



BOTANY DIVISION REPORT

Cultivation, provenance and planting
trials with pingao (*Desmoschoenus spiralis*)

Prepared for Department of Conservation

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1989/90

CULTIVATION, PROVENANCE AND PLANTING TRIALS WITH PINGAO

(Desmoschoenus spiralis)

INVESTIGATION NO: S6020/458
CORPORATE OBJECTIVE NO: 6.44

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PREPARED FOR:
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Department of Conservation

DATE: February 1990

EXECUTIVE SUMMARY (FINAL):

INVESTIGATION NO: S6020/458
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INVESTIGATION TITLE: Cultivation, provenance and planting trials with pingao (*Desmoschoenus spiralis*)

STUDY VENUE: All, Hawkes Bay

INVESTIGATION LEADER: Geoff Walls

INVESTIGATION STATUS: Completed

CLIENT: DOC

INVESTIGATION SUMMARY:

In a study of pingao from 1985 to 1990, four separate but related trials were undertaken. The first investigated pingao as a garden plant, the second explored its morphological variation throughout its geographical range, and the third and fourth focused on planting pingao in the wild.

OBJECTIVES:

1. To determine whether pingao could be readily cultivated.
2. To explore the extent of its variation geographically.
3. To test wild planting techniques for dune rehabilitation and re-establishment of wild populations.

METHODS:

1. A garden trial was established at DSIR, Havelock North in which different growing media were used.
2. A provenance trial was undertaken using pingao from eight geographically separated sites around New Zealand.
3. Trials of wild pingao cuttings were taken from plants growing on dunes at Ocean Beach, Hawkes Bay, and planted in five sites on the dunes. Five cuttings were planted at each site, at about 1 m spacings.
4. Trials of cultivated plants at Ocean Beach were established in 60 x 50 m fenced exclosures.

RESULTS:

1. Pingao grew in all media, and indeed performed best away from beach sand.
2. Although most plants died, enough survived to suggest that the morphological differences, so characteristic of wild populations, are maintained, suggesting a genetic base to this variability.
3. Most wild-origin cuttings died, those in dune hollows performing best.
4. Pot grown material performed well in established in the field.

CONCLUSIONS:

1. Pingao thrives as a garden plant provided a small number of requirements such as weeding are met.
2. Although a faster process, growing from cuttings, either in the garden or wild, does not result in as good a survival as from seed.
3. There is a great deal of genetically based morphological variation in pingao.
4. Planting in the wild results in greatest success of pot grown material is used. Dune hollows provide the best situation.

RECOMMENDATIONS:

1. That pingao be planted extensively as a garden plant.
2. That plantings in the wild take place using pot grown material and be carefully monitored.
3. That such planting carefully consider provenance, as there is a great deal of regional genetic variability.

CULTIVATION, PROVENANCE AND PLANTING TRIALS WITH
PINGAO (DESMOSCHOENUS SPIRALIS)

by

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February 1990

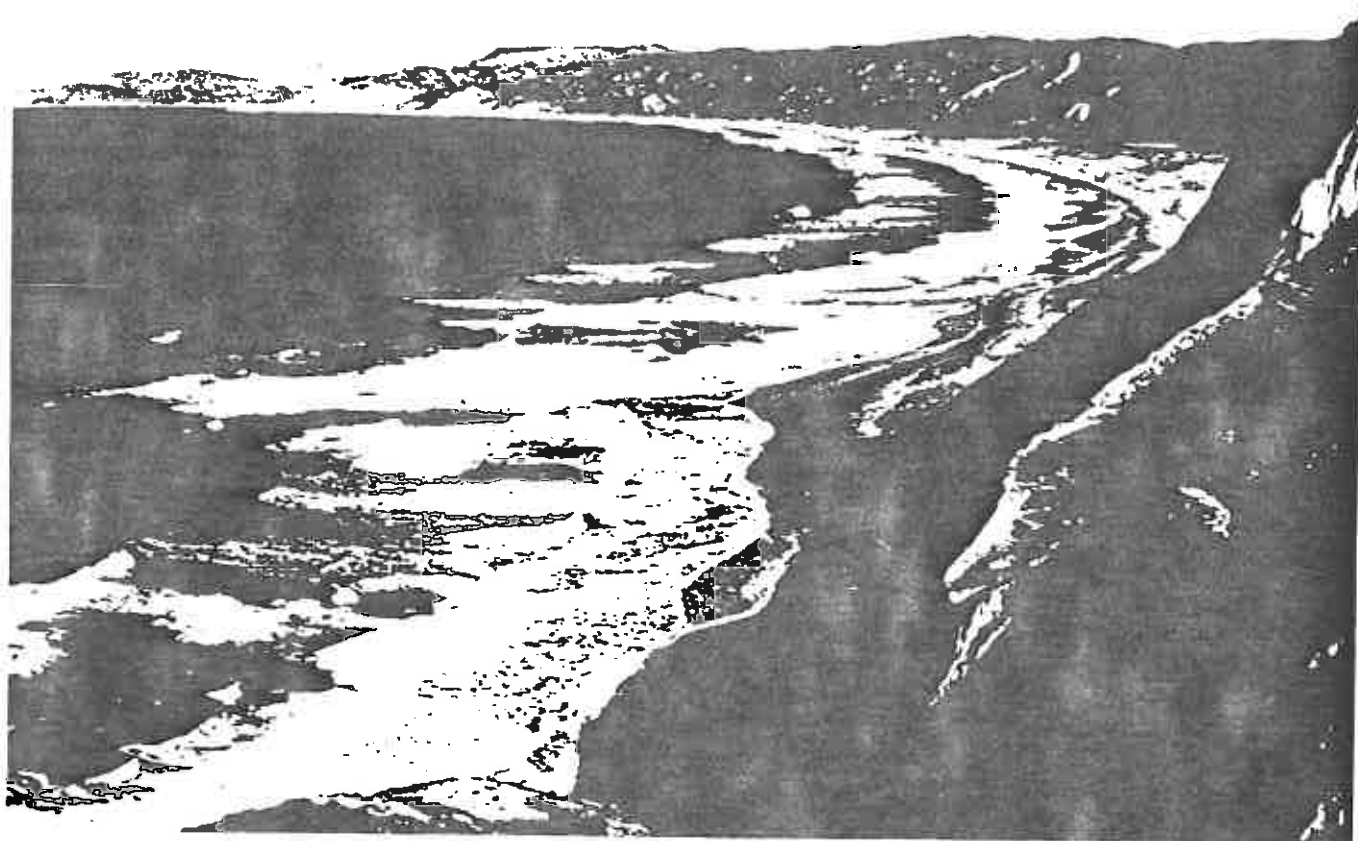
SUMMARY

In a study of pingao (Desmoschoenus spiralis) from 1985 to 1990, four separate but related trials were undertaken. The first investigated pingao as a garden plant, the second explored its morphological variation throughout its geographical range, and the third and fourth focussed on planting of pingao in the wild. The study has demonstrated that pingao can be gardened and container-grown, far from the sea, using basic gardening methods. Some precautions are necessary to avoid excessive moisture extremes, weed competition, insect pests and fungal diseases, and deep mulching with a loose medium is highly beneficial. There is definite variation in size, structure, habit and colour of pingao around New Zealand, and sufficient of these characteristics are retained in cultivation to suggest genetic differences between populations. Wild planting trials have shown that, as in cultivation, container-grown seedlings or cuttings have far higher survival rates than do fresh cuttings, and that the best planting sites are dune hollows. A series of conclusions and recommendations is given.

