e.g. Mountain Pine Ridge, Belize) will be ecotypic. Such populations were therefore given individual attention irrespective of their environmental conditions.

Particular attention was given to isolated stands at the extremes of the species' range, such as those at San Rafael del Norte and Yucul in Nicaragua which are close to the species' most southerly limit. The genetic material from these sources is likely to be valuable in extending the range of conditions into which the species can be successfully introduced.

A flexible approach was adopted for the procurement of seed representative of the different provenances. Too inflexible an attitude

would not have allowed advantage to be taken of good conditions as they occurred. In other circumstances adverse conditions might have resulted in very little material being collected after a great deal of effort. Therefore the procedure followed at any site varied depending on access, the stands available, seed extraction facilities, and the abundance of seed, which varies notoriously from year to year. However, certain basic guidelines were laid down.

When a particular region had been selected for a provenance collection every effort was made to collect from stands that were representative of the best forest conditions. A good fully-stocked stand is more likely to contain the full range of genetic material characteristic of a local genetic adaptation than one which has been selectively exploited, leaving only the poorest trees. For similar reasons, mature unexploited stands were preferred to young regenerated stands, but it was not always possible to find these ideal conditions. Nevertheless the collection of seed from 'minus' stands was not excluded if these were the only representatives of the species in a particularly interesting region. At San Rafael del Norte in Nicaragua the stands remaining can scarcely be regarded as constituting a well-stocked forest condition. They are poor scattered relics of once more extensive stands, yet they are all that exists to represent populations in that locality and to have excluded them would have possibly excluded valuable genetic material.

Seed collections must be suited to the purpose for which they are intended. Seed for provenance trials must be representative of the full genetic variation in the populations from which it is collected. The consequence of genotype-environment interactions cannot be predicted. Thus, the only way to test an unknown provenance is to introduce its full range of genetic material into a range of new environments and see what happens. The frequent assumption that the seed should come only from the best phenotypes is, therefore, not valid.

Ideally all classes of trees in the stand should be stratified and equal amounts of seed collected from randomly selected trees in every class. In practice this would be a very tedious approach because of the very varied seed bearing tendencies of different trees. It would result in an intolerably slow rate of seed collection. Callaham (1964) recommended a more practical approach. It is to collect from dominants or co-dominants every 100 metres to avoid the inclusion of trees from the same parents as far as possible. He advised that a provenance collection from a heterogeneous population should include seed from at least 25-50 trees. These principles were adopted, with care being taken to avoid a disproportionate representation from any individual or class of tree, especially with the smaller collections. Where circumstances permitted, the number of trees included was greatly expanded to provide a bulk seed collection for ex situ conservation stands in addition to seed for provenance trials.

At all the provenance sites, collated herbarium specimens and oleoresin samples were taken from a representative proportion of the trees included in the seed collection. This has provided a sound data base for intensive studies of the variation within and between provenances using both the standard taxonomic procedures based on morphology

and anatomy, and the more recently developed chemo-taxonomic techniques (Burley and Lever, 1973; Burley, 1974). These studies may reveal patterns of genetic variation within the species. The provenance trials, which are fundamentally range-wide first stage provenance trials (Burley, 1969), will show which are the most promising provenances. By combining the two studies, certain taxonomic features may be shown to be correlated with desirable growth characteristics. This will be the most efficient way of achieving the goals of the provenance study, and possibly paving the way for intensive second stage provenance sampling within restricted areas of the natural range of P. oocarpa which appear to contain especially useful genetic material.

7.2 Seed collection

There is a fairly long period during which pollen of P. oocarpa is liberated and receptive female flowers are present, but most of the pollination appears to occur in January, as observed by Mirov (1962) in Nicaragua. It then probably takes eighteen months or more for the seed to mature. The main period of ripening and seed release occurs during the heat of the dry season, beginning in January and reaching a peak in March. However, cones which reach a state of maturity at the end of the dry season frequently retain their seed until the following January. Consequently it is possible to find some mature cones of P. oocarpa at any time of the year, but the most practical seed collecting season is from January to March when the mature cones have turned a uniform light greyish-brown.

All the seed collections undertaken by the project were made by supervised labourers who collected from felled trees in exploitation areas or by climbers who scaled selected standing trees. The climbers invariably preferred to use climbing spurs to ladders or tree bicycles. The cones were cut with pruning shears mounted on long poles.

In a few locations seed from commercial collections was brought to augment the provenance collections. This was only done where the commercial collection was believed to have been carried out to an adequate standard, and represented a wide range of genetic material.

Heating the cones stimulates them to open and release the seed. Spreading the cones out in the sunlight on coffee drying patios or tarpaulins gave satisfactory results, providing that protection was given from rain and that there was adequate sunshine.

Gently raking the cones was sufficient to shake free most of the seeds, but knocking the cones together by hand significantly increased the yield.

A preliminary cleaning of the seed was carried out prior to despatch to Britain. The seed was rubbed in cotton bags to separate the wings from the seeds, and the frass and dust was then removed by 'winnowing' in a slight breeze.

8.0 Site description

Site descriptions were made at the sites of all seed collections with the exception of those in Mexico.

Considerable efforts were made to acquire all available meteorological data applicable to the collection sites. The data for Honduras and Guatemala were extracted from publications (Honduras, 1967; 1969; Guatemala, 1968). The data for Nicaragua were obtained from local stations, and those for Belize from the unpublished records of the Forest Department.

Temperature data were not available for several sites in Guatemala, Honduras and Nicaragua. The feasibility of estimating the mean monthly temperatures for these sites was investigated by examining the relationship between temperature and altitude. The published temperature data for Guatemala cover a large number of locations and a wide range in altitude. Using this data, computer-printed scatter plots of mean monthly temperature over altitude, one for every month, revealed a very distinct linear relationship between the two variables. The parameters of the simple linear regression equations, with temperature as the left hand variable and altitude as the right hand variable, were computed for all months. The results are given in Table 1. The procedure was repeated using the published temperature data that area vailable for many locations in Honduras (see Table 2). In view of the consistently high values of r^2 the equations were considered to be sufficiently accurate for prediction. Tables 1 and 2 were therefore used for estimating mean monthly temperatures in Guatemala and Honduras respectively. Insufficient data were available for deriving a set of equations for Nicaragua. However, the mean monthly temperatures recorded at several stations in Nicaragua did not vary by more than $\pm$ 2°C from values estimated using the equations in Table 2. The table was therefore accepted as being also applicable to Nicaragua.

Where the seed collection site is separated from a temperature recording station by only a small horizontal distance the mean monthly temperatures at the site were estimated by adjusting those recorded at the station according to the lapse rate of 0.56°C decrease in temperature for every 100 m increase in altitude.

Klimodiagrams (Gaussen, 1954) were drawn for all the seed collection sites to illustrate the range of rainfall and mean monthly temperature regimes covered by the provenances (See Appendix III). It is recognised that a klimodiagram is probably not the most accurate way of illustrating the water balance of a site. Penman's method is undoubtedly the most reliable approach (Theron, 1972) yet it requires more meteorological and soil data than are available for this study. In these circumstances klimodiagrams were accepted as a practical and convenient means of demonstrating the relative wetness or dryness of different sites.

9.0 Seed storage and distribution

After a preliminary cleaning all seed lots were sent to the Forestry Commission Research Station at Alice Holt Lodge, England, which deals with the storage and despatch of seed on behalf of the CFI. On arrival at the station the collections were given a final thorough cleaning, tested according to the standards laid down by the International Seed Testing Association (ISTA), and kept in cold storage. Further tests were carried out periodically to monitor the viability of the seed and

Table 1

Parameters of the simple linear regression equations of mean monthly temperature over altitude for Guatemala

January	Y	=	26.55	-	0.005809	X	r^2 = 0.747
February	Y	=	27.36	-	0.005857	X	r^2 = 0.773
March	Y	=	28.46	-	0.005753	X	r^2 = 0.793
April	Y	=	29.33	-	0 005861	X	r^2 = 0.813
May	Y	=	29.27	-	0.005654	X	r^2 = 0.812
June	Y	=	28.57	-	0.005505	X	r^2 = 0.826
July	Y	=	28.35	-	0.005378	X	r^2 = 0.811
August	Y	=	28.43	-	0.005460	X	r^2 = 0.823
September	Y	=	28.12	-	0.005391	X	r^2 = 0.821
October	Y	=	27.53	-	0.005310	X	r^2 = 0.831
November	Y	=	27.18	-	0.005517	X	r^2 = 0.777
December	Y	=	26.66	-	0.005603	X	r^2 = 0.755

Table 2

Parameters of the simple linear regression equations of mean monthly temperature over altitude for Honduras

January	Y	=	25.68	-	0.006107	X	r^2 = 0.771
February	Y	=	26.11	-	0.005790	X	r^2 = 0.756
March	Y	=	27.44	-	0.005438	X	r^2 = 0.707
April	Y	=	28.38	-	0.005301	X	r^2 = 0.877
May	Y	=	28.50	-	0.005062	X	r^2 = 0.899
June	Y	=	27.90	-	0.004677	X	r^2 = 0.862
July	Y	=	27.96	-	0.005402	X	r^2 = 0.876
August	Y	=	28.12	-	0.005403	X	r^2 = 0.878
September	Y	=	27.78	-	0.005289	X	r^2 = 0.881
October	Y	=	27.01	-	0.004806	X	r^2 = 0.764
November	Y	=	26.25	-	0.005482	X	r^2 = 0.807
December	Y	=	26.07	-	0.006386	X	r^2 = 0.810

Y = mean monthly temperature (^{o}C)
X = altitude (m)
r^2 = coefficient of determination

provide up-to-date information for calculating the quantities of seed required for provenance trials.

The seed lots distributed for the provenance trials were examined in accordance with the phytosanitary regulations of the recipient countries and despatched with a phytosanitary certificate.

10.0 Provenance code numbers

All the seed collections made by CFI staff were given collection numbers prefixed by the letter 'K'/1. On being received at the seed store the collections were allocated seed store numbers. These take the form 2/73, in this example meaning the second CFI collection received at Alice Holt Lodge in 1973. Some collections were made by cooperating countries and despatched direct to England. In these collections the 'K' number is usually replaced by a local seed number. All the seed samples despatched for trials have been identified by the seed store number and usually also by the 'K' number when it exists.

A third series of provenance code numbers is used at the CFI to facilitate computerised storage of the provenance data. An example is 'PO18C'. The first set of letters is the species code, P. oocarpa in this case. The central set of numbers is the site identification code, in this instance Yucul. The final letter is the code for the first, second, third, etc. collection at this site labelled A, B, C, etc. respectively. Thus PO18 refers to the P. oocarpa provenance at Yucul and PO18C is the third provenance collection of P. oocarpa at Yucul. In a few cases this sequence has not been followed, mainly as a result of collections made by earlier workers being included in the system as they were noticed.

The computer codes are used as the main provenance identifiers in this paper. However, collaborators in the international trials are requested to continue using the code numbers with which the seed was issued. A cross-reference for all three codes is given in Tables 3-7.

11.0 INTFORPROV

INTFORPROV (International Forestry Provenance Trials) is a computer-based system for the storage and retrieval of information about the provenance seed collections acquired and distributed by the CFI. It has been developed along lines similar to those originally proposed by Burley, Andrew and Templeman (1973) and is designed for running on the ICL 1906A computer at the Oxford University Computer Laboratory.

The system includes four cross-referenced computer files which form the data bank (see Appendices IV). These are:-

1. Source file

This contains information about the locations of the seed sources. It also lists collated herbarium, resin and wood specimens collected

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/1 Originally denoting collections made by R.H. Kemp.

from the same sources as the seed.

2. Distribution file

The distribution file lists the provenance trials established with seed from CFI, and lists the provenances in each trial.

3. Site file

This contains details of the sites on which the trials have been planted. It also indicates if there is published information on any specified trial.

4. Growth file

The growth file contains provenance trial growth and survival data listed by treatment (provenance), age and trial. The data is in the form of treatment means. It is coded so that the traits measured do not have to be the same in all trials. Neither do the traits have to be measured at fixed ages.

The system allows for missing data. Failure to obtain some information about a seed source or the site on which a trial was planted does not cause the system to fail.

The system is not intended to be a basis for statistical analyses. Its purpose is to provide listings of all or part of the information known about a given provenance, a given provenance trial site, or combinations of selected provenances and sites. It is anticipated that the three most common enquiries will be:-

a) What is known about the source of provenance X? A subsidiary enquiry may request only the mean annual rainfall or other special records for this seed source.

b) What is known about the places where provenance X was planted? Subsidiary enquiries may restrict this question to, for example, rainfall records or to sites within a given range of altitude and latitude.

c) How did provenance X perform in provenance trials? All recorded growth traits are listed, with the ages at which they were measured.

The output summarises the questions asked and presents the required information in tabulated form. Since the system is open-ended more data files can be added if a demand for additional information develops. Examples of possible additions are data on stem and crown form, wood properties and oleoresin composition.

All the site and growth data supplied to the CFI by participants in the international P. oocarpa trials have been stored in INTFORPROV. This data is now available to the trial collaborators in keeping with the policy of encouraging international cooperation and the exchange of information. Researchers are invited to submit enquiries of the kind

listed above. This service is provided free of charge.

12.0 The provenances distributed by the CFI; locations of seed collection sites and site descriptions

All the provenance seed collections of P. oocarpa distributed by the CFI are listed in Tables 3-7.

Full site descriptions with meteorological data are available for the Central American provenances collected by the CFI. The meteorological data were compiled as described in section 8.0. The data available varied depending on the location of the seed collection site, consequently meteorological conditions at some locations are more thoroughly described than at others. Data of mean monthly rainfall and mean monthly temperatures are given for all the sites.

Only brief site descriptions are available for the Mexican provenances collected by INIF.

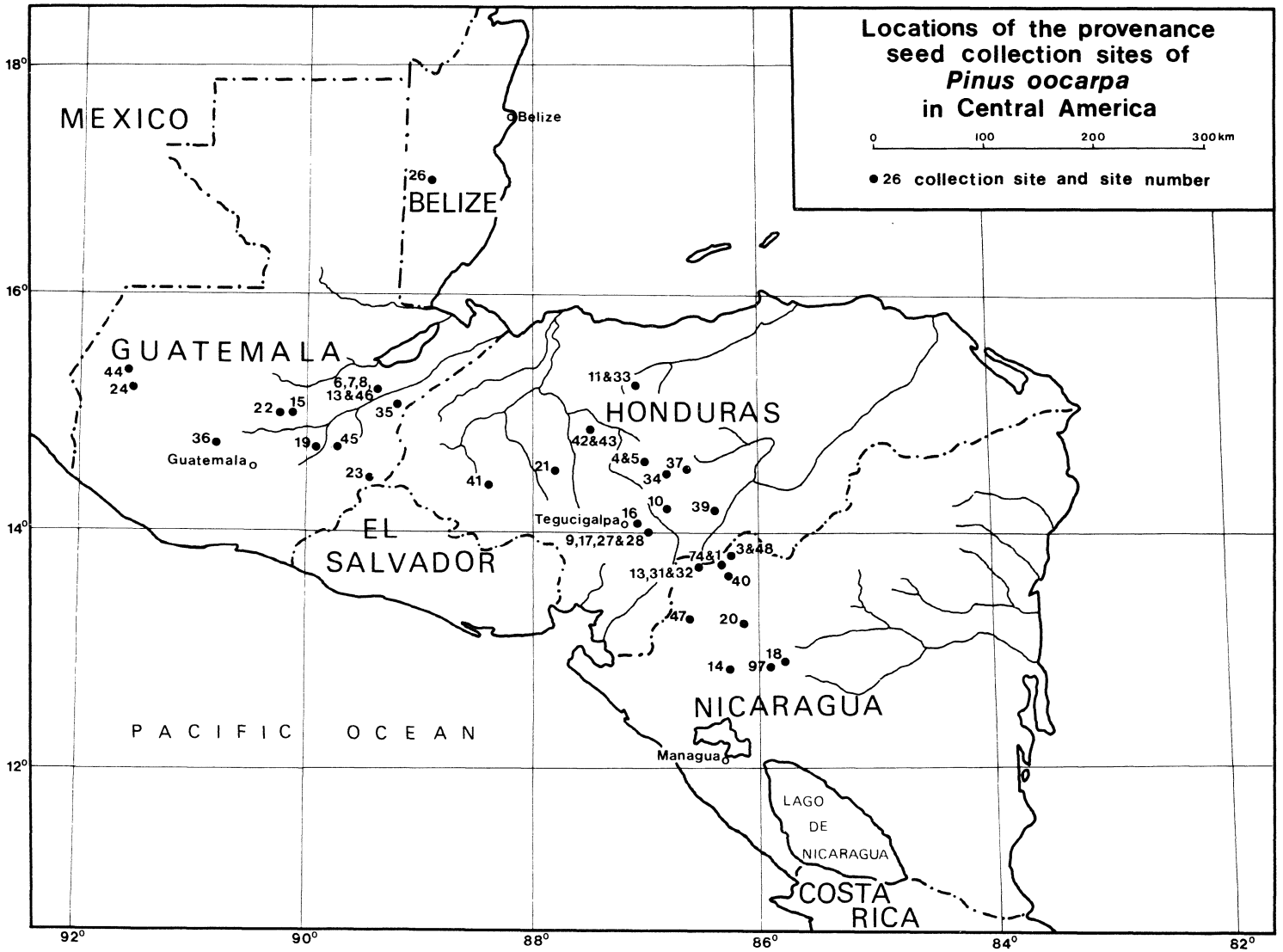

Locations of the provenance seed collection sites of *Pinus oocarpa* in Central America
0 100 200 300km
● 26 collection site and site number
MEXICO
BELIZE
Belize
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
COSTA RICA
PACIFIC OCEAN
LAGO DE NICARAGUA
Guatemala
Tegucigalpa
Managua
18°
16°
14°
12°
92°
90°
88°
86°
84°
82°
44
24
22
15
6,7,8
13&46
35
36
19
45
23
41
11&33
42&43
4&5
37
34
21
10
39
16
9,17,27&28
74&1
3&48
13,31&32
40
47
20
18
14
97

