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SEED COLLECTION UNITS:

1. SEED ZONES

Edited by
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DANIDA FOREST SEED CENTRE

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A. THE CONCEPT OF SEED ZONES

1. INTRODUCTION

Where forests are regenerated naturally, the distance of movement of seeds from the parent trees is limited. Heavy seeds or fruits commonly fall within the area covered by the crown. Light winged seeds can be dispersed more widely by wind and succulent fruits by birds or animals. Even so, the dispersal distance can be measured in tens or hundreds of meters rather than in kilometres. It can be assumed that the adult trees in a natural forest have a high degree of adaptation to the local environment. The seeds inherit the same adaptation from their parents and, with only a limited dispersal, should encounter a similar environment. They should therefore be well equipped to survive on the site where they germinate, if they escape the hazards of pests and diseases.

With the increase in man's afforestation programmes in the past century, the distance between the site where seed is collected and where the resulting plants are planted has been multiplied many times over. Within the natural range of the species, seed may be moved hundreds of kilometres from the locality of collection to the locality of use. Still more spectacular are the intercontinental movements of seeds of exotic species. Some of the resulting plantations have been outstandingly successful, e.g. the eucalypts, the tropical pines, *Pinus radiata*, several temperate coniferous genera. Nevertheless the great increase in the movement of forest seeds, both nationally and internationally, emphasizes both the opportunity and the need to develop recognized systems of seed-collection units within indigenous forests. The size of a seed-collection unit will depend on the purpose for which the seed is to be used. The tree breeder will look upon a single tree as the collection unit and keep its seed separate for progeny tests. For gene-ecological provenance studies, well-defined local populations will be considered as collection units, and it may furthermore be desirable to keep the seed from individual trees separate for testing. For simpler seed-source studies, larger and less well-defined populations will be used as units and their seed kept separate.

For wood production one will often be less critical and collect seed from a broad seed zone covering several elevation belts. If the question is to establish forests for protection at all costs, one may be tempted to be even less critical.

2. SEED ZONES

This Technical Note deals only with seed zones - the largest unit for seed collection. Smaller units, each of which could be included within a seed zone, are selected stands, seed stands, seed production areas, seed orchards and single trees.

A system of seed zones should (1) provide a basis for rational sampling for provenance trials (2) provide a guide as to the transfer of seed for national plantation programnnes, and (3) provide a guide as to the maximum geographic limits within which seed may be mixed.

Unfortunately, there is no international agreement on the terminology or definitions. In the United States, tree breeders have suggested: "A zone of trees with relatively uniform genetic (racial) composition as determined by progeny-testing various seed sources. Usually, the encompassed area has definite geographic bounds, climate, and growing conditions (Snyder, l972)."

In the OECD (Organization for Economic Cooperation and Development) the term "Region of Provenance" is used and the definition is: "The area or group of areas subject to sufficiently uniform ecological conditions on which are found stands showing similar phenotypic or genetic characters" (OECD, 1974).

Ideally, a seed collection unit should be delineated so that it 1) consists of a population of potentially interbreeding trees of similar genetic constitution; 2) is sufficiently large for collection of reproductive material in quantities significant to large-scale operational forestry; and 3) is defined by means of boundaries that can be identified in the field.

In practice, it will be difficult to fulfil these three conditions for seed zones, so we shall have to resort to reasonable compromise solutions. The more one wants to stress the importance of having large areas and practical boundaries of each unit, the more difficult it will be to fulfil the condition of "similar genetic constitution". Thus a seed zone, which normally extends over a considerable area, ranks highly for its ability to produce seed in quantities significant to large-scale afforestation, but the probability of individual trees at opposite extremes of the zone interbreeding is very low. A small seed stand, on the other hand, will rank highly as a fully interbreeding population but can produce only modest amounts of seed.

A typical feature of many tree species is a continuous distribution over a broad range of climates. The single factors of climate normally vary along geographical gradients and the resulting genetic variation of adaptive factors, therefore, will be mostly clinal.

Thus there is a continuous, gradual decrease in temperature with latitude from the equator to the poles and with altitude from the bottom to the top of a mountain. There is often a continuous and gradual decrease in rainfall from the coast to the interior of a continent, though elevation and aspect can greatly affect this relationship in montane topography. Also there is a gradual decrease in the likelihood of two individuals in a population interbreeding as the distance between them increases. Although a long period of separation between populations and sudden changes in geology (e.g. lava flows) or in aspect (on either side of a sharp ridge top) may cause sharp discontinuity in gene frequencies between populations, clinal variation is the general rule. It may be comparatively rapid when associated with elevational changes in steep topography. It may also be repetitive as in the catenary succession of alternating low ridges with coarse red soils and shallow depressions with heavy black soils which characterizes the savanna woodland of much of Africa.

From the practical aspect of organizing seed collection, it is a convenience to have comparatively large units with sharp boundaries following existing administrative boundaries or roads etc. The real problem in delimiting seed zones is in trying to fit a system of large discrete units and clearly defined boundaries, which would be operationally most convenient, to the pattern of natural variation which is commonly clinal and sometimes complex and smallscale.

3. METHODS OF DELINEATION

In theory, a seed zone should be delineated in such a way that it only includes indigenous interbreeding populations. This means that the terms ”seed zones” and ”regions of provenance” should only be used for natural forests and that seed zones should be delineated for each tree species separately dependent on the racial variation of the species.

Only results of comprehensive provenance trials can provide a safe basis for the right delineation of seed-collection units. Such trials are in progress in many countries, both tropical and temperate. They should reveal the extent and pattern of variation in the species under trial. It is possible that a few species will show minimal genetic variation over a wide geographic range (*Pinus resinosa* is often quoted as an example). For such species, choice of seed zone and the need for seed zone delineation are less essential, in fact a single seed zone might cover the whole species range. Other species, such as *Eucalyptus camaldulensis*, show enormous genetic variation related to the ecological variation within the species range. It is likely that the majority of species will be found to exhibit more genetic variation, not less, than expected, so that correct delineation of seed zones will be of vital importance for them.

Conclusions from provenance trials can only be drawn with confidence after at least half a rotation, and preferably a full rotation. There is, however, some evidence (Roche 1968) which warrants the assumption that pre-provenance trial studies in completely controlled environments (growth chambers) and partially controlled environments (greenhouses and nurseries) can yield, in a relatively short period, information concerning the gene-ecology of tree species which is of immediate practical value both to the silviculturist and to the breeder. If the number of juvenile populations tested in any environment is sufficiently large, and if the characteristics measured are those which are of adaptive significance, e.g. times of flushing and dormancy, then, to some extent, it is possible to predict the adaptability of these populations in another environment on the basis of the variation patterns observed. Such studies are of particular value when the populations under test have been selected along altitudinal transections, or other transections associated with progressive climatic changes.

A third possibility is to accept the idea that similarity in ecological **conditions implies similarity in genetic constitution**. This is often the only possible approach when planning a sampling pattern for provenance seed collections or when the forest manager needs to select his seed source for operational afforestation without waiting for provenance trial results. In some cases morphological variation within the natural range of the species may be a guide to physiological variation but such conveniently detectable morphological variation occurs only rarely. Selection and delineation of seed zones in the first instance is thus usually based on ecological conditions and this method is described in more detail below. It can only be an approximation, but if there are good grounds for assuming that the genetic variation within individual seed zones, selected as a result of plant-geographic, physio-graphic and bio-climatic studies, is less than that between them, ecological zoning will justify itself.

A survey of the ecological conditions must be based either on information on climatic factors like precipitation, temperature and physiographic structure or on plant-geographic description of the most important vegetation types of forest trees and the variation in physiognomy and composition of the dominant species or even better on a combination of both. It should be remembered that the relationships that doubtless exist between climate and vegetation remain to be demonstrated in any particular area, see later **F. Discussion**.

Information on climate is important, but there are particularly two things that restrict the applicability.

Firstly, meteorological stations are often missing in the areas that are of greatest interest to afforestation. Secondly, it is difficult to know how to "weight" the different climatic factors that may be available.

In order to make use of any climatic information for our purpose, it is necessary to know the limiting factors for the different species, such as temperature extremes, influence of drought and wind particularly in the critical phases of the growing season.

As the basis for a division into seed zones, forest regions, forest types or equivalent plant-geographic units can often be used. As guidelines for the procedure of zone delineation the following main points can be stated:

i) Remember that a seed zone denotes a much narrower ecological area than a forest region or section.
ii) Use maps of forest regions and sections or similar classification systems as a framework.
iii) Decide which of the species occurring is to come under the scheme.
iv) Procure maps of the distribution of these species. Aerial photography may be used.
v) Utilize available information on racial pattern, interaction with planting site, and environmental factors.
vi) Estimate whether significant differences in racial variation and adaptation may be expected in and between the species.
vii) Decide whether one system of seed zones should be used for all species.
viii) Superimpose map of species distribution on map of forest regions and sections. Delineate seed zones by using geographic or administrative boundaries of the most important forest areas suited for procurement of forest reproductive material.
ix) Establish and publish maps of seed zones with code numbers and a brief description of the ecological conditions prevailing in the zones.

