DEPARTMENT OF GEOGRAPHY
UNIVERSITY OF TASMANIA

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SALT MARSHES IN TASMANIA

Distribution, Community Composition and Conservation

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JBK.

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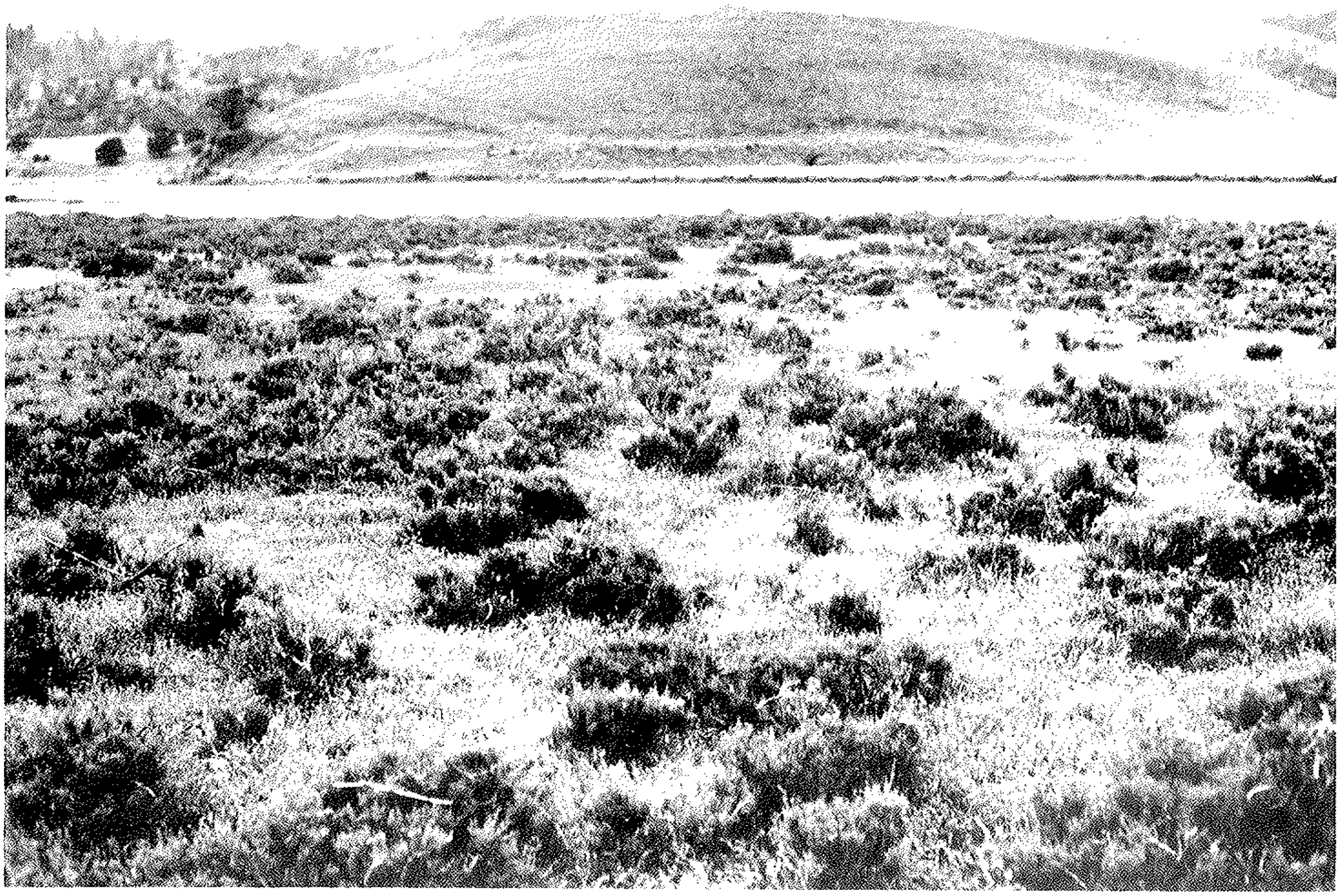
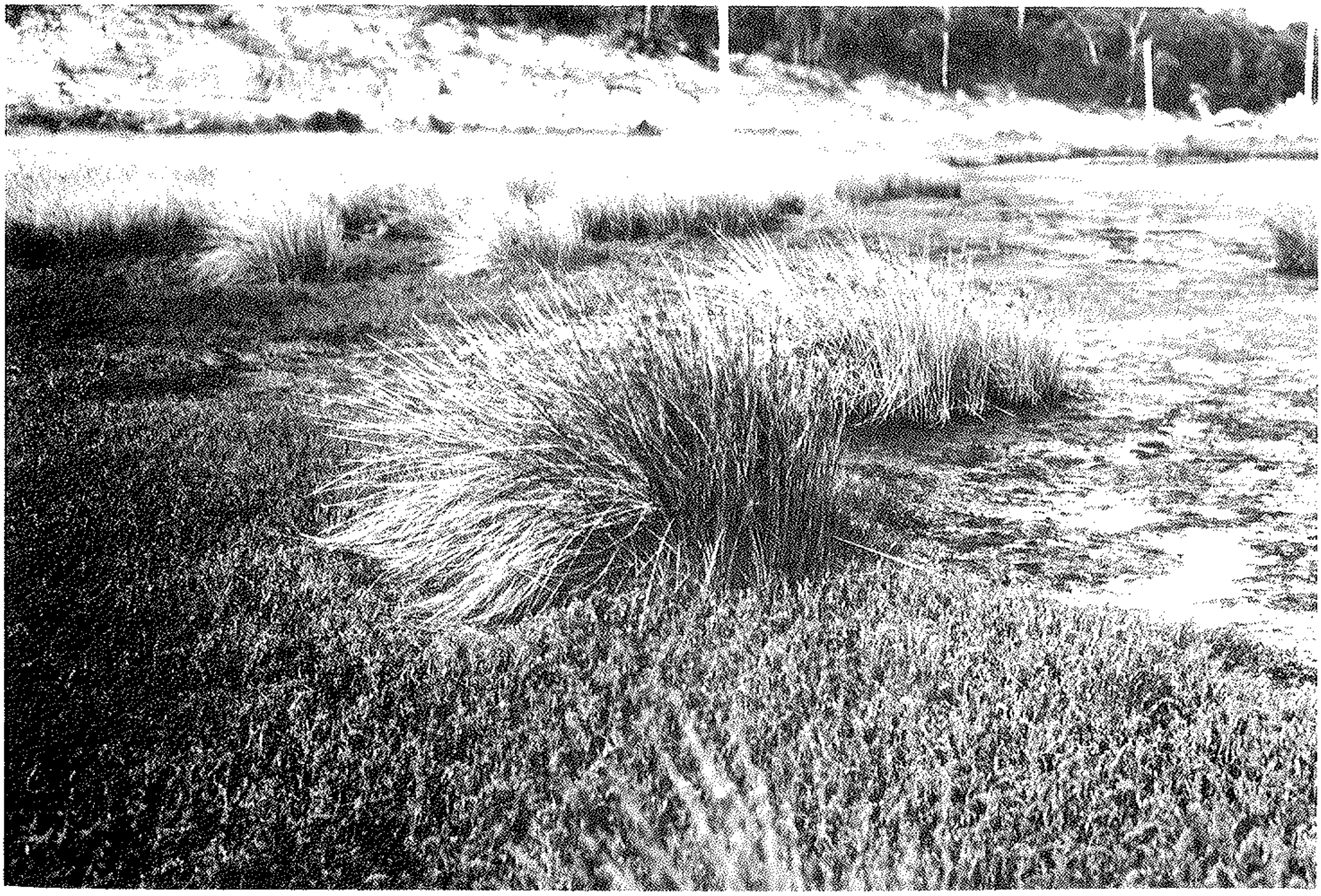