Keywords: pingao, Desmoschoenus spiralis, cultivation, provenances, wild planting, sand dunes, coasts

CONTENTS

	Page
Summary	1
Introduction	3
Study design	4
1. Garden trial, DSIR Havelock North	4
2. Provenance trial	7
3. Planting trials of wild cuttings, Ocean Beach	9
4. Planting trials of cultivated plants, Ocean Beach	11
Conclusions and recommendations	12
Acknowledgements	16
Bibliography	18



The sweeping dune system of Ocean Beach, site for much of this study and last stronghold of pingao in Hawke's Bay.

All photos by Geoff Walls.

INTRODUCTION

Pingao is prized in traditional Maori arts and crafts for its strength and lasting qualities and, above all, for its enduring brilliant yellow-gold colour. Unfortunately, this spectacular endemic sandbinder is no longer common around New Zealand's sandy shores.

In early 1985, Maori craftswomen from Otatara Roopu Raranga in Hawke's Bay approached Botany Division DSIR with a request to investigate the status of wild pingao on the Hawke's Bay coasts. They were concerned that what little was left was declining rapidly, and was already incapable of sustaining even their modest requirements for leaf material.

A few months later I became established as Botany Division's regional botanist for the eastern central North island. I met the Otatara Roopu Raranga women and was shown their traditional use of pingao in plaited items, mostly decorative and ceremonial kete (baskets). I also visited the remaining coastal populations of pingao in Hawke's Bay, and quickly verified their scarcity and decline.

Further research revealed this to be a familiar story throughout New Zealand : the dwindling of a formerly abundant source of prized Maori arts and crafts material, coupled with a revival of traditional use of pingao. The management priority clearly lay with attempting to protect and revive pingao in the wild. An alternative though was to attempt cultivation of this special plant. Both avenues have been pursued : this report is of the cultivation trial, an associated examination of provenances (geographical variants), and some wild planting experiments.

STUDY DESIGN

There were several aspects to the study, resulting in a series of trials:

1. Preparation of an artificial garden at DSIR Havelock North, in which were grown cuttings of pingao from a local source (Ocean Beach, Hawke's Bay).
2. Collection of cutting material from other sites around New Zealand and growing of them in the same garden as in 1.
3. Planting at Ocean Beach of cuttings taken from plants growing there.
4. Planting at Ocean Beach of cultivated plants.

Cutting material was used because it had been successfully tried by others elsewhere, and it created instant trials : if pingao had been grown from seed the trial would have been considerably delayed. The following descriptions detail the techniques used and the results of each study aspect.

1. GARDEN TRIAL, DSIR HAVELOCK NORTH

In September 1985, a piece of land at DSIR Havelock North was rotary hoed and developed as a garden trial for pingao. Short trenches were made at 2 metre spacings, and each filled with a different growing medium : deep soil, shallow soil, beach sand, river sand, sawdust, soil/beach sand, soil/river sand, soil/sawdust. Sufficient medium was used to create parallel mounds and on each were planted 4 pingao cuttings at 1 metre

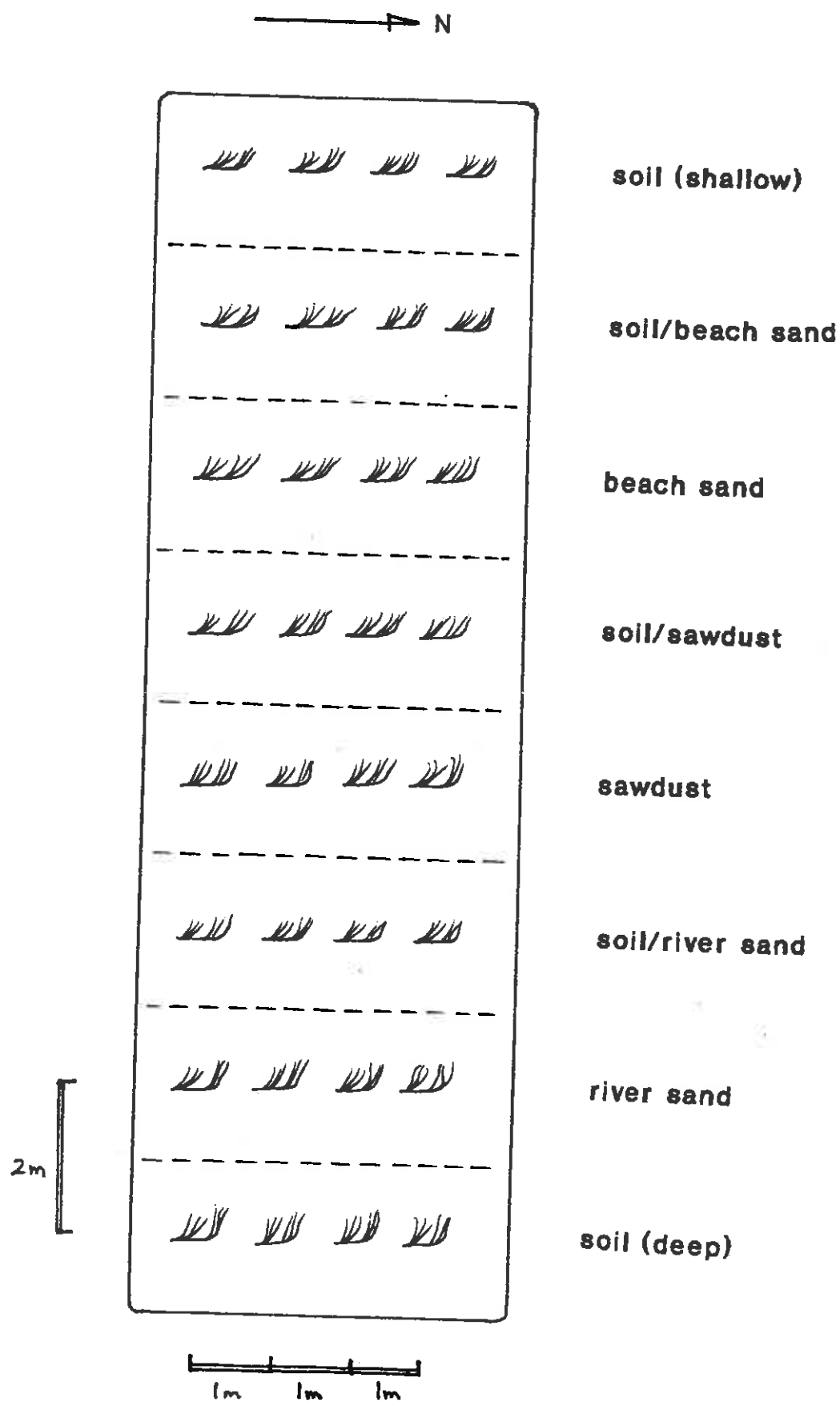


Figure 1: Diagram of layout of pingao trial garden, showing positioning of plants and growing media used.

spacings (Figure 1). These cuttings were stem sections from plants growing at Ocean Beach, the nearest wild pingao population, and each had at least 30 cm of stem containing some roots, and two leafy tufts. The cuttings were planted with their stems horizontal and the growing points of the leafy tufts just above the ground surface. No artificial fertilisers were used at this stage, but the ground was prevented from drying out by regular sprinkling.