For procedures applied in several countries, see examples in the sections B-E.

At the actual delineation in the field one has to resort to compromise, as it is no good having ecologically correct boundaries if these cannot be identified in the field. Therefore it is necessary to use ridges, rivers, roads, railways and other landmarks to mark the boundaries. It will be too simplified merely to use administrative units like counties as zone units.

Beside the horizontal delineation, also a vertical one is often made, where the influence of the altitude on the growing conditions is taken into consideration. This is done by dividing each zone into altitudinal regions, or so-called elevation belts, at intervals of for instance 200-300 m. Seed collected within a single seed zone is then kept separate for the different elevation belts. However, usually the great differences in growing conditions within an elevation belt, for instance between a northern and a southern slope, are not taken into consideration.

B. PINE PROVENANCE REGIONS WITHIN HONDURAS

1. INTRODUCTION

Over a fifth of the 112,000 km^2 extension of the Republic of Honduras is covered with natural forests of *Pinus caribaea Mor. var. hondurensis* Barr. and Golf. and *Pinus oocarpa* Schiede. These two species are of great importance to the country, providing timber for national use and for export, where it ranks third as a source of foreign exchange. The species have also proven to be excellent as exotics in the tropics and sub-tropics of the world, and there is a high demand for seed from Honduran provenances, which at present is approx. 2000 kg./yr. for each species.

In view of the importance of the species, studies were started by the Banco de Semillas of the Escuela Nacional de Ciencias Forestales (ESNACIFOR), (a section of the Corporación Nacional de Desarrollo Forestat (COHDEFOR)), with the aim of delineating provenance regions for *P. caribaea* and *P. oocarpa*. The regions will assist C0HDEFOR in several ways. They will (1) enable the rational selection of provenances for national provenance trials, (2) provide an immediate guide as to the movement of seed for national plantation programmes, (3) establish, for the purposes of seed marketing, the maximum geographic limits within which seed may be mixed, as required by the OECD certification scheme (OECD, 1974) and finally (4) help in identifying provenances in danger of extinction so that conservation measures may be taken.

2. DATA USED

The provenance regions have been deduced from environmental and genetic data. Environmental data has been well covered for Honduras by various national and international organisations, and comprises topography, rainfall, temperature, geology, soils, and vegetation. A considerable amount of genetic data has also been available.

Honduras comprises three main topographical regions (1) the central highlands, (2) the Caribbean coastal plains and valleys to the north and (3) the Pacific coastal plains to the south. Rainfall is determined principally by the NE trade winds, so that the NE coastal plains tend to be the wettest (3000+mm), reducing towards the centre of the country (700 mm), with a corresponding increase in length of dry season (from 3 to 7 months). Rainfall increases again on the Pacific coast, but is more concentrated with the dry season remaining long. Interior valleys tend to be drier than surrounding hills due to topographic effects. Temperature varies greatly due to topography from a mean annual of 24 + ^{o}C down to 12^{o}C at the highest altitudes (max. 2849 m).

The central highlands are underlain mainly by (1) pyroclastic rocks in the west, on which thin, unfertile soils have developed, subject to erosion, and (2) metamorphic rocks to the east, on which deeper, more fertile, soils have developed. Interspersed throughout these soil types are those developed on sedimentary rocks, principally limestone. The NE plains comprise lateritic soils on alluvium.

The natural vegetation of the country consists of several types. Fire climax pine savannas, in which *Pinus caribaea var. hondurensis* is the dominant species from sea level up to approx. 600 m, and *P. oocarpa* from

600 - 1800 m, occur over most of the central highlands, except on soils derived from limestone. Many of the valleys with alluvial soils support semi-deciduous and deciduous broadleaved forest or scrub savanna. The mountain tops above 1800m are mainly covered with montane rain forest, heavily exploited for agriculture. There is a large area of tropical lowland rain forest to the NE, separating the interior pine forests from those of *P. caribaea* on the NE coastal plains of the Mosquitia.

Genetic data has comprised information about the development of pines in general (e.g. genetic systems, distribution) and detailed information that has resulted from the extensive studies carried out by the Commonwealth Forestry Institute, Oxford, U.K., on the two species (see Greaves 1980 and l981). These consist of the international provenance trials, genotype-environment interaction studies, morphological and biochemical studies. Although the provenance sampling was extensive, and did not cover Honduras in detail, considerable information is now available and has been taken into account during the delineation of the provenance regions.

3. METHOD OF DELINEATION

The first step taken in delineation was to produce an accurate map of the distribution of *P. caribaea* and *P. oocarpa*, since only maps and aerial photographs of the pine distribution in general were available, without differentiation into species. Since the two species occupy fairly well defined altitudinal ranges, this was done by superimposing topography on distribution, and assuming that from 0 - 500 m corresponded to *P. caribaea*, 500 - 700 m was either or both species, and 700 m and above was *P. oocarpa*.

The second step was to determine the original, large scale populations that were present during the evolution and colonization of the species, before being broken up by human interference. Since the distributions are largely controlled by altitude and hence topography, this in effect required division of the country into main physiographic zones, representing several discontinuous valley and plain populations of *P. caribaea*, and larger, more continuous populations of *P. oocarpa* on the mountains.

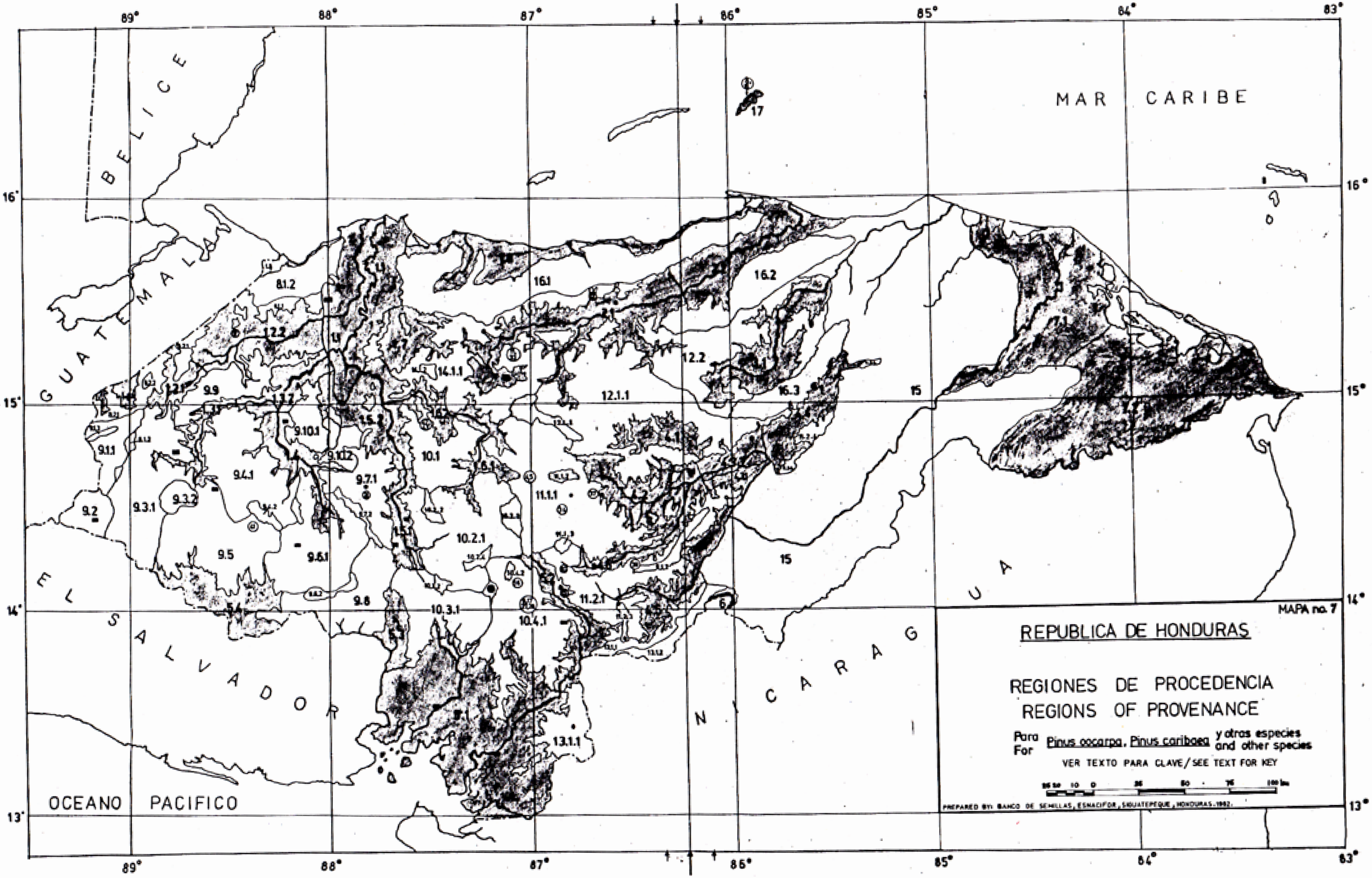
These main populations were then examined for lesser discontinuities resulting from soil types, mountain ridges (out of range of *P. oocarpa*) and human interference.