INTRODUCTION

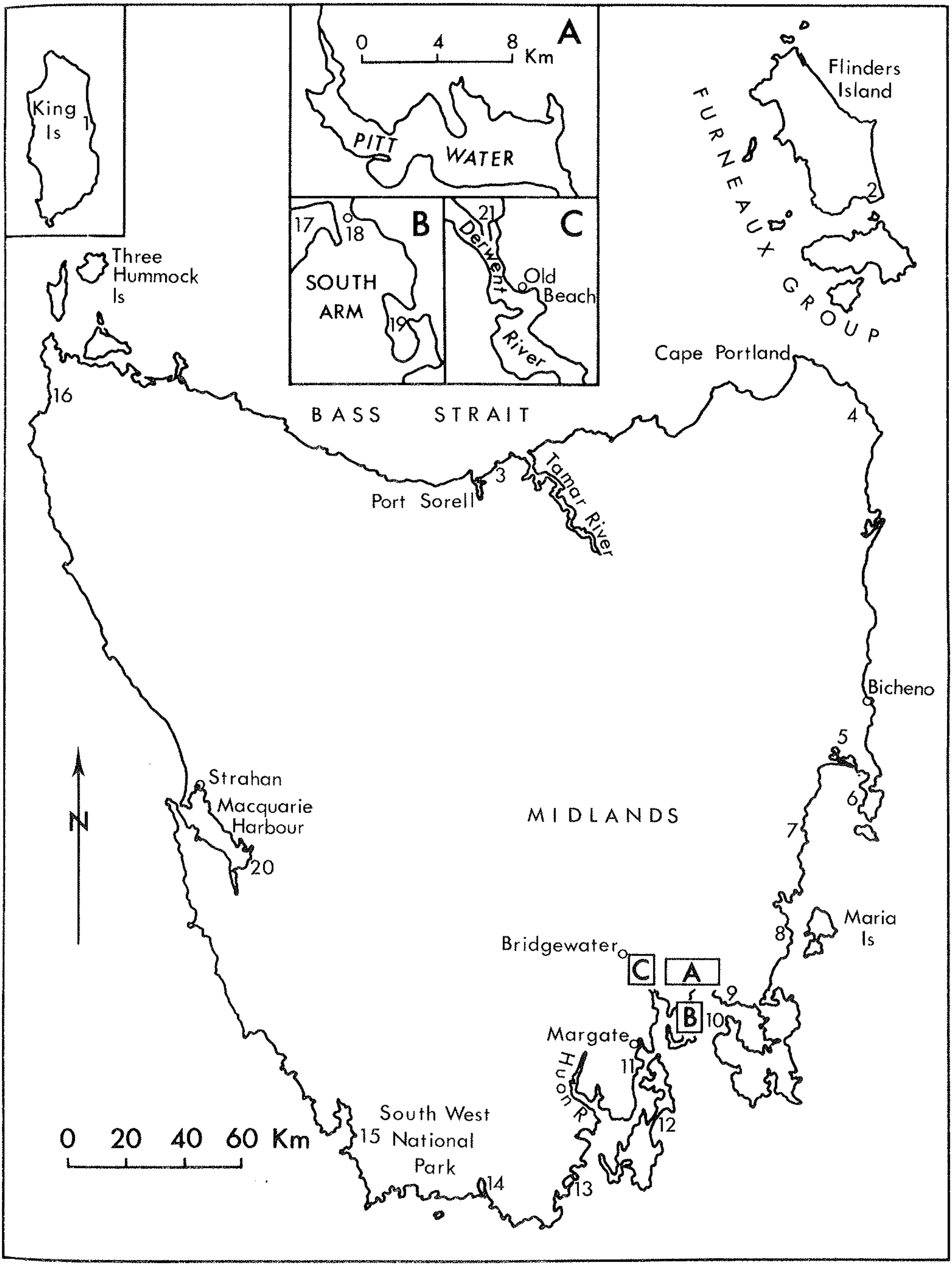
Salt marshes consist of vegetation dominated by higher plants and subject to regular inundation by the sea. They occur worldwide on low energy coasts, usually in the shelter of estuaries and open lagoons. Salt marshes have proved to be fertile areas for scientific research and are known to be of considerable importance in both marine and terrestrial food chains (Ranwell, 1972). For Europe and North America there is a plethora of plant geographical and ecological work on salt marsh. The marshes of Australia are less well known apart from the Sydney region (Clarke and Hannon, 1967, 1969, 1970; Kratochvil *et al.*, 1972). World reviews of the ecology and plant geography of salt marsh can be found in Ranwell (1972) and Chapman (1977), the latter reference providing a general description and a bibliography of Australian salt marshes. Tasmanian salt marsh vegetation is poorly known, although information for restricted localities is given in Curtis and Somerville (1947), Guiler (1951), Bowden and Kirkpatrick (1974), Glasby (1975), Kirkpatrick (1977a), and Brown and Bayly-Stark (1979).

This paper

a) documents the distribution of salt marsh and salt marsh plant species in Tasmania;
b) defines and describes the distribution and environmental relationships of structural and floristic salt marsh communities;
c) assesses the conservation status of salt marsh communities and species; and
d) discusses the physical and cultural factors which may lead to a dimunition in the area and species richness of Tasmanian salt marsh.

The documentation and analysis included in this paper provide the first accurate overall picture of the general features of the ecology and plant geography of Tasmanian salt marshes. As such, it provides information that should be valuable in land use planning and management in the coastal regions of the State, as well as providing comparative data for similar plant communities in other places.