TABLE 3

Provenance seed collections of P. oocarpa made in Nicaragua

Site No.	Collection	Collector's No.	Seed Store No.	Site	Latitude	Longitude	Page
PO14	A	K 32	2/71	Bonete	12°50'N	86°18'W	48
"	B	K 4	4/70	"	"	"	48
"	D	K103	7/74	"	"	"	48
PO18	A	K 42	6/71	Yucul	12°55'N	85°47'W	56
"	B	K 94	12/73	"	"	"	56
"	C	K101	8/74	"	"	"	56
"	E	K128	2/76	"	"	"	56
"	G	K140	5/77	"	"	"	56
PO97	A	K143	8/77	Apanti	12°54'N	85°56'W	112
PO20	A	K 44	27/71	Rafael	13°14'N	86°08'W	60
"	B	K142	7/77	"	"	"	60
PO47	A	K117	7/75	Cusmapa	13°17'N	86°39'W	106
PO48	A	K126	26/75	Jalapa	13°50'N	86°15'W	108
PO 3	A	K 3	3/70	Sullates	13°51'N	86°16'W	26
PO 1	A	K 1	1/70	Camelias	13°46'N	86°18'W	24
"	B	K 2	2/70	"	"	"	24
PO74	A	K130	6/76	San Fernando	13°46'N	86°22'W	110
PO40	A	K 93	11/73	"	13°39'N	86°17'W	92
PO31	A	K 67	1/72	Dipilto	13°43'N	86°32'W	76
"	B	K 91	9/73	"	"	"	76
"	C	K116	6/75	"	"	"	76
PO32	A	K 92	10/73	Dipilto	13°43'N	86°37'W	78
PO13	A	K 31	1/71	Junquillo	13°42'N	86°35'W	46

TABLE 4

Provenance seed collections of P. oocarpa made in Honduras

Site No.	Collection	Collector's No.	Seed Store No.	Site	Latitude	Longitude	Page
PO9	F	K 70	5/72	Zamorano	14°02'N	87°03'W	38
PO17	A	K 36	5/71	Zamorano	13°58'N	86°59'W	54
PO27	A	K 86	3/73	Zamorano	14°02'N	87°03'W	72
PO28	A	K 88	8/73	Zamorano	14°02'N	87°03'W	74
PO16	A	K 35	4/71	Angeles	14°07'N	87°04'W	52
"	B	K 71	6/72	"	"	"	52
PO10	A	K 15	15/70	Maraquito	14°13'N	86°50'W	40
PO39	A	K 85	2/73	Villa Santa	14°12'N	86°25'W	90
PO37	A	K 78	12/72	La Union	14°32'N	86°38'W	88
PO34	A	K 72	7/72	Rio Viejo	14°30'N	86°50'W	82
PO 4	A	K 6	6/70	Zapotillo	14°37'N	87°02'W	28
"	B	K 14	14/70	"	"	"	28
PO 5	A	K 7	7/70	San Marcos	14°36'N	87°00'W	30
PO11	A	K 16	16/70	Agua Fria	15°16'N	87°06'W	42
PO33	A	K 68	2/72	Yoro	15°16'N	87°06'W	80
PO42	A	K 99	5/74	Pimientilla	14°54'N	87°30'W	96
PO43	A	K102	3/74	Valle Bonito	14°53'N	87°31'W	98
PO21	A	K 45	7/71	Siguatepeque	14°32'N	87°50'W	62
PO41	A	K 98	4/74	San Juan	14°24'N	88°23'W	94

TABLE 5

Provenance seed collections of P. oocarpa made in Guatemala

Site No.	Collection	Collector's No.	Seed Store No.	Site	Latitude	Longitude	Page
P023	A	K 47	10/71	San Jose	14°28'N	89°28'W	66
P035	A	K 73	8/72	Jutes	15°05'N	89°15'W	84
P0 6	A	K 9	9/70	Canas	15°10'N	89°23'W	32
P0 7	A	K 10	10/70	Lima	15°11'N	89°21'W	34
P0 8	A	K 11	11/70	Conacaste	15°10'N	89°21'W	36
P012	A	K 28	30/70	Pueblo Caido	15°12'N	89°18'W	44
P046	A	K114	4/75	Mal Paso	15°11'N	89°21'W	104
P045	A	K113	5/75	Pinalon	14°43'N	89°46'W	102
P019	A	K 43	8/71	Lagunilla	14°42'N	89°57'W	58
"	B	K 87	7/73	"	"	"	58
"	C	K112	8/75	"	"	"	58
P015	A	K 34	3/71	Bucaral	15°01'N	90°09'W	50
"	B	K 80	14/72	"	"	"	50
P022	A	K 46	9/71	Chuacus	15°02'N	90°16'W	64
P036	A	K 74	9/72	Chimaltenango	14°45'N	90°50'W	86
P024	A	K 48	29/71	Malacatancito	15°13'N	91°32'W	68
P044	A	K111	3/75	Pueblo Viejo	15°22'N	91°36'W	100

TABLE 6

Provenance seed collections of P. oocarpa made in Belize

Site No.	Collection	Collector's No.	Seed Store No.	Site	Latitude	Longitude	Page
P026	A	K 49	30/71	Mountain Pine Ridge	17° 00'N	88° 55'W	70
"	B	-	10/74	" "	"	"	70
"	C	-	11/74	" "	"	"	70
"	D	-	12/74	" "	"	"	70
"	E	-	15/77	" "	"	"	70

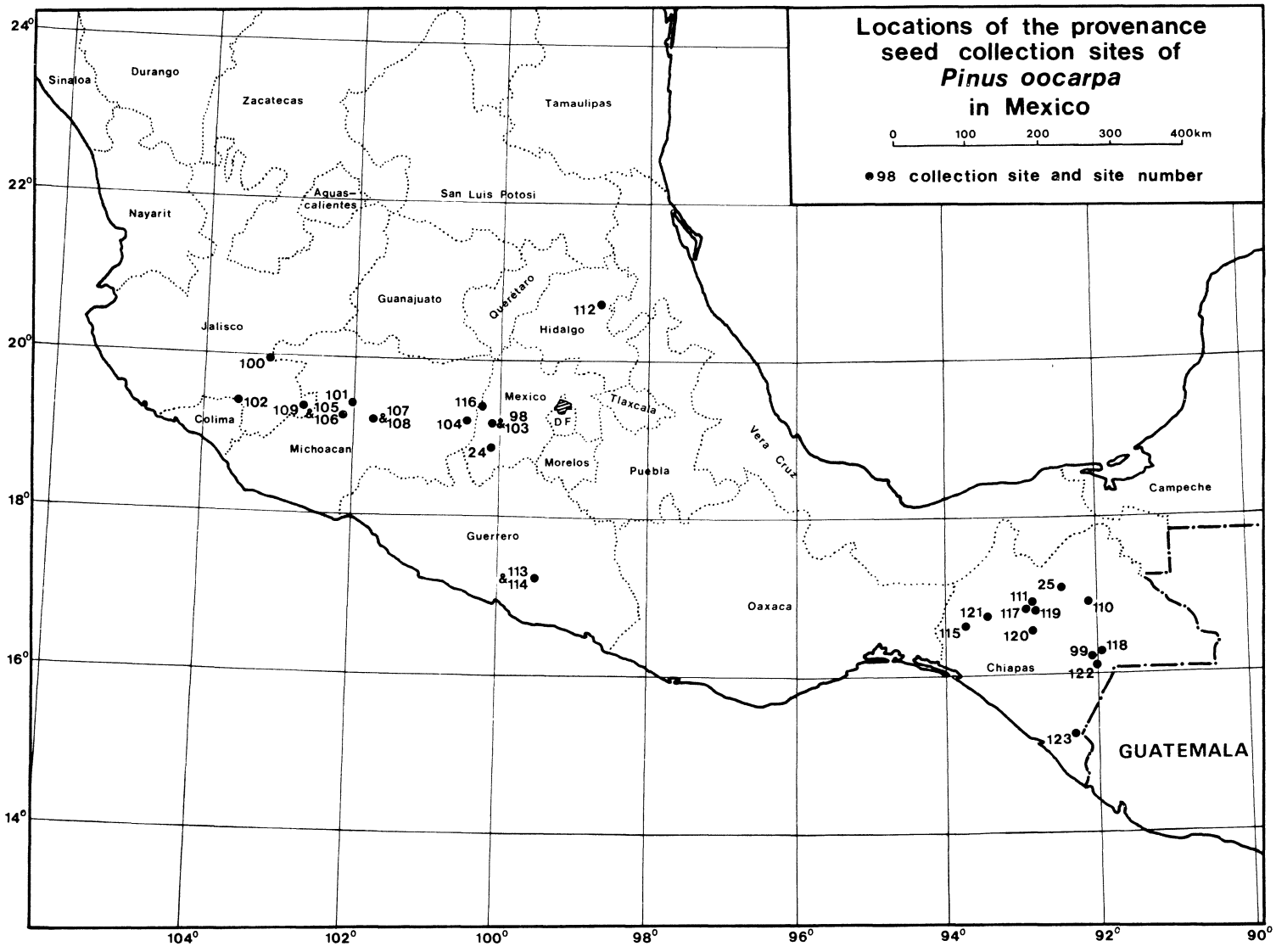

Locations of the provenance seed collection sites of *Pinus oocarpa* in Mexico
0 100 200 300 400km
●98 collection site and site number
Sinaloa
Durango
Zacatecas
Tamaulipas
Aguas-calientes
San Luis Potosi
Nayarit
Guanajuato
Queretaro
Hidalgo
Jalisco
Colima
Michoacan
Mexico
D.F.
Morelos
Tlaxcala
Puebla
Vera Cruz
Campeche
Guerrero
Oaxaca
Chiapas
GUATEMALA
100
101
102
109
105
106
107
108
116
104
98
103
24
112
113
114
25
111
110
121
117
119
115
120
99
118
122
123
24°
22°
20°
18°
16°
14°
104°
102°
100°
98°
96°
94°
92°
90°

TABLE 7

Provenance seed collections of P. oocarpa made in Mexico

Site No.	Collection	Collector's	Seed Store No.	Site	Latitude	Longitude	Page
PO 25	A		31/71	Jitotil	17°05'N	92°30'W	114
PO 91	A	INIF 353	71/78	Valle de Bravo	19°14'N	100°07'W	115
PO 99	A	INIF 367	72/78	La Trinitaria	16°15'N	92°03'W	115
PO100	A	INIF 378	73/78	Mazamitla	19°58'N	103°06'W	116
PO101	A	INIF 379	74/78	Tzararacua	19°25'N	102°02'W	116
PO102	A	INIF 392	75/78	Palos Altos	19°25'N	103°35'W	117
PO103	A	INIF 398	76/78	Valle de Bravo	19°14'N	100°07'W	117
PO104	A	INIF 399	77/78	El Llano	19°15'N	100°25'W	118
PO105	A	INIF 417	78/78	Matanguaran	19°18'N	102°09'W	118
PO106	A	INIF 481	79/78	Ziracuaretiro	19°18'N	102°09'W	119
PO107	A	INIF 489	80/78	Los Sabinos	19°13'N	101°45'W	119
PO108	A	INIF 490	81/78	Los Negros	19°13'N	101°45'W	120
PO109	A	INIF 502	82/78	El Durazno	19°22'N	102°41'W	120
PO110	A	INIF 534	83/78	La Codicia	16°55'N	92°07'W	121
PO111	A	INIF 535	84/78	La Florida	16°55'N	92°53'W	121
PO112	A	INIF 554	85/78	Chinameca	20°45'N	98°39'W	122
PO113	A	INIF 555	86/78	Cafeles	17°16'N	99°30'W	122
PO114	A	INIF 556	87/78	Buena Vista	17°15'N	99°31'W	123
PO115	A	INIF 582	88/78	Los Pinos Ranch	16°40'N	93°45'W	123
PO116	A	INIF 575	89/78	El Durazno	19°27'N	102°05'W	124
PO117	A	INIF 586	90/78	El Sanibal	16°50'N	92°55'W	124
PO118	A	INIF 587	91/78	San Francisco	16°19'N	91°59'W	125
PO119	A	INIF 588	92/78	La Cascada Ranch	16°50'N	93°50'W	125
PO120	A	INIF 596	93/78	San Cristobal	16°50'N	92°36'W	126
PO121	A	INIF 599	94/78	Cienega de Leon	16°45'N	93°45'W	126
PO122	A	INIF 604	95/78	Santa Rita	16°07'N	92°00'W	127
PO123	A	INIF 609	96/78	Toliman	15°16'N	92°20'W	127
PO124	A	INIF 627	97/78	Temascaltepec	18°57'N	100°05'W	128

Site No: P01

Country: Nicaragua Department: Nueva Segovia

District: San Fernando Site: Las Camelias

Latitude: 13° 46'N Longitude: 86° 18'W Altitude (m): 900

Location:

The collection site is on the southern slopes of the Cordillera de Dipilto (Cordillera Segoviana) which lies in an east-west direction along the northern border of Nicaragua, rising to heights of 1,500 to 2,000 metres. The pine forests are continuous with those of the northern slopes, in the El Paraiso department of Honduras, but the highest and most fertile sites along the crest of the cordillera are occupied by broadleaf forest or coffee plantations. On the lower southern slopes, and particularly to the south of the main Ocotal-Jalapa road, the pine stands are more dispersed and open and have been reduced by exploitation, clearing and burning for grazing.

Soil:

The soils are yellowish quartzite gravels with a high percentage of humus in the top ten centimetres and an increasing clay fraction in the lower layers. They are shallow on the ridges where they overlie the decaying parent granite, but deep coluvial accumulations occur on the lower slopes. pH 6.5 (barium sulphate colour test).

Stand description:

The forest is previously unexploited but nevertheless rather open. The main species is P. oocarpa, but there is some oak in patches, bamboo along the streams, and P. pseudostrobus and Liquidambar at higher elevations. Most of the pines show fire damage to the boles and regeneration is generally sparse. A tall grass layer is common, including Andropogon sp. and Hyparrhenia sp.

Seed collections:

1. P01A (K1, 1/70) January 1970

   Seed was collected from 26 felled trees selected for straightness of stem, length of clear bole, crown shape and vigour. As felling was at the rate of 150 trees per day a high standard of selection was possible. The cone crop was very sparse and many trees had few or no cones in the current crop.

   Seed bearers:

   DBH (cm): 60 to 80 Height (m): 30 to 40
   Branching: medium to heavy, 50° to 70°
   Boles: straight, cylindrical

2. P01B (K2, 2/70) January 1970

   All the collection details are identical to those of P01A above, except that the sites are narrowly separated by a ridge. The two collections can be regarded as belonging to the same population.

METEOROLOGICAL DATA

Site No: P01 Site: Las Camelias

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	5	9	29	50	195	284	166	155	228	306	64	9	1,500
2. mean daily temp. °C	20.2	20.9	22.5	23.6	23.9	23.7	23.1	23.2	23.0	22.7	21.3	20.3	22.4

Local meteorological data are not available. The mean annual rainfall is estimated to be about 1,500 mm with a distribution over the year similar to that encountered at Ocotal (20 kilometres to the south west, lat. 13° 38'N, long. 86° 29'W). The mean monthly temperature values have been estimated using the method described on page 11

Site No: P03

Country: Nicaragua Department: Nueva Segovia

District: Jalapa Site: Las Sullates

Latitude: 13°51'N Longitude: 86°16'W Altitude (m): 1,050

Location:

The collection site is on the southern slopes of the Cordillera de Dipilto (Cordillera Segoviana) which lies in an east-west direction along the northern border of Nicaragua, rising to heights of 1,000 to 2,000 metres. The pine forests are continuous with those on the northern slopes in the El Paraiso department of Honduras, but the highest and most fertile sites along the crest of the cordillera are occupied by broadleaf forest or coffee plantations. On the lower southern slopes, and particularly to the south of the main Ocotal-Jalapa road, the pine stands are more dispersed and open and have been reduced by exploitation clearing and burning for grazing. The best remaining stands are on very steep slopes.

Soil:

The soils are derived from coarse-structured granites. They are freely-drained, and probably strongly leached, sandy-loams and gravel-loams with some humus in the top ten centimetres. pH 6.5 (barium sulphate colour test).

Stand description:

The major vegetation is open to very open pine forest on steep slopes in grassland which is subject to seasonal fires. Most trees show signs of fire damage and natural regeneration is almost absent. Liquidambar styraciflua occurs in the shelter of valleys that give some protection from fire. P. pseudostrobus is found at the higher elevations.

Seed collections:

1. P03A (K3, 3/70) January 1970

Seed was collected from seventeen felled trees selected for stem straightness, length of clear bole, crown shape and vigour.

Seed bearers:

DBH (cm): 50 to 70 Height (m): 30
Branching: medium to heavy, 50° to 70°
Boles: straight, cylindrical

METEOROLOGICAL DATA

Site No: P03 Site: Las Sullates

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	64	31	28	55	185	348	262	210	275	239	88	60	1,845
2. mean daily temp. ^{o}C	19.3	20.0	21.7	22.8	23.2	23.0	22.3	22.4	22.2	22.0	20.5	19.4	21.6

Local meteorological data are not available. The mean annual rainfall and its distribution is estimated as being similar to that recorded at Jalapa (lat. 13° 55'N, long. 86° 09'W). The mean monthly temperature values have been estimated using the method described on page 11.

Site No: P04

Country: Honduras | Department: Francisco Morazan

District: Orica | Site: El Zapotillo

Latitude: 14° 37'N | Longitude: 87° 02'W | Altitude (m): 1,000

Location:

The site is about thirteen kilometres south-south-west of Orica town roughly central in the very extensive range of P. oocarpa in Honduras. The stand is on low hills with fairly gentle slopes and southern aspect. It lies within the area now subject to fire prevention and control systems, based on the forestry camp at Guaimaca, approximately 24 km by road from the collection site.

Soil:

The soil is a very shallow (twelve to twenty four centimetres) loam with good humus content in the top ten centimetres, overlying soft crumbling rhyolytic tuff, generally well-drained but with some patches of poor surface drainage in hollows and on lower slopes. pH 5.5 (barium sulphate colour test).

Stand description:

The fairly open pine forest has been subject in the past to selective felling and heavily attacked by Dendroctonus spp. in 1964. Most remaining dominants are 50 to 60 cms d.b.h. with top heights around 30 metres and long clear boles. There are many previously suppressed trees with very small crowns and somewhat sinuous stems. The beetle attack resulted in the death of all trees in some patches but regeneration is excellent in all growth stages. P. oocarpa is the only pine species present and morphologically the stand seems very uniform.

Seed collections:

1. P04A (K6, 6/70) January 1970

   Seed was collected from 35 selected felled trees. The cone crop was very sparse.

   Early diameter growth appeared to have been at the rate of about two rings per centimetre for the first twenty to twenty five rings, but after this the rings became denser and more confused. There was generally a copious resin flow after felling.