Many large populations of *P. oocarpa* could be subdivided into two, following mountain ranges which tend to isolate one half of a population from another. Since such populations naturally take the form of a circular band around the mountain ridge, it was sometimes difficult to decide where the main population should be divided on the lower slopes. As a rule, the division was made where the two sub-populations were most limited in interconnection.

The valley populations of *P. caribaea* generally grow in belts and are in places broken up because of soil changes or clearances for agriculture. Suitable subdivisions were made on the basis of these breaks.

As a final step, soil, temperature and rainfall were examined to see how these varied within the regions so far defined, and to determine if further division was necessary.

In general, the regions tended to coincide with soil changes, and so no further division was made on this factor alone. Rainfall and temperature are mainly controlled by altitude, which is especially variable for the *P. oocarpa* regions. This variation could have been taken into account by defining fixed altitudinal belts, but this in effect would have given very long narrow regions in the form of concentric rings


MAR CARIBE
BELICE
GUATEMALA
EL SALVADOR
NICARAGUA
OCEANO PACIFICO
MAPA no. 7
REPUBLICA DE HONDURAS
REGIONES DE PROCEDENCIA
REGIONS OF PROVENANCE
Para / For Pinus oocarpa, Pinus caribaea y otras especies / and other species
VER TEXTO PARA CLAVE/SEE TEXT FOR KEY
PREPARED BY: BANCO DE SEMILLAS, ESNACIFOR, SIGUATEPEQUE, HONDURAS. 1982.
16.1
16.2
16.3
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11.1.1
11.2.1
13.1.1
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17
8.1.2
9.9
9.10.1
9.10.2
9.7.1
9.4.1
9.3.1
9.3.2
9.2
9.1.1
9.5
9.6.1
9.8

around ridges that would have been impractical to delineate and implement in the field. It therefore seemed more appropriate to leave the divisions so far delineated as the final provenance regions, and define limits to individual seed collections based on a maximum range of altitude and, since some regions are quite extensive, on area extent as well. The limits recommended are that altitude should not exceed 300 m, or horizontal extent not more than 50 km (along contour lines) for any one collection, similar to those proposed for Canada (Piesch and Stevenson, 1976).

During the above process of delineation, note was taken of the result of the C.F.I. provenance trials and associated studies, which, in general, confirmed the proposed divisions.

Once the provenance regions for *P. caribaea* and *P. oocarpa* had been defined, there were certain areas that were not included because of absence of the species. Such areas were generally covered with broadleaved species either as montane rainforest on ridge tops out of the altitudinal range of *P. oocarpa*, or montane/lowland humid forest on limestone soils, or lowland rainforest on the latisols of the N and NE. There were also certain large valley areas that were under dry semi-deciduous forest, scrub, or had been cleared for agricultural use. These areas, for the sake of completeness, were defined on the map and designated as possible provenance regions for the broadleaved species and associated conifers that they include, since many of these species have distributions correlated with that of the pines.

The regions have been numerically coded on the basis of the main physiographic zones, using three digits, so that the location and relationship of the regions may be readily appreciated, and so that further sub-divisions can be added easily. The region names also refer to principal geographic features (mountain ranges, valleys etc.) so that the location is easily understood in the same way.

Many of the regions have artificial boundaries with the neighbouring countries of El Salvador, Guatemala, and Nicaragua, and it is hoped that delineation can be continued into these countries at some later date.

NOTE ON PROVENANCE REGION MAP: Regions with first digit from l-7 are principally for *P. caribaea*, 8-14 are principally for *P. oocarpa* and montane broadleaves, l5-l6 for lowland tropical rainforest. Region 17 is for *P. caribaea*.

NOTE ON PUBLICATION: The full text was published in English by the Oxford, Tropical Forestry Papers No.18, and in Spanish, by ESNACIFOR, Honduras.

C. SEED ZONING SYSTEM FOLLOWED IN INDIA

1. INTRODUCTION

The first attempt in India to create seed zones specifically to facilitate seed collection was taken up in 1978 by the Indo-Danish Project on Seed Procurement & Tree Improvement. This involved many considerations for a country the size of India, especially, as it shows wide variations in climate conditions, soil, physiography and species distribution. Another consideration which could not be overlooked was the administrative setup in different states of the country.

Champion and Seth (1968) described the forest types of India and divided them into six broad types ranging from tropical to alpine types. They were further divided into sixteen climatic forest types and thirty subgroups. This describes the variations in ecological conditions in relation to species distribution in the country. This knowledge is useful in understanding the range of adaptation of a species. But it does not entirely lend itself to a conversion into seed collection units, because forest types in India do not occur in continuous bands but in interrupted patches. Thus one state may contain a number of different forest types, or a given forest type may stretch from one state to another; and as each state has its own independent administrative setup, the establishment of seed collection units or seed zones may become difficult if due consideration is not given to administrative boundaries.

A further complication to this situation is the fact that in the past, seeds have been obtained without any reference to source. And this has continued to happen at least for the last twenty five to thirty years, when India changed its forest policy from conservation forestry to plantation forestry to meet the demands of the industries for raw materials. Foresters have obtained their seeds from wherever available and mixed them all up to meet their annual plantation targets. On account of this practice, it is to be expected that the genetic base of a plantation is mixed, and the areas which have been the centres of plantation activities are expected to be heterogeneous. Therefore the definition of a region of provenance as described in OECD scheme viz:-

> ”For a genus, species, sub-species and distinct variety the region of provenance is the area or group of areas subject to sufficiently uniform ecological conditions on which are found stands showing similar genetic or phenotypic characters ”,

does not always, or may not always hold good for Indian conditions.

It is impractical to delineate regions of provenance for single species under Indian conditions where each species occurs in association with other species, either as predominant or frequent or occasional etc. This is especially so when we have little information on provenance variation in any species. Further the delineation of one species into regions of provenance would overlap with another species, which occurs more or less in association causing confusion in the documentation system. This was another reason why it was found more feasible and practical from the documentation point of view to have seed zones, with seed stands and seed production areas etc. marked out for each species within a given seed zone.

Take for example teak, which has a wide but discontinuous distribution in India and occurs predominantly and frequently in tropical moist deciduous forests and tropical dry deciduous forests. It has been divided into five sub-groups by Seth and Waheed Khan (1958). These are (1) very moist (2) moist (3) slightly moist (4) dry and (5) very dry teak forests. This grouping is based primarily on average annual rainfall. Describing floristic composition (trees and shrubs) of the 5 teak types, the authors list 32 species as associates of very dry teak type, 44 species for dry teak type, 53 species for moist teak type and 13 species for very moist teak type. Some of the associates may be conspicuous in some localities but may not be so in other localities; however teak always forms the main constituent of the crop. A study of distribution of these 5 types on the country's map shows that each of these types occurs in several large as well as small areas, widely separated from one another and at places adjoining the areas of other types. Obviously within each of these types there may be several provenances. Further, some variations have been observed in (1) the time of flowering (2) seed ripening (3) number of fruits per unit weight (4) morphological variations of tree form, texture of leaves, resistance to diseases, rate of growth, timber quality etc. But no systematic information is available on characteristics of each source. This can be obtained only after provenance tests have been conducted.

2. DELINEATION OF SEED ZONES AT A NATIONAL LEVEL

Giving due consideration to all these factors, the Project took up the exercise of delimiting seed zones, on the basis of maps showing broad forest types, along with administrative boundaries as delineated in the Forest Atlas of India. Keeping a forest division as a minimum unit, regions showing compact forest areas having more or less the same forest types were delimited into seed zones.

The country's forests were thus tentatively divided into a number of seed zones as per following criteria:

(i) Except for hilly areas each seed zone has more or less same forest type.
(ii) Extent of seed zone is limited to a territorial circle or a part thereof. This makes it somewhat compact and facilitates demarcation of seed collection areas and their maintenance.
(iii) It was ensured that boundaries of each seed zone were easily identifiable on the ground even if it entailed some compromise on criteria (i).
(iv) In case of hilly zones, each zone is to be divided into sub-zones on the basis of 600 metres altitudinal intervals.

The maps were prepared statewise and sent to Conservator of Forests (Research/Development) or equivalent Officer in each state for corrections, modifications and final approval. Attached along with these maps were blank forms of SC-7 of our Certification Scheme for Forest Reproductive Material, and we requested the states to fill in these forms so as to obtain divisionwise information on species availability. This was done because each seed zone delineated as described above contained a number of species. It could not be otherwise, on account of the situations described above.

As an example of seed-zone maps the Orissa map is shown on page 12.

Our seed zones, therefore, may be defined as areas delineated on state-forest seed-zone maps for the purpose of facilitating seed collection, and as approved by the concerned Conservator of Forests (Research & Development) or equivalent authority. Basic aims of delineating the seed zones are:

(i) To provide for systematic documentation of sources of seed procured for plantation programmes.

(ii) To provide a framework for survey of genetic variation within a species and conduct trials to that effect, viz provenance trials.