About twenty cuttings were potted up in large plastic bags in soil/sand, sawdust/sand and sawdust media at the same time.

By February 1986, just under half of the cuttings in the garden had died, but the rest had established and were thriving. Most deaths were in the soil/beach sand and river sand media :

Growing medium	No. planted September 1985	No. dead February 1986
Soil (shallow)	4	1
Soil (deep)	4	1
Beach sand	4	1
River sand	4	3
Sawdust	4	1
Soil/beach sand	4	4
Soil/river sand	4	2
Soil/sawdust	4	2

Meanwhile, all the potted cuttings were thriving in a semi-shaded situation.

In March 1986, all the dead cuttings were replaced using those from the pots, and a mulch of fresh untreated sawdust about 25 cm deep was applied to the whole garden. The pingao responded markedly to the sawdust, greening in colour, looking more healthy, and sending out runners. Because of this, and the weed-suppressing and moisture-retaining effects of the mulch, a repeat was applied in March 1987. At this time all the plants were

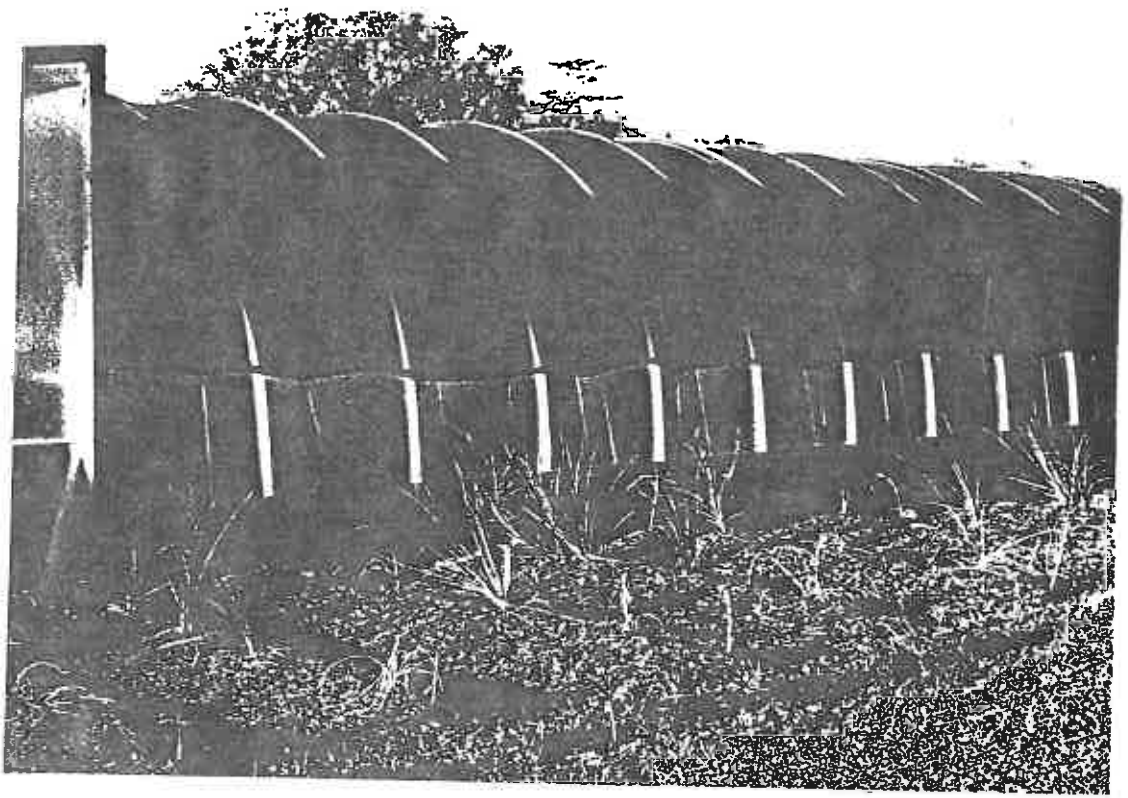
apparently flourishing, and about half had flowered and set seed the previous summer. The first pingao from other localities were planted then too : see the description of the provenance trial below.

From then on the garden trial and potted pingao were maintained, but with deliberately minimal input, and progress was periodically observed. Although DSIR Havelock North is 7.5 km from the coast and receives heavy winter frosts and harsh summer droughts, neither of these climatic conditions seemed to affect the pingao significantly.

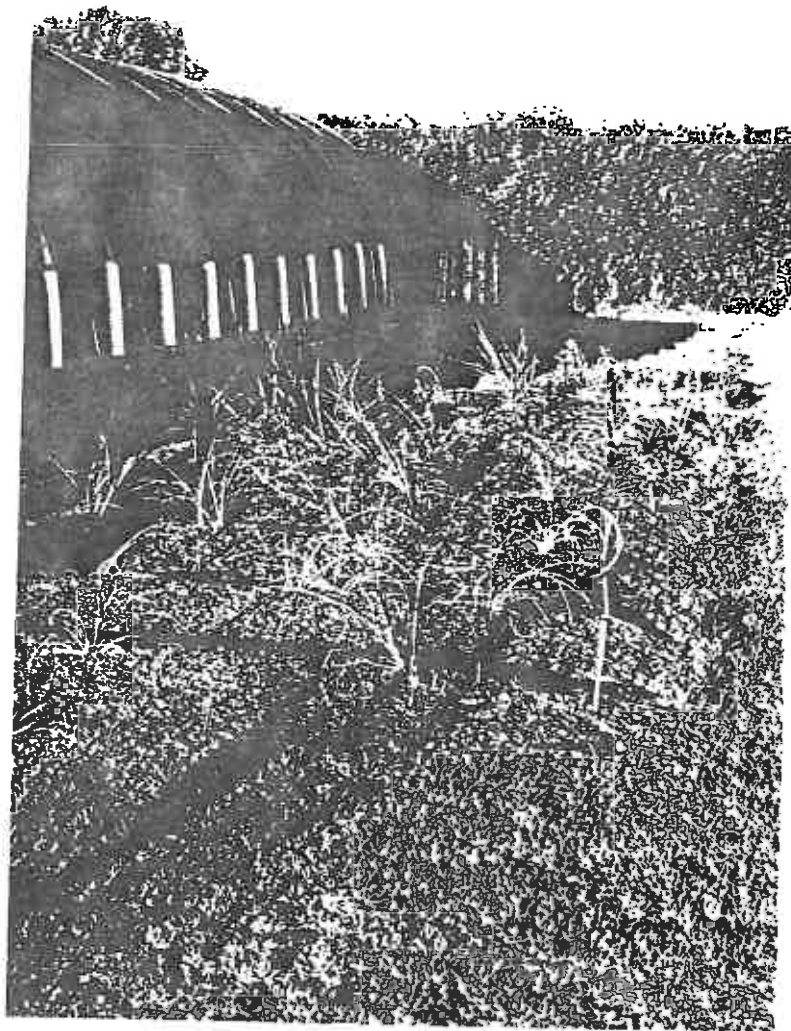
The greatest problems for the gardened pingao were weeds and diseases. Various adventive herbs and grass-like plants made bids for the garden space. Most were kept at bay by the sawdust mulch or were easily weeded out, but two became serious threats to the pingao and were not easy to deal with : field bindweed (Convolvulus arvensis) and nut grass (Cyperus rotundus). Assiduous hand-weeding was required to control these two competitors.

