BOTANY HONOURS PROJECT

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A REPORT ON THE STATE OF ALIEN INVASIVES ON HIGH ALTITUDE ZONES IN THE CAPE PENINSULA - 30 YEARS LATER

INTRODUCTION

The threat by alien trees and shrubs to the Cape Flora is well documented (Macdonald and Richardson,1986; Holmes, 1989; Richardson,1989). The negative impact these aliens have on the fynbos are numerous (Macdonald and Jarman,1984); the most serious is the reduction of species richness, and since the Cape Floral Kingdom is characterized by its high species richness (Goldblatt,1978) any invasion by aliens is drastic. The Cape Peninsula, which falls within the boundaries of this Floral Kingdom, has according to Adamson and Salter (1950), some 2622 species in 702 genera. The Cape Peninsula has more species than Great Britain, even though in area it is only six times the size of the Isle of Wight.

In a conservation and management report of Table Mountain, Moll and Campbell (1976) not only highlight the species richness aspect, but also state that the area should receive high conservation status for its educational, recreational, aesthetic, historical and tourist value. Thus to follow the alien invasion impact on this area is a vitally important monitoring exercise.

Alien vegetation in the Peninsula

Many exotic species were originally introduced to the Cape Town area either for stabilizing sand dunes, the production of timber and or to create more aesthetic surroundings than were presented by the "barren" rocky slopes of Table Mountain (Shaughnessy1986). Many of these introduced species have invasive properties, and where their spread has remained unchecked, invasion has taken place on a regional scale (Macdonald and Richardson,1986). Initially the threat seemed to be confined to Lowland Fynbos only, but in 1961 Hall expressed concern at the fact that invasive species were spreading to higher altitude zones where they pose a threat to Mountain Fynbos. Hall selected the mountains of the northern part of the Peninsula as a study site to assess the distribution patterns and impact of woody invasive species.

These higher altitude areas are owned by a number of independent public authorities, and certian portions are in private ownership (Fig 26), all of whom are responsible for the management of their own land. Various eradication programmes have been implemented to control the alien threat by these authorities/owners. The aim of this study is, therefore, to record the currrent distribution patterns and densities of alien populations on those plots selected by Hall in 1959/60. These data are also compared with a subsequent follow-up of Hall's survey completed in 1976 (McLachlan *et al.*,1980), to assess whether there has been any detectable change in densities of populations or distributions to previously uninfested plots over the past 30 years.

SAMPLING METHODS

The sample sites chosen by Hall (1961) were all the mile by mile intersections above 500 feet (152m) on the 1:25 000 Trigonometrical Survey map of the Cape Peninsula (1951). Sites which fell within plantations were excluded. The total area survey was about 102 km^2 and included the Muizenburg, Constantia and Table Mountain areas. A prismatic compass and an altimeter were used to locate the sample points. Data recorded at each site included: altitude, soil moisture status and soil type, aspect, average plant canopy cover, height and density of the indigenous community, numerically and physiognomically dominant indigenous species, and post-burn age. Only arborescent aliens having the capacity to alter the fynbos structure and species composition were included in the survey. In the present study sample points were relocated by using the Trigonometrical Survey map, photographs taken at these sites and local maps drawn of the surrounding terrain (the same methods used by McLachlan *el al.*, 1980). Compass bearings of certain outstanding features in the vicinity of each site were also used to confirm site location. In most instances the beacons built by Hall indicating the exact location of the sample point were found. Those which could not be relocated were either in very rocky areas, near public footpaths, or in areas were there was a lack of stones with which to erect a beacon initially.

The same data concerning alien and indigenous plant species were collected as in the 1959/60 survey. Indigenous species data were collected within a 10m by 10m plot, whereas alien species data were recorded within a 200 yards (183 m) radius of the sample point. The age structure of aliens were also assessed within the 10 by 10m plot. Where no aliens occurred within the 10 by 10m plot, but were present within the 183 radius (10.5 ha plot), all age categories were added together for the density assessment (Appendix 1). The height classes to which the alien species were assigned were:

1) under 15cm
2) between 15cm and 2m
3) above 2m

Details of four new sites were recorded in this study. These sites lay on the lower northern slopes of Devils Peak (Fig.27 sites 88-91) which in the previous two surveys had been plantation, but which have subsequently been cleared. The present survey commenced in December 1989 and was completed in July 1990.

CHANGES IN PERCENTAGE OCCURRENCE

The percentage occurrence of each alien species, as calculated in 1959/60, and in 1976 in 87 sample sites was compared to the occurrence in 90 sample plots in 1989\90 (Table 1)

Table 1 Percentage frequency occurrence of arborescent alien plant taxa within a 183m radius of sample points.

Species	Common name	Percentage frequency 1959/60	1976	1989/90
Pinus pinaster Ait.	Cluster pine	82	75	61
Pinus radiata D.Don.	Monterey pine	11	5	24
Pinus pinea L.	Stone pine	6	4	2
Pinus canariensis Sweet ex Spreng	Canary Island pine	0	5	1
Hakea gibbosa Cav.	Rock hakea	21	27	16
Hakea sericea R. Br	Silky hakea	9	12,5	4
Hakea suaveolens R. Br.	Sweet hakea	11	9	9
Acacia cyclops A.Cunn.ex G.Don	Rooikrans	17	17	26
Acacia saligna (Labill) Wendl.	Port Jackson	16	25	24
Acacia longifolia (Andr.)Willd.	Long- leaved wattle	7	8	10
Acacia melanoxylon R. Br	Blackwood	6	4	4
Acacia mearnsii De Wild.	Black wattle	-	-	5
Eucalyptus spp.	Gum trees	4	5	11
Albizia lophantha (Willd.)Benth.	Stinkbean	7	6	4

Paraserianthes

The distribution patterns as found in 1976 by McLachlan (McLachlan *et al.*, 1980) were used to compare with present data, the same grouping of density classes were used, being : 1-19, 20-49, 50-200, 200+ trees within a 183m radius of the sample point. The figures illustrated by McLachlan *et al.*(1980) comparing 1959/60 and 1976 data are included to facilitate comparisons to present day data. Twelve sites were alien free compared to only four in 1959/60.

Despite the marked decline in the number of sites on which *Pinus pinaster* occurs, it remains the most wide spread alien species within the study area. *Hakea gibbosa*, the second most prevalent species in 1976, has also declined dramatically. Other species showing a decline in occurence are *Hakea sericea, Pinus pinea, Pinus canariensis, Acacia melanoxylon* and *Albizia lophantha*. The *Acacia* spp. remain problematic and particularly *A.cyclops* has spread since 1976. *A.longifolia* has also increased at a constant rate since 1960. The species which has spread most aggressively is *Pinus radiata,* which together with *H.saligna* has become the third most prevalent species. *Eucalyptus* spp. have also become more abundant

Pinus pinaster, despite the constant decrease in percentage occurrence is still widely dispersed. The sites on which dense stands occur (200 or more individuals) have, however, changed. Once heavily infested sites on the Muizenberg mountains and the northern sections of Table Mountain are now free of *P. pinaster* or densities have been reduced. In contrast, sites on Vlakkenberg (Fig.27 sites 40,41,44 &45), Skoorsteenkop (Fig.27 site 46) and Baviaanskloof (Fig.27 sites 49, 51 & 52) areas of the Constantiaberg are densely infested (Fig.8). This change has occurred during the past fifteen years.

The spread of *P. radiata* has occurred in the aforementioned areas where dense stands of *P. pinaster* occur. The percentage increase has been from 5% to 24% since 1978. *Pinus canariensis* (Fig.10) which occurred in a number of sites in the 1978 survey have been successfully eradicated in all but one of the sites. *Pinus pinea* (Fig.10) has not spread, and mature trees are confined to two sites only.

Hakea populations, particularly *H. gibbosa* (Fig.11 & 12) and *H.sericea* (Fig.13 & 14) have been drastically reduced in their distribution, whereas *H. suaveolens* (Fig.15 & 16) has remained the same. The few new sites to which *H.gibbosa* and *H.suaveolens* have spread are confined to areas adjacent to previously infested areas, on the drier western slopes of mountains in the study area.

Acacia cyclops is now the second most widespread woody alien, occuring on 26% of sites. Rapid spread has occurred over the past fifteen years in the Skoorsteenkop (Fig.27 sites 42,46 & 49), Vlakkenberg (Fig.27 site 40), western slopes of Table Mountain, and the southern slopes of Table Mountain above Hout Bay (Fig.37,38 & 39),(Fig.17 & 18). *A. saligna* has remained constant in the percentage of sites in which it occurs. The distribution is similar to *A.cyclops* but *A. saligna* is more widespread on the western side of the Muizenberg mountains. *A.saligna* was found on two of the four sites, which were once afforested on the northern slopes of Devils Peak (Fig 20). *A.longifolia*, though only occurring on 10% of sites, is widely dispersed on the southern sites of Table Mountain, three sites on Constatiaberg, and on the northern and western sites of Muizenberg mountains (Fig.21). *A.mearnsii* not previously recorded, is now found on four sites, two of which are on deforested areas on Devil's Peak (Fig.23). *A.melanoxylon*, once only occurring at a few isolated sites, now occurs on sites in close proximity of each other in the Orange Kloof area. Relatively dense stands (50-199 class) have developed since 1976 (Fig.22).

Sites on which *Eucalyptus* spp. occur are mostly in the vicinity of plantations, windbreaks/fire arrestors or recently felled plantations, and all but one of these sites (on the Constantiaberg Fig.25) are below the 600m contour line. *Albizia lophantha* is now confined to three sites on the southern slopes of Table Mountain above Hout Bay (Fig.27 sites 37, 38 & 39), whereas it previously occurred on the Vlakkenberg (Fig. 27 site 41) and Skoorsteenkop (Fig.27 site 42) areas of Constantiaberg as well as below the Kloofhoek area of the Western Table (Fig. 27 site 1).

POPULATION CHANGES

Although percentage occurrence of aliens is a good indication of general distribution trends, it does not accurately reflect population dynamics at the different sites over time. The population flux at the different sites in the years between re-surveying, is a more accurate guage of the effectivity of, and the possible progress brought about by alien irradication programs. Table 2 is therefore a more sensitive analysis to show what changes have taken place at those plots at which aliens occur.

Table 2 An analysis of population changes between 1959/60 and 1976, and between 1976 and 1989/90, showing the number of sites where densities have increased or decreased, the number of new sites infested and number of sites previously recorded as being infested but have subsequently been cleared.

Species	No. of Sites ↑density		No.of sites ↓density		New sites infested		Sites cleared	
	'60/76	'76/90	'60/90	'76/90	'60/90	'76/90	'60/76	'76/90
P. pinaster	10	22	15	9	3	8	8	19
P. radiata	1	1	0	2	0	19	4	2
P. pinea	0	0	0	1	0	0	2	1
P. canariensis	-	0	-	0	4	0	-	3
H. gibbosa	5	2	5	5	4	1	1	9
H. sericea	3	0	0	1	4	0	1	6
H. suaveolens	1	1	2	1	0	2	2	3
A. cyclops	2	3	3	5	1	14	3	6
A. longifolia	3	0	0	2	2	6	1	4
A. melanoxylon	0	0	0	1	0	3	2	2
Eucalyptus spp	0	0	2	0	3	10	1	6
A. lophantha	0	1	2	0	1	1	1	4

From the data presented in Figures 5-25 the information in Table 2 can be refined further to indicate the changes which occurred in each of the density categories for each alien species in time (Table 3).

Table 3 The percentage of sample plots in each of the five density categories for each taxon

Species	1959/60					1976					1989/90				
	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
P. pinaster	10	42	19	8	13	26	43	17	8	8	40	28	9	15	8
P. radiata	90	7	0	2	1	95	2	1	1	1	75	10	7	6	2
P. pinea	94	4	1	1	0	97	2	1	0	0	98	2	0	0	0
P. canariensis	100	0	0	0	0	96	4	0	0	0	99	1	0	0	0
H. gibbosa	79	6	1	4	10	75	5	9	4	7	84	4,5	4,5	1	6
H. sericea	91	5	1	0	4	87	2	4	1	6	95	0	2,5	0	2,5
H. suaveolens	89	5	2	1	3	91	5	3	2	0	90	3,5	3,5	1	1
A. cyclops	80	6	6	0	8	83	7	2	3	5	74	10	3,5	9	3,5
A. saligna	84	7	5	1	3	75	11	8	4	2	75	4,5	7	4,5	9
A. longifolia	93	6	0	1	0	93	2	4	1	0	90	7	1	0	2
A. melanoxylon	94	5	0	0	1	97	2	0	0	1	96	1	1	2	0
Eucalyptus sp	96	2	1	0	1	93	4	2	0	1	89	8	1	1	1
A. lophantha	93	0	2	0	5	94	1	1	3	1	97	0	0	1	2

Density classes (plants per 10,5 ha circular plot);
(a) =0 (b) = 1-19 (c) = 20 49 (d) = 50-199 (e) = 200+

Such data indicate the degree of success achieved in eradicating aliens at different densities, and to what extent degree different species growing at different densities are resistant to eradication.

The remarks and conclusions concerning the status of aliens, and how this relates to the areas controlled by the various authorities concerned, are based on the interpretation of Fig.1-25 and Tables 1-3. Those aliens being the most widely dispersed and consequently posing the most serious threat will be discussed individually.

Pinus pinaster (Figs. 5 & 6)

Despite the concerted effort to control *P.pinaster* it still poses the most serious threat to the high altitude regions. However, a remarkable decrease in the number of plots on which it occurs (Table 2) has been brought about. This has been achieved mainly on Table Mountain. In the survey done by Hall(1961) many of these plots were found to be heavily (200+ plants in 10.5 ha plot) to semi- heavily (50-199) infested (Table 3). The density had been reduced in many of these plots by 1976 (McLachlan *et al.*, 1980) and these have subsequently been cleared. Thirteen of the nineteen plots recorded as cleared of *P. pinsaster* (Table 2) are on Table Mountain. This reduction has most certainly been brought about by the clearing of lightly infested plots (1-19) and plots in the density class (20-49) which have shown the largest reduction in percentage frequency of occurrence since 1976 (Table 3 and Figs. 5 & 6). Although most of the plots on Muizenberg Mountain are infested, densities are low, and should the current eradication programme be maintained, this area could soon be cleared.

There have been a large number of sites which have shown an increase in density (Table 2). This increase has been particularly noticable in the 150-199 plants per 10.5 ha category (Table 3 and Fig.2). Fifteen percent of plots are infested at this density compared to 8% found during

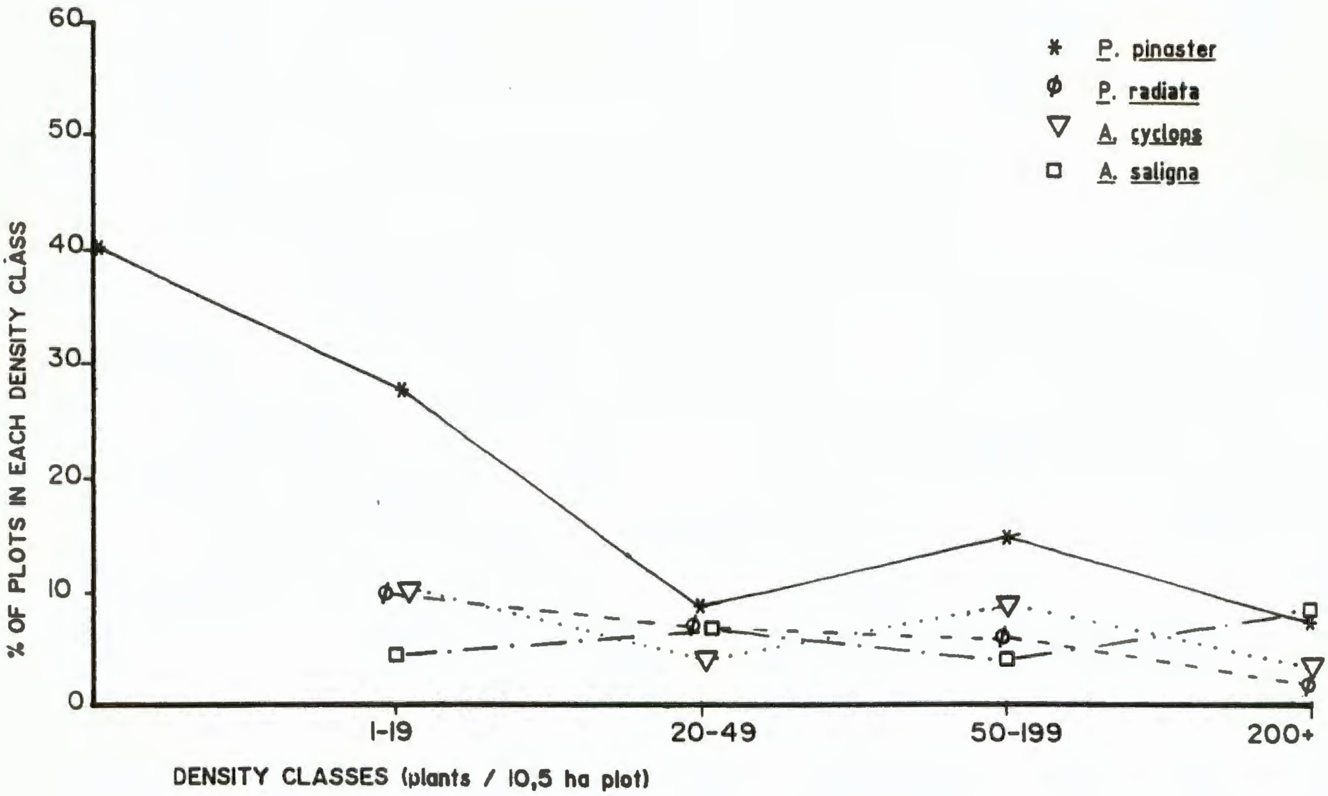

Fig. 1 . Percentage frequency of occurrence of sites in each of the density classes for the four most widely dispersed alien species as found in this study.