As we have little information on genetical traits of our plantation species, the seed zones delimited as above are essentially adhoc in their delineation at this stage. However later on, when results of provenance trials are available, it may necessitate revising the boundaries of seed zones. It may also be pertinent to point out here that seed zones may eventually become useful to indicate (for widespread species) those zones of their distribution range within which seeds may be transferred, and those zones which may be prohibited. This of course will be possible only after results of provenance tests are obtained.

As regards provenance trials, although trials of teak have been initiated as early as 1930 by Forest Research Institute in India, no conclusive results are available to date on provenance differentiations as the seeds were obtained from sources which were neither delimited, demarcated nor documented properly.
For success in provenance research therefore it becomes necessary to develop a proper identification and documentation system of seed collection areas.

3. SPECIES AVAILABILITY IN SEED ZONES

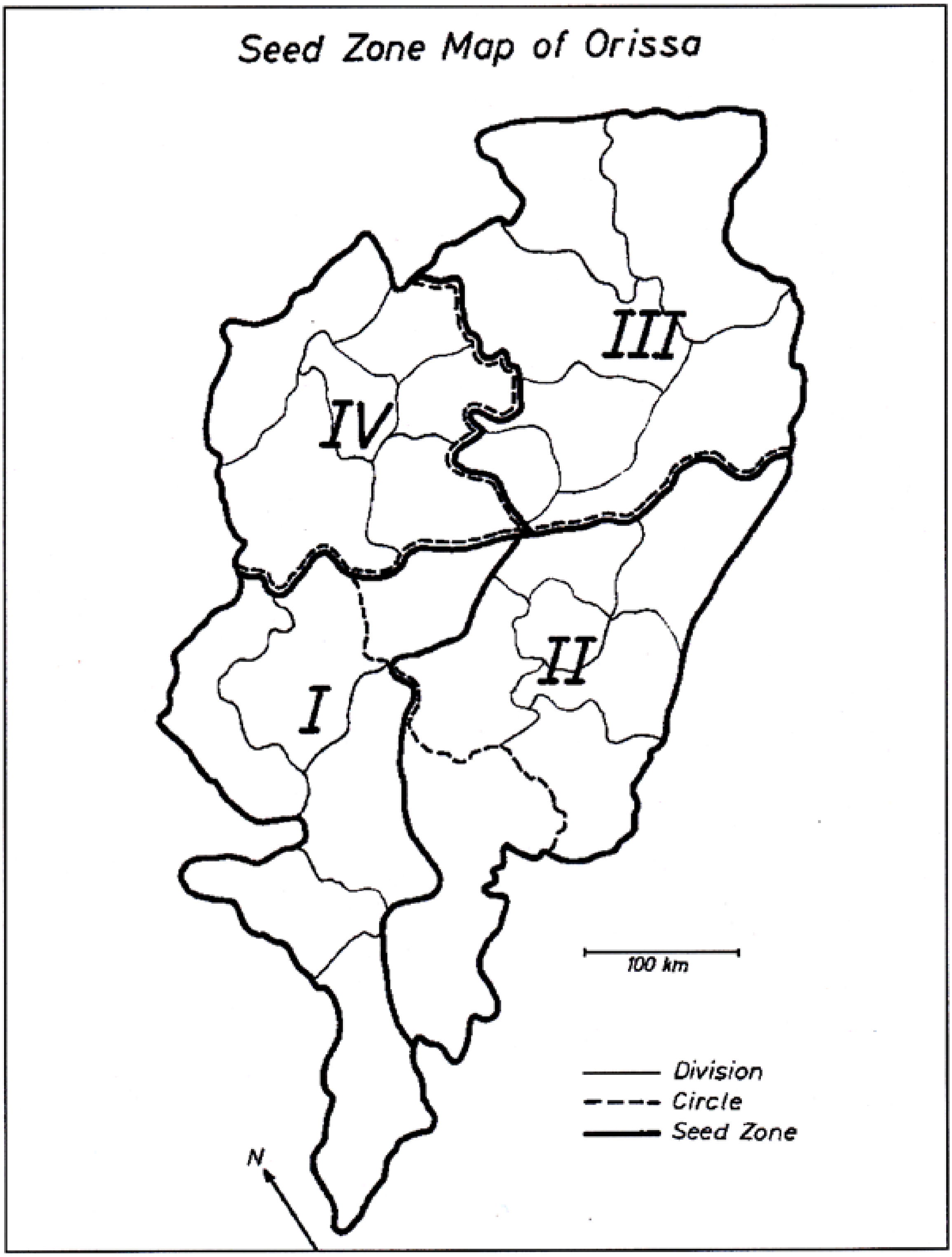
Species listed as per form SC-7 numbered 20 initially, but different states added a few more to the list according to their local importance. This however resulted in information on some species being incomplete. This information on species availability along with state maps showing delimited seed zones were cyclostyled and circulated to states.

Further, recently a number of schemes on social forestry have also been taken up by different states and number of species being planted by the Forest Departments have suddenly increased enormously. It has thus become necessary to collect and update the information on this aspect viz species availability. Information on four species, viz Teak (*Tectona grandis*), Semul (*Bombax ceiba*), Chir (*Pinus roxburghii*) and Kail (*Pinus wallichiana*), is available upon request.

4. IMPORTANCE OF SEED ZONES

In conclusion it may be pointed out that this system will help foresters engaged in seed procurement to locate seed sources of individual species and choose the source suitable for their locations based roughly on forest types initially. It will also enable the personnel involved in provenance research to obtain seeds of a given species from its entire genetic spectrum. Further, when seed certification is finally adapted by all states, it will enable the certification authorities to document their seed sources in a systematic manner by which the source is easily located by even a layman.

Note on this section: This writeup is in pursuance of the requirement of the publication entitled "Certification of Forest Reproductive Material in India" - Revised Scheme 1979, page 3; rule 3 (Delimiting Seed Zones). As per this scheme, mention of seed zone number from where the reproductive material is collected is a prerequisite to its certification. As such this article is to be taken as a companion to the Certification Scheme.


Seed Zone Map of Orissa
III
IV
II
I
100 km
Division
Circle
Seed Zone
N

D. TEAK SEED COLLECTION ZONES IN THAILAND

1. DEFINITIONS OF SEED ZONES

Forest tree seed collection zones are subdivisions of natural forest areas where the species occurs naturally. The zones are delineated to identify seed sources and to control the movement of seed and planting stock. Boundaries of the zones may be delineated either from experimental data that identify genetic variation or by the analysis of the environmental factors that control growth and distribution of the species (Cunningham, 1975).

2. NATURAL DISTRIBUTION OF TEAK IN THAILAND

It is known that teak (*Tectona grandis* Linn.f.) occurs naturally only in the Indian Peninsula, Burma, Thailand and Laos (along the border between Thailand and Laos). In Thailand, the species occurs throughout the northern part of the country (cf. map). It has a range of distribution between the latitudes of l6° - 20° N and longitudes of 97° - 102° E, covering an area of approximately l70,000 km² (Kaosa-ard, 1977; Niyanetara, l983). Within this region, three types of teak forests: the Moist Upper Mixed Deciduous, the Dry Upper Mixed Deciduous and the Low Mixed Deciduous forests, have been broadly classified according to their vegetative compositions, physiographic and climatic conditions (Mahaphol, 1954; Kaosa-ard, 1977). Four types of climatic zones: the wet, moist, medium-humid and dry-humid zones, have also been delineated on the basis of the proportions of the mean annual rainfall and the annual mean temperature (Chankao *et al.* 1975). The range of minimum - maximum climatic conditions within this teak region is presented in the following table.

Table 1. The range of climatic conditions in the teak region in Thailand

Climatic Conditions	**Climatic Stations**	
	Minimum	**Maximum**
Annual rainfall (mm)	1,054 (Tak)	1,795 (Chiengrai)
Mean temperature (°C)	24.6 (Chiengrai)	27.7 (Uttaradith)
Extreme temperature (°C)	0.1 (Loei)	44.5 (Uttaradity)
Mean relative humidity (%)	63.0 (Loei)	76.0 (Chiengrai)
Annual evaporation (mm)	662 (Mae Hong Sorn)	1,085 (Tak)
Rainy days/year	108 (Phrae)	144 (Mae Sod)

Source: "Climatological Data of Thailand: 25 Year Period (1951-1975)" Meteorological Department, Ministry of Communication, Bangkok (1977)

The table shows that teak in Thailand occurs naturally within a wide range of climatic conditions, i.e. from relatively dry to wet sites. It has developed different ecotypes and/or genotypes due to natural selection during the process of evolution to enable itself to survive under different environmental conditions. For example, teak trees growing in dry localities, i.e. in the Dry Upper Mixed Deciduous forests, have a stunted growth and a crooked form (e.g. between Tak and Kampangpet provinces) whereas those growing in the moist localities, i.e. in the Moist Upper Mixed Deciduous forests, normally develop a straight, tall and clear cylindrical bole (in Mae Sod, Mae Hong Sorn etc). A study conducted in India is another good example of genetic variation of teak. Progenies of teak from dry sites have been found to be more tolerant of drought and poor soil than those from moist sites (Kedharnath and Matthews, l962). Conversely, under favourable growth conditions progenies of trees from the moist sites perform much better in terms of growth potential than those of trees from the dry sites.