FIGURE 1 Locations mentioned in the text. Asbestos Range National Park = 1, Bathurst Harbour = 15, Bruny Neck Game Reserve = 12, Carlton River = 9, Freycinet National Park = 6, Gordon River State Reserve = 21, Green Point Nature Reserve = 21, Lauderdale = 18, Lime Bay Nature Reserve = 10, Little Swanport Lagoon = 7, Logans Lagoon Wildlife Sanctuary = 2, Mt. Cameron West Aboriginal Site = 16, Mt. William National Park = 4, Moulting Lagoon Wildlife Sanctuary = 5, New River Lagoon = 14, Oyster Bay Conservation Area = 11, Pipeclay Lagoon = 19, Ralphs Bay = 17, Sandspit River Wildlife Sanctuary = 8, Sea Elephant Wildlife Sanctuary = 1, Southport Lagoon Wildlife Sanctuary = 13.



King Is
1
Three Hummock Is
0 4 8 Km
A
PITT WATER
B
17
18
SOUTH ARM
19
C
21
Derwent River
Old Beach
Flinders Island
FURNEAUX GROUP
2
Cape Portland
16
BASS STRAIT
4
3
Port Sorell
Tamar River
Bicheno
5
6
Strahan
Macquarie Harbour
20
MIDLANDS
7
N
Maria Is
8
Bridgewater
C
A
9
B
10
Margate
11
Huon R
12
0 20 40 60 Km
15 South West National Park
14
13

Salt Marsh Distribution in Tasmania

Although salt marsh occurs sporadically along most sections of the Tasmanian coast it is most extensive along the highly indented southeastern coast and in the far west of the north coast (Figure 2). The formation of extensive areas of salt marsh requires a gentle gradient between land and sea and the absence of waves of sufficient power and frequency to enable the scouring away of plant growth. Thus, extensive salt marshes are most likely to be found in coastal environments in which depositional processes and progradation have either dominated for long periods in the past or are still occurring. The correspondence of most of the larger salt marshes with the mouths or upper estuaries of major streams reflects this relationship. The salt marshes of the far west of the north coast provide the major exception. Here, a sand plain of low relative relief has been drowned by the incursion of the sea, leaving islands and bars (some of which may have formed after sealevels attained their present approximate level) which provide shelter from strong seas. Narrow strips of saltmarsh may also form along the eroding margins of sheltered arms of the sea where the land to sea slope is gentle. This situation prevails near Strahan on the west coast.