In autumn and winter, the planted pingao were attacked by grass mealybugs (Trionymus diminutus), which covered exposed stems and leaf bases en masse. Following their depredations, the pingao apparently lost much vigour. An insecticide was used in August to kill the mealybugs. However, no treatment was given for pathogenic soil fungi, and it is my guess - untested by analysis - that the majority of deaths among the cultivated pingao were caused by such fungi or similar diseases. Others who have grown pingao from both seed and cuttings have had repeated collapse of plants from fungal attack, and have prevented it using fungicides.

In November 1987, various artificial fertilisers were applied. Each was applied to a separate row of pingao in the garden, and three rows were left untreated as controls. The fertilisers were superphosphate, lawn fertiliser, 'Phostrogen' liquid fertiliser, pelletised sheep manure and all-purpose

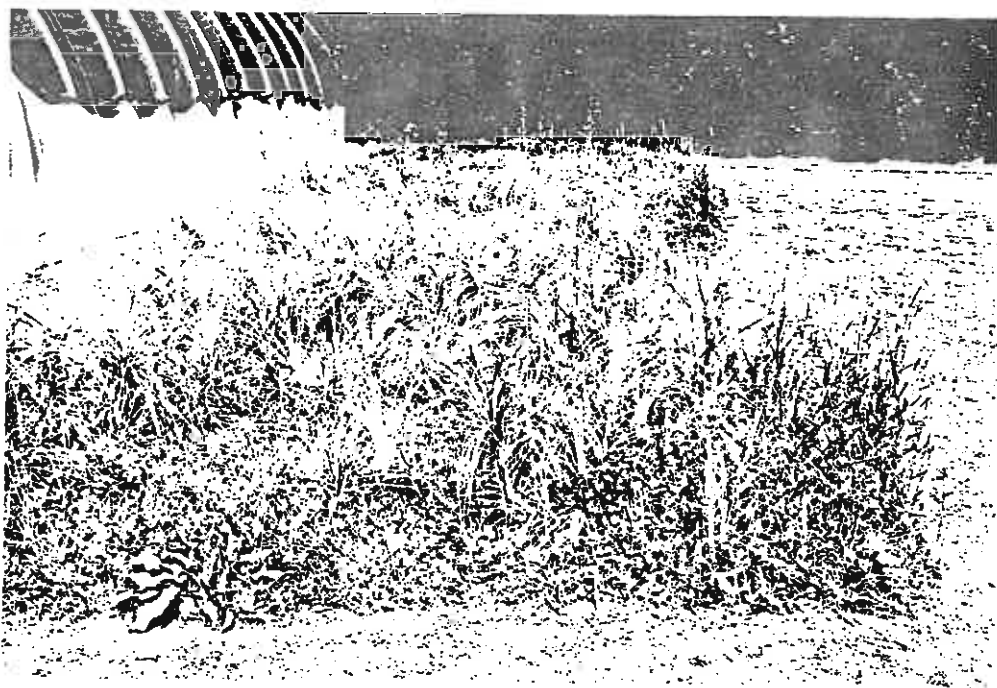


Early stages in the pingao cultivation trial at DSIR, Havelock North: cuttings, taken from nearby Ocean Beach, have been planted in mounded rows of different growing media, and have been deep-mulched with sawdust. Six months after planting, just under half of the cuttings have died; the rest are thriving.





Final stages in the pingao cultivation trial at DSIR, Havelock North: 3.5 years after being planted as cuttings, these plants have initially flourished, then progressively succumbed to the pressure from insects, fungal diseases and weeds.



fertiliser, acquired from a garden shop and applied once at the prescribed rates. Although all the fertilised plants subsequently looked healthier, I did not detect any measurable differences between any of the pingao rows, and regard this part of the trial as inconclusive.

By May 1989, only 10 of the original 32 cultivated pingao plants were still alive in the garden. These were lifted and transplanted on the dunes at Ocean Beach (see description of planting trial at Ocean Beach, below), and the garden trial was concluded. Before then, cuttings had been taken from the cultivated plants for various purposes, including displays and gifts. The garden also provided leaf material for some local Maori craftwork. More important, it acted as a living demonstration that this specialist coastal plant, endangered in its natural homes, could be successfully cultivated using basic gardening techniques.

2. PROVENANCE TRIAL

Between March and October in 1987, cuttings of pingao were collected from eight geographically separated sites around New Zealand (Figure 2):

- * Waipapa Point, eastern Southland
- * Jackson Bay, South Westland
- * Okarito, Westland
- * Lake Grassmere, Marlborough
- * Kaitorete Spit, Canterbury
- * Waikawau Bay, Coromandel Peninsula
- * Whatipu, west Auckland
- * Te Paki Stream, Ninety Mile Beach, Northland

The cuttings were kept cool and moist in transit and were treated with the fungicide 'Captan' before being planted at DSIR