Because of these genetic variations associated with its geographic distribution, it is necessary to establish the seed collection zones of this species for the purposes of controlling the movement of seed and planting stumps and also identifying the sources of seed for future large-scale planting programmes of teak.

3. METHOD OF DELINEATION OF SEED ZONES

The map of teak seed collection zones has been drafted. The zonal boundaries in this map were delineated by analyzing the climatic data recorded throughout the teak region for a period of 25 years. The method used for the analysis of climatic data is the Lang's rain factor moisture index. In this method, the P : T ratio values, where P is mean annual rainfall (mm) and T is mean annual temperature (°C), were calculated and plotted for all climatic stations throughout the teak region. The P : T ratio lines with 5 unit intervals were delineated. Four zones of teak region: the wet, moist, medium-humid and dry-humid zones, were then divided according to their moisture conditions. The P : T ratio values of these four zones are >60, 50 - 60, 40 - 50 and < 40, respectively.

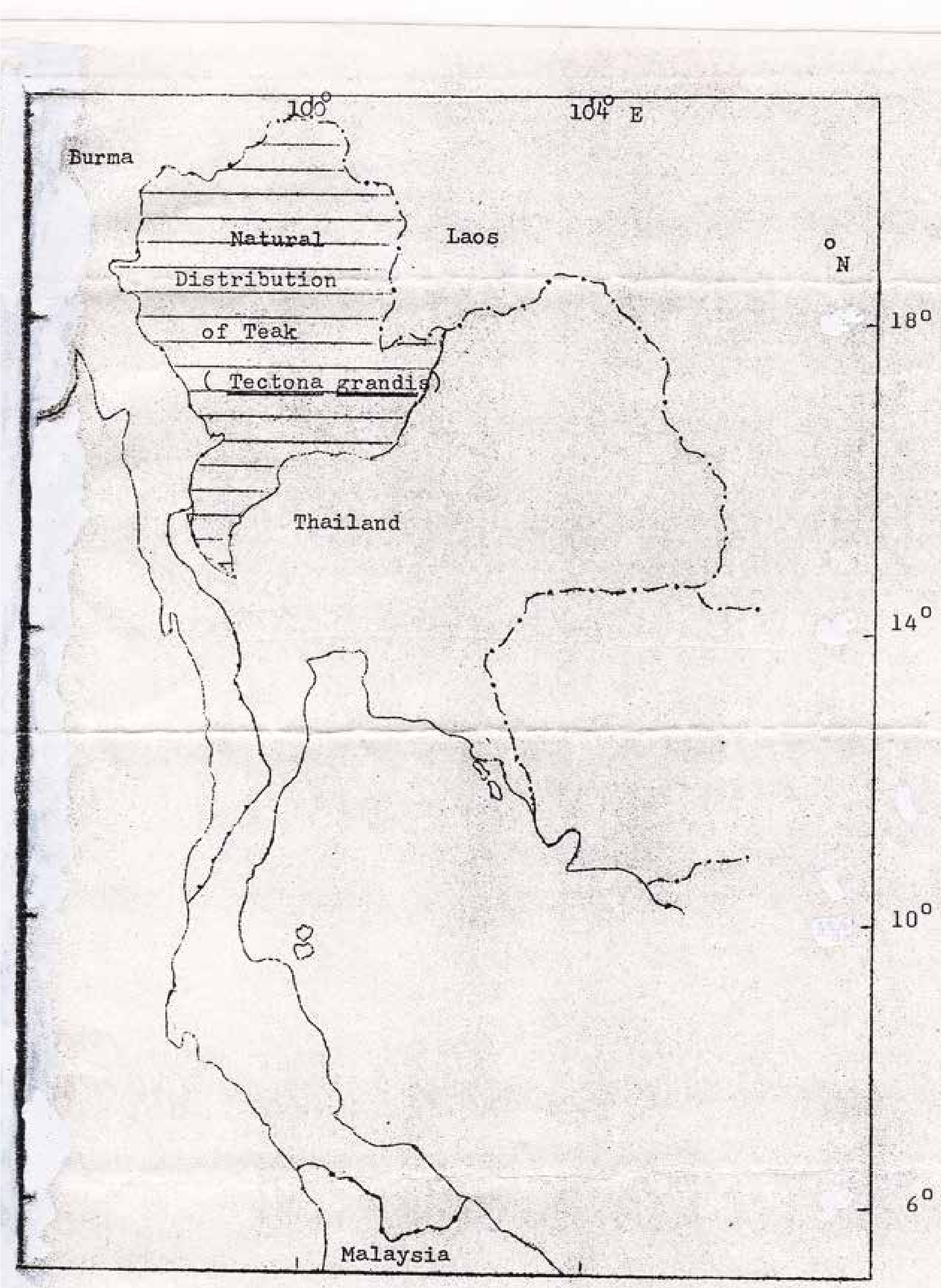
4. RECOMMENDED UTILIZATION OF SEED ZONES

1. The zone of seed sources can be identified either by using the seed zone map or by using the analysis P : T ratio data recorded at the nearby climatic station.

2. As a rule, seed or planting stumps should be planted in the zone where they are collected.

3. As a second best alternative seed from an adjacent zone (both sides) within the same physiographic conditions, e.g. elevation, can be used as substitute.

4. Movement of seed from one zone to another should be done only with considerable caution to ensure that the silvicultural requirements of the introduced seed can be met.



Natural distribution of teak (Tectona grandis) in Thailand (After Kaosa-ard, 1977)

E. SEED ZONING SYSTEM FOLLOWED IN NORWAY

1. INTRODUCTION

More than one quarter of Norway is situated north of the Polar Circle. It is a mountainous country with an average altitude of about 550 meters (l700 ft). One fifth of the country is less than 150 meters (500 feet) above sea level. About 70% of the area is above the timberline.

THE COASTLINE is characterized by mild winters, cool summers and a precipitation ranging from 2000 mm (80 in.) in the South to l000 mm (40 in.) in the North. The Gulf Stream, sweeping along the coast, tends to even out the extremes, and makes an otherwise subarctic area habitable.

In historical times the coast was covered by conifers, mainly Scots pine. But the whole area was nearly deforested through deterioration in the climate, grazing and human exploitation. Low quality broadleaved species are now being replaced with conifers through a large-scale afforestation program which has been carried out during the past few decades. Besides Norway spruce and Scots pine, Sitka spruce is being widely planted.

The timberline is found about 600 meters (2000 feet) above sea level in the South declining nearly to sea level in the far North.

THE INLAND SOUTH has warm summers, cold winters and moderate precipitation, 600-900 mm (24-35 in.). The country's principal forest areas are found here. The timberline is 800-l000 meters (2600-3300 feet).

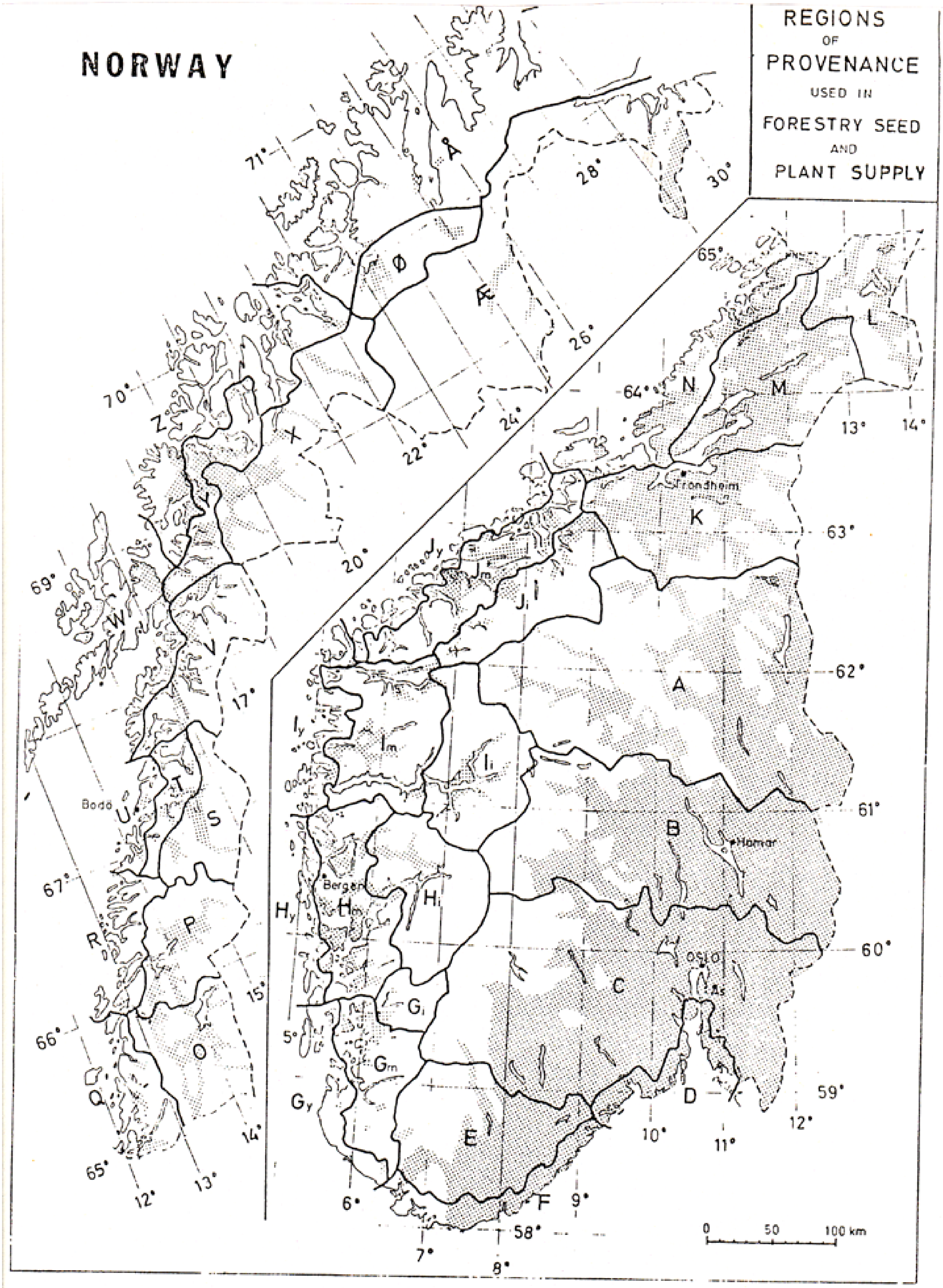
THE INLAND NORTH has very cold and long winters with short, relatively warm summers. The precipitation is low, approx. 300 mm (12 in.). Some pine forests are found on favourable sites, but the landscape is usually dominated by low quality birch. The timberline is 150-250 meters (500-800 feet).