Salt marshes *sensu stricto* do not occur along high energy coasts, but communities similar in their species composition to some salt marsh communities can be found where salt accumulates in crevices, flats or basins along cliffed or rocky coasts (Macphail *et al.*, 1975; Brown, 1980). In fact, these communities could be regarded as highly fragmented salt marsh in which the inundation of the sea is replaced by inputs of salt water from spray. Salt marsh species are also found around the margins of saline wetlands which occur in the dry Midlands of Tasmania. Here, the regular inundation with salt water comes from the response of the level of the lake to seasonal and longterm variations in precipitation and evaporation. Coastal cliff and non-marine marsh are not covered by this study.

Tasmanian salt marshes occur within the mean annual precipitation range of 550-2400 mm. Along the west and north coasts and on the Bass Strait islands there is a distinct winter maximum, whereas on the drier east coast rainfall is distributed reasonably evenly throughout the year. The salt marshes in the south west of the State receive more than 1600 mm per annum, those on the north west coast and King Island receive 900-1200 mm

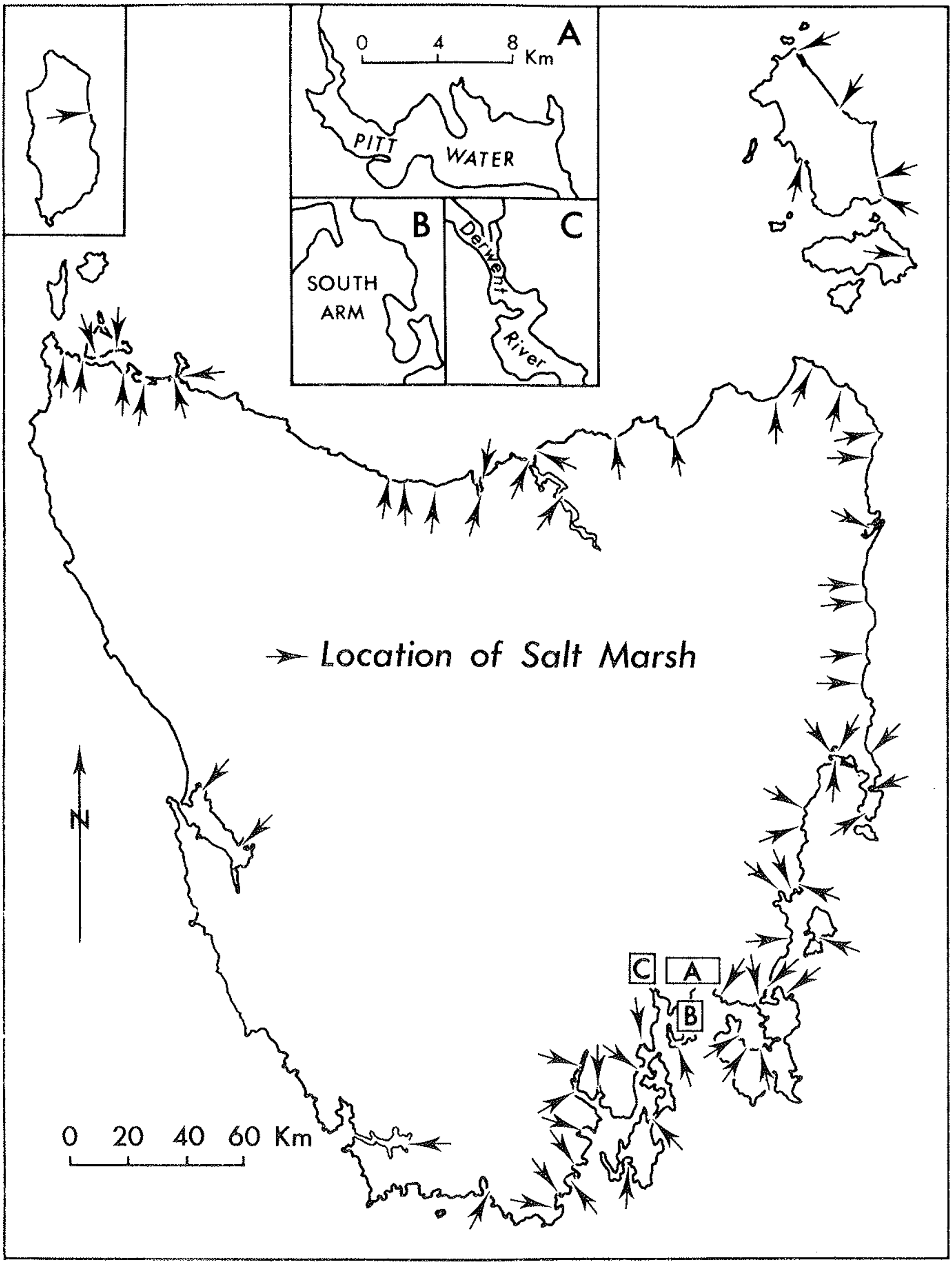


FIGURE 2 Locations of salt marsh in Tasmania. See Figure 3 for insets. Areas (ha) are given for some regions.