   Seed bearers:

   DBH (cm): 50 to 66 | Height (m): 25 to 35
   Branching: light, 70° to 80°
   Boles: straight, cylindrical, clear, sound

2. P04B (K14, 14/70) January 1970

   A bulk collection from the same felling area as P04A above.

METEOROLOGICAL DATA

Site No: P04 Site: El Zapotillo

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	30	20	29	44	149	215	172	144	196	165	67	41	1,272
2. mean daily temp. ^{o}C	19.6	20.3	22.0	23.1	23.4	23.2	22.6	22.7	22.5	22.2	20.8	19.7	21.8

Local meteorological data are not available. The mean annual rainfall and its distribution is estimated as being similar to that recorded at Agua Caliente (lat. 14° 40'N, long. 87° 18'W). The mean monthly temperature values have been estimated using the method described on page 11.

Site No: P05

Country: Honduras | Department: Francisco Morazan

District: Orica | Site: San Marcos de Neda

Latitude: 14°36'N | Longitude: 87° 00'W | Altitude (m): 1,100

Location:

The collection site is about eleven kilometres south-south-west of Orica town, roughly central in the very extensive range of P. oocarpa in Honduras, on very steep slopes with generally southerly aspects. It lies within the area now subject to fire-prevention and control systems, based on the forestry camp at Guaimaca.

Soil:

The soil is a freely-drained sandy-loam with a high proportion of coarse quartzite gravel. There are rock outcrops on the ridge tops and colluvial accumulations on the lower slopes. pH 5.5 (barium sulphate colour test).

Stand description:

The forest is entirely P. oocarpa. It is fairly open, probably as a result of attack by Dendroctonus spp. in 1964. There is a thin and tussocky but seasonally tall grass layer which is susceptible to fire. The pine regeneration is sparse.

Seed collections:

1. P05A (K7, 7/70) January 1970

   Seed was collected from about 30 selected felled trees. The cone crop was very sparse.

   Seed bearers:

   DBH (cm): 70 to 90 | Height (m): 30 to 35
   Branching: light to medium, 70 to 80
   Boles: straight, cylindrical, sound

METEOROLOGICAL DATA

Site No: P05 Site: San Marcos de Neda

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	30	20	29	44	149	215	172	144	196	165	67	41	1,272
2. mean daily temp. ^{o}C	19.0	19.7	21.4	22.5	22.9	22.8	22.0	22.2	22.0	21.7	20.2	19.0	21.3

Local meteorological data are not available. The mean annual rainfall and its distribution is estimated as being similar to that recorded at Agua Caliente (lat. 14^{o} 40'N, long. 87^{o} 18'W). The mean monthly temperature values have been estimated using the method described on page 11.

Site No: P06

Country: Guatemala Department: Zacapa

District: Gualan Site: Las Canas

Latitude: 15° 10'N Longitude: 89° 23'W Altitude (m): 1,200

Location:

The site is on the southern slopes of the Sierra de las Minas, which lies roughly east-west along the northern side of the Motagua Valley. The pines are generally on very steep slopes.

Soil:

The soil is a well-drained gravelly-loam or clay-loam over decaying rock which mainly comprises micaceous schists. pH 6.0.

Stand description:

The open pine forest is on steep slopes with very little regeneration. The main species is P. oocarpa but occasional trees of P. tenuifolia and Liquidambar styraciflua are found at altitudes of 1,200 m and above.

Seed collection:

1. P06A (K9, 9/70) January 1970

   Seed was collected from felled trees by labourers of a local seed collector (Sr. Jose Lewald C.).

   Seed bearers:

   DBH (cm): 60 to 80 Height (m): 21 to 25
   Branching: medium to heavy, 50° to 60°
   Boles: straight, cylindrical

METEOROLOGICAL DATA

Site No: P06 Site: Las Canas

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	2	1	6	11	171	466	331	239	428	222	20	3	1,900
2. mean daily temp. ^{o}C	19.6	20.3	21.6	22.3	22.5	22.0	21.9	21.9	21.6	21.2	20.6	19.9	21.3

Local meteorological data are not available. The mean annual rainfall is estimated be about 1,900 mm with a distribution over the year similar to that encountered at Zacapa (lat. 14° 58'N, long. 89° 31'W). The mean monthly temperature values have been estimated using the method described on page 11.

Site No: P07

Country: Guatemala Department: Zacapa

District: Gualan Site: La Lima

Latitude: 15° 11'N Longitude: 89° 21'W Altitude (m): 1,000

Location:

The site is on the southern slopes of the Sierra de las Minas, which lies roughly east-west along the northern side of the Motagua Valley. The pines are generally on very steep slopes.

Soil:

The soil is a well-drained gravelly-loam or clay-loam over decaying rock which mainly comprises micaceous schists. pH 6.0.

Stand description:

The open pine forest with very little regeneration is on steep slopes with occasional individuals or small patches of *Quercus* sp. There is a thin grass cover which burns annually, and patches of bare soil resulting from the fire and erosion.

Seed collections:

1. P07A (K10, 10/70) January 1970

   Seed was collected from felled trees by labourers of a local seed collector (Sr. Jose Lewald C.).

   Seed bearers:

   DBH (cm): 50 to 60 Height (m): 21 to 25
   Branching: medium to heavy, 50° to 60°
   Boles: straight, cylindrical

METEOROLOGICAL DATA

Site No: P07 Site: La Lima

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	2	1	7	10	162	441	314	226	405	210	19	3	1,800
2. mean daily temp. °C	20.7	21.5	22.7	23.5	23.6	23.1	23.0	23.0	22.7	22.2	21.7	21.0	22.4

Local meteorological data are not available. The mean annual rainfall is estimated to be about 1,800 mm with a distribution over the year similar to that encountered at Zacapa (lat. 14° 58'N, long. 89° 31'W). The mean monthly temperature values have been estimated using the method described on page 11.

Site No: P08

Country: Guatemala Department: Zacapa

District: Gualan Site: El Conacaste

Latitude: 15° 10'N Longitude: 89° 21'W Altitude (m): 550-700

Location:

The site is on the southern slopes of the Sierra de las Minas, which lies roughly east-west along the northern side of the Motagua Valley. The pine is generally on very steep slopes.

Soil:

The soil is a well-drained gravelly-loam or clay-loam over decaying rock, mainly micaceous schists. pH 6.0.

Stand description:

The open pine forest with very little regeneration is on steep slopes with occasional individuals or small patches of Quercus sp. There is a thin grass cover which burns annually, and patches of bare soil resulting from the fire and erosion.

Seed collections:

1. P08A (K11, 11/70) January 1970

   Seed was collected from felled trees by labourers of a local seed collector (Sr. Jose Lewald C.).

   Some stumps showed 20 growth rings in the first eighteen centimetres, but in later years growth appeared to have been slow with six to eight rings per centimetre. On average resin production was slow.

   Seed bearers:

   DBH (cm): 40 to 60 Height (cm): 21 to 25
   Branching: medium to heavy, 50° to 60°
   Boles: straight, cylindrical

METEOROLOGICAL DATA

Site No: P08 Site: El Conacaste

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	2	1	6	11	171	465	331	239	429	222	20	3	1,900
2. mean daily temp. ^{o}C	23.1	23.8	25.0	25.8	25.9	25.3	25.1	25.2	24.9	24.3	23.9	23.3	24.6

Local meteorological data are not available. The mean annual rainfall is estimated to be about 1,900 mm with a distribution over the year similar to that encountered at Zacapa (lat. 14° 58'N, long 89° 31'W). The mean monthly temperature values have been estimated using the method described on page 11.

Site No: P09

Country: Honduras Department: Francisco Morazan

District: El Zamorano Site: El Zamorano

Latitude: 14° 02'N Longitude: 87° 03'W Altitude (m): 1,100

Location:

The collection was made approximately two kilometres south-east of El Zamorano on the lower northern slopes of Montana Oyuca. The pine forest is continuous along the valley above 800 m, but variable in density owing to the rocky nature of the terrain. Pinus pseudostrobus occurs above 1,400 m and dense hardwood forest is found on the summit.

Soil:

The parent material is predominantly volcanic tuff with abundant igneous intrusions giving rise to a freely-drained rocky soil, pale greyish-brown in colour. pH 4.8 (electrode in KCl solution).

Stand description:

The forest cover comprises closed mature stands of P. oocarpa on steep to moderate slopes with a few Quercus sp. along the sheltered valleys. Ground cover is mainly abundant Mimosa tenuifolia, Mimosa albidi and Baccharis trinervis. Scattered patches of Myrica cerifera, Senecio thomasii and bracken also occur. Grasses are sparse, the predominant species being Andropogon condensatus and Leptochloa sp. Many trees show damage from past fires. Stems are mostly straight. There is a wide variation in the degree of branching.

Seed collections:

1. P09F (K70, 5/72) February 1972

   This was a wide ranging bulk collection.

   Seed bearers:

   DBH (cm): 39 to 64 Height (m): 25 to 34
   Branching: medium to light, 60° to 90°
   Boles: cylindrical, some slight basal sweep and bow.

METEOROLOGICAL DATA

Site No: P09 — Site: El Zamorano

Meteorological station: El Zamorano — Country: Honduras

Latitude: 14° 00'N — Longitude: 87° 02'W — Altitude (m): 792

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1.	mean monthly rainfall mm	11	7	14	36	154	206	150	144	195	144	42	14	1,117	22
2.	mean daily temp. °C	18.5	19.0	20.4	21.4	22.0	20.8	20.4	20.7	20.7	20.2	19.3	18.5	20.2	10

The collection site is 320 m higher than the meteorological station. The mean monthly temperatures recorded above are those registered at the meteorological station minus 2.0°C.

Site No: P010

Country: Honduras | Department: Francisco Morazan

District: Orica | Site: El Maraquito

Latitude: 14° 13'N | Longitude: 86° 50'W | Altitude (m): 1,000

Location:

The collection site is about twelve kilometres south-south-east of Orica town, on very steep slopes and roughly central in the very extensive range of P. oocarpa in Honduras. It lies within the area now subject to fire-prevention and control management based on the forestry camp at Guaimaca.

Soil:

The soil is a freely-drained sandy-loam with a high proportion of coarse quartzite gravel. It is shallow on the ridge tops, where there are rock outcrops, but there are deeper, colluvial accumulations on the lower slopes. pH 5.5 (barium sulphate colour test).

Stand description:

The forest is fairly open, probably as a result of attack by Dendroctonus sp., in 1964. There is a thin and tussocky but seasonally tall grass layer (including Andropogon sp. and Hyparrhenia sp.) which is susceptible to fire. The pine regeneration is sparse.

Seed collections:

1. P010A (K15, 15/70) February 1970

   The seed was collected from about 150 selected felled trees. The cone crop was very sparse.

   Seed bearers:

   DBH (cm): 70 to 90 | Height (m): 30 to 35
   Branching: light to medium, 70° to 80°
   Boles: straight, cylindrical, sound

METEOROLOGICAL DATA

Site No: P010 Site: El Maraquito

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	30	20	29	44	149	215	172	144	196	165	67	41	1,272
2. mean daily temp. ^{o}C	19.6	20.3	22.0	23.1	23.4	23.2	22.6	22.7	22.5	22.2	20.8	19.7	21.8

Local meteorological data are not available. The mean annual rainfall and its distribution is estimated as being similar to that recorded at Agua Caliente (lat. 14° 40'N, long. 87° 18'W). The mean monthly temperature values have been estimated using the method described on page 11.

Site No: P011

Country: Honduras Department: Yoro

District: Yoro Site: Agua Fria

Latitude: 15° 16'N Longitude: 87° 06'W Altitude (m) 1,100

Location:

The site is approximately 20 km in a straight line north-north-east of Yoro town. It lies in an area of extensive pine forests, with P. caribaea in the valleys giving way to P. oocarpa at altitudes above 800 m. Much of the more accessible pine (mainly P. caribaea) was cut during the nineteen fifties and sixties by the Yoro Lumber Co. Some areas of dense forest have also suffered from heavy mortalities brought about by Dendroctonus attack, but this has been followed by good natural regeneration.

To reach Agua Fria follow the Yoro to Jocon road (1970) for 24.8 km to Desvio Tercales and from there by mule track and footpath to Agua Fria.

Soil:

The soil is reddish-brown, shallow and stony.

Stand description:

The seed was collected from open forest along the ridge-tops and on the steep slopes. Many of the larger trees are heavily branched and some have forked stems.

Seed collections:

1. P011A (K16, 16/70) January and February 1970

   A bulk collection was made by a Peace Corps forester (Ken Scott), mainly from felled trees but also by climbing some standing trees.

METEOROLOGICAL DATA

Site No: P011 — Site: Agua Fria

Meteorological station: Agua Fria — Country: Honduras

Latitude: 15° 10'N — Longitude: 87° 07'W — Altitude (m): 610

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1.	mean monthly rainfall mm	27	30	15	31	131	156	109	100	153	157	104	56	1,069	13
*2.	mean daily temp. °C	19.4	20.4	22.9	23.6	23.7	23.2	22.0	22.1	21.0	20.8	20.8	19.5	21.6	10 (1952-61)

* The collection site is 490 m higher than Yoro. The mean monthly temperatures recorded above are those registered at the meteorological station minus 2.7°C.

Site No: P012

Country: Guatemala Department: Zacapa

District: Gualan Site: Pueblo Caido

Latitude: 15° 12'N Longitude: 89° 18'W Altitude(m): 800

Location:

The site is on the southern slopes of the Sierra de las Minas, which lies roughly east-west along the northern side of the Motagua Valley. The pine is generally on very steep slopes.

Soil:

The parent rock is a micaceous schist which is decaying in situ to form a freely-drained sandy or gravelly loams over a heavier sub-soil. pH 6.0.

Stand description:

The open pine forest with very little regeneration is on steep slopes with occasional individuals or small patches of Quercus sp. There is a thin grass cover, which burns annually, and patches of bare soil resulting from fire and erosion.

Seed collections:

1. P012A (K28, 30/70) March 1970

   Seed was collected from felled trees by labourers of a local seed collector (Sr. Jose Lewald C.)

   Seed bearers:

   DBH (cm): 70 to 90
   Branching: medium to heavy, 60
   Boles: straight, cylindrical

METEOROLOGICAL DATA

Site No: P012

Site: Pueblo Caido

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	2	1	6	11	171	465	331	239	429	222	20	3	1,900
2. mean daiiy temp. ^{o}C	21.9	22.7	23.8	24.6	24.7	24.2	24.0	24.1	23.8	23.2	22.8	22.2	23.5

Local meteorological data are not available. The mean annual rainfall is estimated to be about 1,900 mm with a distribution over the year similar to that encountered at Zacapa (lat. 14^{o} 58'N, long. 89^{o} 31'W). The mean monthly temperature values have been estimated using the method described on page 11.

Site No: P013

Country: Nicaragua Department: Nueva Segovia

District: Dipilto Site: El Junquillo

Latitude: 13° 42'N Longitude: 86° 35'W Altitude (m):1,000

Location:

The site is located at the western end and on the southern slopes of the Cordillera de Dipilto, which forms the northern boundary of Nicaragua at this point. The stands, which lie about five kilometres north of Macuelizo and eight kilometres west of Dipilto, form part of an area of about 150,000 hectares of generally open pine forest which stretches more than 70 km roughly east-west along the cordillera and extends northwards to the pine forests of Honduras. Rainfall increases progressively eastwards and in this direction the lower slopes below 800 metres elevation are increasingly occupied by P. caribaea and the higher slopes above 1500 by P. pseudostrobus and broadleaf forest. At the western end, in the Macuelizo area, the lower slopes and valleys support only a dry thorn scrub and the only pine species is P. oocarpa which in fact forms most of the pine forest throughout the cordillera.

Soil:

Granitic rocks, decaying in situ, have given rise to freely-drained sandy soils with abundant quartz. Erosion is active and the parent rock outcrops extensively on the steeper slopes and ridges. The soils are generally very shallow, except in hollows or valleys, and have very little humus content. pH 5.7.

Stand description:

The pine forest is very open and on steep slopes (20° to 35°). There is only a thin grass cover including Andropogon sp. and Pennisetum sp. A few Quercus sp. occur in some moister valleys. The largest pines are over 30 metres (100 ft) high and up to 80 cm d.b.h. Pine regeneration is generally sparse although good in patches. The area shows evidence of frequent fierce fires over a long period of years. Growth rings are confused and difficult to interpret but growth appears to be slow, with three to five rings per centimetre.

Seed collection:

1. P013A (K31, 1/71)

Seed was collected from 36 selected felled trees.

Seed bearers:

DBH (cm): 40 to 60 Height (m): 25 to 30
Branching: 70° to 80°
Boles: straight, cylindrical, sound

METEOROLOGICAL DATA

Site No: P013 Site: El Junquillo

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	4	1	21	16	113	180	110	85	149	163	49	13	904
*2. mean daily temp. ^{o}C	19.6	20.3	22.0	23.1	23.4	23.2	22.6	22.7	22.5	22.2	20.8	19.7	21.8

* Local temperature data are not available. The mean monthly values have been estimated using the method described on page 11.

Site No: P014

Country: Nicaragua Department: Leon

District: Sebaco Site: Cerro el Bonete

Latitude: 12° 50'N Longitude: 86° 18'W Altitude (m): 950

Location:

The site is located at the extreme southern limit of the natural range of the species, on hills west of the Rio Grande de Matagalpa, which flows through the broad fertile plain of Sebaco at about 470 m elevation. A few scattered older pines may be found on the lower slopes down to 700 m but farm clearing, grazing and burning, with selective felling, are progressively reducing the area of pine forest which is now found in scattered open stands in the higher and less accessible terrain.

Soil:

The pale freely-drained sandy soils with very little humus have been derived from volcanic rocks, mainly rhyolitic tuff and ignimbrites. pH 6.0.

Stand description:

The collections were made in an area of very open stands of scattered pines on steep slopes with only thin grass cover and areas of bare soil and rock. All older trees show damage from repeated severe fires but there is good pine regeneration in a few areas which have escaped regular burning. Many young stems show marked basal sweep, probably due to fire damage resulting in death of the stem and regrowth from shoots at the base, and many saplings show a rather sinuous habit.

Seed collections:

1. P014A (K32, 2/71) January 1971

   Seed was collected from 38 standing trees selected principally for straightness of stem.

   Seed bearers:

   DBH (cm): 30 to 60 Height (m): 15 to 25
   Branching: rather heavy 60° to 80°
   Boles: straight, some basal sweep

2. P014B (K, 4/70) February 1970

   Seed was collected from six selected trees. The cone crop was very sparse.