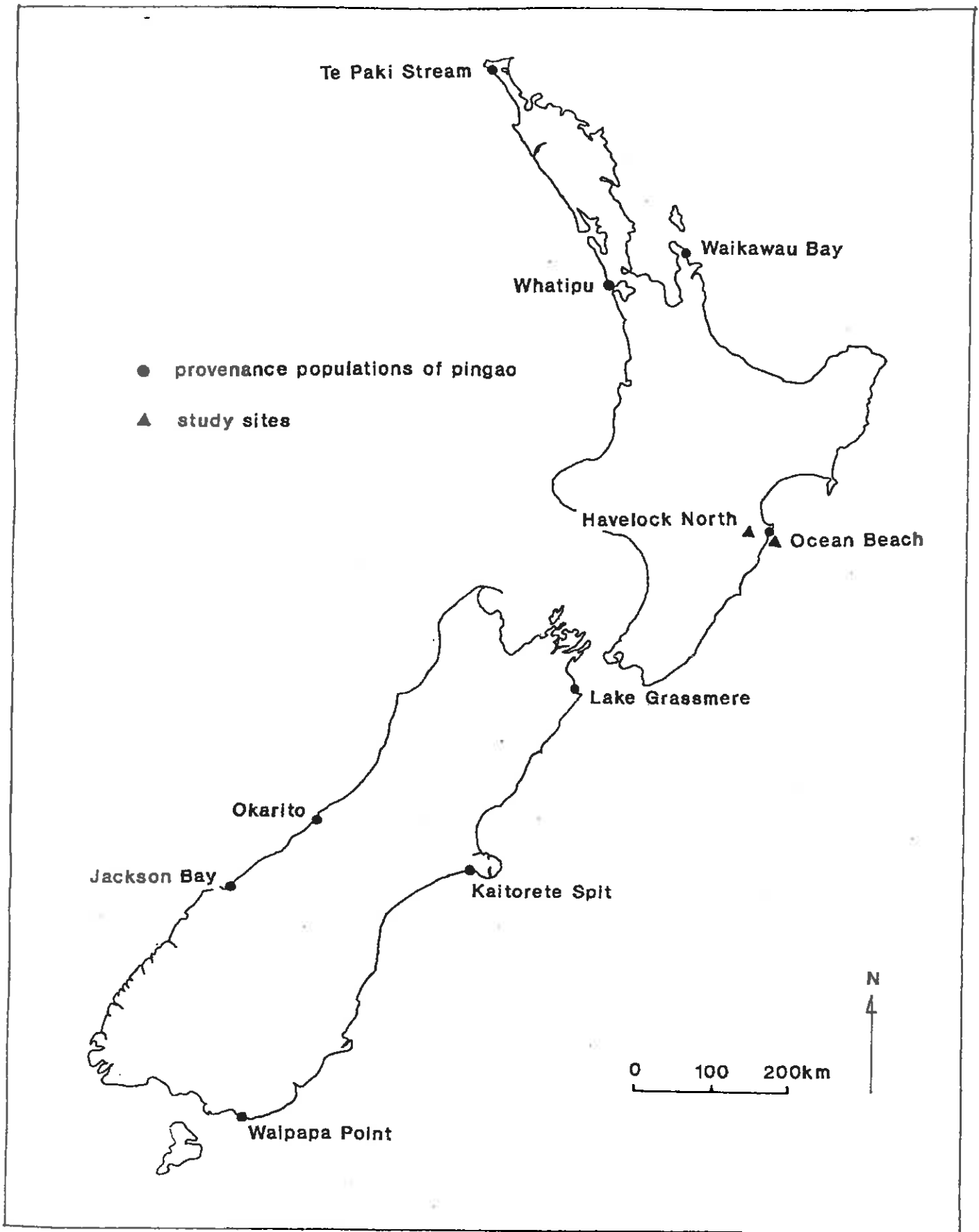


Figure 2: Location map of study sites and pingao populations used in provenance trial.

Havelock North adjacent to the Ocean Beach plants used in the garden trial (above). Each provenance (material from a specific geographical site) was accorded a separate row. The planting medium was sawdust, and a sawdust mulch was applied, so that the pingao plants were effectively in sawdust 'dunes'.

Unlike during the garden trial, the establishment rate of these planted pingao cuttings was very low. Most died almost straight away, others died back then sprouted afresh, and only a very few grew well from the start. The plants that did establish were from Waipapa Point, Jackson Bay, Lake Grassmere and Te Paki Stream. None thrived for long though, and very few of these plants were still alive when the study was wound down in May 1989. They did not establish sufficiently to allow a good comparison of their morphological characteristics as was hoped, although they did retain sufficient differences to support the contention that each of these populations is genetically distinct. The remnants of this trial are still alive at Ocean Beach (February 1990), and their characteristics persist, lending further weight to the above contention.

In the wild, it was obvious that the pingao in each of these localities looked different, in size, colour and growth habit. The following features were noted :

- * Waipapa Point - short, narrow leaves; seed heads shortish, slender; plants tufted, not sprawling much; colour dull yellow-gold (22 May 1987).
- * Jackson Bay - shortish narrow leaves; seed heads tall, slender; plants quite erect; colour beautiful rich orange (29 May 1987).
- * Okarito - leaves like those at Jackson Bay; seed heads tallish, slender; plants clumped and tufted; colour drab yellow-gold (29 May 1987).
- * Lake Grassmere - leaves small and fine (short and narrow); seed heads very short and slender; plants small, tufted,

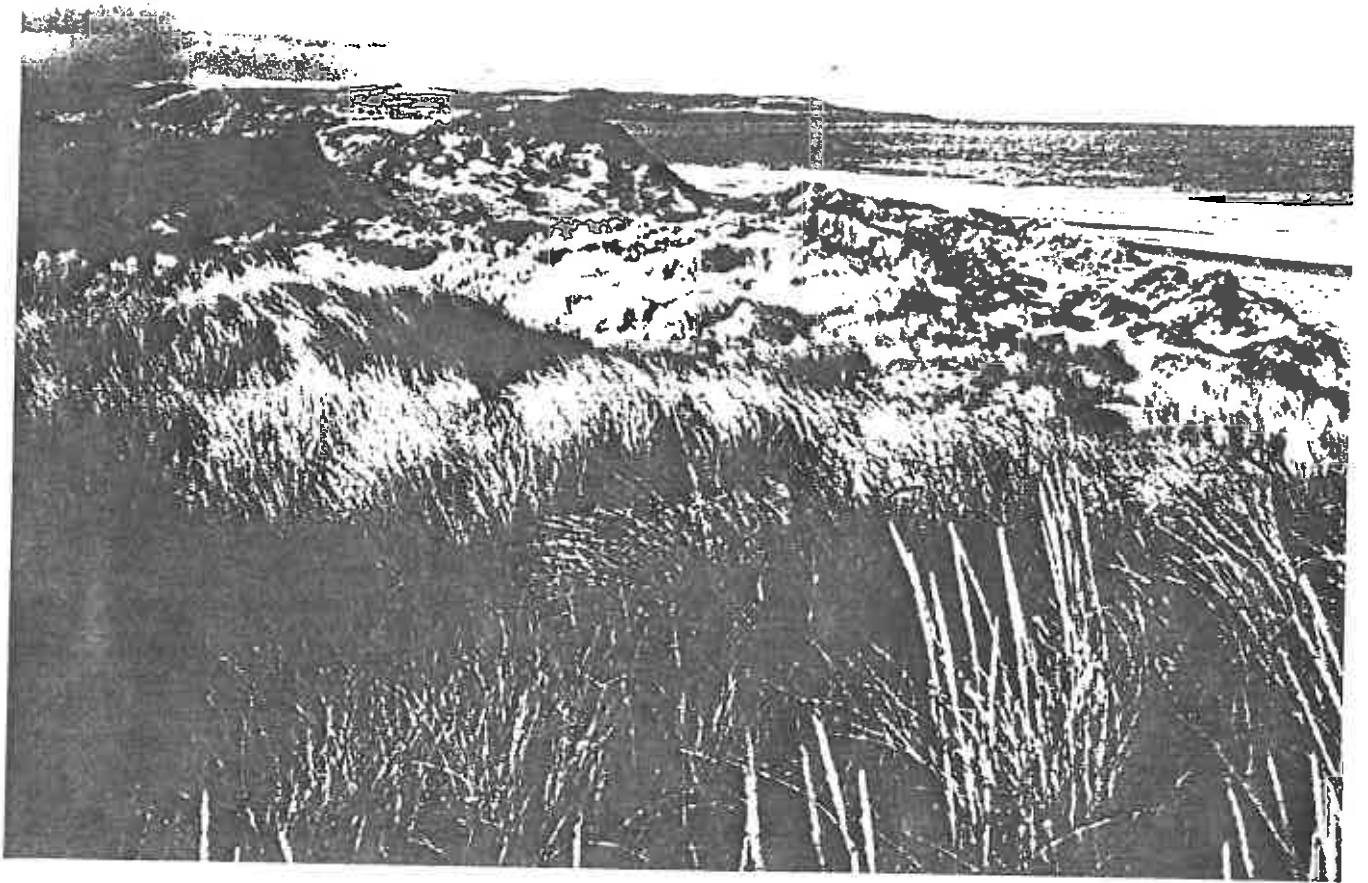
with few runners; colour dull yellow.