THE GROWING SEASON. If we define the growing season as the yearly number of days with a normal temperature above 6ºC (43 ºF), the growing season is 176 days in the Oslo region, 196 in Bergen, 157 in Trondheim, 115 in Tromsø, and 90 days in Kirkenes.

Temperature is the minimum factor for forest growth over the greater part of the country.

Norway belongs to the oldest land areas of the Earth, and has been exposed to every possible natural catastrophe in the form of volcanic activity, folding and erosion. Three or four ice ages, with ice layers one or two kilometres thick, left what is seen today - bare rock, moraines and deposits of various origins. Even if the land is very old, the soil is young and often rich in mineral nutrients, due to the short history of decomposition of the parent material. A considerable amount of material of Cambrian-siluric origin especially favours the growth of forests.

The arable land is located mainly on the water deposits round the Oslo Fjord, in the East central inland, and in Mid-Norway (the two counties of Trøndelag), and on morainic soils where the topography is favourable, as on the south-west coast. The forest occupies morainic soils where the topography is suitable, and sedimentary soils along the main watercourses in the East.


NORWAY
REGIONS OF PROVENANCE USED IN FORESTRY SEED AND PLANT SUPPLY
Trondheim
Hamar
Oslo
Ås
Bergen
Bodø
0 50 100 km

As a result of Norway's violent geological history, the forest land is generally hilly and steep, nearly inaccessible in some places. About 25 % of the productive forest area is so steep that some form of cable transportation for timber extraction is required.

The natural species are:

CONIFERS

Norway spruce (*Picea abies*)
Scots pine (*Pinus silvestris*)
Juniper (*Juniperus communis*)
Yew (*Taxus baccata*)

BROADLEAVES (hardy species)

White birch (*Betula odorata*)
Lowland birch (*Betula verrucosa*)
Mountain birch (*Betula Lortuosa*)
Aspen (*Populus tremula*)
Grey alder (*Alnus incana*)
Mountain ash (*Sorbus aucuparia*)
Willow (*Salix caprea*)
Bird-cherry (*Prunus padus)*

BROADLEAVES (non-hardy species)

Black alder (*Alnus glutinosa*)
Oak (*Quercus ssp.*)
Ash (*Fraxinus excelsior*)
Elm (*Ulmus glabra*)
Beech (*Fagus silvatica*)
Lime (*Ti1ia cordata*)
Norway maple (*Acer platanoides*)
Hazel (*Corylus avellana*)

A number of foreign conifers have been tried, but only one is widely used: Sitka spruce (*Picea sitchensis*). According to preliminary research results there may also be a future for Lodgepole pine (*Pinus contorta*) in Norway.

Only Norway spruce and Scots pine, besides the Sitka spruce on the West Coast, are economically important. Birch was formerly valuable because of its qualities as fuelwood. Nowadays birch can be used profitably in the pulp and particle board industry.

2. DELINEATION OF SEED ZONES (REGIONS OF PROVENANCE)

The delineation of regions of provenance is based on the prevailing ecological conditions within the regions. For practical reasons the regional boundaries in most cases follow the county or district boundaries. The system comprises 37 regions of provenance, designated by capital letters, see map. Four regions in south*west Norway (G, H, I and J) have been subdivided into coastal (y), central (m) and interior (i) subregions.

Selected climatic data for the regions have been published.

In addition to the horizontal altitude zones according to the division there is a vertical division into following table:

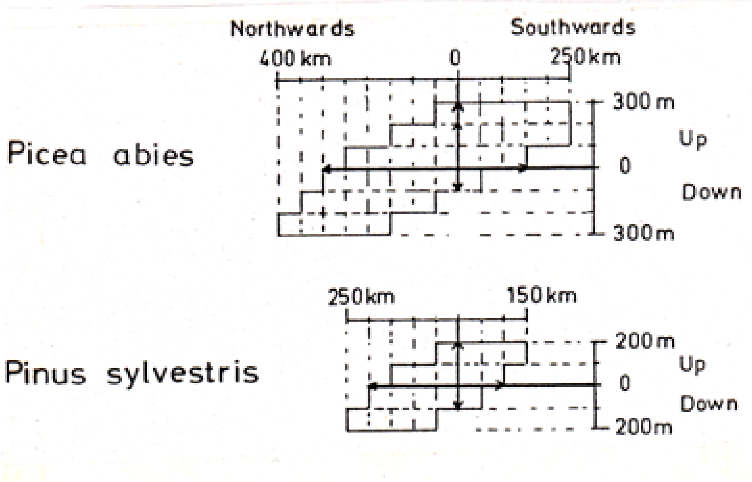
Altitude zone l:		0 - 149	metres	above	sea	level
”	”	2: 150 - 249	”	”	”	”
”	”	3: 250 - 349	”	”	”	”
”	”	8: 750 - 849	”	”	”	”

3. TRANSFER OF SEEDS AND PLANTS

Seeds and plants should preferably be used within the region of provenance from which the material is derived.

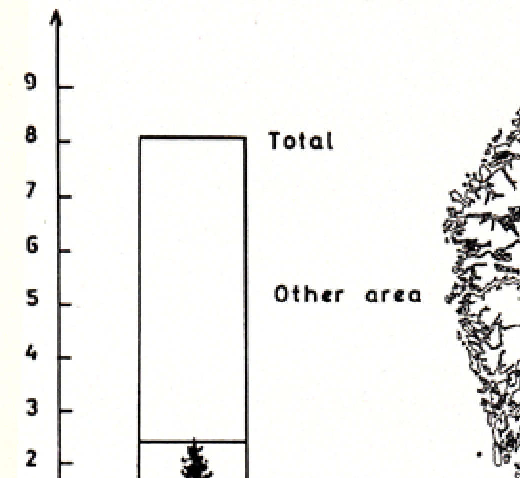
However, seeds and plants can be moved within certain limits. The diagrams indicate the ranges within which seeds or plants can be moved from the place of collection with satisfactory results. Within the same altitude zone, spruce can be moved up to 300 km northwards and pine 200 km. To the south, spruce should not be moved further than 150 km and pine l00 km. Within the same district, spruce may be moved 200-300 m upwards and pine 200 meters. This, however, is not applicable in areas of high elevation. Downwards the figures are 100 meters for both species. The limits of movement in both horizontal and vertical direction, are seen in the diagrams.