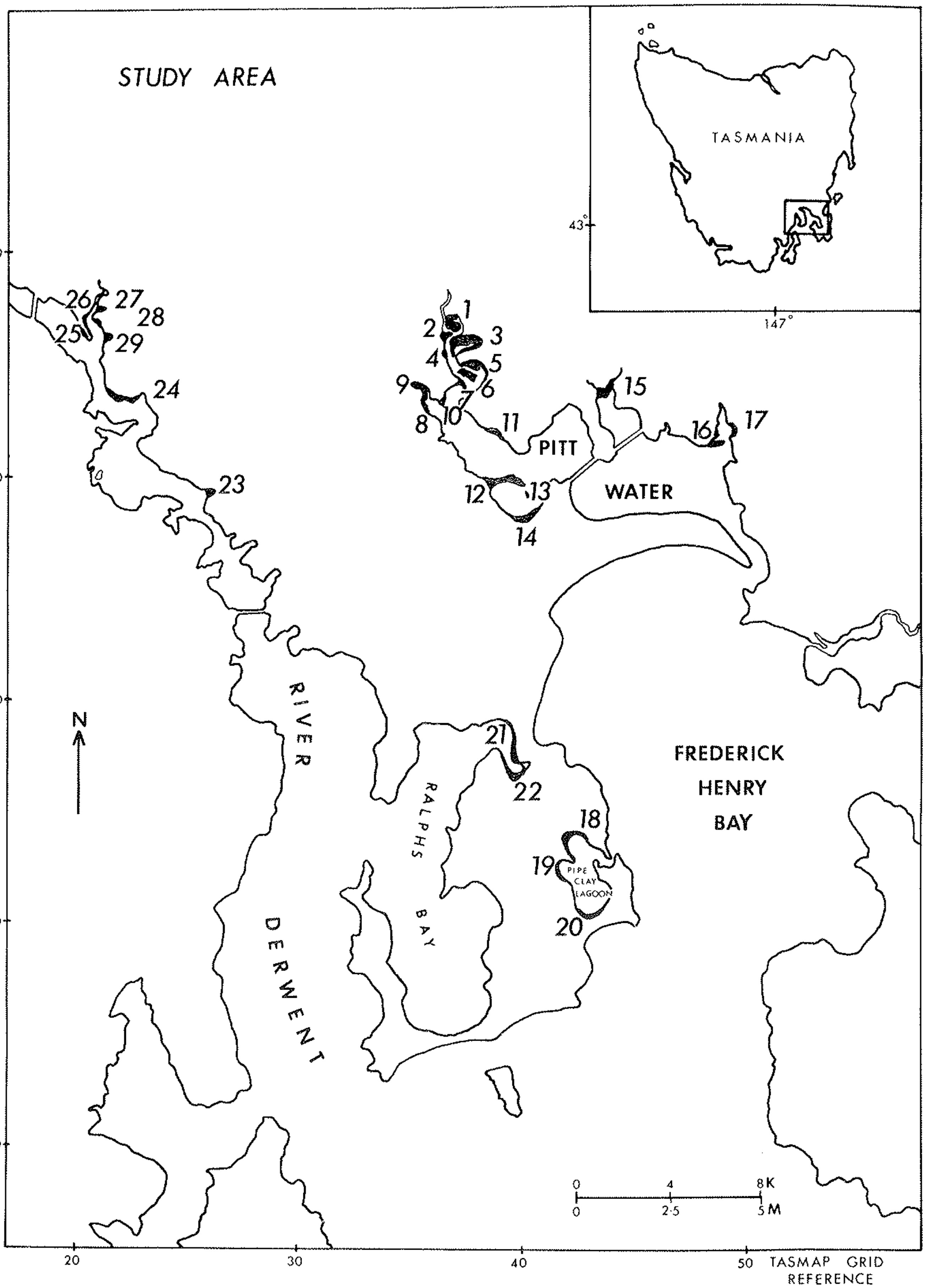


FIGURE 3 The locations and codes of salt marshes mapped in Figures 4-14.

per annum, those in the Furneaux Group, the east coast north of Bicheno and south of Margate and the north coast east of the Tamar estuary receive between 700 and 900 mm per annum, and those marshes between Margate and Bicheno generally receive between 500 and 700 mm per annum. Temperatures are equable although frosts probably occur occasionally in most marshes. The mean monthly temperatures for January vary between 15 and 19°C and those for July vary between 7 and 10°C. During winter the north coast and the Bass Strait islands are warmest, and during summer the east and north coasts and the Bass Strait islands have the highest temperatures.