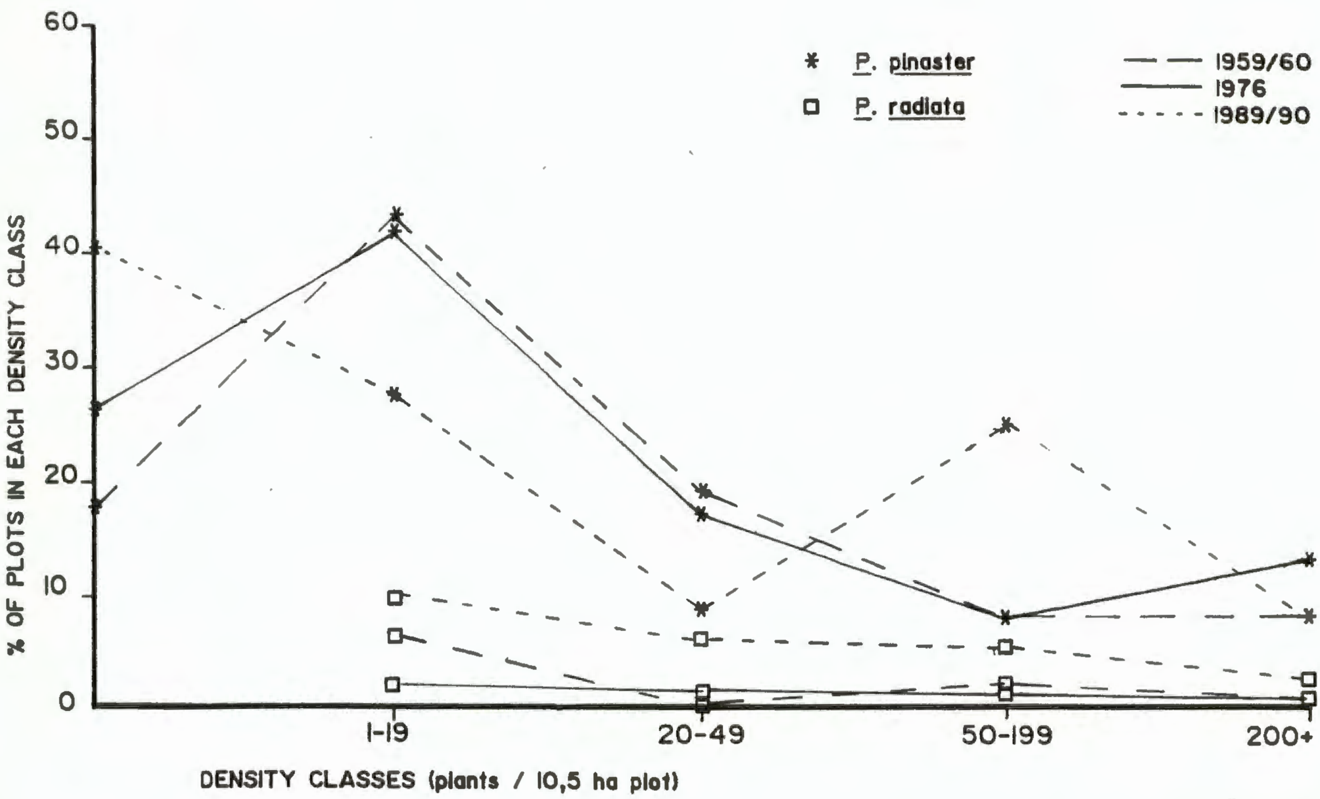

Fig. 2. Percentage frequency of occurrence of sites in each of the density classes for *P. pinaster* and *P. radiata* in 1959/60, 1976 and 1989/90.

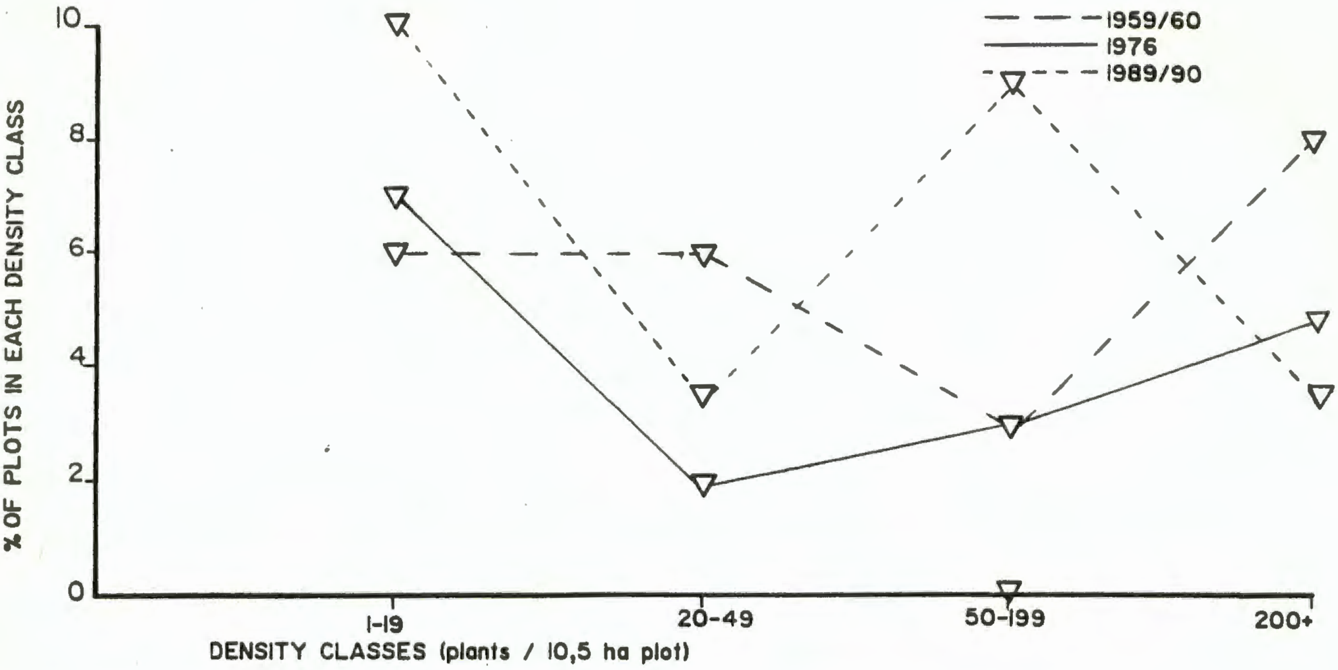

Fig. 3a. Percentage frequency of occurrence of sites in each of the density classes for *A. cyclops* in 1959/60, 1976 and 1989/90.

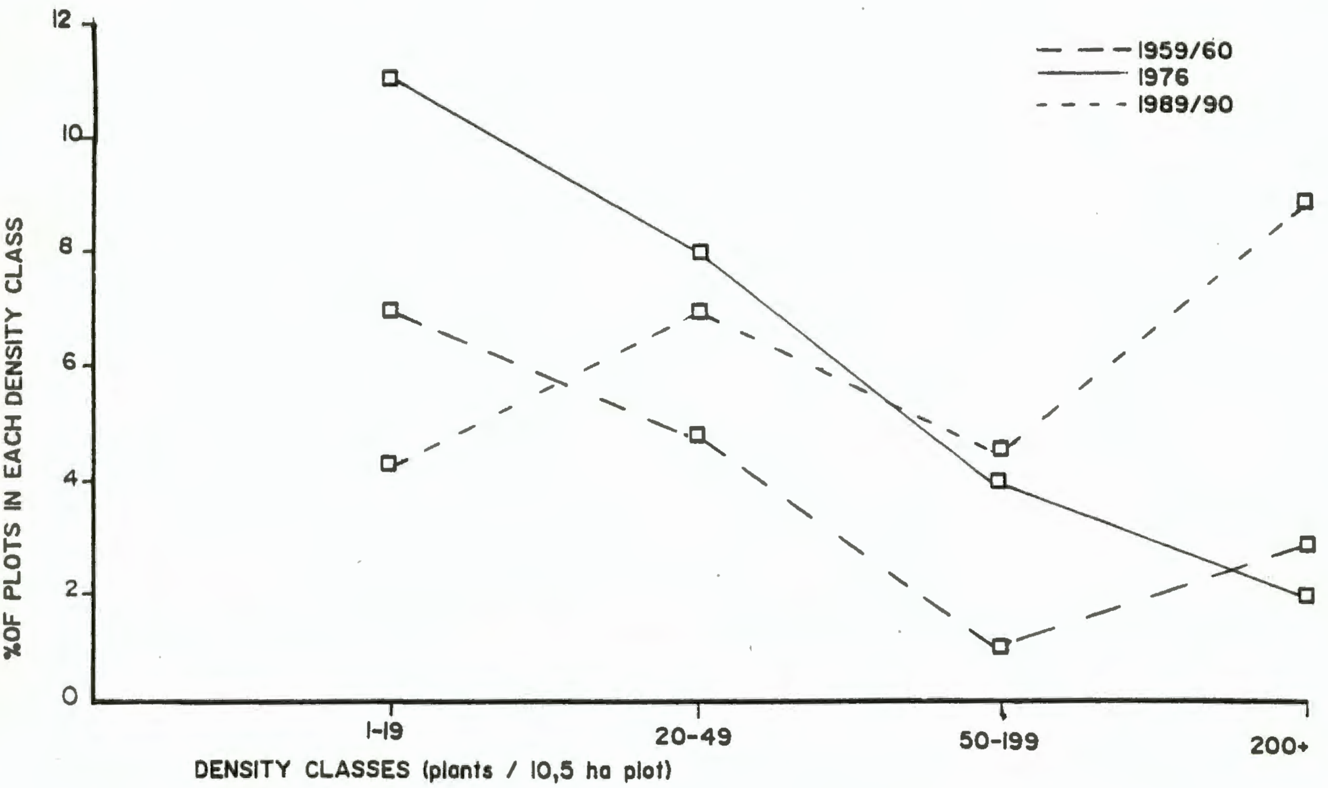

Fig. 3b. Percentage frequency of occurrence of sites in each of the density classes for *A. saligna* in 1959/60, 1976 and 1989/90.

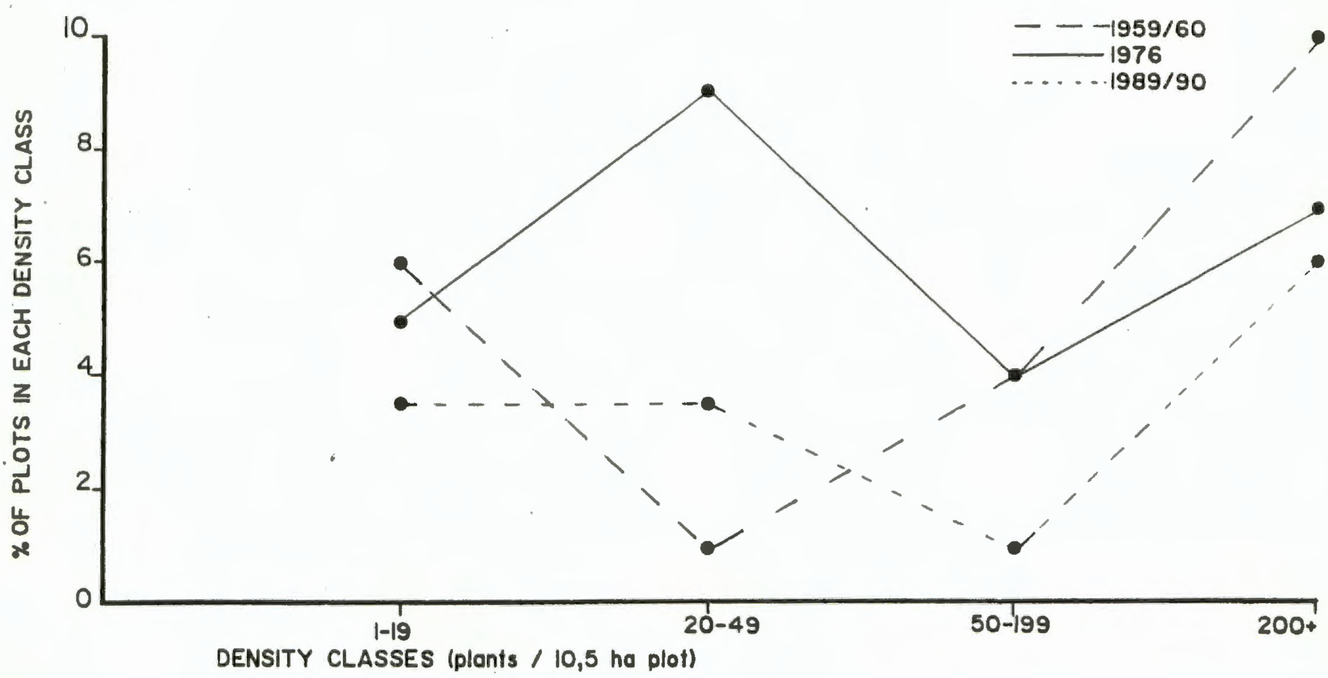

Fig. 4. Percentage frequency of occurrence of sites in each of the density classes for *H. gibbosa* in 1959/60, 1976 and 1989/90.

previous surveys (Table 2). Those plots showing an increased density in the Table Mountain region are mostly on inaccessible sites (Mowbray Ridge (Fig.27 site 5), Saddle corner (Fig. 27 site 10) and Window Gorge (Fig.27 site 21)), or in close proximity to those plantations which have been cleared in the vicinity of Woodhead Dam (Fig.27 sites 19,20 & 24). Clearing of these plantations commenced in 1983 (Parks and Forestry Department, unpublished data) but possibly remained a major source of infestation to these sites until recently. Two other sites, above and below Myburgh's Corner north of Hout Bay (Fig.27 sites 33 & 39) are heavily infested.

Almost 50% of plots on Constantiaberg have shown an increase in population density; 10 of the 23 plots now fall into the 50-199 and 200+ density classes. In the 1976 survey only three plots fell into these classes. This would suggest that management practices in this area have not been able to control *P.pinaster* population growth. It is unfortunate that those areas which have become more heavily infested since 1976, and particularly those in inaccessible sites, will reamain a source of infestation by virtue of the fact that the winged seeds of *P.pinaster* are adapted for long distance dispersal (Van Wilgen and Siegfried, 1986).

Pinus radiata (Figs.7 & 8)

P. radiata has not been regarded as a particularly aggresive invasive alien (Moll and Campbell, 1976 and was excluded from "Plant Invaders" by Stirton,1978). Recent evidence suggests that this species does in fact present a problem in Mesic Moutain Fynbos (Richardson and Brown,1986; Fish,1989; Richardson,1989). Van Wilgen and Siegfried (1986) report that *P.radiata* seeds, being light and winged, are similar to *P.pinaster* seed in their ability to disperse long distances. Richardson and Brown (1986) determined that initial colonizers may establish up to 3km from the seed source. Fire greatly enhances establishment, yet seedlings are also able to establish in unburnt vegetation up to 10 years old, after which time Mountain Fynbos is closed to invasion by *P.radiata* (Fish,1989). However gaps created by senescing vegetation over 30 years old does allow recruitment.