   Seed bearers:

   DBH (cm): 50 to 60 Height (m): 18 to 23
   Branching: heavy, persistent, 50° to 70°
   Boles: straight, cylindrical

3. P014D (K103, 7/74) February 1974

   Seed was collected from 80 standing trees selected principally for straightness of stem.

   Seed bearers:

   Details as for P014A.

METEOROLOGICAL DATA

Site No: P014 — Site: Cerro el Bonete

Meteorological station: Sebaco — Country: Nicaragua

Latitude: 12° 51'N — Longitude: 86° 06'W — Altitude (m): 470

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall mm	3	3	4	23	117	204	79	67	169	213	36	4	922	17
*2. mean daily temp. °C	20.2	20.7	22.0	22.9	22.9	21.3	21.1	21.5	21.6	21.5	20.5	20.5	21.4	16

* The collection site at Cerro el Bonete is 480 m higher than Sebaco. The mean monthly temperatures recorded above are those registered at the meteorological station minus 2.7°C.

Site No: P015

Country: Guatemala | Department: El Progresso

District: Morazan | Site: Finca el Bucaral

Latitude: 15° 01'N | Longitude: 90° 09'W | Altitude (m): 1,000-1,300

Location:

The site is at the western end and on the southern slopes of the Sierra de las Minas, and immediately north of the very hot, arid central lowlands of El Progreso and Zacapa. No pines are found in the lowlands but scattered stands occur at about 700 m upwards on foothills to the north and extensive forests of P. oocarpa are found, mainly between 800 to 1500 m elevation, along the southern slopes of the Sierra de las Minas and Sierra de Chuacus which tend to be aligned in an east-west direction.

Soil:

Shallow, freely-drained, sandy or gravelly soils have been derived from the parent rock, a micaceous schist, decaying in situ, Heavier sub-soils are found in the valley bottoms. In many places the pines are found growing directly on the decaying rock. pH 5.7.

Stand description:

Twenty to thirty years of fire protection following a felling has resulted in a young dense forest of pure P. oocarpa. Over much of the area the pine is so dense as to suppress all other vegetation but open patches occur with thin grass cover and occasional Curatella americana, Miconia sp. and some Quercus spp. Growth rates seem to be low due to a dry site and very heavy stocking. The relief is very broken with steep slopes of 35° common.

Seed collections:

1. P015A (K34, 3/71) January 1971

   Seed was collected from 111 standing trees selected principally for straightness and persistence of the main axis and light horizontal branching. Selection was made over an area of more than 150 hectares on either side of the track from La Providencia towards Bucaral. There is a large difference in elevation along the two kilometres transversed.

   Seed bearers:

   DBH (cm): 40 to 60 | Height (m): 25 to 35
   Branching: light, 80°
   Boles: straight, cylindrical

2. P015B (K80, 14/72)

   A bulk collection was made from the trees cut during a selective felling.

METEOROLOGICAL DATA

Site No: P015 Site: Finca el Bucaral

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	2	2	4	20	134	206	123	78	194	119	15	3	900
2. mean daily temp. ^{o}C	19.9	20.6	21.8	22.6	22.8	22.2	22.2	22.2	21.9	21.4	20.8	20.2	21.6

Local meteorological data are not available. The mean annual rainfall at Salamá, about 25 km east north east is 790 mm while at El Rancho in the lowlands, ten kilometres to the south, it is only 583 mm. The mean annual rainfall at the collection are is probably about 900 mm with a distribution throughout the year similar to that encountered at El Rancho.

The mean monthly temperature values have been estimated using the method described on page 11

Site No: P016

Country: Honduras Department: Francisco Morazan

District: Tegucigalpa Site: Valle de Angeles

Latitude: 14° 07'N Longitude: 87° 04'W. Altitude (m): 1,300

Location:

The site is approximately thirteen kilometres east of Tegucigalpa and five kilometres south-west of Valle de Angeles on the steep southern slopes and spurs of Cerro el Granadillo. This location is about central in the very extensive pine forest of Honduras.

Soil:

The parent rock is a purplish-brown mudstone or siltstone which has given rise to a shallow freely-drained soil composed mainly of rock fragments. pH 6.0.

Stand description:

The collection area lies within a water catchment which has been protected from fire since the last exploitation. Consequently the stands are predominantly young trees of P. oocarpa, in some areas very densely stocked. In the dense young stands all other vegetation has been suppressed but in more open areas the ground is covered with tall grasses, notably Hyparrhenia rufa, Andropogon sp. and Paspalum sp. Pteridium occurs in some areas, with salvias and some oak (Quercus sp.) in the valleys. Pinus pseudostrobus also occurs at elevations of 1,300 m and above, mainly in stream valleys. The slopes are very steep from 30° to nearly 40° in places.

Seed collections:

1. P016A (K35, 4/71) January 1971

   Seed was collected from 114 standing trees selected principally for straightness and persistence of main axis and light horizontal branching. Selection was made over an area of more than one square kilometre on either side of the road from Tegucigalpa to Valle de Angeles.

   Seed bearers:

   DBH (cm): 30 to 40 Height (m): 20 to 30
   Branching: light, 70° to 80°
   Boles: straight, cylindrical

2. P016B (K71, 6/72)

   A bulk collection was made from standing trees by a local seed collector (St. Marco Tulia Moya).

METEOROLOGICAL DATA

Site No: P016 — Site: Valle de Angeles

Meteorological station: Tegucigalpa (Airport) — Country: Honduras

Latitude: 14° 03'N — Longitude: 87° 13'W — Altitude (m): 1,007

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall mm	11	5	9	29	152	164	88	95	182	133	39	13	920	31
*2. mean daily temp. °C	17.8	18.9	20.1	21.5	21.8	21.7	20.8	21.0	21.2	20.2	19.1	18.1	20.2	

* The collection site at Valle de Angeles is 300 m higher than Tegucigalpa. The mean monthly temperatures recorded above are those registered at the meteorological station minus 1.7°C.

Site No: P017

Country: Honduras Department: Francisco Morazan

District: El Zamorano Site: El Zamorano

Latitude: 13° 58'N Longitude: 86° 59'W Altitude (m): 1,100

Location:

The collection site is on the steep hills on the eastern side of the broad valley of El Zamorano, approximately eight kilometres directly south-east of the Escuela Agricola Panamericana. This location is roughly central in the very extensive pine forests of Honduras.

Soil:

The soil is freely-drained, sandy and pale in colour with little humus. It is apparently little altered from the parent rocks which are white and rather soft ignimbrites, mainly rhyolitic tuff.

Stand description:

The principal vegetation comprises open stands of P. oocarpa with a few small Quercus sp. in more sheltered valleys. The ground cover is mainly grasses but with locally dense patches of Mimosa albida. All older trees show signs of past damage from severe and repeated fires but areas of excellent sapling and pole regeneration of P. oocarpa occur locally, often on steep slopes among rocky outcrops where fire is less intense and less frequent.

Seed collections:

1. P017A (K36, 5/71) February 1971

Seed was collected from about 120 selected felled trees, many of them yielding very few cones.

Seed bearers

DBH (cm): 40 to 60 Height (m): 25 to 35
Branching: light, 80°
Boles: straight, cylindrical

METEOROLOGICAL DATA

Site No: P017 — Site: El Zamorano

Meteorological station: El Zamorano — Country: Honduras

Latitude: 14° 00'N — Longitude: 87° 02'W — Altitude (m): 792

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1.	mean monthly rainfall mm	11	7	14	36	154	206	150	144	195	144	42	14	1,117	22
*2.	mean daily temp. °C	18.8	19.3	20.7	21.7	22.3	21.1	20.7	21.0	21.0	20.5	19.6	18.8	20.4	

* The collection site is 300 m higher than the meteorological station. The mean monthly temperatures recorded above are those registered at the meteorological station minus 1.7°C.

Site No: P018

Country: Nicaragua Department: Matagalpa

District: Matagalpa Site: Yucul

Latitude: 12° 55'N Longitude: 85° 47'W Altitude (m): 900

Location:

The collection site is near the southern extreme of the natural range of the species, on the southern slopes of the Cordillera de Darien, fifteen kilometres east-south-east of Matagalpa.

Soil:

The parent rock is mainly basalt or andesite, outcropping on the crests of the hills. The soil is a sandy loam, overlying a heavier clay loam, with a dark humus layer in the top eight to twelve centimetres. Drainage is generally free.

Stand description:

The pine forest is fairly open and mature. The stems are straight but many exhibit nodal "bumps".

Seed collections:

1. P018A (K42, 6/71) February 1971

   Seed was collected from 46 selected trees, of which 29 were cut in selective felling and the remainder climbed.

   Seed bearers:
   DBH (cm): 45 to 60 Height (m): 20 to 32
   Branching: light, 70° to 80°
   Boles: straight with stem bumps

2. P018B (K94, 12/73) March/April 1973

   Seed was collected from about 108 selected standing trees.

   Seed bearers:
   DBH (cm): 40 to 60 Height (m): 32 to 35

3. P018C (K101, 8/74) March 1974

   Seed was collected from selected standing trees.

   Seed bearers:
   Details as for P018A

4. P018E (K128, 2/76)

   Seed was collected from about 15 selected standing trees.

   Seed bearers:
   Details as for P018A

5. P018G (K140, 5/77)

   Seed was collected from about 75 selected standing trees.

   Seed bearers: Details as for P018A

METEOROLOGICAL DATA

Site No: P018 Site: Yucul

Meteorological station: Matagalpa Country: Nicaragua

Latitude: 12° 55'N Longitude: 85° 55'W Altitude (m): 680

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall mm	20	12	11	26	131	286	180	161	235	238	67	27	1,394	16
2. mean daily temp. °C	20.2	20.9	22.5	23.6	23.9	23.7	23.1	23.3	23.0	22.7	21.3	20.3	22.4	

Local temperature data are not available. The mean monthly temperature values have been estimated using the method described on page 11

Site No: P019

Country: Guatemala Department: Jalapa

District: Jalapa Site: Finca la Lagunilla

Latitude: 14° 42'N Longitude: 89° 57'W Altitude (m): 1,600

Location:

The site is on steep hills about seven kilometres north of Jalapa. The pine forest in this area is now restricted to isolated stands on the higher and generally less accessible and less fertile terrain.

Soil:

The parent rock is mainly cemented volcanic ash and tuff producing a pale greyish sandy soil with a deep, dark humus layer in the top 15 to 20 cm and grading below into a yellowish, slightly heavier subsoil but still with very free drainage. pH 5.1.

Stand description:

The principal vegetation is mainly dense young stands of P. oocarpa with many 'plus' quality trees. Liquidambar styraciflua occurs in some stream valleys. There is also a little P. pseudostrobus. Lower down the hillsides are areas of Quercus spp. with dense grass, but in the pine stands most of the ground vegetation has been suppressed. Some Pteridium sp. and wild blackberry (Rubus sp.) occur locally.

Seed collection:

1. P019A (K43, 8/71) February 1971

   Seed was collected from 43 selected standing trees.

   Seed bearers:

   DBH (cm): 40 to 60 Height (m): 25 to 35
   Branching: light, 80° to 90°
   Boles: straight, cylindrical

2. P019B (K87, 7/73) March 1973

   Seed collection details as for P019A

3. P019C (K112, 8/75) February 1975

   A bulk collection from selected standing trees

METEOROLOGICAL DATA

Site No: P019 — Site: Finca la Lagunilla

Meteorological station: Jalapa — Country: Guatemala

Latitude: 14° 38'N — Longitude: 89° 59'W — Altitude (m): 1,362

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1.	mean monthly rainfall mm	0	0	7	9	105	256	141	152	192	74	0	0	936	4
*2.	mean daily temp. °C	17.5	18.7	19.7	21.4	21.2	20.7	20.0	20.1	19.6	19.0	18.3	17.6	19.5	5

* The collection site at Finca la Lagunilla is 240 m higher than Jalapa. The mean monthly temperatures recorded above are those registered at the meteorological station minus 1.3°C.

Site No: P020

Country: Nicaragua Department: Jinotega

District: San Rafael del Norte Site: San Rafael del Norte

Latitude: 13° 14'N Longitude: 86° 08'W Altitude (m): 1,200

Location:

The site is at the western end of the broad Cordillera Isabella which is separated from the main pine forests of the Sierra de Dipilto by the valley of the Rio Coco. Scattered stands of P. oocarpa occupy the less fertile slopes and crests, separated by broad areas of grazing land and cultivation.

Soil:

There is a great variety of rock types in the areas but andesite was seen outcropping most frequently in the collection area. The soil is a well-drained sandy loam with a dark humus content in the top eight to twelve centimetres.

Stand description:

The forest cover is generally very open stands of P. oocarpa, mostly about 30 metres high in better areas with large number of very good straight stems, Dense grass is the main ground cover including Paspalum sp., Andropogon sp. and Aristida sp. but fire damage to the pines appears less frequent and severe than in most other areas. P. pseudostrobus also occurs locally.

Seed collections:

1. P020A (K44, 27/71) March 1971

   Seed was collected from about 60 standing trees.

   Seed bearers:

   DBH (cm): 40 to 60 Height (m): 25 to 35
   Branching: light, 80°
   Boles: straight, cylindrical

2. P020B (K142, 7/77) January-February 1977

   Seed was collected from about 170 selected standing trees. Other collection details as for P020A.

METEOROLOGICAL DATA

Site No: P020 — Site: San Rafael del Norte

Meteorological station: San Rafael del Norte — Country: Nicaragua

Latitude: 13° 12'N — Longitude: 86° 06'W — Altitude (m): 1,078

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual rainfall	Number of years of observations
1. mean monthly rainfall mm	68	26	22	31	118	206	165	159	191	218	92	70	1,366	22 (1952-73)
4. mean daily temp. °C	18.4	19.2	20.9	22.0	22.4	22.3	21.5	21.6	21.4	21.2	19.7	18.4	20.8	

Local temperature data are not available. The mean monthly temperature values have been estimated using the method described on page 11

Site No: P021

Country: Honduras Department: Comayagua

District: Siguatepeque Site: Siguatepeque

Latitude: 14° 32'N Longitude: 87° 50'W Altitude (m): 1,100

Location:

The site is located immediately south of the forestry school, on the outskirts of Siguatepeque town. These stands are part of the very extensive but generally very open forest of P. oocarpa on the mountains between the valleys of Comayagua to the east and the Rio Ulua to the west.

Soil:

The parent rocks are the massive deposits of Miocene ignimbrites deeply exposed in cuttings on the new Carretera del Norte and estimated to be up to 300 m thick. They are mainly rhyolitic tuffs, white and soft, giving rise to very shallow soils with little humus and apparently little altered from the parent material. Drainage is free. pH 6.0.

Stand description:

The forest in the collection area is mostly very open as a result of previous felling and frequent fires. The older trees left are scattered and usually of poor form but there are areas of good young trees from 15 to 25 metres in height. A few scattered Quercus sp. occur locally but over most of the area P. oocarpa is the only tree species. The ground cover is dense short grass with the sedges Cyperus flavus and Dichromonas sp. although some bracken occurs and patches of Clitoria sp. and Melochia villosa.

Seed collections:

1. P021A (K45, 7/71) February 1971

   The collection was made from about 100 standing trees by climbers under partial supervision.

   Seed bearers:

   DBH (cm): 25 to 35 Height (m): 15 to 30
   Branching: light, 70°
   Boles: generally straight, cylindrical

METEOROLOGICAL DATA

Site No: P021 — Site: Siguatepeque

Meteorological station: Siguatepeque — Country: Honduras

Latitude: 14° 32'N — Longitude: 87° 50'W — Altitude (m): 1,078

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1.	mean monthly rainfall mm	21	13	6	18	161	188	182	142	205	208	59	44	1,247	8
2.	mean max. daily temp. °C	24.9	25.5	29.1	30.6	29.8	28.0	28.1	27.6	28.1	27.6	26.7	25.1	27.6	3
3.	mean daily temp. °C	17.8	18.1	20.8	21.4	21.3	21.1	20.7	20.3	20.3	20.4	19.1	17.4	19.9	3
4.	mean min. daily temp. °C	11.0	10.9	11.5	12.2	13.1	14.5	13.4	13.3	12.5	13.3	11.3	10.4	12.3	3

Site No: P022

Country: Guatemala Department: Baja Verapaz

District: Salama Site: Chuacus

Latitude: 15° 02'N Longitude: 90° 16'W Altitude (m): 1,300

Location:

The site is located at the western end of the Sierra de Chuacus, about eight kilometres south-south-east of Salama. Extensive forests of P. oocarpa occupy most of this range and extend eastwards along the adjoining Sierra de las Minas.

Soil:

The parent rock is micaceous schist decaying in situ to form a shallow sandy or gravelly loam, about ten centimetres deep, with some humus in the top two to four centimetres, overlying a rather heavier subsoil grading downwards into decaying rock. Drainage is free. pH 6.0.

Stand description:

The collection was made from fairly open pine forest on dry gravelly slopes close to the site of an old sawmill. Some selective logging was done about fifteen years previously. Many trees showed evidence of damage from repeated severe fires and several cases of Cronartium attack were seen.

Liquidambar styraciflua occurs in some moister stream valleys, and a few Pinus pseudostrobus which become more frequent above 1,500 metres, Quercus spp. are also present. Bracken and shrubs such as Miconia sp. are quite dense locally. Byrsonima crassifolia also occurs.

Seed collections:

1. P022A (K46, 9/71) February 1971

Seed was collected from 25 selected standing trees

Seed bearers:

DBH (cm): 40 to 60 Height (m): 20 to 30
Branching: light, 70° to 80°
Boles: mostly straight, some basal sweep

METEOROLOGICAL DATA

Site No: PO22 — Site: **Chuacus**

Meteorological station: Salama — Country: Guatemala

Latitude: 15° 06'N — Longitude: 90° 19'W — Altitude (m): 977

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1.	mean monthly rainfall mm	20	6	15	24	70	224	134	75	102	74	34	12	790	6(1938-40,52,53,56)
2.	absol. max. temp. °C	29	31	34	33	32	32	29	30	31	29	30	27		5
3.	mean max. daily temp. °C	25.9	27.2	29.3	30.0	28.8	26.5	26.8	27.7	27.8	27.0	26.5	24.1	27.3	5
4.	mean daily temp. °C	20.2	21.1	22.8	24.5	24.4	23.3	23.2	23.8	23.6	22.7	21.3	19.6	22.5	5
5.	mean min. daily temp. °C	14.4	14.9	16.3	19.0	19.9	20.1	19.4	19.7	19.3	18.2	16.0	15.0	17.7	5
6.	absol. min. temp. °C	8	10	11	16	15	17	17	14	16	14	13	9		5
7.	mean daily R.H. %	66	65	63	66	70	75	71	73	78	72	70	67	69.7	3

Site No: P023

Country: Guatemala Department: Chichimula

District: Esquipulas Site: Finca San Jose

Latitude: 14° 28'N Longitude: 89° 28'W Altitude (m): 1,000

Location:

The site is located at the extreme eastern edge of Guatemala, close to the frontiers with El Salvador and Honduras Republic, about six kilometres south of Concepcion las Minas. Scattered areas of open pine forest are found mainly on the less fertile hills.