Salt Marsh Communities in Tasmania

The nature of the available data for Tasmanian salt marsh enabled two distinct approaches to classification: firstly by structure (cover, height and lifeform characteristics) and dominance, and secondly by floristic similarity (classification by re-occurring combinations of species). The structural-dominance classification reflects variation in the appearance of salt marsh vegetation. The floristic classification may relate more closely to site conditions. Mapping has been undertaken at the structural level, floristic groupings being difficult to map as they do not necessarily correspond with boundaries perceptible from aerial photographs or ground survey.

The structural-dominance classification

The major divisions of the classification are based on the lifeform of the dominants, which are those species with the greatest cover in the tallest stratum. These groups are then further divided by the dominant species and are characterized in terms of height and cover by the classification of Specht (1974) modified to include low heath and low closed-heath categories where the height of the woody dominants is less than 0.2 m, and to include a rushland category where the dominants are in the Restionaceae and Juncaceae.

These communities usually have sharp boundaries, defined by the distributions of the larger dominant species. However, where the dominants attain the same height and if environmental change is gradual, they are found widely in variable mixture. In particular the communities defined by *Arthrocnemum arbuscula, Gahnia filum, Juncus kraussii* and *Stipa stipoides* tend to intergrade. This is illustrated by the large scale maps of the marshes in the Upper Derwent, Pitt Water, Ralphs Bay and Pipeclay Lagoon (Figures 3-14).

The list of structural-dominance communities below includes only those subject to tidal inundation. Other associated community types are mapped in Figures 4-14. The distributions of the communities outside the areas mapped in detail can be approximated by reference to the distribution maps of the dominant species (Figures 15-49). However, with the exceptions of *Arthrocnemum arbuscula*, *Juncus kraussii*, *Gahnia filum*, *Stipa stipoides* and *Spartina townsendii*, the presence of a species does not necessarily denote the presence of the community defined by it.

Structural-dominance communities

a) Communities dominated by succulent shrubs

1. *Arthrocnemum arbuscula* open-heath (also closed-heath and low shrubland)
2. *Suaeda australis* open to closed-heath
3. *Salicornia quinqueflora* low open-heath
4. *Salicornia blackiana* low open-heath
5. *Hemichroa pentandra* low open- to closed-heath
6. *Disphyma blackii* low open-heath

b) Communities dominated by grasses

7. *Stipa stipoides* tussock grassland to closed-tussock grassland
8. *Distichlis distichophylla* closed-grassland
9. *Puccinellia stricta* open-grassland
10. *Spartina townsendii* grassland to closed-grassland

c) Communities dominated by sedges or rushes

11. *Gahnia filum*-(*Gahnia trifida*) tussock sedgeland to closed-tussock sedgeland
12. *Juncus kraussii* open-rushland
13. *Leptocarpus brownii* open-rushland

d) Communities dominated by herbs

14. *Wilsonia backhousei* herbfield to closed-herbfield
15. *Samolus repens*±*Schoenus nitens* closed-herbfield

Communities 3, 6, 7, 8, 11, 12, 13 and 15 are found widely outside the salt marsh environment. Communities 1, 2, 4, 5, 9, 10 and 14 are almost totally confined to areas subject to tidal inundation. Communities 2, 4, 5, 6, 8, 9 and 14 are extremely restricted in area, the most widespread communities being 1, 3, 12 and 14.

The floristic classification

The floristic classification was based on quadrat sampling of the Derwent, Pitt Water and Pipe Clay Lagoon marshes (Figures 4-14). Presence data from 200 one square metre quadrats distributed randomly in a stratified manner, such that each mapping unit, with the exceptions of *Poa labillardieri* tussock grassland and scrub, were sampled in proportion to their area. Species were considered to be present if any aerial part overlapped the quadrat.

The quadrats were classified using normal association analysis (Williams and Lambert, 1958) with a cutoff value of 40 for the sum of significant Chi-squared values. Species occurring in less than five quadrats were excluded at each stage of the analysis.

The analysis resulted in seven groups (Figure 50). Group 1 was defined by the presence of *Stipa stipoides* and *Samolus repens*, *Salicornia quinqueflora* being the only other highly constant species (Table 1). Group 2 was defined by the presence of *Stipa stipoides* and the absence of *Samolus repens*. *Disphyma blackii* and *Spergularia media* were the most constant associates of *Stipa*. Group 3 was defined by the absence of *Stipa* and the presence of *Leptocarpus brownii*. The most constant species were *Leptocarpus*, *Samolus repens*, *Schoenus nitens*, *Selliera radicans* and *Juncus kraussii*. Group 4 was defined by the absence of *Stipa* and *Leptocarpus* and the presence of *Spergularia media*. *Spergularia media* and *Salicornia quinqueflora* were the highly constant species. Group 5 was defined by the absence of *Stipa*, *Leptocarpus* and *Spergularia* and the presence of *Hemichroa pentandra*. The constant species were *Hemichroa*, *Samolus repens*, *Salicornia quinqueflora* and *Arthrocnemum arbuscula*. Group 6 was defined by the absence of *Stipa*, *Leptocarpus*, *Spergularia* and *Hemichroa* and the presence of *Juncus kraussii*, *Samolus repens* being the only constant associate. Group 7 was defined by the absence of all dividing species, the only constant being *Salicornia quinqueflora*.