Most of the plots infested since 1976 are on the northern and north-western slopes of Constantiaberg, and on the southern slopes of Table Mountain above Hout Bay. These areas lie downwind (summer Southeasters) from the Tokai plantations on the eastern slopes of Constatiaberg, and the plantations and wind breaks south of the plots below Myburgh's Corner and Geelklipstut north of Hout Bay (Fig 27 sites 37, 38 & 39). This clearly shows the ability of long range dispersal of the this species.

The exact reasons why the high rate of infestation has occurred since the last survey are not known. However, the uneven aged stands and the high post-burn age of these plots would seem to indicate that recruitment has taken place in gaps created by aging fynbos vegetation. The success of recruitment is clearly reflected by the many plots which support populations which fall within the 20-49 and 50-199 plants per 10ha density classes (Figs.1 & 2).

P.radiata has shown the propensity to become highly invasive in the study area. Although it now occurs in 24% of plots, the distribution is concentrated in specific areas and it is advocated that these plots be cleared as soon as possible before their spread becomes even more problematic.

Hakea gibbosa (Figs.11 & 12)

The increase in both the distribution to new sites and density within populations of *H.gibbosa* between 1959\60 and 1976 was rapid. The situation has fortunately been reversed and *H.gibbosa* is no longer the second most widely dispersed alien in the study area. This marked reduction has been brought about by the clearing on Table and Muizenberg mountains. Where sites have not been completely cleared, a substantial reduction in the density of plants has been achieved. Currently the largest percentage of infested sites is in the high density catagory (Fig. 4) and these on the northern and western slopes of Constantiaberg.

Hakea sericea* and *Hakea suaveolens (Figs. 13,14,15 & 16)

These two *Hakea* spp. deserve comment even though their distribution is limited. *H.sericea*, after showing an increased distribution in the 1976 survey (McLachlan *et al.*,1980), has been reduced to a mere 4%. Dense stands still occur in the Bokkemanskloof area of Vlakkenberg (Fig.27 sites 42 & 43) and have maintained this density status since the survey by Hall (1960). No new sites have been infested by this species which is encouraging. *H.suaviolens* has maintained the same percentage frequency occurrence since 1976. The same number of plots have been cleared as new sites infested. Those new plots on the western slopes of Table Mountain (Fig.27 sites 17 & 27) which have been infested are most certainly due to the release of propogules after a controlled burn in this region in 1984 (Department of Parks and Forests, unpublished data). *H.suaviolens* has good germination on unburnt sites (Richardson *et al.*, 1987), which would explain its presence in old stands of fynbos. The spread to a new site and the increased density on a second in the Baviaanskloof area (Fig. 27 sites 49 & 52) could possibly be explained in terms of the same phenomenon. Fire records were however not obtained for areas under the management of Cape Department of Nature and Environment Conservation (C.D.N.E.C.)

It is evident that much success has been achieved in the control of *Hakea* spp., particularly in the Table and Muizenberg mountain areas. Attributes of the seed biology and ecology of these *Hakea* spp. would dictate that control measures should not be relaxed. All three species have long lived canopy stored seeds which are resistant to fire, disperse well when released, and apart from *H. gibbosa*, germinate well both in burned and unburned sites. *H. sericea* has a further advantage in that it produces very large amounts of seeds (Richardson *et al.*, 1987). Being serotinous, seed dispersal events are coupled to fire frequency. Uncontrolled fires are a relatively common phenomenon on the Peninsula, and together with controlled block burns, 26 fires have occurred on the Cape Town City Council managed section of Table Mountain since 1962 (Fig.26 and Parks and Forestry Department, unpublished data). Certain plots in this area have been burned up to three times during the past 28 years. It is therefore evident that under such high fire frequencies *Hakea* spp. have the potential of becoming highly dispersed within a short period of time. Until all sites have been completely cleared *Hakea* spp. will remain a potential threat on the Peninsula.

Acacia cyclops (Figs.17 & 18)

Second to *P. radiata, A.cyclops* has shown the highest increase (9%) in percentage occurrence. This has occurred despite the rigorous eradication programme; as reflected by the number of sites cleared and sites in which the density has been reduced (Table 2). A large number (14) of new sites have been infested since the previous survey, of which many have already reached semi- to high-density status which calls for concern. The graph for this species shows two peaks: 10% of occurrences were in the low density and 9% in the semi-high density class (Fig. 3a and Table 3). This reflects the findings of Taylor and MacDonald (1985) in their study on aliens in the Cape of Good Hope Nature Reserve and supports their reason advanced for this phenomenon being: efficient seed dispersal and the species' ability to rapidly form dense stands if unchecked. Infested plots are virtually all below the 300m contour, and on the drier western and southern slopes, particularly those slopes above Hout Bay. These sites are mostly easily accessible and should be cleared as soon as possible. The fact that regeneration is particularly good after fires, and that seeds are readily eaten and dispersed by a variety of birds and animals (Boucher and Stirton, 1978) (the red-winged starling *Onychognathus morio* in particular) makes *A.cyclops* potentially the most threatening woody alien in the study area.

Acacia saligna (Figs. 19 & 20)

This species increased between the 1959/60 and 1976 surveys, but has remained constant since that time (Table 1). The initial increase was reflected in the disproportionate number of new sites which were infested compered to previously infested sites now cleared (Table 2). However, new sites were mostly lightly infested (1-19 palnts per 10.5 ha) as shown by the increased percentage frequency of this category (Fig. 3b). The fact that frequency occurrence has neither increased nor decreased since 1976 is because the same number of sites have been cleared as to new plots infested (Table 1). There has, however, been a noticable change in population density. More sites are densely infested (the 200+ category now forms the largest percentage density class) whereas less sites are lightly infested than in 1976. Most sites cleared were lightly infested, whereas 30% of the new sites are already heavily infested.

A number of conclusions can be drawn from these data. Firstly there has been a concerted effort to control *A.saligna* which has been brought about mostly by the removal of small isolated populations. Secondly dense stands have not been successfully eradicated, but a reduction in the population size in such plots has been achieved, particularly in the Muizenberg area. Thirdly, western Constantiaberg, which 14 years ago had little *A.saligna*, now has many dense populations.

OTHER ALIENS

The remaining alien species have not undergone many changes in the past thirty years. Although none have been successfully removed, their spread and population growth have been contained.

DISCUSSION AND RECOMMENDATIONS

Eradication programmes, as presently implemented, have controlled the spread, and in most instances reduced the distribution of a number of alien species. Success has been particularly noticable in the control of *P. pinaster, H. gibbosa* and *H. sericea* (three highly aggressive species in the study area). However, *P. pinaster* and *A. cyclops* have increased their distribution. Management strategies need to be reviewed concerning these two species as they must be brought under control before their spread and population densities reach unmanagable proportions. The problem of *A.*

saligna developing into dense stands (200 or more plants) on many sites also needs to be addressed, as this density class now forms the largest percentage of sites infested in this spesies. Although *A. longifolia* does not occur on many sites, it should be closely monitored as it has spread to new sites since 1976 of which two are already heavily infested. This has occurred in spite of the release of the gall forming wasp (*Trichilogaster acaciae longifolia*) in 1982 (Joubert, 1985). It cannot be stated with certainty whether these new sites were infested between the 1976 survey, and the time of release of the gall wasp. Judging by the age structure of populations on newly infested sites (Appendix 1), it would appear that infestation may well have occurred prior to 1982; in which case one cannot yet evaluate the success of this biological control method in this area. Invasive *Eucalyptus* spp., which only occur in the vicinity of plantations and and belts planted as spark arrestors, pose no real threat. These will no doubt be easily removed once the programme to fell all planted *Eucalyptus* stands (Ashton,1985) has been completed.

The majority of study sites fall within areas controlled by the Cape Town City Council (C.C.C.) and the C.D.N.E.C., and to a lesser degree the Regional Services Council (R.S.C.)and private individuals (Fig.26). The largest proportion of these sites, however, are within the Table Mountain and Silvermine Nature Reserves which are managed by the C.C.C..

Eradication programmes in these areas have been particularly successful. This is reflected in the marked reduction in both the distribution and population densities on many sites. This reduction pertains to all alien species. The improvement has been particularly noticable since the 1976 survey. Eradication programmes have been rigorous during this time and reached a peak in the mid 1980's (Wagner pers. comm.). In both these nature reserves, *P. pinaster* remains the most problematic alien. *A. saligna* also still occurres in dense stands on the western Muizenberg Mountains and appears to be difficult to eradicate in this area.

In contrast, those areas which have recently been placed under the control of the C.D.N.E.C., and notably the Constantiaberg area, are in urgent need of improved eradication management. This also applies to those areas above Hout Bay which are either privately owned or belong to the R.S.C.. These areas are heavily infested by all the most threatening species. The densest stands of *Eucalyptus* spp. *A. lophantha* and *A. longifolia* are also found in these areas. Much deterioration has taken place, particularly during the past 14 years; since the previous survey. Until these areas receive attention, they will remain a constant source of infestation to those areas which are now well controlled.

CONCLUSIONS

Alien eradication operations are expensive and labour intensive. The worsening economic situation sees budgets being revised, and amounts allocated by the various authorities in control to eradication programmes are constantly being reduced (Wagner, pers. comm.). Under such circumstances one can only predict that that which has been achieved over the past 30 years, could rapidly deteriorate into a situation which may be impossible to rectify. It is therefore imperative that funds be made available to maintain current alien eradication operations.

The ultimate solution as I see it, would be for the authorities in control to contract a private company to execute all eradication programmes. These authorities would then collectively contibute to the financing of such an operation. Amounts that each institution would contribute, would be proportionate to the amount of land each owns.

However, those in charge of this area, which forms an integral part of our national heritage, are under an obligation to maintain it in a condition acceptable to those in generations to come.

ACKNOWLEDGEMENTS

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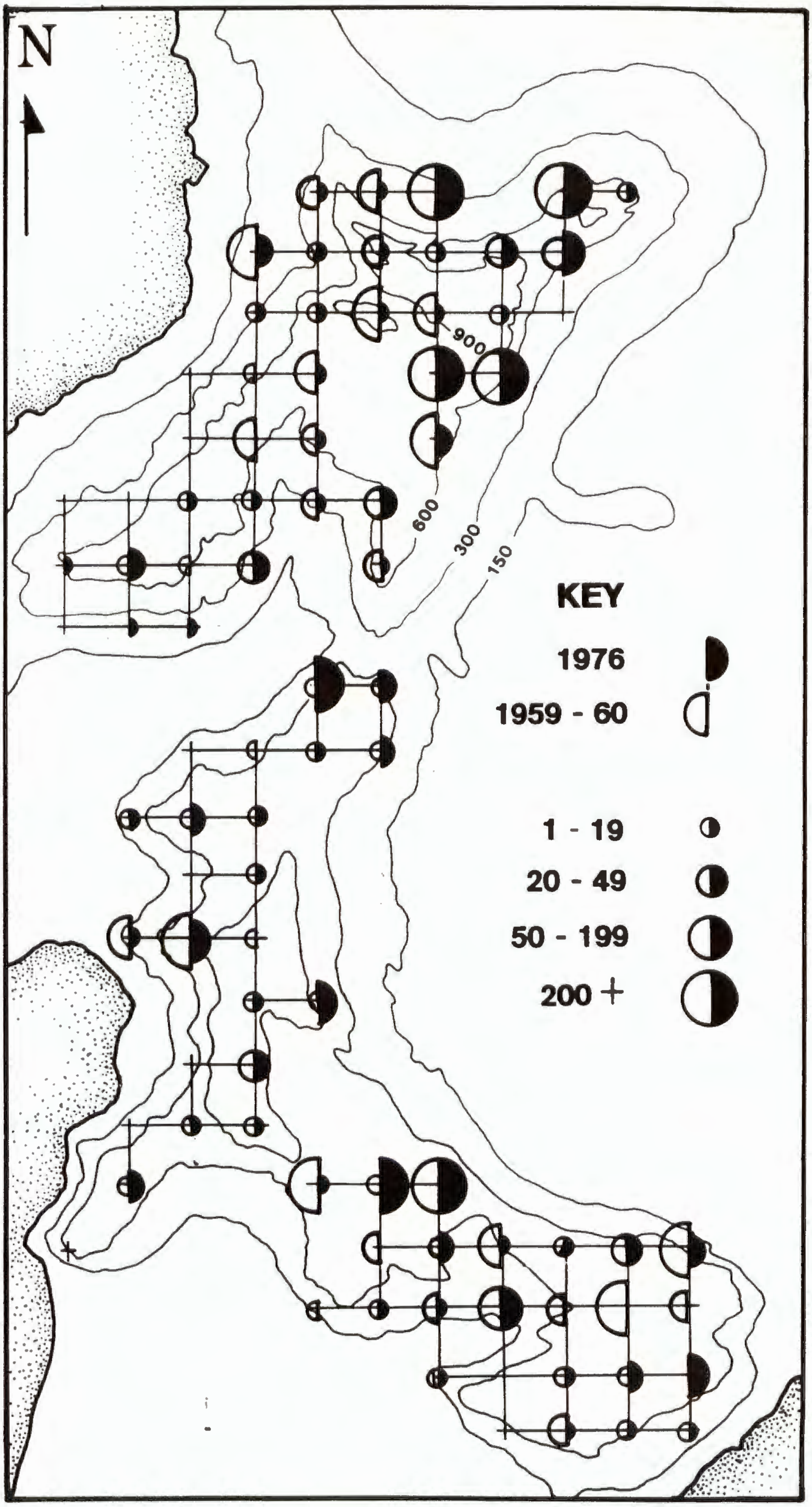


Fig. 5. Distribution of Pinus pinaster showing density classes recorded in each plot (1959/60 and 1976).
[ex McLachlan et al., 1980]

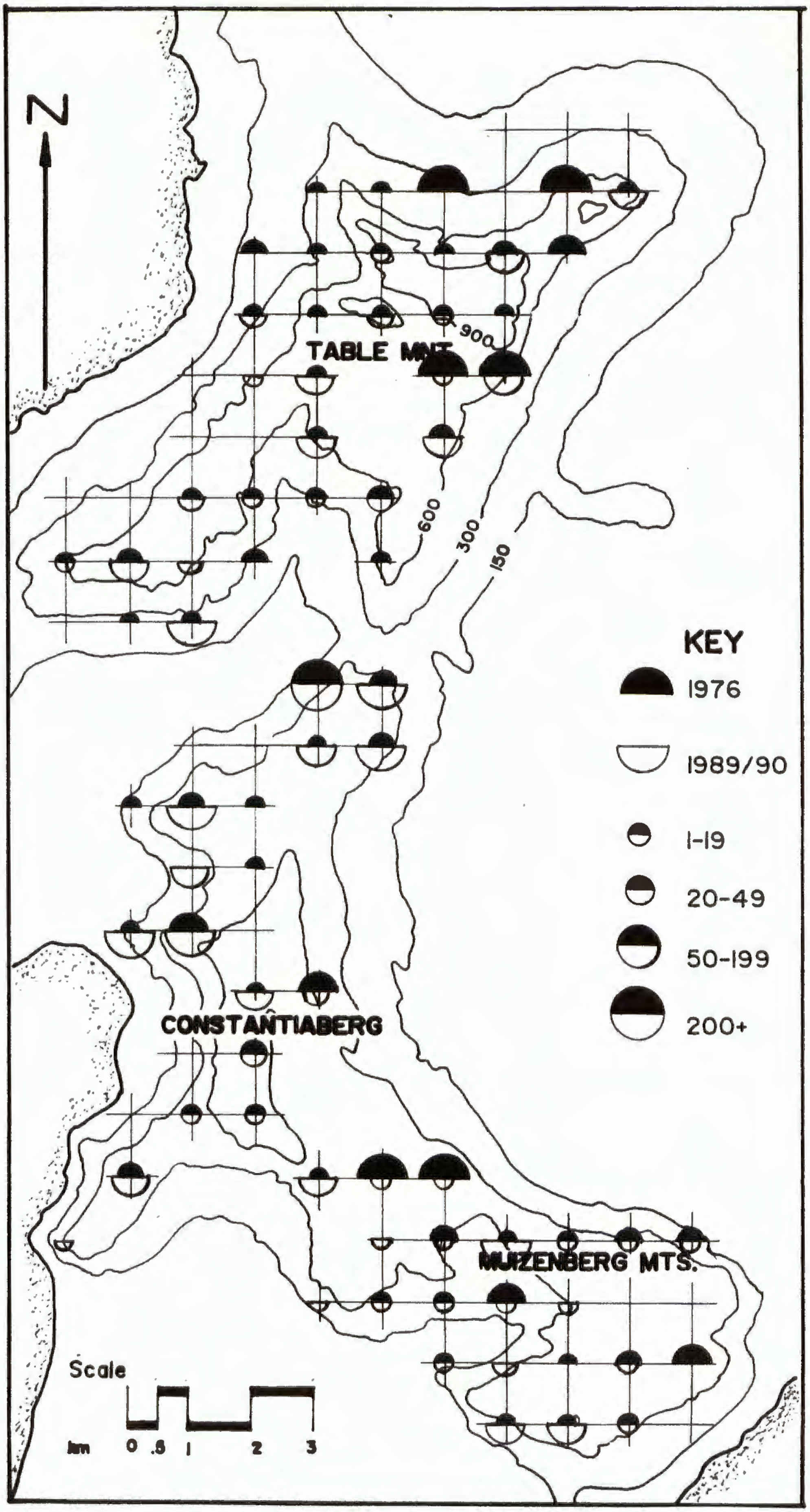


Fig. 6. Distribution of Pinus pinaster showing density classes recorded in each plot (1976 and 1989/90).