Soil:

Overy most of the collection area the parent rock is a schist giving rise to a shallow sandy or gravelly soil over a slightly heavier subsoil, very freely-drained. The pine forest also extends onto the extensive surrounding areas of soils derived from pale cemented volcanic ash or tuff. These volcanic soils are also freely-drained pale sandy-loam over a yellowish-grey heavier subsoil.

Stand description:

The forest cover is almost entirely pure P. oocarpa, the ground cover being mainly grasses. The collection stand is on very steep slopes. It is part of about 700 hectares of private forest, most of which has been under protection from fire for up to fifteen years. In the adjoining municipal forest fires occur annually and most older trees in the private forest show evidence of past severe fires as well as severe damage from illegal and crude resin tapping.

Seed collections:

1. P023A (K47, 10/71) February 1971

   Seed was collected from 34 standing trees selected principally for straightness and persistence of the main axis.

   Seed bearers:

   DBH (cm): 30 to 40 Height (m): 20 to 30
   Branching: medium to heavy, 70° to 90°
   Boles: mostly straight, cylindrical

METEOROLOGICAL DATA

Site No: P023 Site: Finca san José

Meteorological station: Conception las Minas Country: Guatemala

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	0	1	2	14	104	215	159	168	195	86	11	1	956
2. mean daily temp. ^{o}C	20.8	21.5	22.7	23.5	23.6	23.1	23.0	23.0	22.7	22.2	21.7	21.0	22.4

The mean monthly temperature values have been estimated using the method described on page 11

Site No: PO24

Country: Guatemala Department: Huehuetenango

District: Huehuetenango Site: Malacatancito

Latitude: 15° 13'N Longitude: 91° 32'W Altitude (m): 1,700

Location:

The site is at the western end of Guatemala, approaching the Mexican border, in an area of relatively low elevation and low fertility compared with the main mountain mass surrounding it.

Soil:

The parent material appears to be granite and gneiss giving rise to a freely-drained very shallow sandy or gravelly soil. Surface erosion is active and there is very little humus even in the surface layers.

Stand description:

The collection was made in very open pine forest on moderate to steep slopes with thin grass cover and extensive areas of bare soil in places. P. oocarpa is by far the commonest species although P. montezumae also occurs. Regeneration of the pine is generally poor but there are good patches. Most mature trees show rather poor form with relatively short boles and heavy branches.

Seed collections:

1. PO24A (K48, 29/71) March 1971

   Seed was collected from 39 standing trees selected principally for straightness and persistence of the main axis.

   Seed bearers:

   DBH (cm): 30 to 40 Height (m): 16 to 25
   Branching: Heavy, 70° to 80°
   Boles: short, tapering strongly

METEOROLOGICAL DATA

Site No: PO24 Site: Malacatancito

Meteorological station: Huehuetenango Country: Guatemala

Latitude: 15° 19'N Longitude: 91° 28'W Altitude (m): 1,902

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1.	mean monthly rainfall mm	0	2	12	20	116	185	157	118	190	226	11	0	1,037	3(1948,49,52)
2.	absol. max. temp. °C	30	29	32	31	30	30	28	28	28	27	26	26		3
3.	mean max. daily temp. °C	24.5	25.1	27.2	27.5	26.4	25.4	25.4	25.6	24.9	24.7	24.5	24.6	25.5	3
4.	mean daily temp. °C	15.2	16.0	17.4	18.5	18.5	17.6	17.5	17.6	17.2	16.7	15.7	15.3	16.9	3
5.	mean min. daily temp. °C	8.2	10.4	11.7	12.5	13.8	14.9	15.3	15.9	15.1	15.4	12.4	11.4	13.1	3
6.	absol. min. temp. °C	2	4	3	5	8	9	10	11	10	9	7	4		3
7.	mean daily R.H. %	68	65	65	67	77	74	78	80	82	81	75	70	74	3

Site No: P026

Country: Belize

District: Cayo Site: Mountain Pine Ridge

Latitude: 17° 00'N Longitude: 88° 55'W Mean altitude (m): 700

Location:

The Mountain Pine Ridge is a dissected upland plateau covering about 640 sq. km. to the south-east of Cayo.

Ecology and soil:

The Mountain Pine Ridge forms the north-west corner of the Maya Mountain massif. Originally it was a limestone peneplain. This has now dissolved away over a considerable part so that most of the forest reserve comprises a granite basin draining to the west. The mantel of limestone remains in the north-west, whilst to the east, north and south the central basin is bounded by higher ground consisting of metamorphosed Palaeozoic sediments. The soils derived from these rocks have a very poor nutrient status.

Stand description:

P. caribaea occupies the infertile and exposed sites on the ridge tops and in the granite basin. P. oocarpa has a tendency to be restricted to sheltered sites and is more common on the soils derived from the sedimentary rocks than those derived from the granite. It is most prevalent on the shales and slate ridges.

The ground vegetation beneath the P. oocarpa is predominantly shrubby fern and dumbcane (Deiffenbachia seguine). Beneath the P. caribaea it is mostly a tussocky grass.

Seed collections:

1. P026A (K49, 30/71) February 1971

2. P026B (10/74) February 1974

3. P026C (11/74) February 1974

4. P026D (12/74) February 1974

5. P026E (15/77) February 1977

All these collections were from young stands of variable density. Practically all the original forest was either felled or badly damaged by the hurricane in 1961.

The seed was collected by climbers working under contract to the Belize Forest Department. They are therefore wide-ranging bulk collections of unknown quality.

Site No: P026
Meteorological station: Augustine
Latitude: 16°58'N

Site: Mountain Pine Ridge
Country: Belize
Longitude: 89°00'W

Altitude(m): 487

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall	mm	87	45	45	54	91	167	142	164	242	245	176	100	1,558	22
2. absol. max. temp.	°C	31	34	37	39	39	37	33	38	34	36	33	34		5
3. mean max. daily temp.	°C	24.7	25.8	28.5	31.3	31.9	31.0	30.0	30.0	29.7	28.2	25.2	26.2	28.5	6
4. mean daily temp.	°C	20.0	21.0	23.2	25.6	26.8	26.9	25.7	25.1	25.1	24.8	21.8	21.5	23.9	6
5. mean min. daily temp.	°C	15.3	16.2	17.9	20.0	21.6	22.8	21.4	19.8	20.5	20.0	18.4	16.8	19.2	6
6. mean daily R.H.%		88.4	82.2	78.5	71.2	73.0	81.1	80.8	82.0	82.2	84.5	83.5	86.0	81.1	6
7. absol. min. R.H.%		40	40	38	28	31	38	52	50	35	44	43	45		4

These data are probably typical of conditions in the main granite basin.

Site No: P026
Meteorological station: Cooma Cairn
Latitude: 17°00'N

Site: Mountain Pine Ridge
Country: Belize
Longitude: 88°51'W

Altitude(m): 953

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall	mm	172	84	28	78	85	212	228	166	243	271	335	162	2,064	13
2. absol. max. temp.	°C	26	27	32	33	34	33	30	29	31	28	27	28		5
3. mean max. daily temp.	°C	20.6	21.9	23.9	26.9	29.0	27.4	25.9	26.1	25.6	24.0	21.2	21.2	24.5	6
4. mean daily temp.	°C	17.7	18.8	20.5	23.0	24.2	23.6	22.8	22.9	22.5	21.1	18.8	18.6	21.2	6
5. mean min. daily temp.	°C	14.8	15.8	17.1	19.1	19.4	19.9	19.7	19.7	19.4	18.2	16.5	15.9	17.9	6
6. absol. min. temp.	°C	8	6	9	16	14	17	17	17	18	14	10	9		5
7. mean max. R.H.%		92	88	84	78	72	79	80	80	65	86	90	88	81.8	5
8. mean min. daily R.H.%		53	50	39	39	40	56	38	52	53	57	62	63		5

These data apply to the hilly eastern part of the Mountain Pine Ridge.

Site No. P027

Country: Honduras Department: Francisco Morazan

District: El Zamorano Site: El Zamorano, School Forest

Latitude: 14° 02'N Longitude: 87° 03'W Altitude (m): 1,100-1,240

Location:

The collection was made approximately two kilometres south of El Zamorano within the forest belonging to the Escuela Agricola Pan Americana on the northern slopes of Montana Oyuca. The pine forest is continuous along the valley above eight hundred metres, but variable in density owing to the rocky nature of the terrain. Pinus pseudostrobus occurs above 1,400 metres and dense hardwood forest is found on the summit.

Soil:

The parent material is predominantly volcanic tuff with abundant igneous intrusions giving rise to a freely-drained rocky stony soil, pale greyish brown in colour. pH 4.8 (Electrode in KCl solution).

Stand description:

The forest cover comprises closed mature stands of P. oocarpa on steep to moderate slopes with few Quercus sp. along the sheltered valleys. Ground cover is mainly abundant Mimosa tenuifolia, Mimosa albidi and Baccharis trinervis. Scattered patches of Myrica cerifera, Senecio thomasii and bracken also occur. Grasses are sparse, the predominant species being Andropogon condensatus and Leptochloa sp. Many trees show damage from past fires. Stems are mostly straight. There is a wide variation in the degree of branching.

Seed collections:

1. P027A (K86, 3/73) February 1973

   Seed was collected from 49 standing trees selected principally for straightness and persistence of the main axis. The cone crop was very sparse.

   Seed bearers

   DBH (cm): 39 to 64 Height (m): 25 to 34
   Branching: medium to light, 60° to 90°
   Boles: cylindrical, some slight basal sweep and bow

METEOROLOGICAL DATA

Site No: PO27 — Site: El Zamorano, School Forest

Meteorological station: El Zamorano — Country: Honduras

Latitude: 14° 00'N — Longitude: 87° 02'W — Altitude (m): 792

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall mm	11	7	14	36	154	206	150	144	195	144	42	14	1,117	22
2. mean daily temp. °C	18.5	19.0	20.4	21.4	22.0	20.8	20.4	20.7	20.7	20.2	19.3	18.5	20.2	10

The collection site is 350 m higher than the meteorological station. The mean monthly temperatures recorded above are those registered at the meteorological station minus 2.0°C.

Site No: P028

Country: Honduras Department: Francisco Morazan

District: El Zamorano Site: El Zamorano, School Forest

Latitude: 14° 02'N Longitude: 87° 03'W Altitude (m): 1,300-1,420

Location:

The collection was made approximately two kilometres south of El Zamorano within the forest belonging to the Escuela Agricola Pan Americana on the northern slopes of Montana Oyuca (immediately above the site of PO 27). The pine forest is continuous along the valley above eight hundred metres, but variable in density owing to the rocky nature of the terrain. Pinus pseudostrobus occurs above 1,400 metres and dense hardwood forest is found on the summit.

Soil:

The parent material is predominantly volcanic tuff with abundant igneous intrusions giving rise to a freely-drained rocky stony soil, pale greyish brown in colour. pH 4.8 (Electrode in KCl solution).

Stand description:

The forest cover comprises closed mature stands of P. oocarpa on steep to moderate slopes with few P. pseudostrobus at the higher elevations. Ground cover is mainly abundant Mimosa albidi and Baccharis trinervis. Scattered patches of Myrica cerifera, Senecio thomasii, Mimosa tenuifolia, and bracken also occur, with Rubus sp. at the upper limit of the altitudinal range. Grasses are sparse, the predominant species being Andropogon condensatus and Andropogon virginicus.

Seed collections:

1. P028A (K88, 8/73) April 1973

   Seed was collected from 30 standing trees selected principally for straightness and persistence of the main axis. The cone crop was very light.

   Seed bearers:

   DBH (cm): 42 to 55 Height (m): 26 to 34
   Branching: medium to light, 60° to 90°
   Boles: cylindrical, some slight basal sweep and bow.

METEOROLOGICAL DATA

Site No: P028

Site: El Zamorano, School Forest

Meteorological station: El Zamorano

Country: Honduras

Latitude: 14° 00'N

Longitude: 87° 02'W

Altitude (m): 792

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of Years of observations
1. mean monthly rainfall mm	11	7	14	36	154	206	150	144	195	144	42	14	1,117	22
2. mean daily temp. °C	17.5	18.0	19.4	20.4	21.0	19.8	19.4	19.7	19.7	19.2	18.3	17.5	19.2	10

The collection site is 550 m higher than the meteorological station. The mean monthly temperatures recorded above are those registered at the meteorological station minus 3.0°C.

Site No: P031

Country: Nicaragua Department: Nueva Segovia

District: Dipilto Site: Dipilto

Latitude: 13° 43' Longitude: 86° 32'W Altitude (m): 1,000-1,200

Location:

The collection was made within a three kilometre radius of the entrance to the timber extraction road, situated two kilometres north of Dipilto on the west side of the main Ocotal-Las Manos highway. Seed was collected from trees on the western side of the highway on the north east facing slopes.

Soil:

The underlying rock is granite which has decayed in situ giving rise to a freely-drained sandy soil varying in depth from 0.25 to 3.0 metres. pH 5.8.

Stand description:

The stands in the collection area vary greatly in stocking, height and form, but the best trees appear to be superior to all others of the species seen in Nicaragua.

Seed collections:

1. P031A (K67, 1/72)

   A bulk collection from selected trees.

2. P031B (K91, 9/73) January-March 1973

   Seed was collected from approximately 430 standing trees.

   Seed bearers:

   DBH (cm): 40-65 Height (m): 30-36

3. P031C (K116, 6/75) January 1975

   Seed was collected from 113 standing trees. Trees from the eastern side of the highway were also included in this collection.

METEOROLOGICAL DATA

Site No: P031 Site: Dipilto

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	3	7	22	38	149	217	126	118	173	234	49	7	1,143
2. mean daily temp. ^{o}C	19.0	19.7	21.4	22.5	22.9	22.8	22.0	22.2	22.0	21.7	20.2	19.0	21.3

Local meteorological data are not available. Precipitation is estimated as being similar to that recorded at San Fernando, fourteen kilometres distant. The mean monthly temperature values have been estimated using the method described on page 11

Site No: PO32

Country: Nicaragua Department: Nueva Segovia

District: Dipilto Site: Dipilto

Latitude: 13° 43'N Longitude: 86° 37'W Altitude (m): 1,200

Location:

The collection site is located twelve kilometres along the timber extraction road situated two kilometres north of Dipilto on the west side of the main Ocotal-Las Manos highway.

Soil:

The underlying rock is granite which has decayed in situ giving rise to a freely-drained sandy soil varying in depth from 0.25 to 2.0 metres or more. pH 6.2.

Stand description:

The collection was made from the older trees which were left after a first felling about fifteen years previously. The stands are on the hill tops and somewhat open (200 to 500 trees per hectare). They consist of reasonable but not outstanding trees.

Collections:

1. PO32A (K92, 10/73) January 1973

   Seed was collected from approximately 150 felled trees.

   Seed bearers:

   DBH (cm): 50 to 65 Height (m): 33

METEOROLOGICAL DATA

Site No: P032 Site: Dipilto

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	3	7	22	38	149	217	126	118	173	234	49	7	1,143
2. mean daily temp. ^{o}C	18.4	19.2	20.9	22.0	22.4	22.3	21.5	21.6	21.4	21.2	19.7	18.4	

Local meteorological data are not available. Precipitation is estimated as being similar to that recorded at San Fernando, fourteen kilometres distant. The mean monthly temperature values have been estimated using the method described on page 11

Site No: P033

Country: Honduras Department: Yoro

District: Yoro Site: Yoro

Latitude: 15° 16'N Longitude: 87° 06'W Altitude (m): 1,100

Location:

The site is north-east of Yoro town in an area of extensive pine forests. P. caribaea occurs in the valleys, giving way to P. oocarpa above 800 m altitude.

Stand description:

The seed was collected from open forest along ridge-tops and on the steep slopes.

Seed collections:

1. P033A (K68, 2/72) February 1972

   A bulk collection was made from felled trees by a local seed collector (Sr. Marco Tulio Moya).

METEOROLOGICAL DATA

Site No: P033 Site: Yoro

Meteorological station: Yoro Country: Honduras

Latitude: 15° 10'N Longitude: 87° 07'W Altitude (m): 610

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall mm	27	30	15	31	131	156	109	100	153	157	104	56	1,069	13
*2. mean daily temp. °C	19.4	20.4	22.9	23.6	23.7	23.2	22.0	22.1	21.0	20.8	20.8	19.5	21.6	10 (1952-61)

* The collection site is 490 m higher than Yoro. The mean monthly temperatures recorded above are those at the meteorological station minus 2.7°C.

Site No: P034

Country: Honduras

Department: Francisco Morazan

District: Guaimaca

Site: Rio Viejo

Latitude: 14° 30'N Longitude: 86° 50'W Altitude (m): 1,100

Location:

The site is near to Guaimaca which is roughly central in the very extensive range of P. oocarpa in Honduras.

Soil:

The soil is a shallow sandy loam with surface quartzite gravel.

Stand description:

The collection was made from open pine forest which had been selectively exploited in the past. It had also suffered from Dendroctonus attack during the 1964 epidemic.

Seed collections:

1. P034A (K72, 7/72) January 1972

   A bulk collection was made from felled trees by a local seed collector (Sr. Marco Tulio Moya).

METEOROLOGICAL DATA

Site No: P034 — Site: Rio Viejo

Meteorological station: Talanga — Country: Honduras

Latitude: 14° 23'N — Longitude: 87° 06'W — Altitude (m): 806

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observation
1. mean monthly rainfall mm	29	16	18	61	190	149	110	84	149	142	74	51	1,073	12
*2. mean daily temp. °C	19.0	19.7	21.5	22.6	22.9	22.8	22.0	22.2	22.0	21.7	20.2	19.0	21.3	

* Local temperature data are not available. The mean monthly temperature values have been estimated using the method described on page 11

Site No: P035

Country: Guatemala Department: Zacapa

District: La Union Site: Los Jutes

Latitude: 15° 05'N Longitude: 89° 15'W Altitude (m): 600-800

Location:

The site is situated approximately mid-way between Gualan and San Enrique on the south side of the Motagua valley.