Thus, *Stipa stipoides* tussock grassland was divided into two floristic groups, group 1 being found lower in the marshes than group 2. Group 1 also includes some *Arthrocnemum arbuscula* heath and *Gahnia filum* tussock sedgeland. Groups 3 and 6 predominantly consist of *Juncus kraussii* rushland, although group 3 also includes *Leptocarpus brownii* rushland. Most of the quadrats in group 4 are *Salicornia quinqueflora* low open-heath as are half the quadrats in group 7 and ten percent of the quadrats in group 5. The remainder of the quadrats in groups 5 and 7 were located in *Arthrocnemum arbuscula* heath.

Species distribution

The distributions of the species most characteristic of salt marshes were mapped (Figures 15-49). Distributional data were obtained from fieldwork of the authors, the Tasmanian Wetland Survey and the National Parks and Wildlife Service. The only major areas of salt marsh from which reasonably complete floristic information was not obtained were those along the lower Huon River and the marsh in the far northeast of Flinders Island. The latter marsh is dominated by *Arthrocnemum arbuscula* (C.E. Harwood, personal communication) and the former marshes are dominated by *Juncus kraussii, Leptocarpus tenax* and *Samolus repens*. The maps only include records for salt marshes and other wetlands. *Disphyma blackii, Stipa stipoides, Rhagodia baccata, Apium prostratum, Distichlis distichophylla* and *Salicornia quinqueflora* are common components of coastal cliff vegetation, and *Triglochin minutissima* is found occasionally in coastal heath (Kirkpatrick, 1977b).

Only four of the mapped native species are recorded only from salt marsh. These are *Arthrocnemum arbuscula, Limonium australe, Salicornia blackiana* and *Wilsonia humilis*. *Disphyma blackii, Stipa stipoides, Rhagodia baccata* and *Triglochin minutissima* are recorded from no other type of wetland, but are found in other coastal habitats. *Angianthus eriocephalus, Cotula longipes, Leptocarpus brownii, Salicornia quinqueflora, Suaeda australis, Wilsonia backhousei* and *Zoysia matrella* are found in enclosed near coastal wetlands as well as saltmarsh, and the remaining species are found in saltmarsh, enclosed near coastal wetlands and inland wetlands.

Eighteen of the mapped native species are found in salt marshes on all sectors of the Tasmanian coast. *Arthrocnemum arbuscula, Chenopodium glaucum* ssp. *ambiguum, Cotula coronopifolia, Distichlis distichophylla, Gahnia filum, Hemichroa pentandra, Limonium australe, Puccinellia stricta, Salicornia blackiana* and *Suaeda australis* are common in the marshes in the Bass Strait islands, north coast, east coast and southeast coast, but are absent from the brackish marshes of the west and south coasts. *Wilsonia backhousei* and *Spergularia media* do not appear to occur in the marshes of the northwest, west and south. *Lawrencia spicata* and *Triglochin minutissima* occur occasionally in the salt marshes of the southeast, east and Flinders Island, *Angianthus preissianus* is confined to the northeastern marshes, *Wilsonia humilis* to the southeastern marshes and *Zoysia matrella* to marshes in the northern part of the State.

Species relationships

The species constellation diagram (Figure 51) shows the species that occur together significantly more often than could be expected by chance. Three major groups of species are evident. Group 1, consisting of *Juncus kraussii, Selliera radicans, Schoenus nitens* and *Leptocarpus brownii*, contains the species that are most abundant in the marshes of the Upper Derwent. Group 2, consisting of *Arthrocnemum arbuscula, Hemichroa pentandra, Samolus repens, Wilsonia humilis, Suaeda australis* and *Rhagodia baccata*, contains species that occur together in the lower elevations of the more saline marshes. The third group is linked to the second by *Distichlis distichophylla* and contains species that are characteristically found in the sedgeland and tussock grassland on the higher ground in the more saline marshes.

Environmental relationships

The environmental relationships of the major communities and species can only be deduced from their patterns of occurrence in the field, as direct environmental data are almost totally lacking. Clarke and Hannon (1967, 1969, 1970) have presented evidence that salinity and waterlogging are the two environmental variables that best explain the distribution of salt marsh and mangrove species in the Sydney region. Although no mangroves are found in Tasmania, the Sydney salt marsh communities are similar to those in Tasmania and the same major environmental influences probably prevail.

Figure 52 is a hypothesis of the relationship between the distribution of the major communities and salinity and waterlogging. It is derived from observation and an indirect ordination of the quadrats using the method of Kirkpatrick and Hutchinson (1977). For the axis related to salinity, the polar groups selected were 3 (brackish) and 7 (saline). For the axis related to waterlogging (frequency of inundation) the polar groups selected were 2 (infrequently inundated) and 6 (frequently inundated). The distribution of the floristic groups and individual species on this ordination (Figure 53) reflects their relative environmental positions as established by field observation.