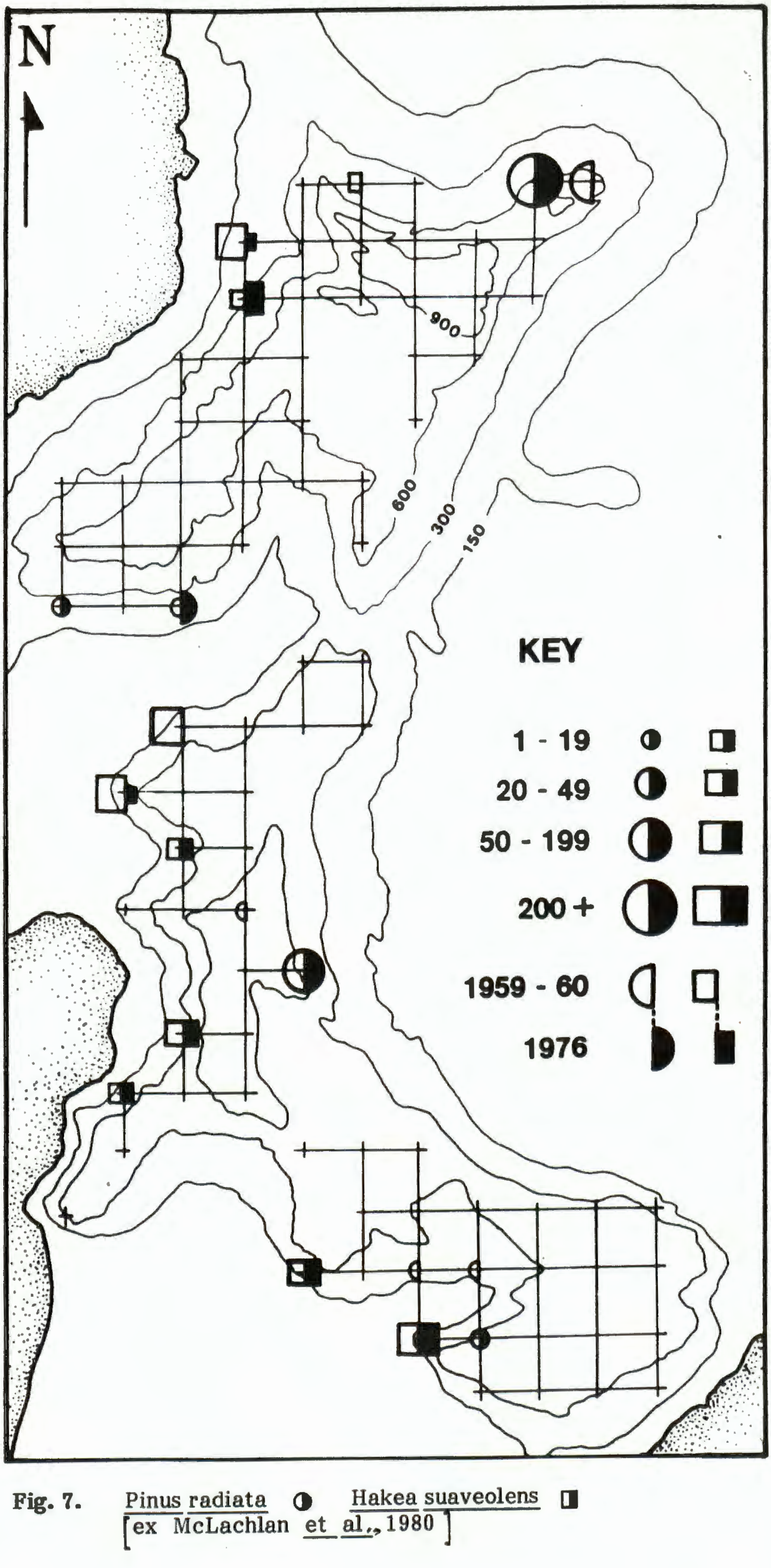


Fig. 7. Pinus radiata ◑ Hakea suaveolens ◨
[ex McLachlan et al., 1980]

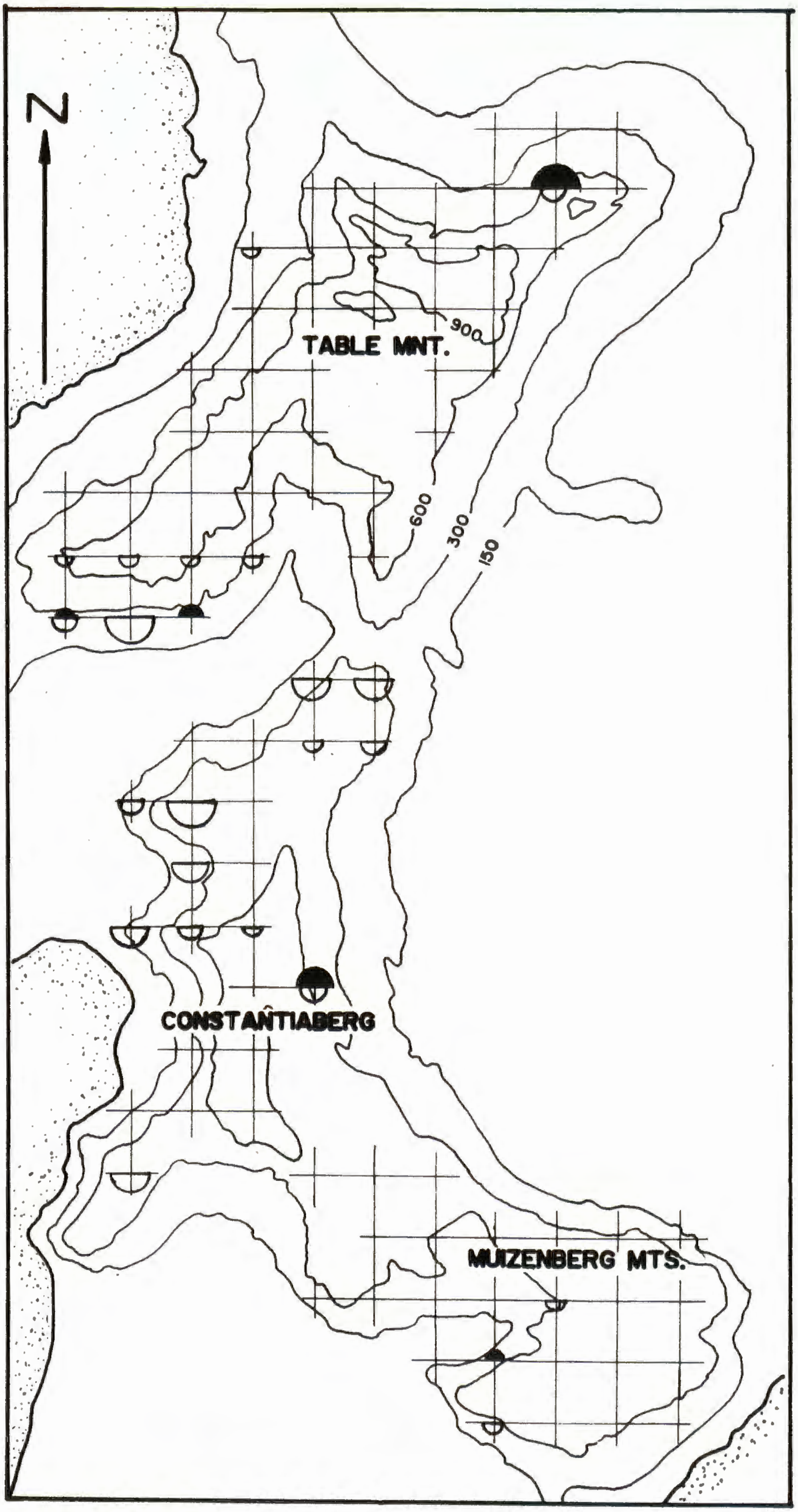


Fig. 8. Pinus radiata

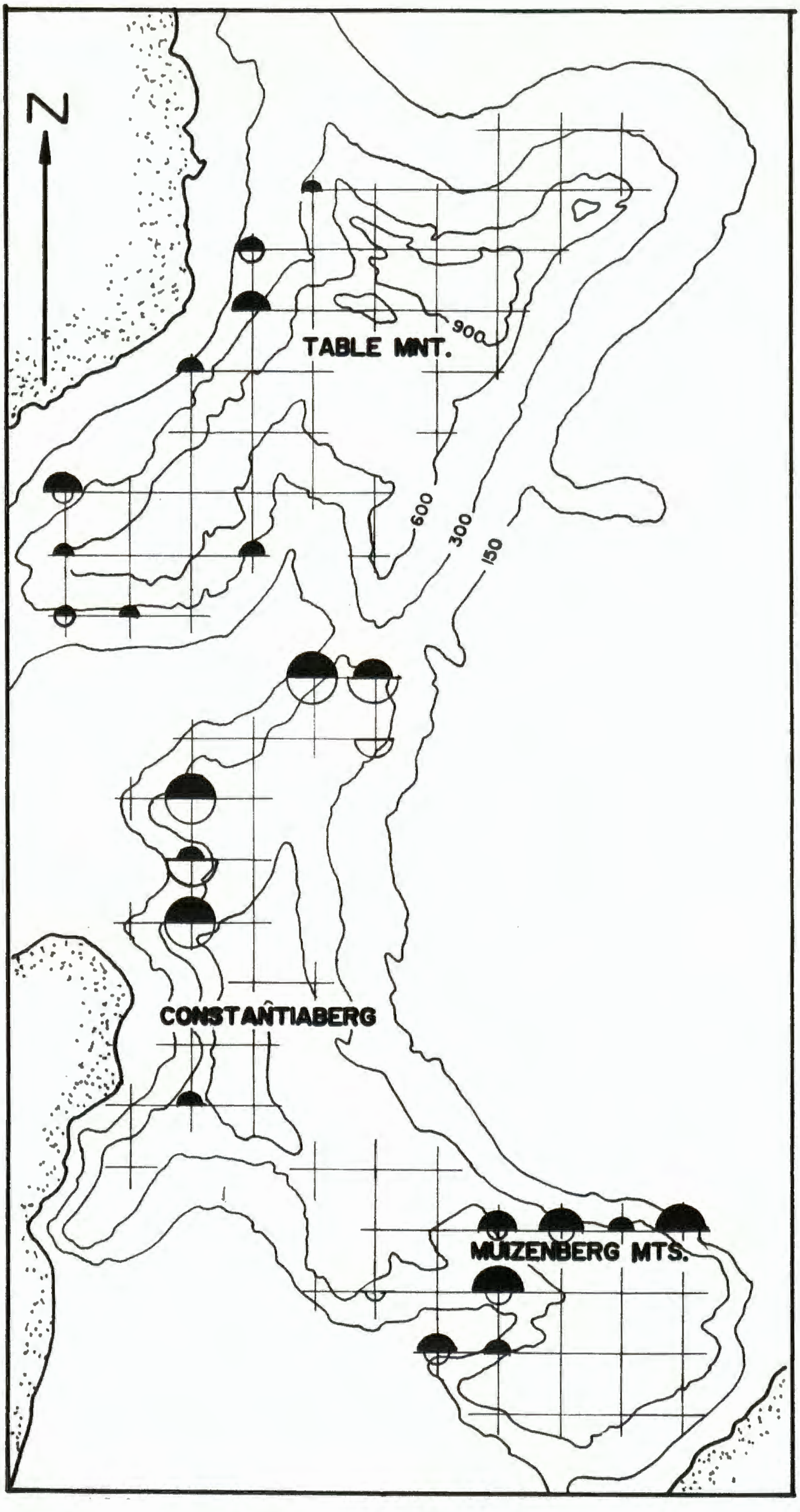


Fig. 12. Hakea gibbosa

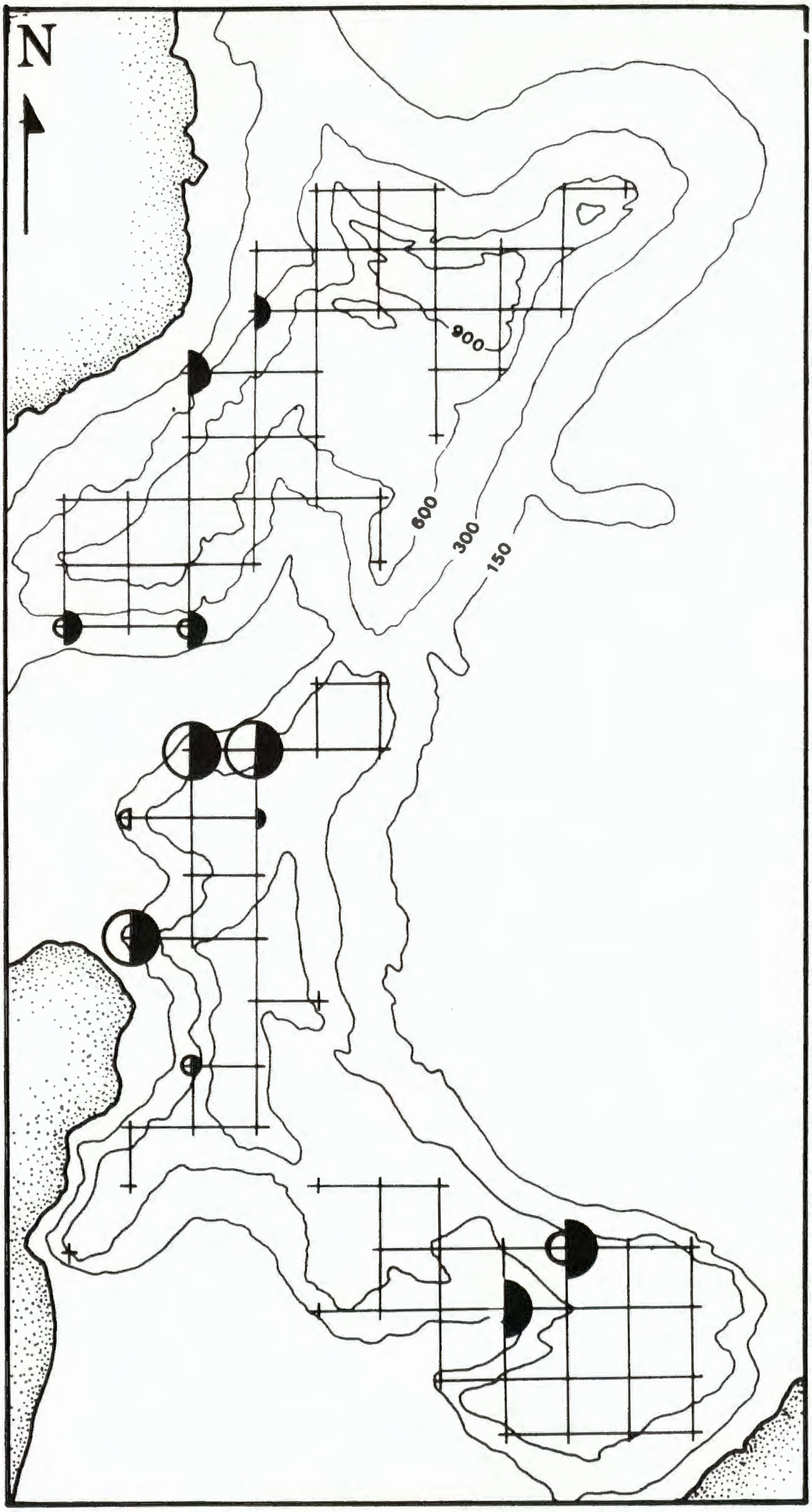


Fig. 13. Hakea sericea [ex McLachlan at al., 1980]