Seed collections:

1. P035A (K73, 8/72) October 1971

   A bulk collection from felled trees made by the labourers of a local seed collector (Sr. Jose Lewald C.). The trees felled were selected for at least 20 m of clear bole. They probably represent the better quality trees in the stand.

METEOROLOGICAL DATA

Site No: P035 Site: Los Jutes

Meteorological station: San Agustin Buena Vista Country: Guatemala

Latitude: 14° 58'N Longitude: 89° 17'W Altitude (m): 880

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall mm	15	36	26	24	88	223	190	202	240	242	88	64	1,438	4 (1956-59)
*2. mean daily temp. °C	21.4	22.0	23.6	24.7	25.0	24.6	24.2	24.3	24.1	23.6	22.4	21.6	23.4	

*Local temperature data are not available. The mean monthly temperature values have been estimated using the method described on page 11

Site No: P036

Country: Guatemala Department: Chimaltenango

District: Chimaltenango Site: Chimaltenango

Latitude: 14° 45'N Longitude: 90° 50'W Altitude (m): 1,750

Location:

The site is on hilly municipal land in the vicinity of Chimaltenango, much of it on 30° to 45° slopes.

Soil:

The soil is sandy or clay-sand. pH 5.7-6.0.

Stand description:

The seed was collected from stands of P. oocarpa aged 30-40 years growing in mixture with some P. tenuifolia and P. montezumae.

Seed collections:

1. P036A (K74, 9/72) October 1971

   A bulk collection made from standing trees by the labourers of a local seed collector (Sr. Jose Lewald C.).

   Seed bearers:

   DBH (cm): 30 to 35 Height (m): 20-25

METEOROLOGICAL DATA

Site No: PO36 — Site: Chimaltenango

Meteorological station: Chimaltenango — Country: Guatemala

Latitude: 14° 39'N — Longitude: 90° 49'W — Altitude (m): 1,793

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1.	mean monthly rainfall mm	7	8	5	101	132	298	268	238	312	96	124	0	1,589	6 (1934-39)
2.	absol. max. temp. °C	25.0	26.0	29.0	31.0	30.0	27.0	25.0	26.0	27.0	26.0	25.0	24.0		2 (1958-59)
3.	mean max. daily temp. °C	22.0	22.9	25.8	26.5	26.4	23.6	23.2	23.3	23.6	22.7	22.4	21.8	23.7	2 (1958-59)
4.	mean daily temp. °C	15.6	16.1	18.3	19.7	20.2	19.1	18.7	18.7	18.8	17.5	17.1	15.6	17.9	2 (1958-59)
5.	mean min. daily temp. °C	8.3	9.4	10.7	12.7	14.0	14.7	14.2	14.1	13.9	12.4	12.6	9.7	12.2	2 (1958-59)
6.	absol. min. temp. °C	3.0	2.5	6.0	7.5	10.5	12.0	12.0	10.0	10.5	9.0	6.0	3.5		2 (1958-59)
7.	mean daily R.H. %	73	72	76	76	78	85	84	83	86	85	85	79	80	1938

Site No: P037

Country: Honduras Department: Olancho

District: Campamento Site: La Union

Latitude: 14° 32'N Longitude: 86° 38'W Altitude (m): 800

Location:

The site is located approximately five kilometres south-east of Campamento town and roughly central in the very extensive range of P. oocarpa in Honduras.

Soil:

The parent rock is schist which has decayed in situ to form a shallow freely-drained red sandy loam.

Stand description:

The tree cover is pure P. oocarpa, mostly dense, with some Quercus sp. in neighbouring valleys. Some bracken and short grasses are found in the more open areas.

Seed collections:

1. P037A (K78, 12/72) February 1971

The seed collection was a bulk collection from felled trees.

Seed bearers

The seed bearers were of good form and up to 35 metres in height. The rates of growth appeared to be high with about 31 rings in 23 centimetres of cross section radius.

METEOROLOGICAL DATA

Site No: P037 Site: La Union

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall mm	30	20	29	44	149	215	172	144	196	165	67	41	1,272	15
2. mean daily temp. °C	20.8	21.5	23.1	24.1	24.4	24.2	23.6	23.8	23.5	23.2	21.9	21.0	22.9	

Local meteorological data are not available. The precipitation is estimated as being similar to that recorded at Agua Caliente (lat. 14° 40'N, long. 87° 18'W). The mean monthly temperature values have been estimated using the method described on page 11

Site No: P039

Country: Honduras | Department: El Paraiso

District: Villa Santa | Site: Villa Santa

Latitude: 14° 12'N | Longitude: 86° 25'W | Altitude (m): 900

Location:

The site is situated about 20 kilometres east-north-east of Danli on the south eastern slopes of the Montane La Batua. The principal topographic features are ridges with steep slopes. The pine forest is found from the lower slopes to the ridges. A few scattered P. caribaea occur on the lower slopes below 800 metres. The site is markedly drier and less humid than the areas of pine forests to the south west, south of El Paraiso.

Soil:

The parent material is a fine grained metamorphic rock with small areas of schist giving rise to a sandy stony soil of variable depth with free to excessive drainage. The top 20-30 cm is humic stained. pH 4.7. (electrode is KCl solution).

Stand description:

The forest cover is predominantly old stands of P. oocarpa of medium to light density with some areas of greater density comprising young to middle aged trees. Many of the old trees show fire damage. Very little basal sweep or bow is present but the eccentric ring growth shown on some cut stumps indicates that basal sweep might be evident at an earlier age. Stems are mostly straight with a persistent main axis and free from nodal 'bumps'. Angle and degree of branching is variable.

Other trees and bushes are scattered along the seasonal water courses, the main species being Quercus pedunculata var. sublanosa, Q. olevides, Q. hondurensis, Psidium guincense, Zanthoxylon anodynum, Casearia sylvestris and Byrsonima crassifolia.

The grass and herb cover is light as a consequence of grazing and repeated burning. The principal species are: Sporobolus poiretti, Andropogon elliottii, Fimbristylis dishotoma, Axonopus aureus, Muhlenbergia sp., Eupatorium sp., Triumfetta speciosa, Vernonia sp. with scattered light patches of Mimosa albidi and a little bracken.

Seed collections:

1. P039A (K85, 2/73) January-February 1973

   Seed was collected from a mixture of felled and standing trees selected principally for straightness and persistence of the main axis. The cone crop was very light.

   Seed bearers:

   DBH (cm): 30 to 55
   Branching: medium to light, 60° to 90° with some 45° knot angles
   Boles: straight, cylindrical, clear

METEOROLOGICAL DATA

Site No: P039 Site: Villa Santa

Meteorological station: Danli Country: Honduras

Latitude: 14° 02'N Longitude: 86° 32'W Altitude (m): 710

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	35	24	16	25	168	263	184	133	271	141	46	42	1,348
2. mean daily temp. °C	20.2	20.9	22.5	23.6	23.9	23.7	23.1	23.2	23.0	22.7	21.3	20.3	22.4

Local temperature data are not available. The mean monthly temperature values were estimated using the method described on page 11

Site No: P040

Country: Nicaragua Department: Nueva Segovia

District: San Fernando Site: San Fernando

Latitude: 13° 39'N Longitude: 86° 17'W Altitude (m): 800-1000

Location:

The collection sites are on the tops of the hills five kilometres along the timber extraction road, the entrance of which is situated on the south side of the main Ocotal-Jalapa road, six kilometres east of San Fernando village.

Soil:

The underlying rock is granite which has decayed *in situ* to give 0.25-2.0 metres of freely-drained sandy soil. pH 5.5.

Stand description:

The forest cover comprises open stands of *P. oocarpa* with mixed scrub oak. The pines are of reasonable but not outstanding quality.

Seed collections:

1. P040A (K93, 11/73) January-February 1973

   Seed was collected from approximately 20 felled trees.

   Seed bearers:

   DBH (cm): 50 to 65 Height (m): 33

METEOROLOGICAL DATA

Site No: P040 | Site: San Fernando

Meteorological station: San Fernando | Country: Nicaragua

Latitude: 13° 42'N | Longitude: 86° 16'W | Altitude (m): 700

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall mm	3	7	22	38	149	217	126	118	173	234	49	7	1,143	3 (1970-72)
2. mean daily temp. °C	20.2	20.9	22.5	23.6	23.9	23.7	23.1	23.2	23.0	22.7	21.3	20.3	22.4	

Local temperature data are not available. The mean monthly temperature values were estimated using the method described on page 11

Site No: P041

Country: Honduras Department: Intibuca

District: San Juan Site: San Juan

Latitude: 14° 24'N Longitude: 88° 23'W Altitude (m): 1,250-1,330

Location:

The site is on the lower middle south-west slopes of the Cerro Grande, three kilometres due east of San Juan, and to the north of the San Juan-San Miguelito trail.

Soil:

The freely-drained pale grey or greyish-brown gravelly soil has been derived from volcanic tuff. The soil depth is variable, but mostly shallow.

Stand description:

The forest cover is pure P. oocarpa of moderate density on gentle, south-western slopes. The site is subject to frequent fires and as a consequence carries only a sparse grass cover. Occasional small Quercus spp. occur adjacent to the seasonal stream channels. Diameter growth of the pines is moderate for the first ten years, becoming extremely slow thereafter.

Seed collections:

1. P041A (K98, 4/74) January 1974

   The collection was a bulk collection from felled trees.

   Seed bearers:

   DBH (cm): 40 to 60 Height (m): 25 to 30
   Branching: 50° to 90°
   Boles: straight

METEOROLOGICAL DATA

Site No: P041 Site: San Juan

Meteorological station: Gracias Country: Honduras

Latitude: 14° 35'N Longitude: 88° 34'W Altitude (m): 792

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall mm	28	8	17	30	137	275	160	162	224	134	52	34	1,261	7
2. mean daily temp. °C	17.7	18.6	20.4	21.5	21.9	21.8	20.9	21.1	20.9	20.8	19.1	17.8	20.2	

Local temperature data are not available. The mean monthly temperature values were estimated using the method described on page 11

Site No: P042

Country: Honduras Department: Comayagua

District: Site: Pimientilla

Latitude: 14° 54'N Longitude: 87° 30'W Altitude (m): 650-850

Location:

The collection site is an area of approximately two square kilometres south and south-west of Pimientilla bounded by the Quebrada Grande and the Quebrada Los Lirios. The site is immediately adjacent to P043.

Soil:

The pale grey to brownish-grey freely drained soil has been derived from volcanic tuff. The texture is that of a clayey sand. It is mostly deep but areas of exposed rocks also occur, predominantly on the higher ground to the west.

Stand description:

The forest cover consists of light to dense stands of P. oocarpa on predominantly level to gently sloping ground. There is continuous grass cover which is subject to occasional fires.

Seed collections:

1. P042A (K99, 5/74) February-March 1974

   The collection was a bulk collection from felled trees.

   Seed bearers:

   DBH (cm): 30 to 70 Height (m): 20 to 30
   Branching: 50° to 90°
   Boles: straight

METEOROLOGICAL DATA

Site No: P042 Site: Pimientilla

Meteorological station: Victoria Country: Honduras

Latitude: 14° 56'N Longitude: 87° 23'W Altitude (m): 385

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	24	26	4	57	95	139	201	144	198	176	55	15	1,134
2. mean daily temp. °C	21.4	22.1	23.6	24.7	25.0	24.6	24.2	24.3	24.1	23.6	22.4	21.6	23.5

Local temperature data are not available. The mean monthly temperature values were estimated using the method described on page 11

Site No: P043

Country: Honduras Department: Comayagua

District: Site: Valle Bonito

Latitude: 14° 53'N Longitude: 87° 31'W Altitude (m): 850-950

Location:

The site is three kilometres north-east of the village of Valle Bonito and north of the Junction of the Quebrada Los Limos and Quebrada Las Lagunas. The location is immediately above P042.

Soil:

The soil has been derived from volcanic tuff. It is light grey to greyish brown and freely-drained. There are exposed rocks in many places.

Stand description:

The tree cover is pure P. oocarpa of medium to poor quality growing on gently to steeply sloping ground with a variety of aspects. Owing to the rocky nature of much of the terrain, and occasional fires, the ground cover is mostly sparse grasses.

Seed collections:

1. P043A (K102, 3/74) February-March 1974

   The collection was a bulk collection from felled trees.

   Seed bearers:

   DBH (cm): 30 to 70 Height (m): 25 to 30
   Branching: 60° to 90°
   Boles: straight

METEOROLOGICAL DATA

Site No: PO43 Site: Valle Bonito

Meteorological station: Victoria Country: Honduras

Latitude: 14° 53'W Longitude: 87° 31'W Altitude (m): 385

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	24	26	4	57	95	139	201	144	198	176	55	15	1,134
2. mean daily temp. °C	20.2	20.9	22.5	23.6	23.9	23.7	23.1	23.3	23.0	22.7	21.3	20.3	22.4

Local temperature data are not available. The mean monthly temperature values were estimated using the method described on page 11

Site No: P044

Country: Guatemala Department: Huehuetenango

District: Stand: Pueblo Viejo

Latitude: 15° 22'N Longitude: 91° 36'W Altitude (m): 1,700-1,900

Location:

The site is three kilometres south-east of San Sebastian Huehuetenango on the lower and middle slopes above highway CAI, opposite the confluence of the Rio Tojcail and Rio Chicol.

Soil:

The soil has been derived from a complex of volcanic rocks, is very pale grey in colour, freely-drained and of variable depth.

Stand description:

The forest cover consists of a variety of age classes of medium to high density stands of P. oocarpa, with an occasional P. montezumae. The average form is good, especially as regards straightness of the stem, with a few individuals of plus tree quality. The ground vegetation is mostly grasses with little or no pine regeneration owing to the high incidence of grazing by sheep and goats.

Seed collections:

1. P044A (K111, 3/75) January 1975

   The collection was a bulk collection made from standing trees selected for straightness and persistence of the main axis.

   Seed bearers:

   DBH (cm): 35 to 80 Height (m): 10 to 30
   Branching: light to medium, 30° to 90°
   Boles: straight, cylindrical

METEOROLOGICAL DATA

Site No: PO44 — Site: Pueblo Viejo

Meteorological station: Huehuetenango — Country: Guatemala

Latitude: 14° 53'N — Longitude: 87° 31'W — Altitude (m): 1,902

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1.	mean monthly rainfall mm	0	2	12	20	116	185	157	118	189	226	11	0	1,036	3
2.	absol. max. temp. °C	30.0	29.0	32.5	31.0	30.5	29.5	28.5	28.0	27.5	27.0	26.0	25.5		3
3.	mean max. daily temp. °C	24.5	25.1	27.2	27.5	26.4	25.4	25.4	25.6	24.9	24.7	24.5	24.6	25.5	3
4.	mean daily temp. °C	15.2	16.0	17.4	18.5	18.5	17.6	17.5	17.6	17.2	16.7	15.7	15.3	16.9	3
5.	mean min. daily temp. °C	8.2	10.4	11.7	12.5	13.8	14.9	15.3	15.9	15.1	15.4	12.4	11.4	13.1	3
6.	absol. min. temp. °C	2.0	4.0	3.0	5.0	8.0	9.0	10.0	11.0	10.0	9.0	7.0	4.0		3
7.	mean daily R.H. %	68	65	65	67	77	74	78	80	82	81	75	70	74	3

Site No: P045

Country: Guatemala Department: Zacapa

District: Stand: El Pinalon

Latitude: 14° 43'N Longitude: 89° 46'W Altitude (m): 1,300 -1,400

Location:

The collection site is situated eight kilometres south of San Diego, above and below the road 1.0 to 1.5 kilometres west of El Pinalon in an extensive area of P. oocarpa.

Soil:

The freely-drained and very gravelly soil has been derived from metamorphic rocks.

Stand description:

The stands are mature and form a virtually continuous cover of medium to high density. Rate of growth appears to be less than that achieved on soils more favourable to greater root penetration, but form is good, there being a notable absence of sweep and bow in most trees. The area is subject to frequent ground fires giving rise to very sparse ground cover, mostly grasses.

Seed collections:

1. P045A (K113, 5/75) January-March 1975

   The collection was a wide-ranging commercial collection made from standing trees.

METEOROLOGICAL DATA

Site No: P045 — Site: El Pinalon

Meteorological station: Jalapa — Country: Guatemala

Latitude: 14° 38'N — Longitude: 89° 59'W — Altitude (m): 1,362

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1.	mean monthly rainfall mm	0	0	7	9	105	256	141	152	192	74	0	0	936	4 (1956-59)
2.	mean max. daily temp. °C	25.3	26.8	28.3	29.9	29.1	27.4	26.2	26.6	25.8	25.0	24.6	24.5	26.6	5
3.	mean daily temp. °C	18.8	20.0	21.0	22.7	22.5	22.0	21.3	21.4	20.9	20.3	19.6	18.9	20.8	5
4.	mean min. daily temp. °C	12.3	13.2	14.0	15.4	15.9	16.5	16.3	16.1	15.9	15.6	14.6	13.3	14.9	5
5.	mean daily R.H. %	73	71	71	72	77	83	80	80	84	82	77	75	77	5

Site No: P046

Country: Guatemala Department: Zacapa

District: Gualan Site: Mal Paso

Latitude: 15° 11'N Longitude: 89° 21'W Altitude (m): 1,000

Location:

The site is situated on the southern slopes of the Sierra de las Minas, which lies roughly east-west along the northern side of the Motagua Valley. The pine is generally on very steep slopes.

Soil:

The soils are predominantly shallow, well-drained, gravelly-loams or clay-loams over decaying rock, mainly micaceous schists. pH 6.0.

Stand description:

The tree cover is open pine forest on steep slopes with occasional Quercus sp. either singly or in small patches. There is a thin grass cover, which burns annually, and patches of bare soil resulting from fire and erosion.

Seed collections:

1. P046A (K114, 4/75) January-March 1975

   The collection was a wide-ranging commercial collection made from standing trees.

METEOROLOGICAL DATA

Site No: P046 Site: Mal Paso

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	2	1	7	10	162	441	314	226	405	210	19	3	1,800
2. mean daily temp. ^{o}C	20.7	21.5	22.7	23.5	23.6	23.1	23.0	23.0	22.7	22.2	21.7	21.0	22.4

Local meteorological data are not available. The mean annual rainfall is estimated to be about 1,800 mm with a distribution over the year similar to that encountered at Zacapa (lat. 14^{o} 58'N, long. 89^{o} 31'W). The mean monthly temperature values have been estimated using the method described on page 11

Site No: P047

Country: Nicaragua Department: Madriz

District: San Jose de Cusmapa Site: Cusmapa

Latitude: 13° 17'N Longitude: 86° 39'W Altitude(m): 1,250

Location:

The site is along the Loma La Lumbrera about two kilometres north-west of San Jose de Cusmapa and five kilometres from the border with Honduras. Extensive areas of P. oocarpa occur to the north and north-west, and also in the immediate vicinity to the east.