- * Kaitorete Spit - leaves very short though not as fine as at Lake Grassmere; seed heads short and chunky; plants low-growing, densely tufted and erect; colour bright yellow (March 1987).
- * Waikawau Bay - leaves shortish, robust; seed heads tall, robust; plants sprawling with many runners; colour orange-green (10 October 1987).
- * Whatipu - leaves shortish, very broad and thick; seed heads shortish, stout; plants clumped and erect, but creeping freely; colour yellow-gold with a distinct blue-grey tint (16 October 1987).
- * Te Paki Stream - leaves very long, broad and erect; seed heads tall and robust; plants large, lush, erect, with numerous active runners; colour bright yellow-green (14 October 1987).

By comparison, the plants from Ocean Beach, Hawke's Bay, have the following characteristics:

leaves quite long, fairly narrow, erect; seed heads shortish, robust; plants erect, not densely clumped, with numerous active runners; colour rich yellow-gold in summer, orange-green in winter.

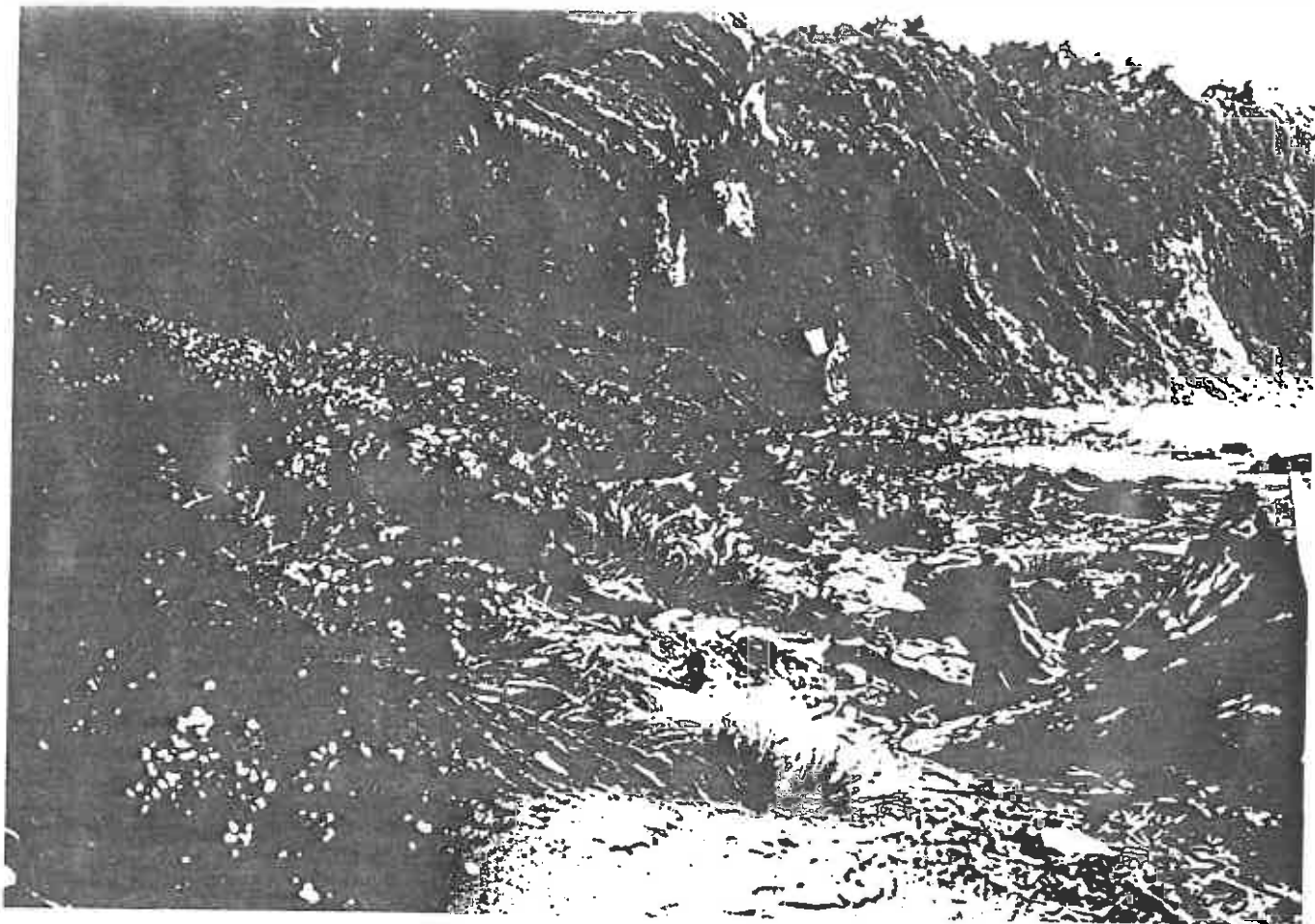
Although this study yielded little information on the genetic variability within wild pingao, I think it provided enough to make further research worthwhile. I think it likely that there are considerable genetic differences between populations, but that growing conditions also affect pingao morphology enough to make field observations inconclusive on the matter.