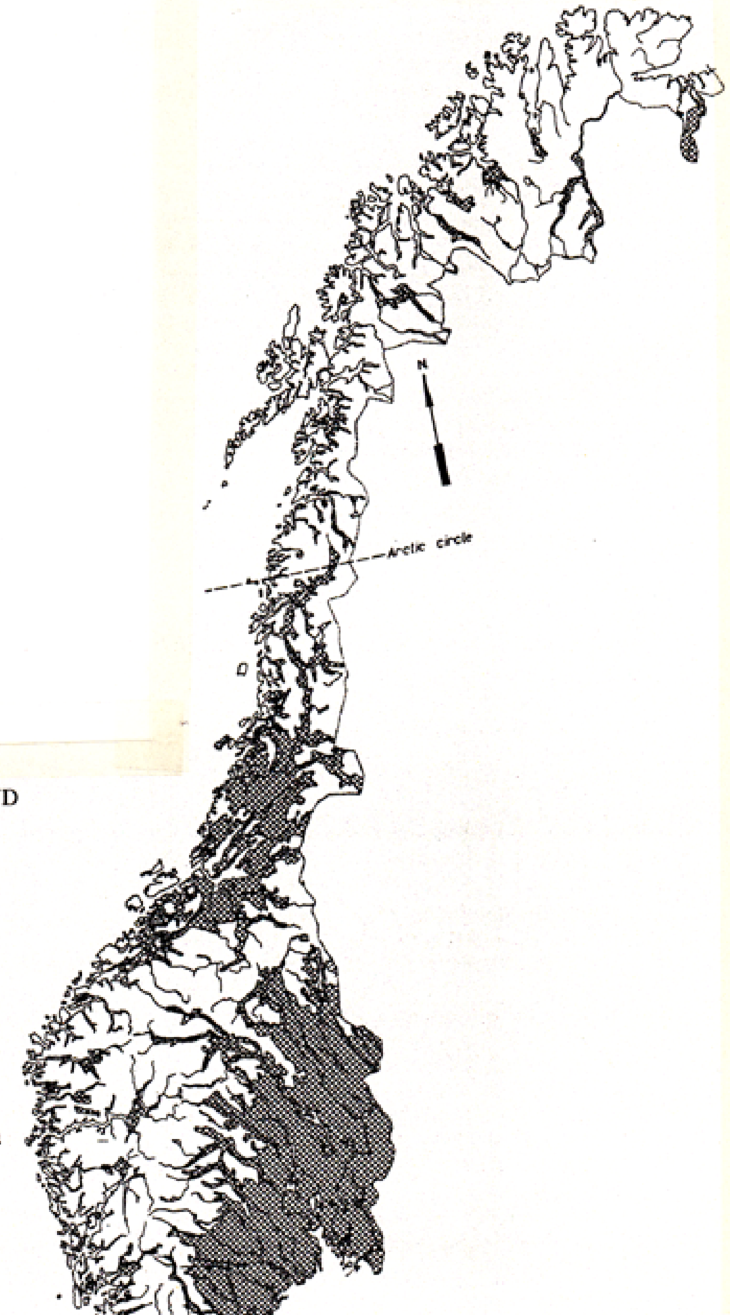
Guidelines for Transfer



NORWAY

AREA PER PERSON BY TYPE OF LAND





Coniferous forest areas below the timber line.

F. DISCUSSION

1. COMPARISON OF PROCEDURES IN DIFFERENT COUNTRIES

It can be seen from the above examples that local circumstances influence the choice of seed zoning method. In Orissa, India, ecological control is provided by the use of the forest type but the boundaries of each zone follow pre-existing administrative boundaries such as the forest circle and division. In Thailand moisture availability is considered the dominant factor affecting the variation in teak, so a moisture index, based on rainfall and temperature, is the criterion for delimiting the four zones used. In Honduras, a mountainous country, the main zonation is physiographic, while in Norway the effect of temperature is over-riding and zonation is based on both latitude and elevation, as well as distance from the sea. Although the size and shape of seed zones vary considerably both within and between countries, the majority are between 2,000 and 20,000 km^2 in area.

2. TRANSFER OF SEED AND PLANTS

Once seed zones have been decided, described and mapped, there remains the question as to whether seed can be transferred between the seed zone and a new site for afforestation outside the collecting zones. This may be (a) outside the seed zone but within the natural range of the species (b) outside the natural range where the species is being introduced as an exotic.

Within the natural range the merits and risks of using non-local sources (transfer of seed) have been widely discussed. There is only one safe method for solving the problem and that is, as already stressed, to carry out short-term or long-term provenance trials. In the absence of these, foresters will often feel that seed of local origin is safest (a minimum risk of maximum loss). This is based on the assumption that natural stands of any given species have usually become adapted to the precise environment in which they are found, through the process of selection which can generally be reckoned to have operated over long periods. If reproductive material is taken from such stands and planted in the same locality, it will therefore have a higher proportion of genotypes favourable to that area than if taken from elsewhere.

Local adaptability in nature is usually adaptability for survival, not suitability for the purposes of man (high yield, straight boles, useful wood properties, etc.). So, although the local seed source may be the safest, there is wide experience that it is not always the best. Some provenances of some species are capable of producing high yields of useful produce over a wide range of sites. In addition the forester may be able to compensate for a certain lack of local adaptability in the ”better” introduced provenance by the intensive management accorded to plantations (e.g. timely thinning can compensate for an inherent susceptibility to drought stress caused by excessive competition). Local seed sources should not be abandoned until something better has been convincingly demonstrated, but most foresters will be alert to the possibilities of finding and testing promising non-local sources.

The idea of ”locality” is often uncertain. How far can one go horizontally or vertically from the planting area and still speak of a local seed source? It depends partly on how much the ecological conditions vary, partly on the genetic response of the species in question to the ecological variation. The general rule is that seed of an indigenous species should be used within the seed zone and elevation belt from where it is collected, yet with a certain margin as to transfer of seed to a higher or lower elevation belt. When an exotic species is introduced, there is no question of comparing introduced with local seed source.

If relevant provenance trials do not exist, we shall have to base our search for suitable seed sources solely on our knowledge of the local ecological conditions and our knowledge of the ecological conditions of the possible new seed sources. The procedure is to search for stands that apparently grow under similar conditions as those in the area to which we want to introduce the species. It must be kept in mind, however, that many exotics have been successfully introduced in cases where evidence of "climatic match" or other similarities were not established, while in other cases introduction of exotics has been a failure in spite of apparent "climatic match".

3. MIXING OF SEED BATCHES

Whether it is proper to mix seed within or between seed zones will depend on (1) the application of the seed, (2) its genetic composition, and (3) the differences in prevailing ecological conditions between the seed-source area and the planting site.

For large-scale afforestation schemes, seed from a suitable seed zone is required and it may be acceptable to have a mixture of seed sources from within that zone. If seed supply from the approved zone is inadequate, it may be necessary to accept seed from another zone to make up the shortfall. In such a case it would be preferable to keep separate the two batches of (a) more and (b) less suitable seed rather than mixing them.

It must be noted that although seed from the same seed zone may be mixed without much risk if it is to be used locally, it may well happen that such a mixture of seed in a quite different environment will grow into stands that are very heterogeneous in growth and quality. The cause may be found in the fact that all the local stands, the seed of which is found in the mixture, have adapted well enough to the locality to secure a reasonably homogeneous development of the new local plantations. Under different growth conditions, however, considerable differences may appear. It is stressed that it is these very reservations that apply to seed moving in international trade. Therefore, one must be more critical of what can be accepted as to "mixing" at the introduction of seed than at the application of local seed. If seed has been collected from different elevation belts within the same seed zone, these seed lots should be kept separate.

4. NON-INDIGENOUS STANDS

All the above discussion refers to seed zones in indigenous stands. The situation in plantations of exotic species is very different. Because they are planted and usually given some form of management, it is much simpler than in natural forests to organize seed collection by smaller units, e.g. the compartment, of which the boundaries are clearly demarcated on the ground and which are commonly surveyed and mapped. Seed collected from a particular compartment can be handled and shipped separately, in the same way as that from a seed stand. In the second place, the local adaptation of an exotic plantation, especially in its first rotation, is much less certain than that of a natural stand on the same site. Its genetic characteristics may be more strongly influenced by the site conditions of its natural forest ancestors than by those where it is growing now. For this reason any description of or zonation of ecological conditions in the present locality needs to be supplemented by information on pedigree, as described by Jones and Burley (1973).

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GFTI: Wright, J.W., 1962
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GGC: Rieger, R., Michaelis, A. and Green, M.M., 1968
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TFS: Society of American Foresters. *1971*
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Adaptation

The process of evolutionary (genetic) adjustments fitting individuals or groups to their environment. Also the changed structure or function itself (GFTIW)

Adaptability

The potentiality for adaptation. (GGC)

Association

A plant community of some particular kind or grade. An association may have several dominants, either mixed together or occurring in different places. (TFS abbreviated)

Catena

A sequence (”chain”) of different soils, generally derived from similar parent soil material, each of which owes its character to its particular physiographic position. (TFS)

Climax

The culminating stage in plant succession for a given environment, the vegetation being conceived as having reached a highly stable condition. (TFS)

Cline

A geographical gradient of phenotype or genotype within the species’ range. Determining whether a cline is genetic requires a test in a single environment. Usually clinal variation results from an environmental gradient. Portions of populations exhibiting such continuous (clinal) change from one area to another should not be designated as ecotypes, races or taxa. (GFTIW)

Clone

A genetically uniform assemblage of individuals derived originally from a single individual by vegetative propagation: for example, by cuttings, divisions, grafts, layers or apomixis. (OECD)

Community

Any assembly of organisms living together, no particular ecological status being implied. (TFS)

Composition

Composition of a forest crop or stand: the representation of tree species in it. Composition is expressed quantitatively as percent by volume or basal area of each species, as percent by number only at the seedling stage. (TFS)

Constitution

Constitution of a forest crop or stand: the distribution and representation of age and/or size classes. (TFS)

Ecotype

A race adapted to the selective action of a particular environment. Most differences among ecotypes show up only when different ecotypes are tested in a uniform environment. Ecotypes are described e.g. as climatic or edaphic. (GFTIW)

Exotic

Strictly speaking, an organism introduced from a foreign country. Often used in a broader sense to include an introduction from another area. (GFTI)

Forest region

A major geographic belt or zone characterized vegetationally by a broad uniformity both in physiognomy and in the composition of the dominant tree species. (FRC)

Forest section

A subdivision of the region, conceived as a geographic area possessing an individuality which is expressed relative to other sections in a distinctive patterning of vegetation and of physiography. (FRC)

Forest type

A category of forest defined by its vegetation (particularly its composition) and/or locality factors. (TFS)

Gene

The basic unit of heredity, which is normally associated with a fixed position (locus) on a chromosome, is transmitted in the gametes from parents to offspring, and governs the transmission and development of a hereditary character. (TFS)

Gene pool

The sum of all the genes in a given cross-breeding group of organisms. In the widest sense, natural forests or artificial plantations of both indigenous or exotic species are gene pools, in the narrower sense also seed stands, provenance collections, tree gene banks and arboreta. (TFS)

Generation

All those individuals of an organism that are separated from a common parent or ancestor by an equal number of reproductive cycles. (TFS)

Genotype

(1) An individual's hereditary constitution, with or without phenotypic expression of the one or more characters it underlies. Also the gene classification of this constitution expressed in a formula. The genotype is determined chiefly from performance of progeny and other relatives. It interacts with the environment to produce the phenotype.