Soil:

The freely-drained soil is derived from volcanic tuff. A shallow layer with humic staining overlies a yellow subsoil.

Stand description:

The stands are predominantly young and occur mostly on steep slopes. Average form is poor with a high proportion of the trees having heavy low angle branching.

Seed collections:

1. P047A (K117, 7/75) February 1975

   Seed was collected from eighteen standing trees selected principally for straightness and persistence of the main axis.

   Seed bearers:

   DBH (cm): 40 to 60 Height (m): 15 to 27
   Branching: medium to heavy, 40° to 80°
   Boles: mostly straight and cylindrical

METEOROLOGICAL DATA

Site No: P047 Site: Cusmapa

Meteorological station: San Jose de Cusmapa Country: Nicaragua

Latitude: 13° 17'N Longitude: 86° 39'W Altitude (m): 1,250

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values
1. mean monthly rainfall mm	6	2	0	27	297	234	67	167	401	211	46	16	1,474
2. mean daily temp. °C	18.0	18.9	20.6	21.8	22.2	22.0	21.2	21.4	21.2	21.0	19.4	18.1	20.5

Local temperature data are not available. The mean monthly temperature values were estimated using the method described on page 11

Site No: P048

Country: Nicaragua Department: Nueva Segovia

District: Jalapa Site: Jalapa

Latitude: 13° 50'N Longitude: 86° 15'W Altitude (m): 1000-1300

Location:

The collection site is in undulating country on the north-west side of the Ocotal-Jalapa road close to the Honduras border.

Soil:

The parent rock is granite which has decayed in situ to form a freely-drained sandy loam.

Stand description:

Both P. oocarpa and P. pseudostrobus occur within the area in low-stocked stands as a consequence of earlier logging operations and damage from fires.

Seed collections:

1. P048A (K126, 26/75) March-April 1975

   The collection was a bulk collection from felled trees. It was undertaken by the timber company which was carrying out the exploitation.

METEOROLOGICAL DATA

Site No: PO 48 Site: Jalapa

Meteorological station: Jalapa Country: Nicaragua

Latitude: 13° 55'N Longitude: 86° 09'W Altitude (m): 680

		J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1.	mean monthly rainfall mm	66	34	31	55	168	333	271	197	290	214	97	62	1,818	6 (1963-68)
2	mean daily temp. °C	18.6	19.4	21.2	22.3	22.7	22.5	21.7	21.9	21.7	21.5	19.9	18.7	21.0	

Local temperature data are not available. The mean monthly temperature values were estimated using the method described on page 11

Site No: P074

Country: Nicaragua Department: Nueva Segovia

District: San Fernando Site: San Fernando

Latitude: 13° 46'W Longitude: 86° 22'W Altitude (m): 1,000-1,200

Location:

The collection site is on the southern slopes of the Cordillera de Dipilto, six kilometres north-north-east of the village of San Fernando. The Cordillera de Dipilto (Cordillera Segoviana) lies in an east-west direction along the northern border of Nicaragua and rises to heights of 1,500 to 2,000 metres. The pine forests are continuous with those on the northern slopes in the El Paraiso department of Honduras, but the highest and most fertile sites along the crest of the cordillera are occupied by broad-leaf forest or coffee plantations.

The site is six kilometres west of the Las Camelias collection site (P01).

Soil:

The soils are yellowish gravelly-sands with pronounced humic staining in the top ten centimetres and an increasing clay fraction in the lower layers. They are shallow on the ridges when they overlie the decaying parent granite, but deep colluvial accumulations occur on the lower slopes. pH 5.5.

Stand description:

The tree cover consists of open stands of previously exploited *P. oocarpa*, with local occurrences of *P. pseudostrobus*, *Liquidambar styraciflua*, and *Quercus* spp. Most of the pines have suffered fire damage to their boles. Regeneration is sparse. There is a dense grass layer which includes *Andropogon* sp. and *Hyparrhenia* sp.

Seed collections:

1. P074A (K130, 6/76) February 1976

   Seed was collected from a large number of felled trees by a felling contractor. Therefore it was a bulk collection of unknown quality.

METEOROLOGICAL DATA

Site No: P074 — Site: San Fernando

Meteorological station: San Fernando — Country: Nicaragua

Latitude: 13° 42'N — Longitude: 86° 16'W — Altitude (m): 700

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number years of observations
1. mean monthly rainfall mm	3	7	22	38	149	217	126	118	173	234	49	7	1,143	3 (1970-72)
2. mean daily temp. °C	19.0	19.7	21.4	22.5	22.9	22.8	22.0	22.2	22.0	21.7	20.2	19.0	21.3	

Local temperature data are not available. The mean monthly temperature values have been estimated using the method described on page 11

Site No: P097

Country: Nicaragua Department: Matagalpa

District: Matagalpa Site: Apanti

Latitude: 12° 54'N Longitude: 85° 56'W Altitude (m): 950

Location:

The collection site is on the north-west slopes of the Cerro Apanti, adjacent to the San Domingo road five kilometres south of Matagalpa. This location is very close to the extremity of the species natural range.

Soil:

The soil is a freely-drained sandy-loam with dark humic staining in the top 8-12 cm, overlying a clay-loam.

Stand description:

The tree cover consists mainly of mature open stands of P. oocarpa with a long history of sporadic exploitation. Form is mostly poor, except in a few locations when the canopy is closed owing to less intense exploitation. Pine regeneration is very sparse. A few scattered Quercus spp. also occur on the site.

Seed collections:

1. P097A (K143, 8/77) February 1977

   Seed was collected from about 65 selected standing trees.

METEOROLOGICAL DATA

Site No: P097 Site: Apanti

Meteorological station: Matagalpa Country: Nicaragua

Latitude: 12° 55'N Longitude: 85° 55'W Altitude (m): 680

	J	F	M	A	M	J	J	A	S	O	N	D	Mean annual values	Number of years of observations
1. mean monthly rainfall mm	20	12	11	26	131	286	180	161	235	238	67	27	1,394	16
2. mean daily temp. °C	19.9	20.6	22.3	23.3	23.7	23.5	22.8	23.0	22.8	22.4	21.0	20.0	22.1	

Local temperature data are not available. The mean monthly temperature values have been estimated using the method described on page 11

Site No: P025

Country: Mexico

State: Chiapas
Site: Jitotil

Latitude: 17° 05'N Longitude: 92° 30'W Altitude (m): 1,650

Seed source:

In 1968, E. Mortenson made provenance seed collections in Central America and Mexico on behalf of the East African Agriculture and Forestry Research Organisation (EAAFRO) (Mortenson, 1969). These included provenances of P. oocarpa, one of which (EM71, EAAFRO batch 1522) was made available to the CFI for inclusion in the P. oocarpa international provenance trial.

Unfortunately Mortenson did not give geographical coordinates for his collection sites, and the precise location of Jitotil is in doubt. A place called 'Jitotil' cannot be found on any map of Chiapas, but there is a 'Jitotol' at latitude 17° 0'N longitude 92° 54'W and altitude approximately 1,000 metres. It is possible that Mortenson collected on the higher ground to the east of Jitotol.

Wherever EM71 has been planted it has produced a mixture of two taxa. One consists of fast-growing well-formed trees with a smooth red-brown bark and thin papery scales. The other comprises slow-growing poorly-formed trees with a thick greyish-or blackish-brown bark cracking deeply into square blocks.

Styles (1976) states that the better-formed taxa is possibly a rare example of P. patula var. longipedunculata in cultivation (see Section 2.0 and Greaves and Dyson, 1977). Unfortunately Mortenson did not collect voucher herbarium specimens from the parent trees and, until further botanical evidence is available, firm conclusions cannot be drawn about the precise identity of the trees.

Seed collections:

1. P025A (EM71, EAAFRO 1522, 31/71) 1968

The seed was collected from four trees.

Site No: P091

Country: Mexico State: Mexico

Site: Valle de Bravo

Latitude: 19° 14'N Longitude: 100° 07'W Altitude (m): 1,870

Stand description:

P. oocarpa in association with Pinus pringlei, Cupressus sp. and Quercus sp.

Meteorological data:

Data not available.

Seed collections:

1. P091A (INIF 353, 71/78) January 1971.

Site No: P099

Country: Mexico State: Chiapas

District: La Trinitaria Site: La Trinitaria

Latitude: 16° 15'N Longitude: 92° 03'W Altitude (m): 1,450

Location:

Along the Comitan-Lagunas de Monte Bello Road.

Stand description:

P. oocarpa in association with Pinus michoacana, P. michoacana var. fumida, Pinus montezumae, Quercus spp., Alnus spp. and Juniperus comitana.

Meteorological data:

Mean annual rainfall:	1,276 mm
Maximum temperature:	32.4°C
Minimum temperature:	5.2°C
Mean annual temperature:	20.1°C

Seed collections:

1. P099A (INIF 367, 72/78) February 1972

Site No: P0100

Country: Mexico State: Jalisco

Site: Mazamitla

Latitude: 19° 58'N Longitude: 103° 06'W Altitude (m): 1,720

Location:

5 km before Mazamitla on the Guzman to Mazamitla road.

Stand description:

P. oocarpa in association with P. michoacana, Pinus douglasiana, and Quercus spp.

Meteorological data:

Mean annual rainfall:	822 mm
Maximum temperature:	34.0°C
Minimum temperature:	2.2°C
Mean annual temperature:	19.4°C

Seed collections:

1. P0100A (INIF 378, 73/78) February 1972

Site No: P0101

Country: Mexico State: Michoacan

Site: Tzararacua

Latitude: 19° 25'N Longitude: 102° 02'W Altitude (m): 1,400

Location:

10 km from Uruapan in the direction of Apatzingan, and 5 km from the turning to Cutzato.

Stand description:

P. oocarpa in association with Pinus lawsoni, P. michoacana and Quercus sp.

Meteorological data:

Mean annual rainfall:	1,048 mm
Maximum temperature:	24.0°C
Minimum temperature:	9.9°C
Mean annual temperature:	15.9°C

Seed collections:

1. P0101A (INIF 379, 74/78) February 1972

Site No: P0102

Country: Mexico State: Jalisco

Site: Palos Altos

Latitude: 19° 25'N Longitude: 103° 35'W Altitude (m): 1,508

Location:

Section 3 exploitation unit of Forestal Atenquique.

Stand description:

P. oocarpa in association with P. douglasiana and Quercus sp.

Meteorological data:

Mean annual rainfall: 1,118 mm
Maximum temperature: 39.5°C
Minimum temperature: 7.5°C
Mean annual temperature: 24.4°C

Seed collections:

1. P0102A (INIF 392, 75/78) November 1972

Site No: P0103

Country: Mexico State: Mexico

Site: Valle de Bravo

Latitude: 19° 14'N Longitude: 100° 07'W Altitude (m): 1,860

Stand description:

P. oocarpa in association with P. pringlei, Pinus pseudostrobus and Quercus sp.

Meteorological data:

Mean annual rainfall: 1,046 mm
Maximum temperature: 32.5°C
Minimum temperature: 1.5°C
Mean annual temperature: 17.8°C

Seed collections:

1. P0103A (INIF 398, 76/78) January 1973

Site No: P0104

Country: Mexico State: Michoacan

Site: El Llano

Latitude: 19° 15'N Longitude: 100° 25'W Altitude (m): 1,760

Location:

7 km from Susupuato on the Zitacuaro to Susupuato road.

Stand description:

P. oocarpa in association with P. lawsoni, P. pseudostrobus, Quercus sp. and Almus sp.

Meteorological data:

Mean annual rainfall: 1,007 mm
Maximum temperature: 32.0°C
Minimum temperature: 7.0°C
Mean annual temperature: 19.1°C

Seed collections:

1. P0104A (INIF 399, 77/78) January 1973

Site No: P0105

Country: Mexico State: Michoacan

District: Uruapan Site: Matanguaran

Latitude: 19° 18'N Longitude: 102° 09'W Altitude (m): 1,560

Stand description:

P. oocarpa in association with P. michoacana, P. lawsoni, P. douglasiana and Quercus sp.

Meteorological data:

Mean annual rainfall: 790 mm
Maximum temperature: 28.5°C
Minimum temperature: -0.5°C
Mean annual temperature: 15.4°C

Seed collections:

1. P0105A (INIF 417, 78/78) February-March 1974

Site No: P0106

Country: Mexico State: Michoacan

District: Ziracuaretiro Site: Ziracuaretiro

Latitude: 19° 18'N Longitude: 102° 09'W Altitude (m): 1,500

Location:

Sites 'Matanguaran' and 'La Tzararacua'.

Stand description:

P. oocarpa in association with P. michoacana, P. douglasiana, P. lawsoni and Quercus sp.

Meteorological data:

Data not available.

Seed collections:

1. P0106A (INIF 481, 79/78) December 1974

Site No: P0107

Country: Mexico State: Michoacan

Site: Los Sabinos

Latitude: 19° 13'N Longitude: 101° 45'W Altitude (m): 1,710

Location:

Sites 'Los Sabinos' and 'San Agustin' in the municipalities of La Huacana and Ario de Rosales.

Stand description:

P. oocarpa in association with Quercus sp.

Meteorological data:

Mean annual rainfall:	1,758 mm
Maximum temperature:	42.0°C
Minimum temperature:	2.5°C
Mean annual temperature:	18.8°C

Seed collections:

1. P0107A (INIF 489, 80/78) October 1975

Site No: P0108

Country: Mexico State: Michoacan

District: Ario de Rosales Site: Los Negros

Latitude: 19° 13'N Longitude: 101° 45'W Altitude (m): 1,710

Stand description:

P. oocarpa in association with Quercus sp.

Meteorological data:

Mean annual rainfall: 1,758 mm
Maximum temperature: 42.0°C
Minimum temperature: 2.5°C
Mean annual temperature: 18.8°C

Seed collections:

1. P0108A (INIF 490, 81/78) October 1975

Site No: P0109

Country: Mexico State: Jalisco

District: Jucutacato Site: El Durazno

Latitude: 19° 22'N Longitude: 102° 41'W Altitude (m): not available

Stand description:

Not available.

Meteorological data:

Mean annual rainfall: 790 mm
Maximum temperature: 28.5°C
Minimum temperature: -0.5°C
Mean annual temperature: 15.4°C

Seed collections:

1. P0109A (INIF 502, 82/78) March 1975

Site No: P0110
Country: Mexico
State: Chiapas
District: Ocozingo
Site: La Codicia
Latitude: 16° 55'N Longitude: 92° 07'W Altitude: (m): not available

Stand description:
Not available.

Meteorological data:
Not available.

Seed collections:
1. P0110A (INIF 534, 83/78)

Site No: P0111
Country: Mexico
State: Chiapas
District: Ocozingo
Site: La Florida
Latitude: 16° 55'N Longitude: 92° 53'W Altitude (m): not available

Stand description:
Not available.

Meteorological data:
Not available.

Seed collections:
1. P0111A (INIF 535, 84/78)

Site No: P0112
Country: Mexico
State: Hidalgo
Site: Chinameca
Latitude: 20° 45'N Longitude: 98° 39'W Altitude (m): 1,550

Location:
Between Molango and Tianguistengo.

Stand description:
Not available.

Meteorological data:
Not available.

Seed collections:
1. P0112A (INIF 554, 85/78) February 1977

Site No: P0113
Country: Mexico
State: Guerrero
District: Chilpancingo
Site: Cafeles
Latitude: 17° 16'N Longitude: 99° 30'W Altitude (m): 860

Stand description:
Not available.

Meteorological data:
Not available.

Seed collections:
1. P0113A (INIF 555, 86/78) February 1977

Site No: PO114

Country: Mexico State: Guerrero

Site: Buena Vista

Latitude: 17° 15'N Longitude: 99° 31'W Altitude (m): 710

Stand description:

Not available:

Meteorological data:

Not available.

Seed collections:

1. PO114A (INIF 556, 87/78) January 1977

Site No: PO115

Country: Mexico State: Chiapas

District: Cintalapa Site: Los Pinos Ranch

Latitude: 16° 40'N Longitude: 93° 45'W Altitude (m): 750

Location:

4 km southwest of Rosendo Zalazar.

Stand description:

P. oocarpa in association with Quercus sp. and Byrsonima crassifolia.

Meteorological data:

Not available.

Seed collections:

1. PO115A (INIF 582, 88/78) January 1977

Site No: PO116
Country: Mexico State: Michoacan
District: Uruapan Site: El Durazno
Latitude: 19° 27'N Longitude: 102° 05'W Altitude (m): 1,600

Stand description:
Not available.

Meteorological data:
Not available.

Seed collections:
1. PO116A (INIF 575, 89/78) January 1977

Site No: PO117
Country: Mexico State: Chiapas
Site: El Sanibal
Latitude: 16° 50'N Longitude: 92° 55'W Altitude (m): 1,180

Location:
Escopetazo-Villahermosa-Soyalo road.

Stand description:
Pure P. oocarpa.

Meteorological data:
Not available.

Seed collections:
1. PO117A (INIF 586, 90/78) December 1976

Site No: P0118

Country: Mexico State: Chiapas

District: Margaritas Site: San Francisco

Latitude: 16° 19'N Longitude: 91° 59'W Altitude (m): 1,600

Stand description:

P. oocarpa in association with P. michoacana, and P. tenuifolia.

Meteorological data:

Not available.

Seed collections:

1. P0118A (INIF 587, 91/78) January 1977

Site No: P0119

Country: Mexico State: Chiapas

District: Ciénega de Leon Site: La Cascada Ranch

Latitude: 16° 50'N Longitude: 93° 50'N Altitude (m): 900

Stand description:

Pure P. oocarpa.

Meteorological data:

Not available.

Seed collections:

1. P0119A (INIF 588, 92/78) January 1977

Site No: P0120

Country: Mexico State: Chiapas

District: San Cristobal las Casas Site: San Cristobal

Latitude: 16° 50'N Longitude: 92° 36'W Altitude (m): 2,220

Location:

Kilometres 2 and 3 on the San Cristobal to Zantehuitz road.

Stand description:

Not available.

Meteorological data:

Not available.