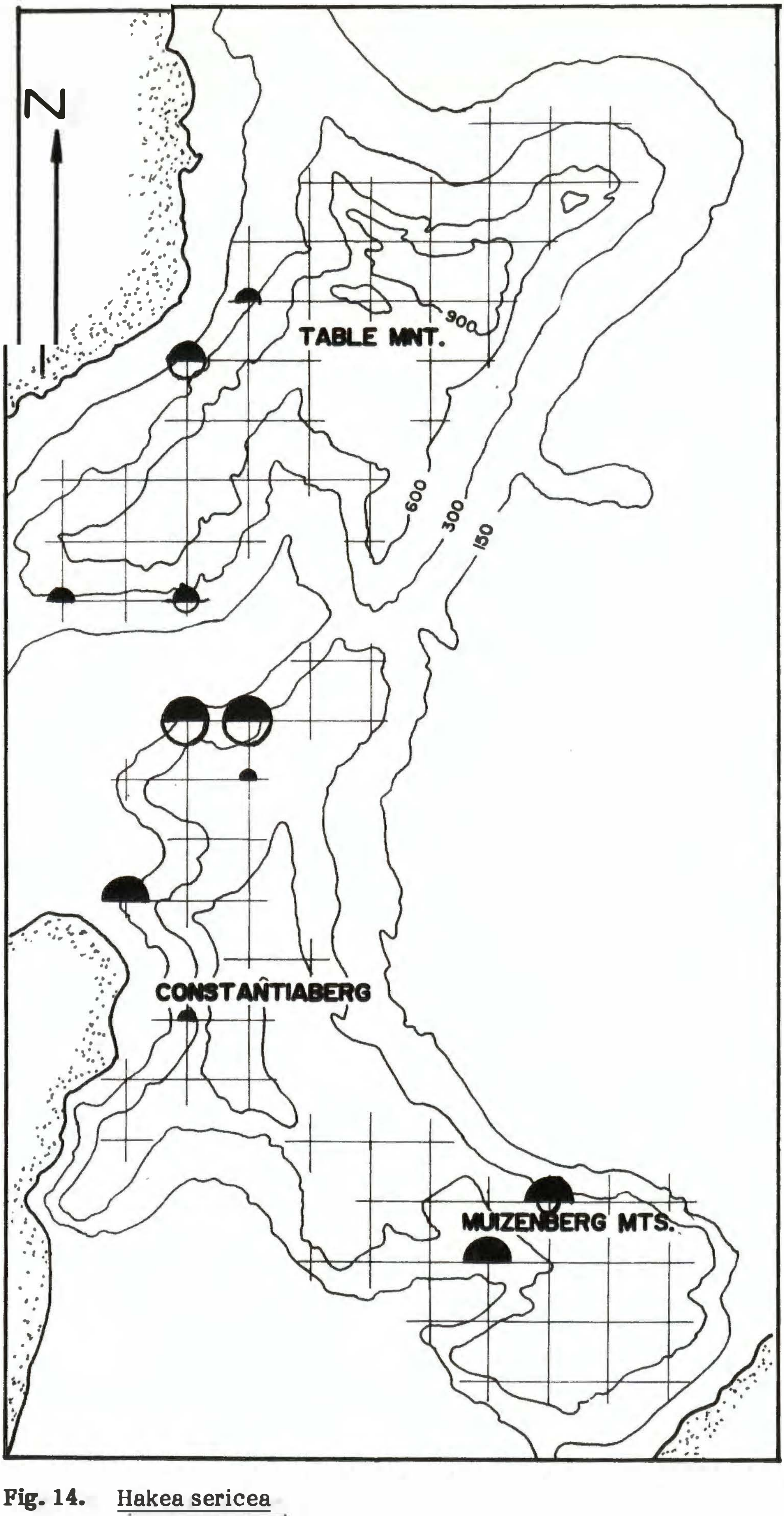


Fig. 14. Hakea sericea

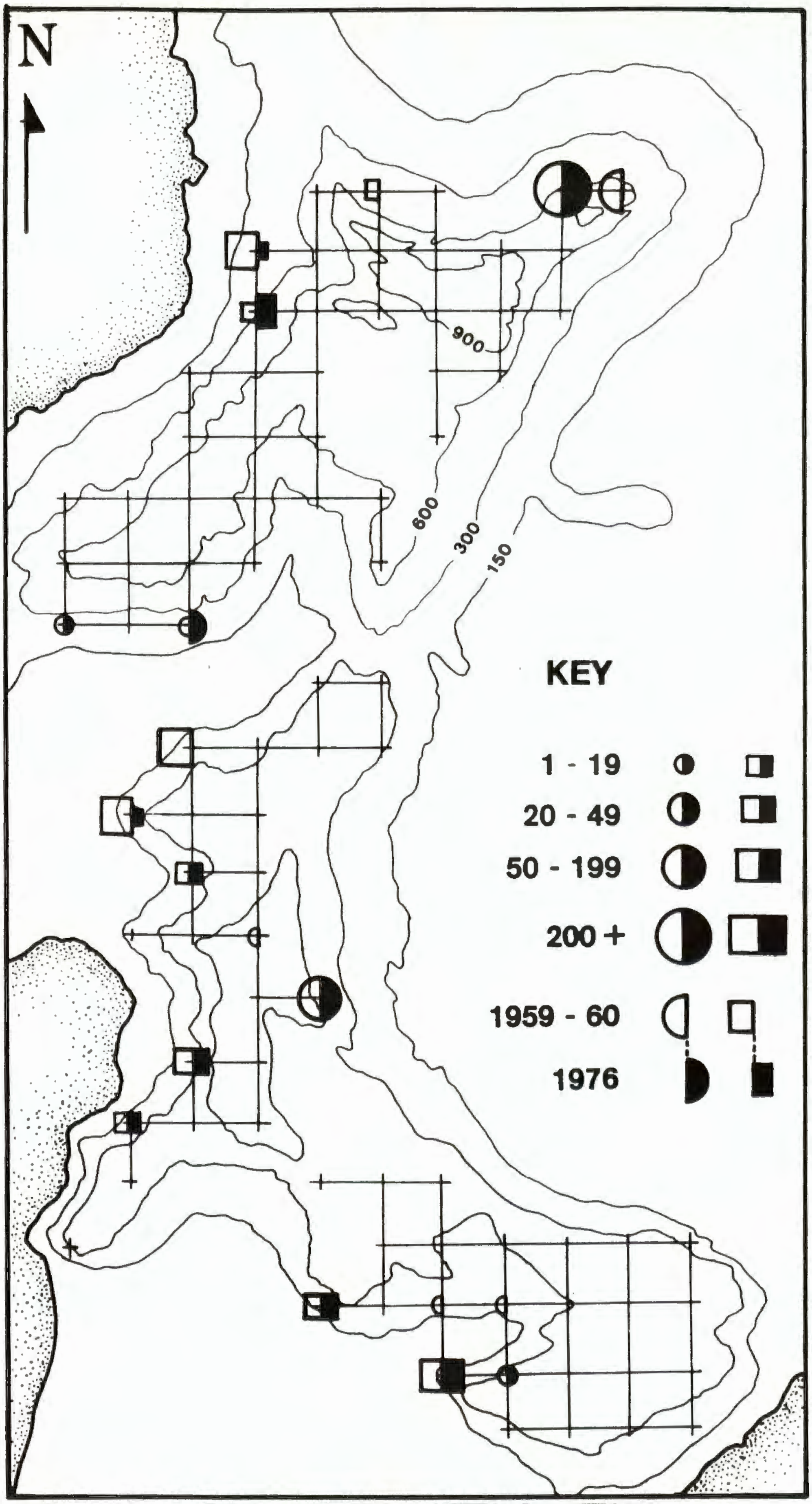


Fig. 15. Pinus radiata ◑ Hakea suaveolens ◨
[ex McLachlan et al., 1980]

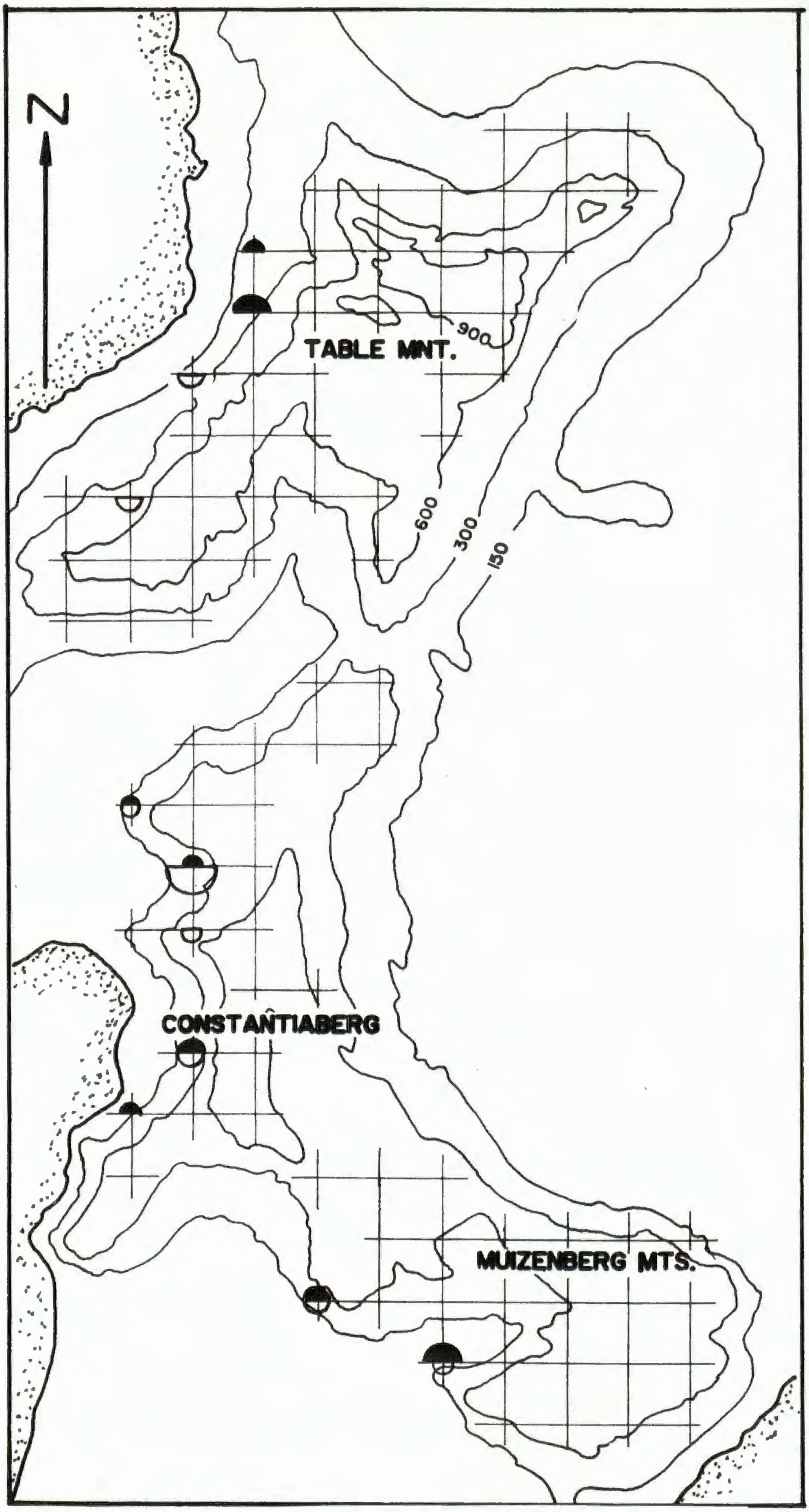


Fig. 16. Hakea suaveolens

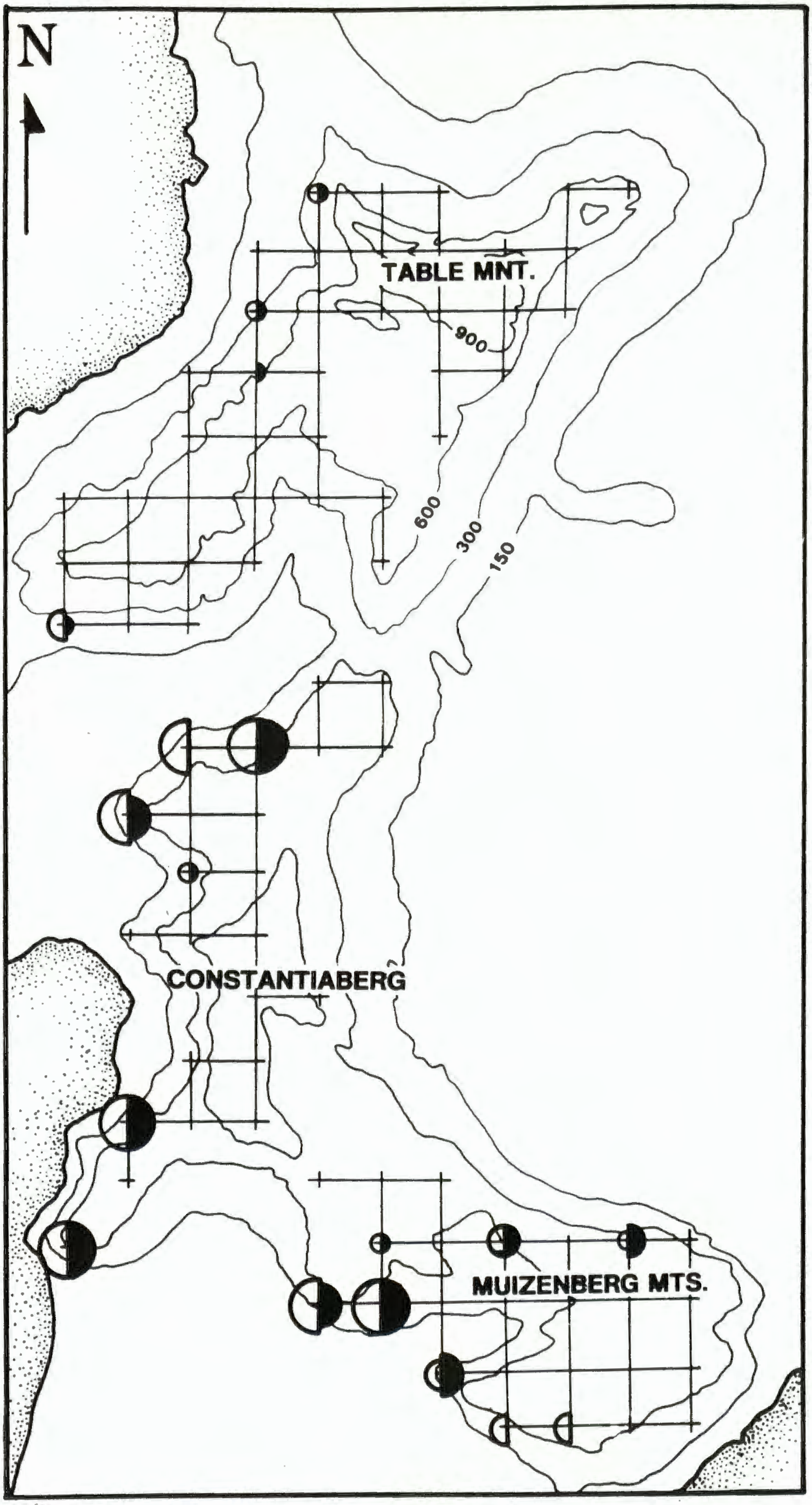


Fig. 17. Acacia cyclops [ex McLachlan et al., 1980]