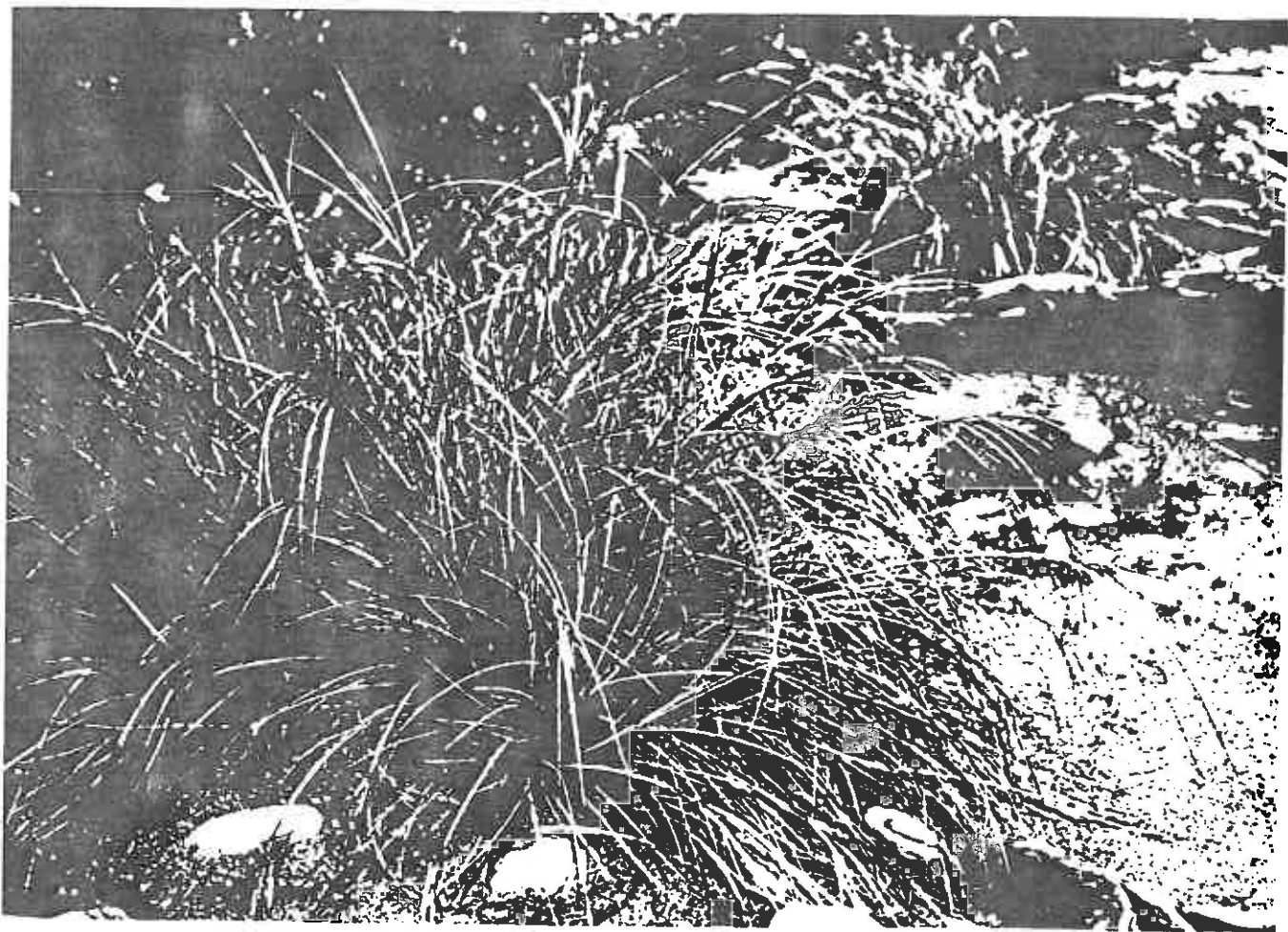
Pingao sharing the dunes at Waipapa Point, Southland, with marram grass. Plants here are relatively small in stature compared with other New Zealand pingao.



Pingao growing alongside gorse, Jackson Bay, south Westland. Note the slender drooping seedheads.



Pingao growing in coarse sand between gorse and storm-tossed driftwood, Okarito, Westland. Plants are relatively small.



Pingao plant at Okarito, Westland. Leaves and seedheads are quite slender.



At Lake Grassmere, Marlborough, pingao is very small (plants less than 50 cm tall), dwarfed by the marram grass.



Typical Hawke's Bay pingao, growing amongst spinifex, at Rangaika.



Closeup of pingao at Ocean Beach, Hawke's Bay, showing the erect curving nature of the tufts.



Live pingao in the foreground; high dunes in the background, formerly stabilised by pingao, now collapsing following the death of those plants. Ocean Beach, Hawke's Bay.



An unusual situation for pingao: moist flats on dark iron sands, Whatipu, west Auckland. These pingao are extraordinarily robust and have a blue-grey tint to their colour. Seedlings abound, despite rabbit presence.



Pingao in full flower at Waikawau Bay, Coromandel Peninsula.



The tall erect robust pingao of Te Paki Stream dunes, Northland.

3. PLANTING TRIALS OF WILD CUTTINGS, OCEAN BEACH

In October 1985, cuttings were taken from plants growing on the dunes at Ocean Beach, Hawke's Bay, and planted immediately in five sites on the dunes :

- * on inner dunes in a virtually flat broad dune hollow
- * near the first planting, but on a portion of the dune hollow consolidated by other vegetation (Carex pumila and small adventive herbs and grasses)
- * on a steep north-facing dune face amongst spinifex (Spinifex sericeus)
- * on a gentle dune ridge slope (south-facing)
- * on an unconsolidated sand slope right on the shore, at the base of a dune covered in pingao.

The cuttings were stem sections with roots and leaf tufts as described for and used in the garden trial, and were planted with their growing tips just at sand surface level. Five cuttings were planted at each site, at about 1 m spacings.

By April 1986, all of the above plantings looked dead, except for two cuttings at the seaside planting. At this time, new plantings of cuttings were made in four places :

- * alongside the existing seaside ones
- * alongside the dune ridge ones
- * alongside the ones in the inner consolidated dune hollow
- * in a deep narrow dune hollow mid-way between the shore and the inner dunes

By July 1986, all of the earlier cuttings were thoroughly dead, and the later ones looked yellow and non-growing except for some green tips in the seaside plants. Five more cuttings were taken, and planted alongside the others in the mid-dune hollow.

In March 1987, about half of the cuttings in the seaward planting were still alive and had produced new leaves. In the mid-dune hollow, some of the cuttings had died, but most were flourishing. At the inner consolidated site, only two cuttings retained a glimmer of green.

In January 1988, all cuttings had died except for about half of the originals in the mid-dune hollow and a single plant at the inner consolidated site. Two years later, in January 1990, the only cuttings still alive were three in the mid-dune hollow, looking quite healthy.

The results of this trial are not encouraging for the use of cuttings in extending or revitalising wild pingao populations. Despite care in cutting selection and planting, choice of a number of sites (including the dampest and most sheltered ones) and avoidance of the hot dry seasons for planting, successful establishment of new plants was minimal. I suspect that desiccation and inundation by sand were the problems for the cuttings : they died quickest on the driest sites and where they were most undermined or buried as sand was blown about.

Larger cuttings planted with their stems vertical could be more successful in weathering the dune conditions. Well-rooted seedlings are likely to be better still. The best places to plant appear to be dune hollows, where moisture and some shelter are most available.

4. PLANTING TRIALS OF CULTIVATED PLANTS, OCEAN BEACH

In May 1989, I erected a 60 x 50 m fenced enclosure in a broad dune hollow at Ocean Beach, Hawke's Bay. This was part of a

separate study to assess various impacts on pingao growing there and the trends in the wild pingao population, and to elucidate dune patterns and processes. The fence has excluded cattle, sheep, goats, horses and off-road vehicles since being erected.