Seed collections:

1. P0120A (INIF 596, 93/78) April 1977

Site No: P0121

Country: Mexico State: Chiapas

District: Cintalapa Site: Ciénega de León

Latitude: 16° 45'N Longitude: 93° 45'W Altitude (m): 1,100

Stand description:

Not available.

Meteorological data:

Not available.

Seed collections:

1. P0121A (INIF 599, 94/78)

Site No: P0122

Country: Mexico State: Chiapas

District: Trinitaria Site: Santa Rita

Latitude: 16° 07'N Longitude: 92° 00'W Altitude (m): 1,640

Location:

1 km to the west of Santa Rita.

Stand description:

Not available.

Meteorological data:

Not available.

Seed collections:

1. P0122A (INIF 604, 95/78) January 1977

Site No: P0123

Country: Mexico State: Chiapas

Site: Tolimán

Latitude: 15° 16'N Longitude: 92° 20'W Altitude (m): not available

Location:

On the Huixtla to Motozintla road.

Stand description:

P. oocarpa in association with P. tenuifolia, Cupressus benthami and Quercus sp.

Meteorological data:

Not available.

Seed collections:

1. P0123A (INIF 609, 96/78) February 1977

Site No: P0124

Country: Mexico State: Mexico

Site: Temascaltepec

Latitude: 18° 57'N Longitude: 100° 05'W Altitude (m): 1,650

Location:

Kilometre 10 on the Temascaltepec to Tejupilco road.

Stand description:

Pinus oocarpa in association with P. pringlei and P. pseudostrobus.

Meteorological data:

Not available.

Seed collections:

1. P0124A (INIF 627, 97/78) November 1977

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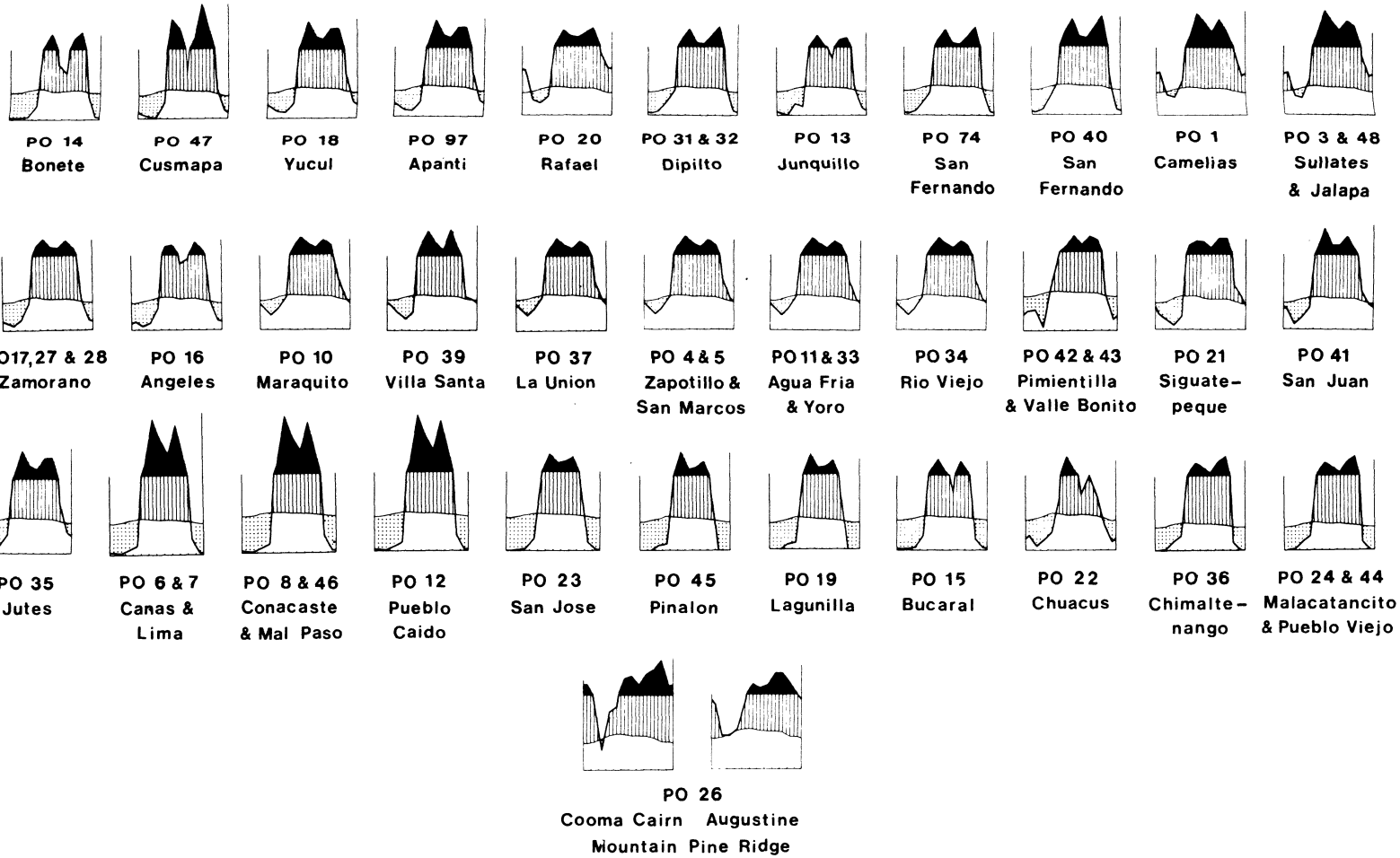
Appendix I

Specific names used in the site descriptions, and their authorities

Andropogon condensatus H.B. & K.
Andropogon elliottii Chapm.
Andropogon virginicum L.
Axonopus aureus Beauv.
Baccharis trinervis Pers.
Byrsonima crassifolia H.B. & K.
Caesaria sylvestris Sw.
Curatella americana L.
Cyperus flavus (Vahl) Nees.
Dieffenbachia seguine Schott.
Fimbristylis dichotoma Vahl.
Hyparrhenia rufa Stapf.
Liquidambar styraciflua L.
Melochia villosa Fawcett and Rendle
Mimosa albida Humb. and Bonpl.
Mimosa tenuifolia Rojas
Myrica cerifera L.
Pinus caribaea Morelet
Pinus patula var. longipedunculata Loock ex Martinez
Pinus montezumae Lamb.
Pinus pseudostrobus Lindl.
Pinus tenuifolia Benth.
Psidium guineense Sw.
Quercus hondurensis Trelease
Quercus oleoides Schlect. and Cham.
Quercus peduncularis var. sublanosa (Trelease) Muller
Senecio thomasi Klatt
Sporobolus poiretii (Roem. and Schult.) Hitchc.
Triumfetta speciosa Seem.
Zanthoxylum anodynumA. Molina

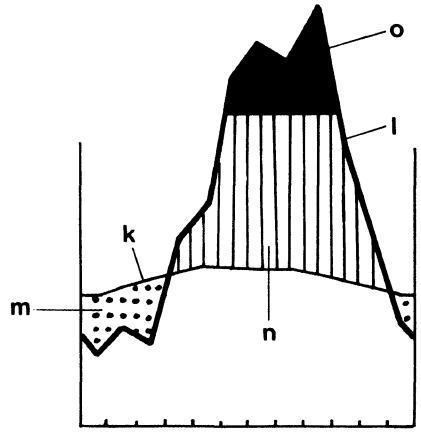
Appendix II

Climodiagrams
for the provenance seed collection sites



Appendix III

Interpretation of the klimodiagrams



The monthly means of temperature (k-thin line) and of precipitation (l-thick line) are drawn as curves. Both stand in a fixed proportion to each other; ten degrees centigrade corresponds to a precipitation of twenty millimetres. Using this proportion, and working with data from the Mediterranean region, Gaussen /1 established that an arid period prevails as soon as precipitation falls below the temperature curve (m-dotted area), and a humid period as soon as precipitation exceeds temperature (n-hatched area).

Precipitation above 100 mm is printed on the scale 1:10 and marked in black (o).

The full system as proposed by Gaussen uses additional data, mainly annotations on the mean values of annual rainfall and the extremes of temperature. Since this data, and more, has already been tabulated in the site descriptions it has been omitted here to preserve clarity.

A useful aid for making rapid comparisons of the climatic regimes of different regions is the atlas of climodiagrams produce by Walter and Lieth /2.

/1 Gaussen, H.: 8me Congres Internationale Botanique, Paris, 1954, Sections 7 et 3, 125-130.

/2 Walter, H. and Lieth, H. (1960). Klimadiagram - Weltatlas. VEB Gustav Fischer Verlag, Jena. 86 pp.

Appendix IV.

Contents of the INTFORPROV computer files

The following information is stored in the four INTFORPROV computer files:-

Source file

1. provenance seed collection code number
2. collector's number
3. seed store number
4. country
5. site
6. latitude
7. longitude
8. altitude
9. mean annual rainfall
10. dry season severity code
11. number of trees in the collection
12. number of herbarium specimens
13. number of resin samples
14. number of increment cores

*15. indicates if additional meteorological data are available
*16. indicates if additional site data are available
*17. indicates if additional comments on the collection area available

Distribution file

1. provenance trial code number
2. the provenances included in the trial

Site file

1. provenance trial code number
2. country
3. site
4. latitude
5. longitude
6. altitude
7. mean annual rainfall
8. dry season severity code
9. total number of treatments in the trial
10. the number of treatments planted with seed not distributed by CFI

*11. indicates if additional meteorological data are available
*12. indicates if additional site data are available
*13. indicates if additional comments on the trial are available
*14. indicates if there are any publications which refer to the results obtained from the trial

Growth file

1. provenance trial code number
2. provenance seed collection code

*3. indicates if additional comments are available
4. growth traits and survival data in both the nursery and field, and the ages at which the measurements were made

* Information relating to these items is stored on supplementary paper files.



Plate 1

Photo: R.H. Kemp

Yucul, Nicaragua. A typical example of the erosion of the genetic resources of P. oocarpa. In this instance a valuable seed source at the southern limit of the species' natural range has been seriously depleted by felling and burning.

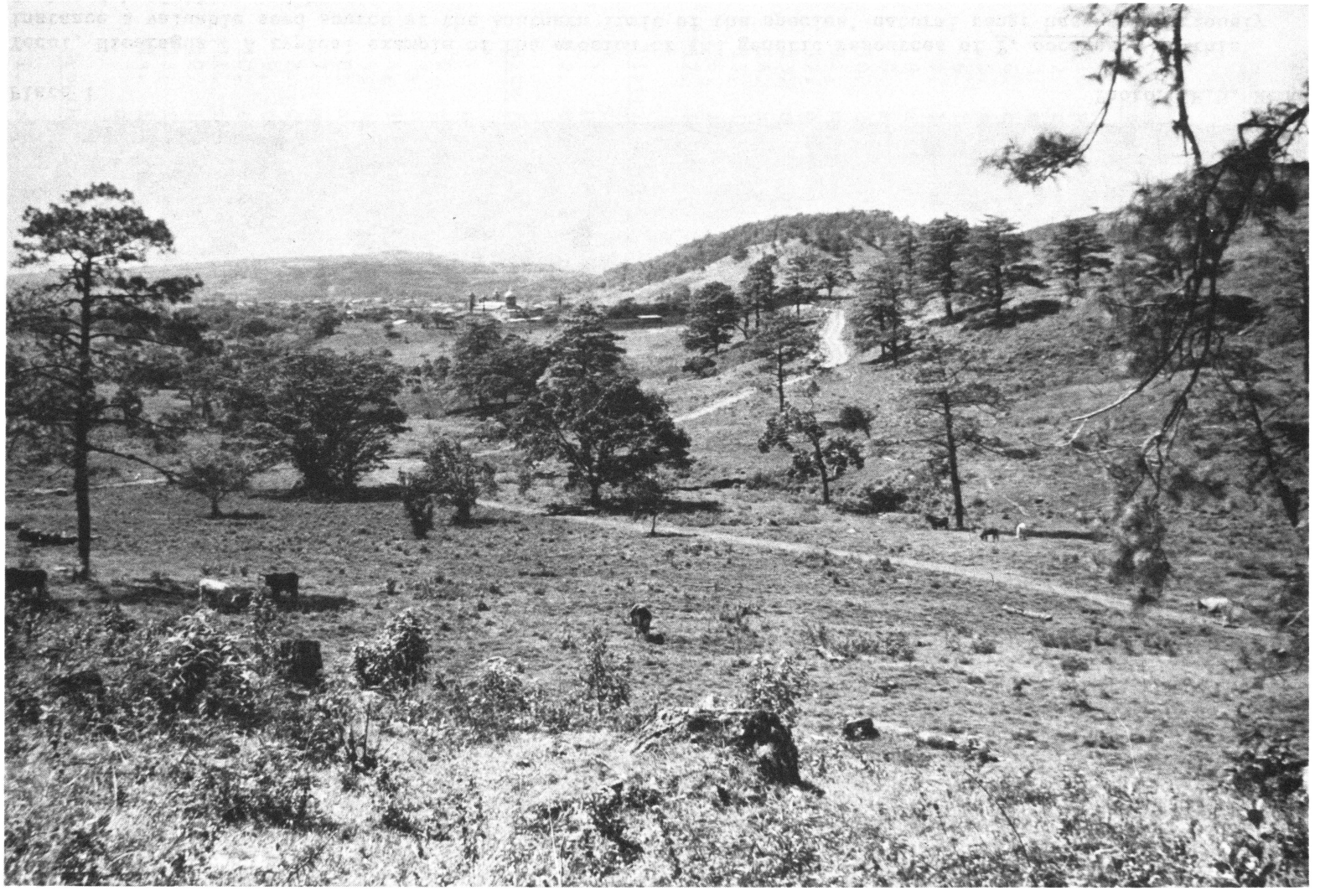


Plate 2

Photo: R.H. Kemp

San Rafael del Norte, Nicaragua. The relics of a once-extensive P. oocarpa forest.



Plate 3 Photo: R.H. Kemp

Dipilto, Nicaragua. Mature stands of P. oocarpa.



Plate 4

Photo: R.H. Kemp

Cerro el Bonete, Nicaragua. A mature stand of P. oocarpa depleted by selective fellings. Note the regeneration which is now immune from the fires arising from the frequent burning of the sparse ground vegetation.



Plate 5 Photo: R.H. Kemp

El Zamorano, Honduras. Dense mature stands of P. oocarpa in the process of being felled.



Plate 6 Photo: R.H. Kemp

El Bucaral, Guatemala. A dense pole-stage stand of natural regeneration.



Plate 7 Photo: A. Greaves

El Pinalon, Guatemala. A dense mature stand of P. oocarpa on a very infertile stony soil. Note the sparse ground cover; a consequence of frequent ground fires.

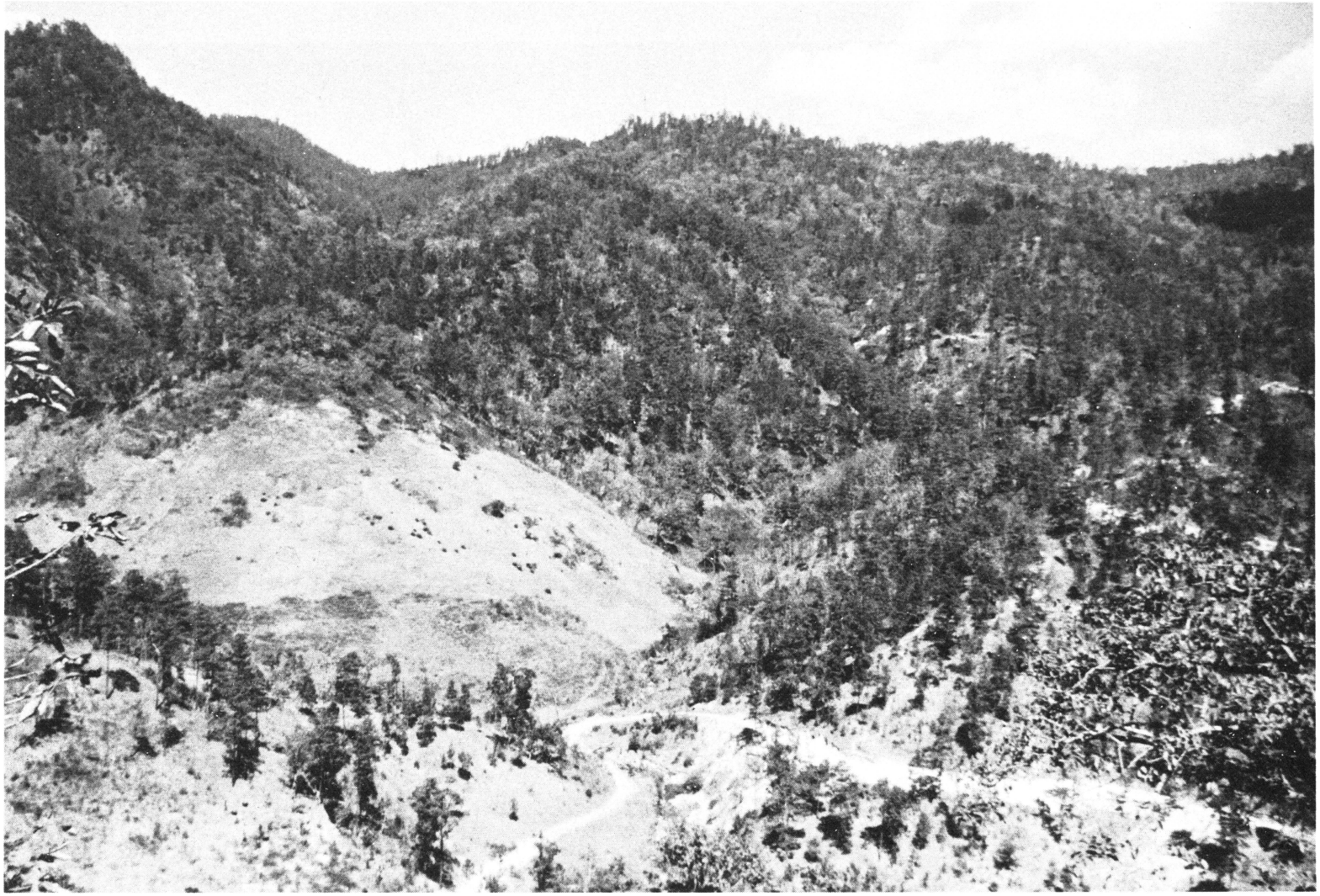


Plate 8 Photo: R.H. Kemp

La Lagunilla, Guatemala. A typical Central American P. oocarpa forest with patches of both sparse and dense stocking.

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