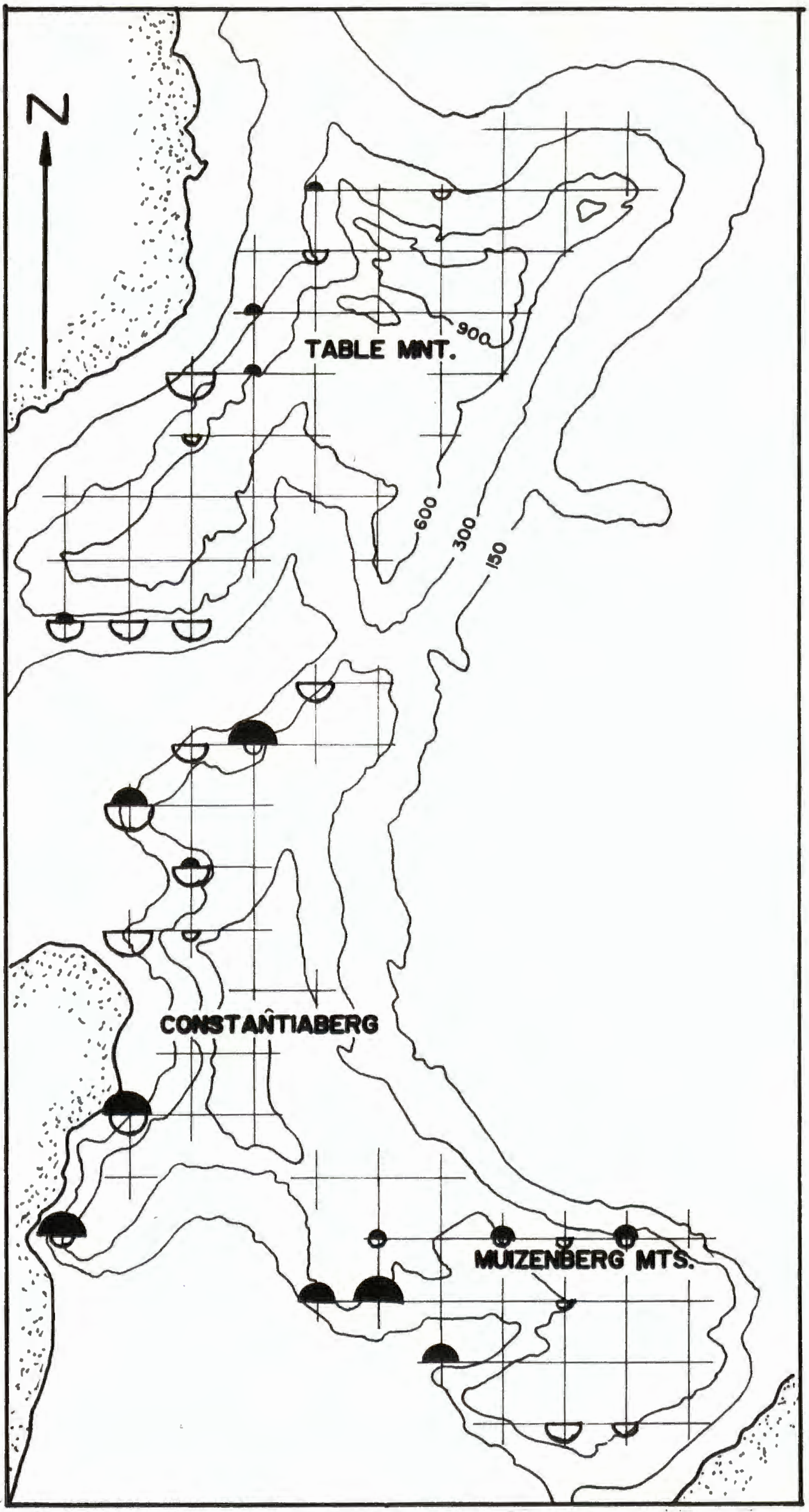


Fig. 18. Acacia cyclops

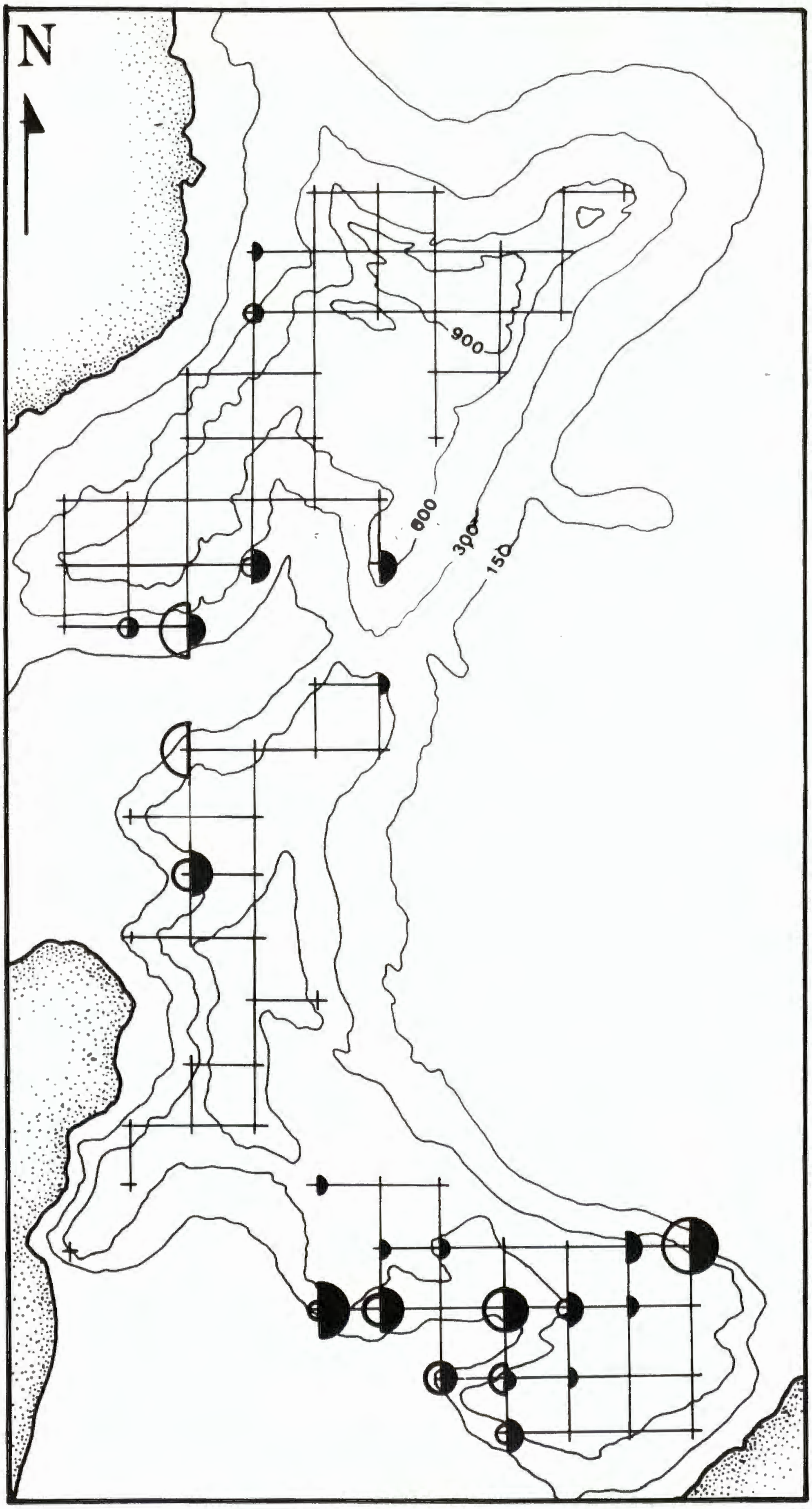


Fig. 19. Acacia saligna [ex McLachlan et al., 1980]

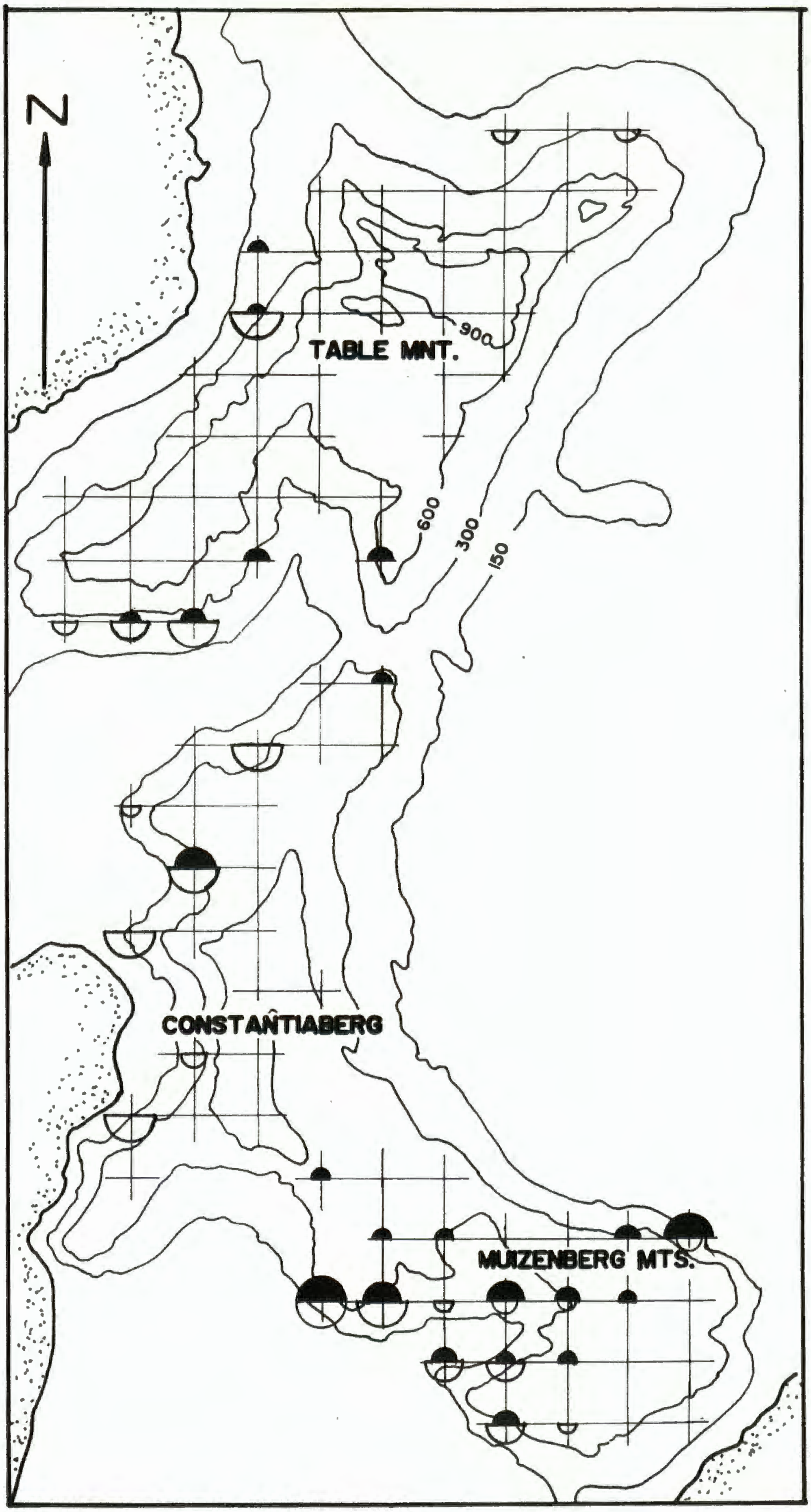


Fig. 20. Acacia saligna

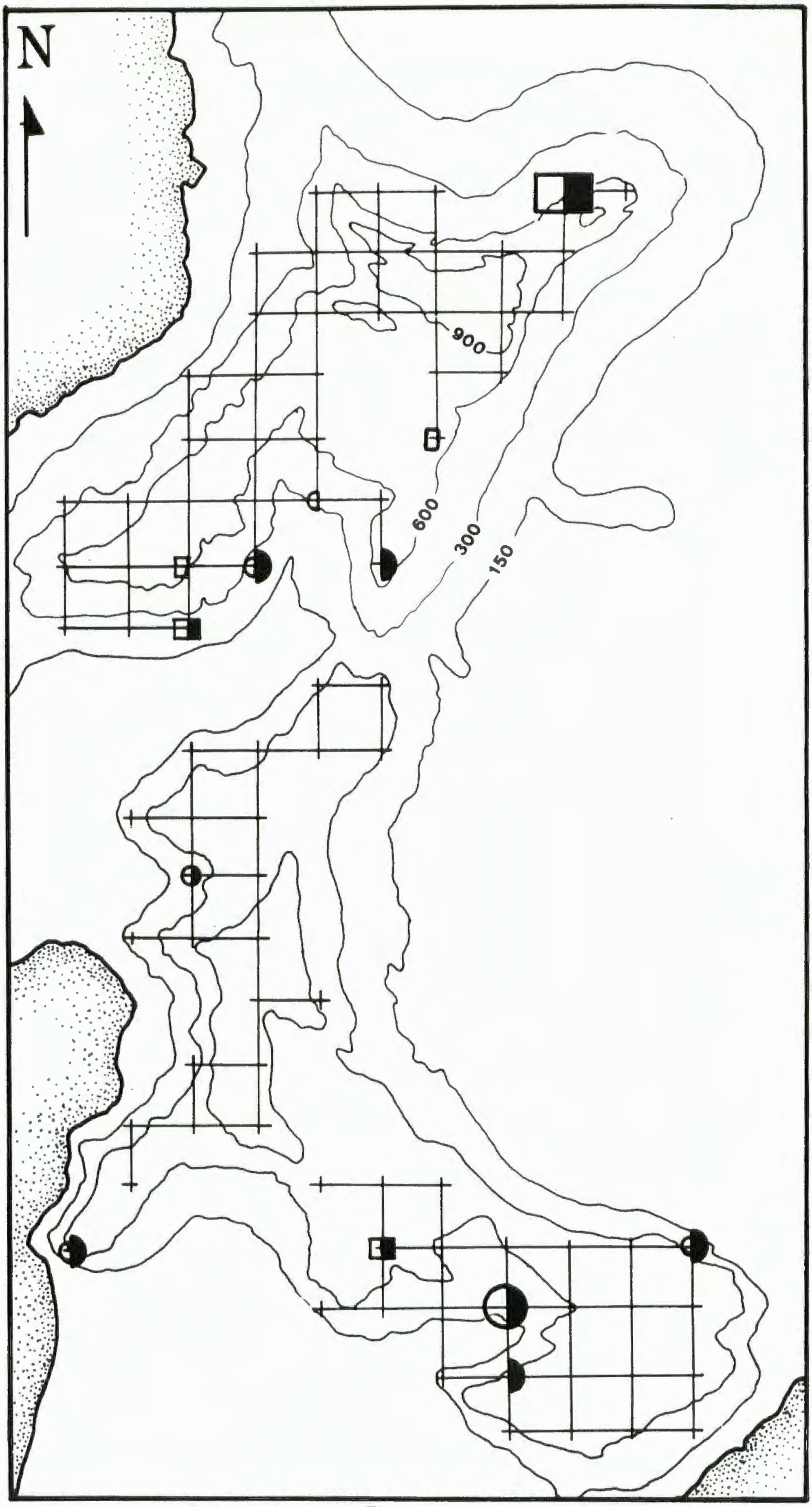


Fig. 21. Acacia longifolia ◑ Acacia melanoxylon ◧
[ex McLachlan et al., 1980]