Within the enclosure, in May 1989, I planted three lots of cultivated pingao plants:

- * rooted cuttings taken from the Ocean Beach plants remaining from the garden trial (see above)
- * rooted cuttings taken from the provenance trials (see above): Waipapa Point, Lake Grassmere and Te Paki Stream plants
- * potted plants grown earlier from Ocean Beach plants used in the garden trial

At the time of writing, February 1990, the situation with these plantings is as follows:

- * half of the Ocean Beach cutting material has died; the rest is established and healthy
- * of the provenance material, the Waipapa Point plant is barely alive; the Lake Grassmere plant has produced seed heads but has not thrived; the Te Paki Stream plant has died
- * of the potted plants from Ocean Beach material only two have died : the others look healthy and two have produced seed heads.

In June 1989, three more pingao plants were planted in the enclosure. These were reared from Ocean Beach seed, and were about three years old, 30 cm tall and with good root systems. By February 1990, one has died, but the other two are thriving.

The results and conclusions from this trial complement and support those from the wild cutting planting trial. It is clear that for any planting, the use of seedlings or pot-grown cuttings is more successful than the use of fresh cuttings. I am convinced too that the best sites for planting are relatively stable dune hollows : the greater shelter and moisture provided there ensure greater success in pingao establishment.

CONCLUSIONS AND RECOMMENDATIONS

These trials into the cultivation and natural morphological variation of pingao have provided many insights into the plant and its requirements. A list of the major findings and recommendations for practical work and further research, grouped under three headings, follows:

A. Pingao as a garden plant

1. It is quite feasible to cultivate pingao in gardens and containers, using basic gardening techniques. As long as certain precautions are taken, and regular maintenance done, it is possible to establish and perpetuate pingao in sites and conditions quite different from those of their natural coastal origins. In this way, supplies of materials could be provided for arts and crafts without threatening remaining wild populations, backups to wild populations could be grown, and the plant could be shown to advantage as live specimens.
2. In these trials, the majority of work was done using

vegetative techniques, i.e. cuttings. It was clear that cuttings are best if taken from healthy stems, and at least 30 cm long. They should be planted or potted as soon as possible : if allowed to sit long beforehand they generally die. Plants can be renewed from cuttings as they straggle or die from their centres : this happens naturally in the wild.

3. Cultivation from seed is less prone to failure, and is recommended in preference to using cuttings. It takes longer to produce mature pingao plants from seed, but the rewards in terms of resilience and longevity are well worthwhile. Using seed is far less damaging to wild plants too.
4. The growing medium is evidently not as critical for pingao as would have been expected: it can grow in soil, sand, sawdust and commercial potting mixes at least. A well-drained medium is likely to be better than a poorly-drained one. Creation of mounds or artificial dunes for pingao appears to favour survival. Open sunny sites produce healthiest plants. Frost is not a problem.
5. Use of a deep mulch applied at least annually markedly improves the establishment, health and survival of cultivated pingao. In these trials fresh untreated sawdust was very successful in retaining moisture, inhibiting weeds and providing a sprouting medium. It is likely that sand, fine bark, peat or pumice would be just as good.
6. Weeds can be a serious threat to cultivated pingao, as in the wild. Regular weeding by hand is the only practical solution I know of should weeds appear. The deep regular mulching mentioned above is an excellent preventative.

7. In cultivation, pingao is subject to pests and diseases it would scarcely encounter in the wild. In these trials, the worst were grass mealybugs and (suspected) pathogenic soil fungi. The mealybugs were easily treated with insecticide. Fungi can be readily kept at bay using fungicides.
8. Fertilisers are probably required to maintain pingao in cultivation long-term. I suspect the plant does not demand a highly fertile medium, but it certainly responds to nitrogenous fertilisers.
9. Enough is now known to be able to successfully grow pingao in cultivation, but more study could fine-tune the process and ensure repeated success. Most investigation is required into the following : diseases, treatment and resistance; effects of varying and various moisture regimes; fertility requirements; best substrates and mulches; weed control and competition.

B. Provenances of pingao

1. There are distinct morphological differences between widely separated pingao populations around the New Zealand coasts. These differences lie in leaf size, shape, and curvature, stem size, tuft structure, flower and seed head size and structure, plant habit and plant colour. There could also be differences in root morphology.
2. Sufficient morphological differences were retained in

cultivation in this study to suggest they have a genetic origin.

3. This trial only began to scratch the surface of this subject, which remains wide open for further study. Not only could the area of geographical differences bear detailed scrutiny, but also so too could that of morphological variation within populations. Using plants propagated from seeds would be easier, more rewarding and less damaging than using cuttings. Some work is being done on these subjects by Department of Conservation (Taupo) and Ministry of Forestry (Rotorua) at present.

C. Planting of pingao in the wild

1. The use of fresh pingao cuttings is almost certainly doomed to failure : despite the great care taken during this study, very few cuttings have survived. It is possible that larger cuttings could be more successful, but the damage caused to plants by taking them is excessive.
2. The use of cultivated plants is far more successful. Container-grown seedlings or cuttings have been planted in several sites, and most have established and are still growing well.
3. Dune hollows appear to provide the best conditions for establishment and survival of planted pingao. Pingao seedlings naturally establish best here too. Probably the availability of moisture near the surface and shelter from sand movement are important.
4. The best season to plant is probably when it is coolest :

late autumn to early spring.

5. Various planting trials have been done by others around the country. Most have been total failures because of bad timing, unsuitable sites, poor plant material, lack of care or browsing animal damage. However, Department of Conservation, Ministry of Forestry and others are raising large numbers of pingao plants from seed, with the intention of carrying out large-scale well-planned planting trials on coastal sites. The results of this work are awaited with great interest. There seems little reason why pingao should not be able to be used instead of marram grass in large-scale dune rehabilitation and in revitalisation and recreation of wild pingao populations.

ACKNOWLEDGEMENTS

For the initial stimulus and continued impetus I must thank Atareta Paul and Jody Scott of Otatara Roopu Raranga, Hawke's Bay. Dr Warwick Harris, Director of Botany Division, DSIR, has fostered this study. To those who have willingly shared their experience and knowledge of pingao I am most grateful, in particular to Shannel Courtney (Nelson), Averil and John Herbert (Rotorua), Jennifer Oliphant (Auckland), Saana Murray (Kaitaia), Herwi Scheltus (Taupo) and Emily Schuster (Rotorua). The owners of Haupouri Station, Hawke's Bay kindly allowed me access to the Ocean Beach dunes for the study. Tania Crockford skilfully typed this report. Finally I thank Sue Scheele for her unfailing support and participation in various stages of this work.

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In lieu of a reference list, a list of the most useful information sources on pingao is offered. The brevity of this bibliography simply illustrates the scarcity of information.

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Roots of pingao exposed following the death of this large plant. The dune will subsequently collapse. Ocean Beach, Hawke's Bay.



Pingao seedling, Ocean Beach, Hawke's Bay. About 3 years old and 20 cm tall, this plant has weathered inundation with sand, undermining, intense heat and dryness, and browsing by rabbits.