(2) Individual(s) characterized by a certain genetic constitution. (GFTIW)

Genotype- environment interaction

The failure of entries to maintain the same relative ranks and level of differences when tested in different environments. The tests are planted at more than one location or under more than one cultural condition. (GFTTW)

Heritability

Degree to which a character is influenced by heredity as compared to environment. Narrow-sense heritability is the fraction of total variation that is contributed by additive effects of genes, i.e. it is the ratio of additive genotypic variance to phenotypic variance. Broad-sense heritability, applicable to vegetatively propagated species, includes also non-additive effects. High heritability indicates that individual phenotypes are indicative of their genotypes. If calculated from parent-progeny data, it estimates the degree of resemblance between parent and progeny. (GFTIW)

Hybrid

(l) The offspring of genetically different parents. The term is applied as well to the progeny from matings within species (intraspecific) as to those between species (interspecific). Hybrids combine the characteristics of the parents or exhibit new ones.

(2) An individual possessing unlike alleles. (GFTIW)

Indigenous stand

A stand which has been continuously regenerated by natural regeneration, or one raised artificially from seed collected in indigenous stands of the same region of provenance. (OECD)

Interbreeding

- of individuals capable of actual or potential gene exchange by hybridization. It is the process that holds individuals together in populations, and populations together in subspecies (races) and species. (GGC)

Isolation

(1) Geographic, allopatric isolation: absence of crossing among populations because of disturbance

or geographic barriers.

(2) Genetic isolation: absence of crossing because of gene or chromosome differences preventing fertilization or normal seed development. (TFS)

Laterite

A term originally applied to red, or red and yellow, residual clay subsoils, found widely in the Indian subcontinent, already hard or, if plastic, hardening on exposure, and hence much used for making bricks. Subsequently applied to any red and yellow, mottled tropical clay. (TFS)

Metamorphic rocks

Rocks that have been re-formed and re-crystallized because of extreme changes in pressure and temperature.

Morphology

The external and internal form and structure of whole plants, organs, tissues, or cells; also the study of such form and structure, including life cycles of organisms. Internal morphology is often known as anatomy. Functional aspects of structure are an aspect of physiology rather than morphology. (GFTIW)

OECD

The Organization for Economic Cooperation and Development.

Origin

For an indigenous stand of trees, the origin is the place in which the trees are growing; for a non-indigenous stand, the origin is the place from which the seed or plants were originally introduced. (OECD).

Orographic

Connected with the physical character, features and relative position of mountains.

Pedigree

The ancestry of an individual, family or stock and its record (TFS)

Phenology

The science that deals with the time of appearance of characteristic periodic phenomena in the life cycle of organisms in nature, e.g. migration of birds, flowering and leaf-fall in plants, particularly as these phenomena are influenced by locality factors. (TFS)

Phenotype

The plant or character as we see it; state, description or degree of expression of a character; the product of the interaction of the genes of an organism (genotype) with the environment. When the total character expressions of an individual are considered, the phenotype describes the individual. Similar phenotypes do not necessarily breed alike. (GFTIW)

Physiognomy

External features or appearance of anything. The habit of a plant or plant community.

Physiography

Physical geography. The study of the origin and evolution of the structural features of the Earth's surface, i.e. of relief. (TFS)

Population

(1) Genetically, a group of individuals which are related by common descent and which for convenience may be treated as a unit.

(2) Statistically, a group of observations (or the individuals on which the observations are made), which are homogeneous. (GFTI)

Progeny

Offspring of a particular mating or of a particular mate, or a particular individual in the case of apomictic reproduction. (OECD)

Provenance

The place in which any stand of trees is growing. The stand may be indigenous or non-indigenous. (OECD)

Pyroclastic

Formed of fragments broken in the process of volcanic eruption.

Race

An intraspecific category, primarily a population or aggregate of populations, with characteristic gene frequencies or features of chromosome structure that distinguish a particular group of individuals from other groups of the same kind within formally recognizable subspecies or within species. Race differences are relative, not absolute. The term subspecies is frequently used in the same sense as race. Any race is able to interbreed freely with any other race of the same species. Whenever different races of a cross-fertilizing species occupy geographically separate territories they are said to be allopatric; those occupying the same territory are sympatric. Races may become distinct species by the production of reproductive isolation (with respect to the other races of the same species) and thus the formation of isolated gene pools.

Geographic races are subspecies occupying a geographic subdivision of the range of a species.

Ecological races are local races owing their most conspicuous attributes to the selective effect of a specific environment (ecotype).

Physiological races are races characterized by certain physiological, rather than morphological, characters.

Chromosomal races are races differing in respect to features of chromosome structure (cytotype) or in chromosome number (polyplotypes). (GGC)

Region of provenance

For a species, subspecies or distinct variety, the region of provenance is the area or group of areas subject to sufficiently uniform ecological conditions on which are found stands showing similar phenotypic or genetic characters. (OECD)

Reproductive material

Seeds: Cones, fruits and seeds intended for the production of plants.

Parts of plants: Stem, leaf and root cuttings, scions and layers intended for the production of plants.

Plants: Plants raised by means of seeds or parts of plants, also includes natural regeneration. (OECD)

Reproductive stability

Ability to retain the distinguishing features when recurrently reproduced over time, depending on: age; development; number and type of trees contributing; and isolation from outside pollen sources.

Seed collection zone/unit

Zone of trees with relatively uniform genetic (racial) composition as determined by progeny-testing various seed sources. The encompassed area usually has definite geographic boundaries, climate, and growing conditions. A single geographic race may be divided into several zones. (GFTIW)

Seed-orchard

A plantation of selected clones or progenies which is isolated or managed to avoid or reduce pollination from outside sources, managed to produce frequent, abundant and easily harvested crops of seed. (OECD)

Seed production area

A plus stand that is generally upgraded and opened by removal of undesirable trees and then cultured for early and abundant seed production.

Seed source

The locality where a seed lot was collected; also the seed itself. If the stand from which collections were made was in turn from non-native ancestors, the original seed source should also be recorded and designated as the provenance. (GFTIW)

Selected stand

A stand of trees superior to the accepted mean for the prevailing ecological conditions when judged by the criteria set out by OECD and which may be treated for the production of seed. Where necessary, particularly to comply with the requirements of uniformity, the approval of a selected stand would be dependent on the removal of inferior trees. (OECD).

Selection

Natural selection acts to preserve in nature favourable variations and ultimately to eliminate those that are ”injurious” (Darwin). It is a consequence of differences between genotypes in respect to their ability to produce progeny and represents a process without purpose whose primary form (”Darwinian selection”) takes place between individuals in a population. However, both competition and selection do occur between reproducible biological units of greater and lesser complexity than that of individuals.

Artificial selection in contrast to natural selection, is a purposeful process with definite goals set by the breeder and means selection applied under a selected set of environmental conditions. It normally occurs with controlled matings of a few selected genotypes, and its goal is to change specific phenotypic characters of a population. Artificial selection applied to one character almost always leads to changes in others (”correlated response”). (GGC)

Source - identified

Of seed and plants, derived from a defined area (seed source), registered by a designated authority. Source-identified seed is normally harvested, processed, and stored, and plants raised under the supervision of a designated authority. (TFS)

Species

The main category of taxonomic classification into which genera are subdivided, comprising a group of similar individuals having a number of correlated characters. There is generally a sterility barrier between species or at least reduced fertility in interspecific hybrids. The species is the basic unit of taxonomy, on which the binomial system has been established. The lower hierarchy is form, variety, subspecies, species. (TFS)

Stand

A population of trees possessing sufficient uniformity in composition, constitution and arrangement to be distinguishable from adjacent populations. (OECD)

Stock (strain)

A group of plants of common lineage which, although not taxonomically distinct from others of the species or variety, are distinguishable on the basis of productivity, vigour, resistance to disease, or other ecological characters. (TFS)

Superior

A non-technical term referring to selections which appear or have been proved to be outstanding.