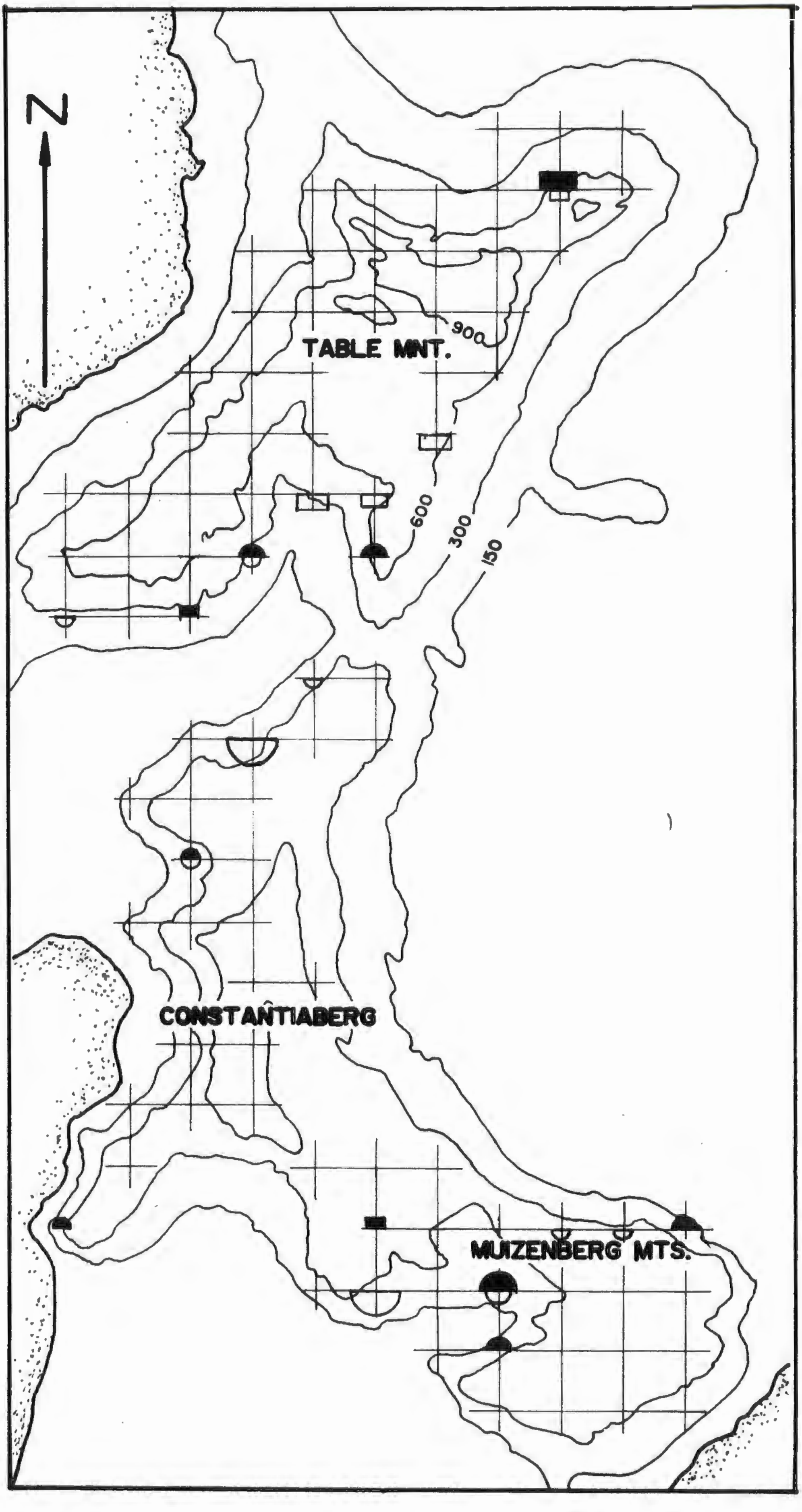


Fig. 22. Acacia longifolia ◓ Acacia melanoxylon ▬

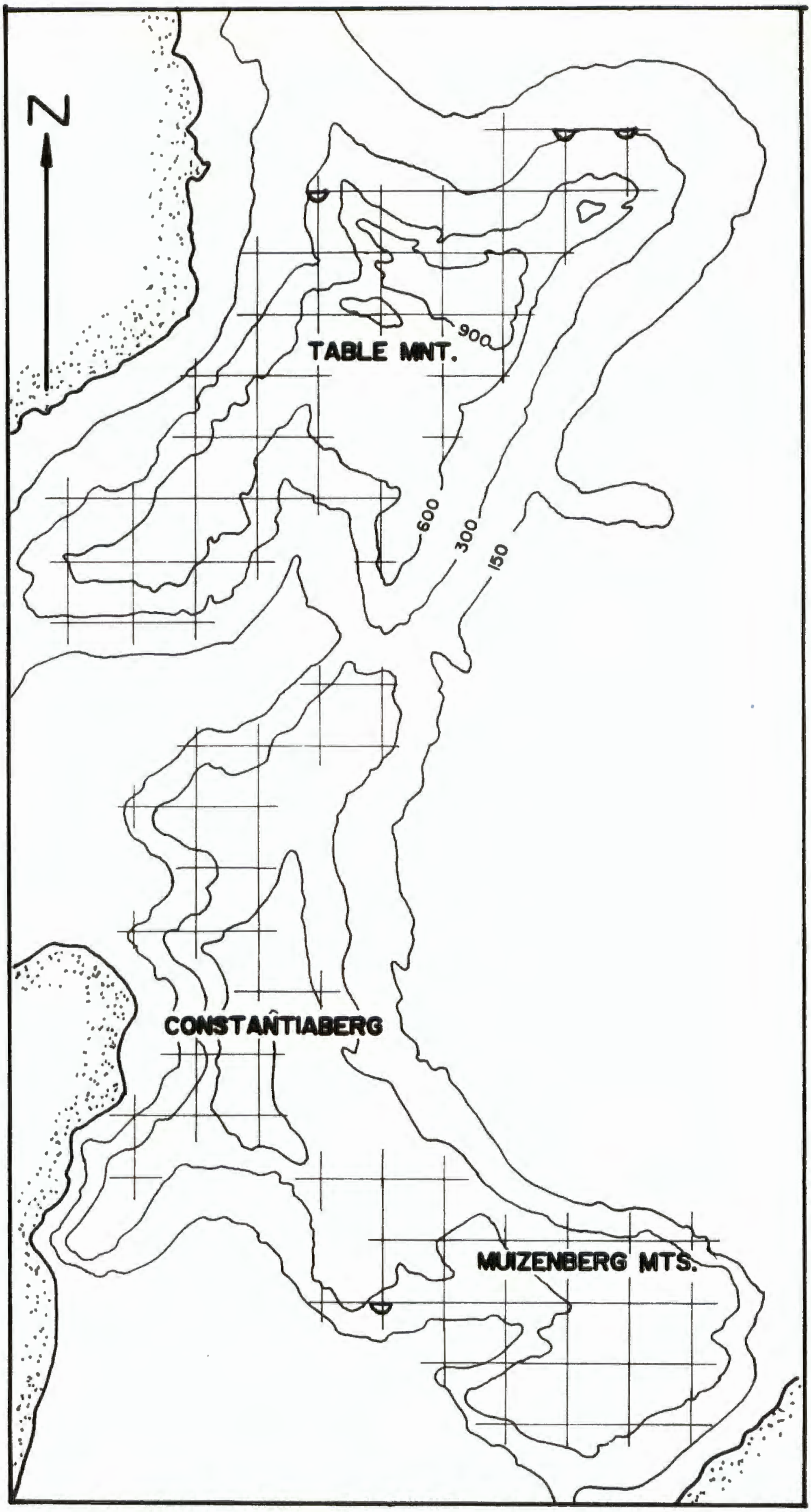


Fig. 23. Acacia mearnsii

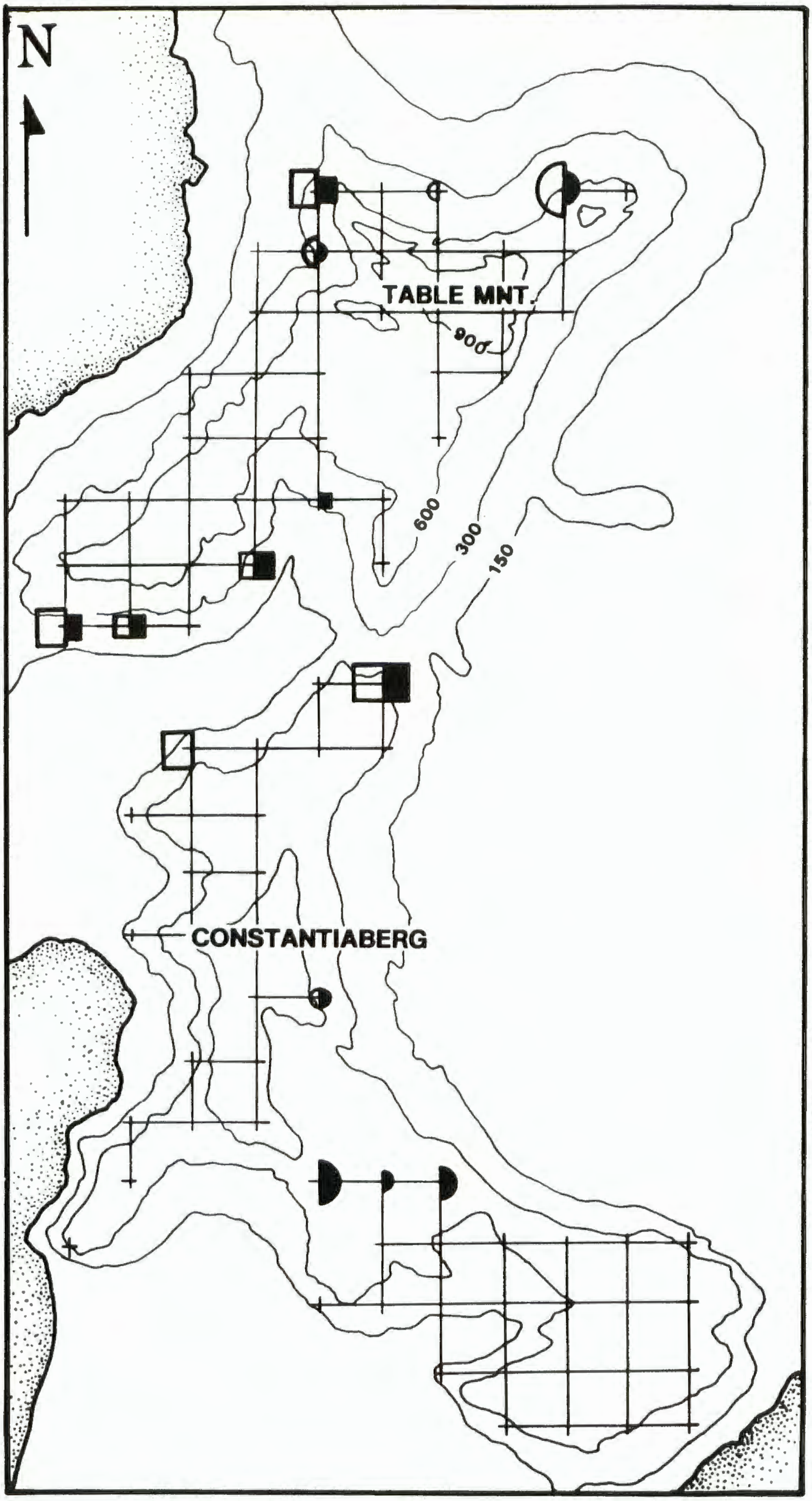


Fig. 24. Eucalyptus sp ◐ Albizia lophantha ◧
[ex McLachlan et al., 1980]

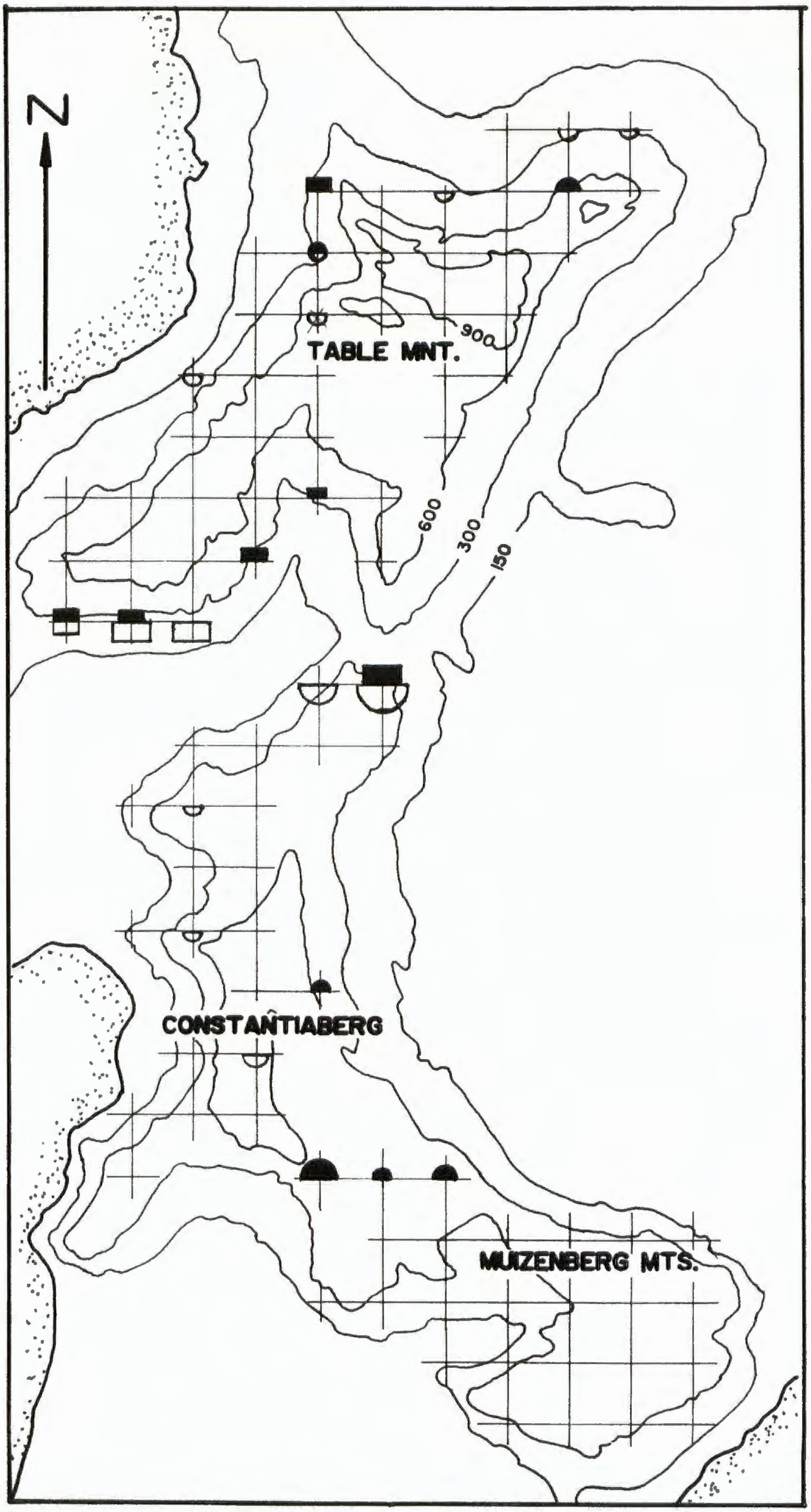


Fig. 25. Eucaluptus sp ◓ Albizia lophantha ⬒

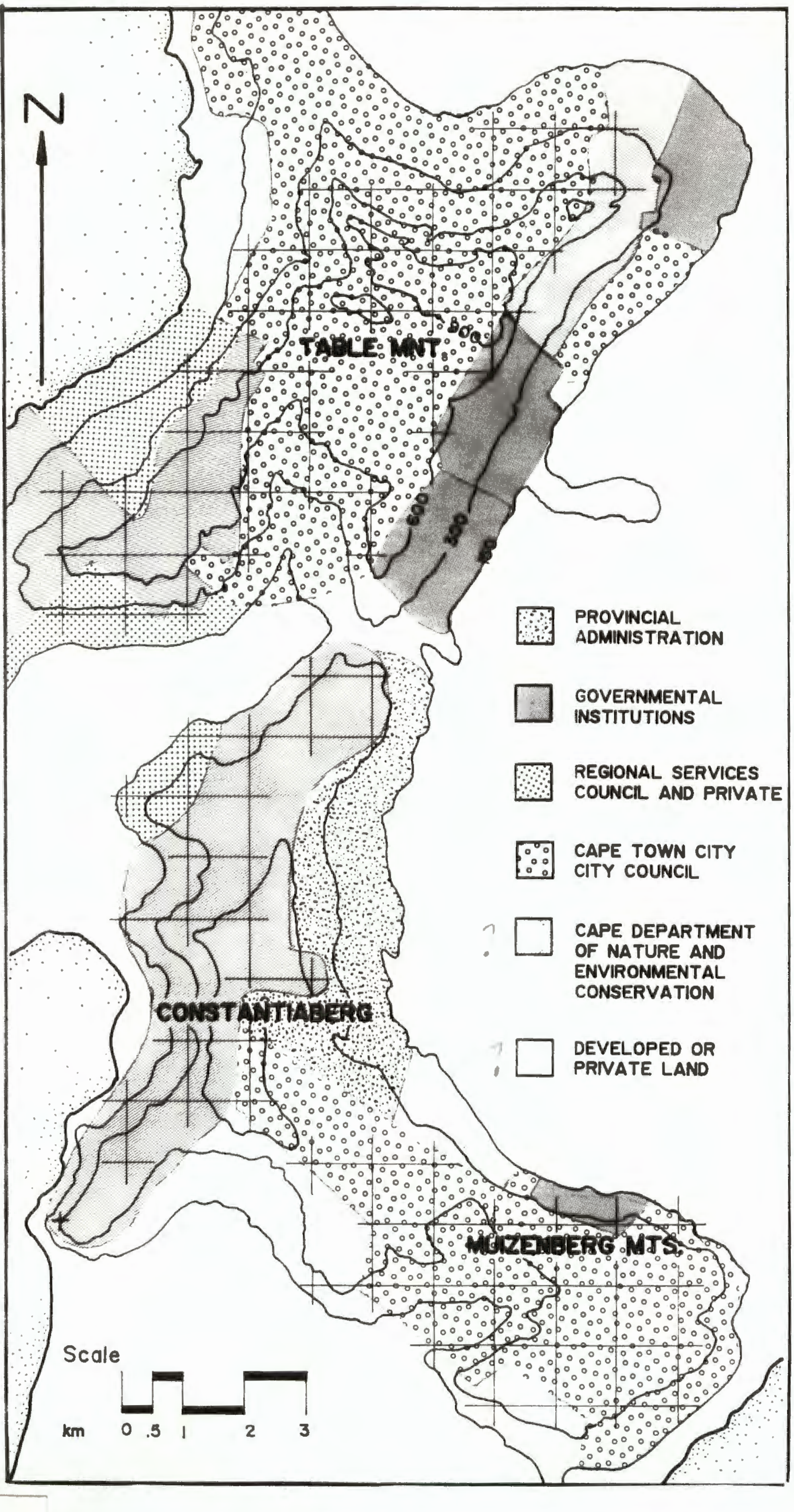


Fig. 26. Map indicating the different authorities in control, and also responsible for the management, of the sites within the study area.

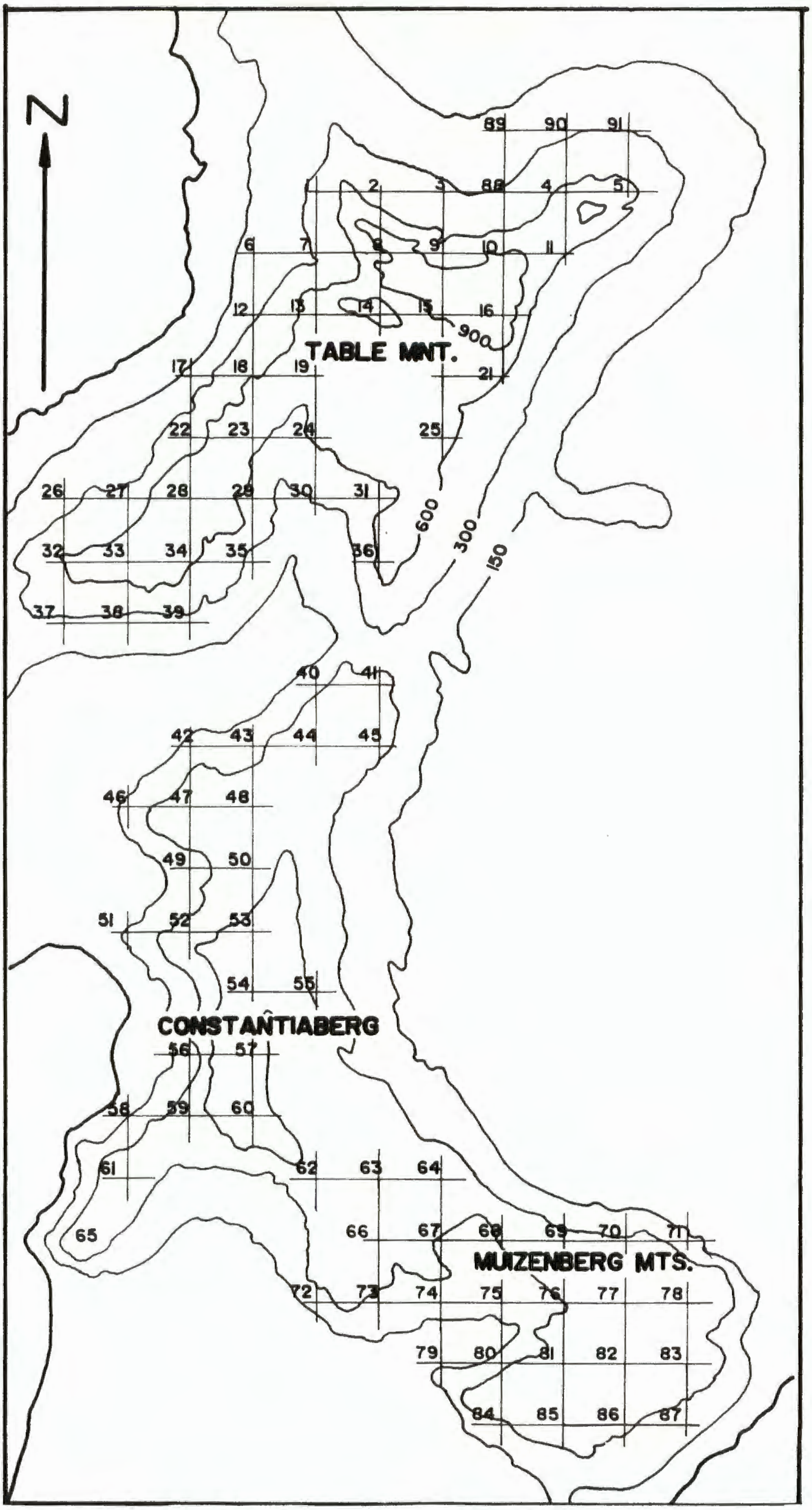
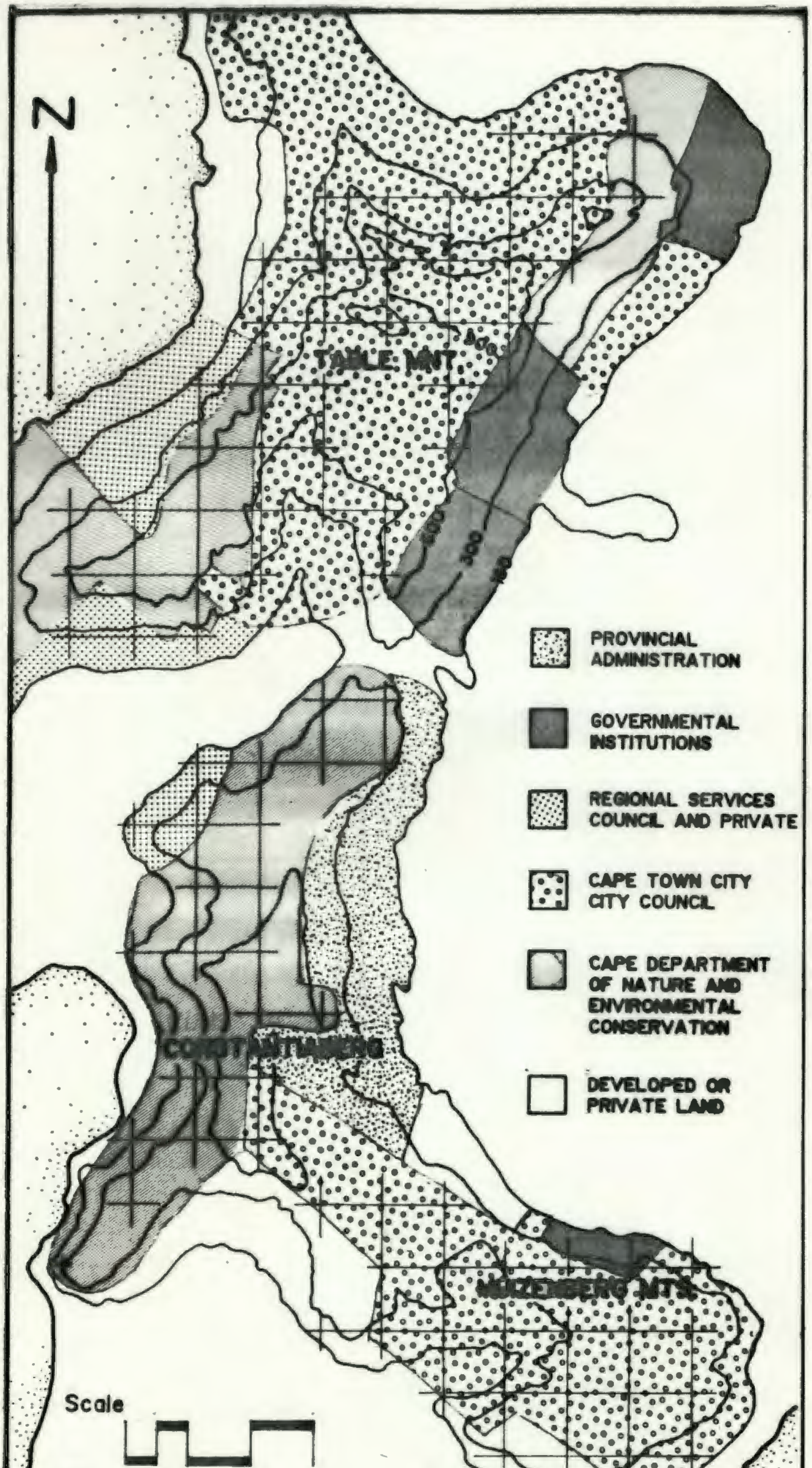
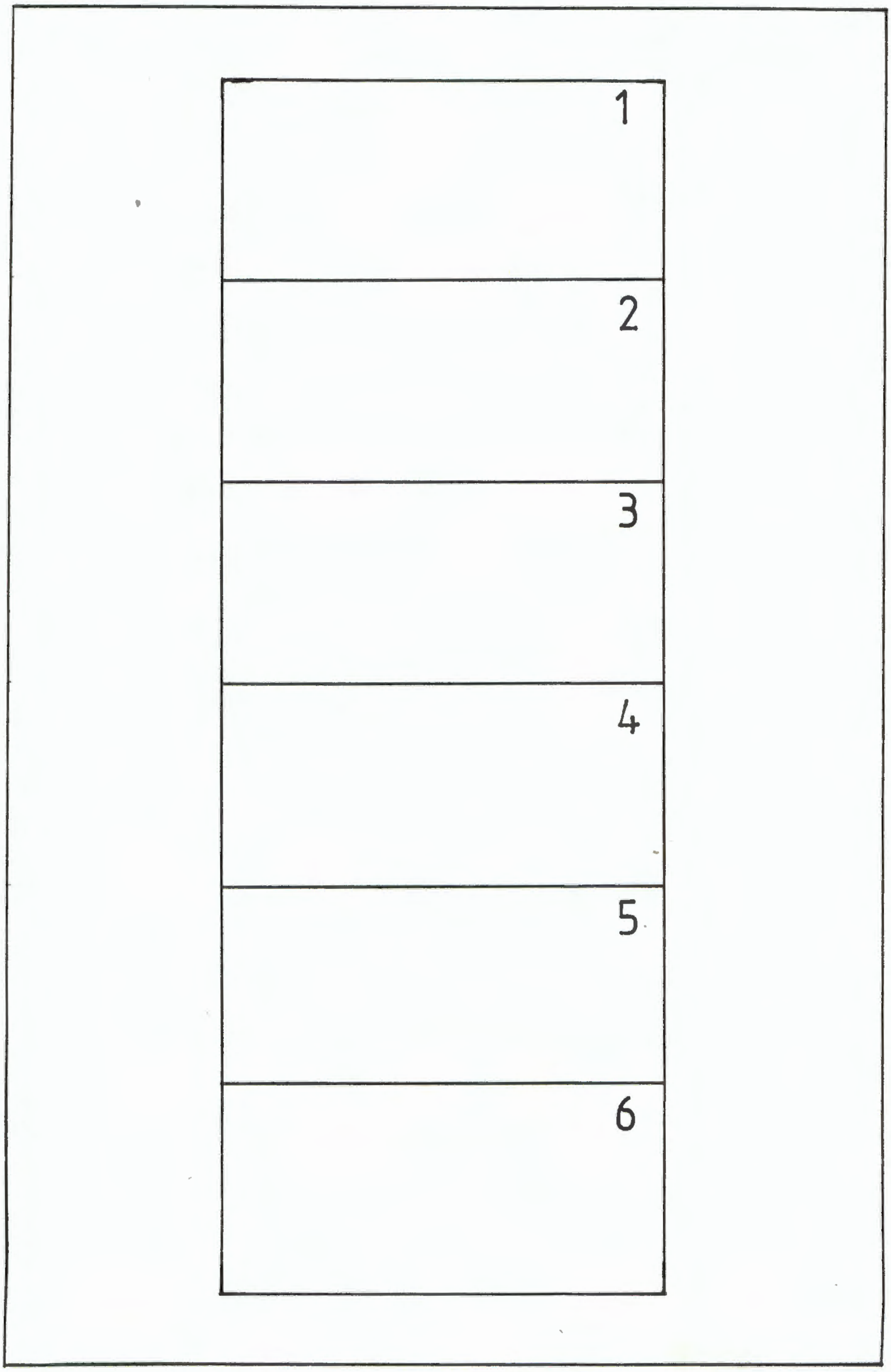


Fig. 27. A map of the survey area showing the system of enumeration of sample points.



Map indicating the different authorities in control, and also responsible for the management, of the sites within the study area.

A diagram showing how individual pages should be placed in order to read the Appendix in its entirety.



A Table showing the age structures of those alien species within a 10 by 10m plot at each sample point and the total number of aliens within a 200 yard (183m) radius of the sample point.

ALIEN / SITE	A.saligna	A.mearnsii	A.longifolia	A.melanoxylon	A.cyclops	H.gibbosa	H.sericea	H.suaveolens	P.pinaster	P.radiata	P.canariensis	P.pinea	P.halipensis	Eucalyptus spp	Albizia lopa.
92/91															
<15cm	2														
<2m	1														
200	<10														
93/91															
<15cm		2													
<2m		6												1	
>2M														<10	
200		<10													
94/91															
<15cm	7														
<2m	14														
200	<10	<10													
89/90															
<15cm															
200												<10			
90/90															
91/90															
200					<10									<10	
92/90															
93/90															
<15cm				4											
<2m				9						12					
>2m				<10						2					
200										<10					
94/90															
<2m									2						
200									<50						
88/89															
200						<50				<10					
89/89															
200					<50							<10		<10	
90/89															
200.									<10						
91/89															
92/89															
200									>50						
93/89															
200									<50						
88/88															
200	>200								<50						
89/88															

90/88 200						<50	
91/88 200						<10	
92/88							
87/87 200			>200		>50		<20
88/87 200						<10	
89/87 200						<50	
90/87							
91/87 <2m 200						6 <10	
92/87 200						>100	
87/86 200			<50				
88/86 200						<10	
89/86 200						<100	
91/86 <2m 200		>100				6 >200	
85/85 200			>10	<10			
86/85 200							
87/85 200						>20	
88/85 200						<10	
89/85 200	>10	>100				<10	
90/85 200		>50				<50	
84/84							

85/84														
200								<10	<10					
86/84														
200								>50	1					
87/84														
200								<50	<10					
88/84														
>2m									2				>10	
89/84														
90/84														
85/83														
>2m				6									3	
200	>10		>20	>20	<10				<10				>20	
86/83				>50										
200	>100								>100				>200	
87/83				>100										
200	>200					>200		>200			>200		>200	>200
89/82														
<2m					3			3						
>2m					4			12				1		
200		1	>10		>200			>200	>100			<50		
90/82														
<2m			>200		80			2	>100					
200				>50	>200			>200				>200		
87/81														
<15cm				10										
<2m				14										
>2m				9		>200								>200
88/81														
<15cm				3										
<2m			3	7										
200	>200		>200			>200								
89/81														
<2m								3						
200								>50	1					
90/81														
>2m								2						
200					>50			>200	<50					
86/80														
<15cm				1										
<2m	2													
200				>200			<10		<20	<10		>10		
87/80														
<2m									1					

>2m						5	1	
200				>200		>200	>200	
08/80								
07/79								
<2m					10	1		
>2m	1			3	32	15		
200	>200	>20	50	>200	>200	>200	>50	
08/79								
03/78								
>2m	1							
200	>400		>200					
06/78								
>2m	2		1			1		
200	>250		>200			<200	>50	>10
07/78								
<2m				1				
>2m				1				
200			<10	>200	>10	>50	>20	
08/78								
200							<20	
03/77								
>2m			34					
200			200					
07/77								
08/77								
200						<50		
09/77								
>2m						1		
200						<50	>20	>20
07/76								
200					>20			
08/76								
200	<10					<50		
06/75								
<15cm			2					
<2m			15					
200	>500		>100					
07/75								
200						<10		
08/75								
200						<10		
06/74								
200			>20			>50	<50	

89/74										
200								>50		
90/74										
200								>10		
91/74										
200								>10		
85/73										
<2m				1						
200				>200				<10		
90/73										
200				<10				<10		
91/73										
200								<10		
92/73										
200			>10	>10	>10			>200		
93/73										
200			<10	>10	<50	<50		<10		
94/73										
200				>10				<10		
95/73										
<15cm	11									
<2m	17			1						
200								<10		
89/72										
<2m	20							20		
>2m	10						10			
200	>500						>20	<10		
90/72										
>2m								2		
200	>200	<10	>200		<10			>10		
91/72										
200	<10							>10		
92/72										
<2m			8		4			1		
>2m	12		2		9			2		
200	>10		<10		>10			>10		
93/72										
200	>10			<10				<200	<10	<10
94/72										
95/72										
91/71										
200	>50				>20		<10	<10		

92/71 200	>100				>20	
93/71						
94/71 200					<10	
95/71						
91/70 200	>50				<10	
92/70 200				>100	>50	<10
93/70 200		10	>20		>50	
94/70 200					<10	