SALICORNIA QUINQUEFLORA

ARTHROCNEMUM ARBUSCULA

STIPA STIPOIDES

JUNCUS KRAUSSII

GAHNIA FILUM

BARE

POA

STIPA - GAHNIA

ARTHROCNEMUM - GAHNIA

ARTHROCNEMUM - STIPA

DEAD ARTHROCNEMUM

SALICORNIA - PUCCINELLIA

JUNCUS - STIPA

SUAEDA AUSTRALIS

SAMOLUS REPENS

SAMOLUS - SUAEDA

JUNCUS - GAHNIA

STIPA - POA

PUCCINELLIA STRICTA

DISPHYMA BLACKII

SALICORNIA BLACKIANA

DISTICHLIS DISTICHOPHYLLA

LEPTOCARPUS BROWNII

HEMICHROA PENTANDRA

SCIRPUS NODOSUS

SCIRPUS PUNGENS

WILSONIA BACKHOUSEI

POA - LEPTOCARPUS

JUNCUS - S. NODOSUS

POA - S. NODOSUS

RHAGODIA BACCATA

TREES & COASTAL SHRUBS

ATRIPLEX CINEREA

DISPHYMA - SALICORNIA

KEY TO FIGURES 4-14

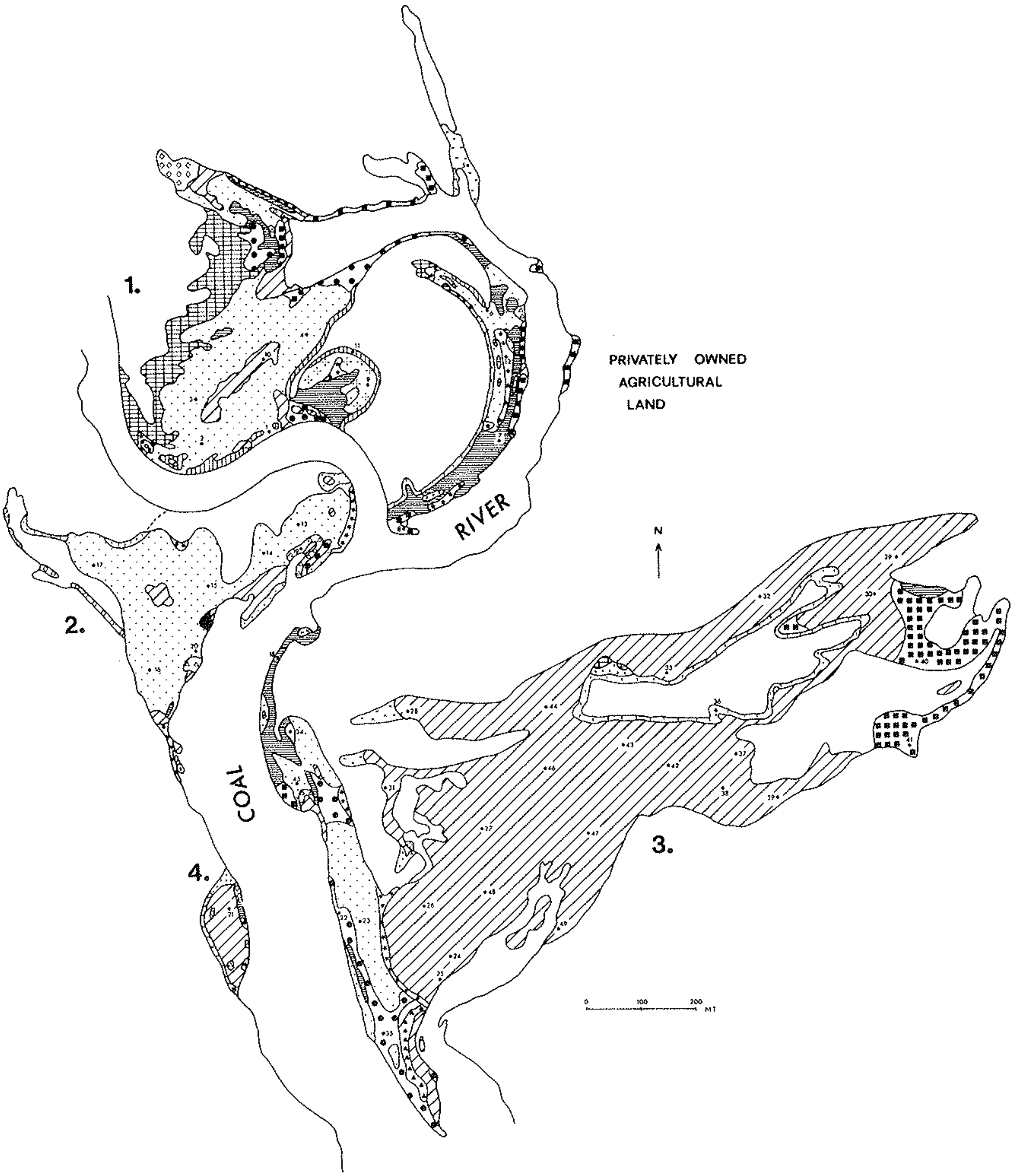


FIGURE 4 Dominance patterns in salt marshes 1-4 (Figure 3)

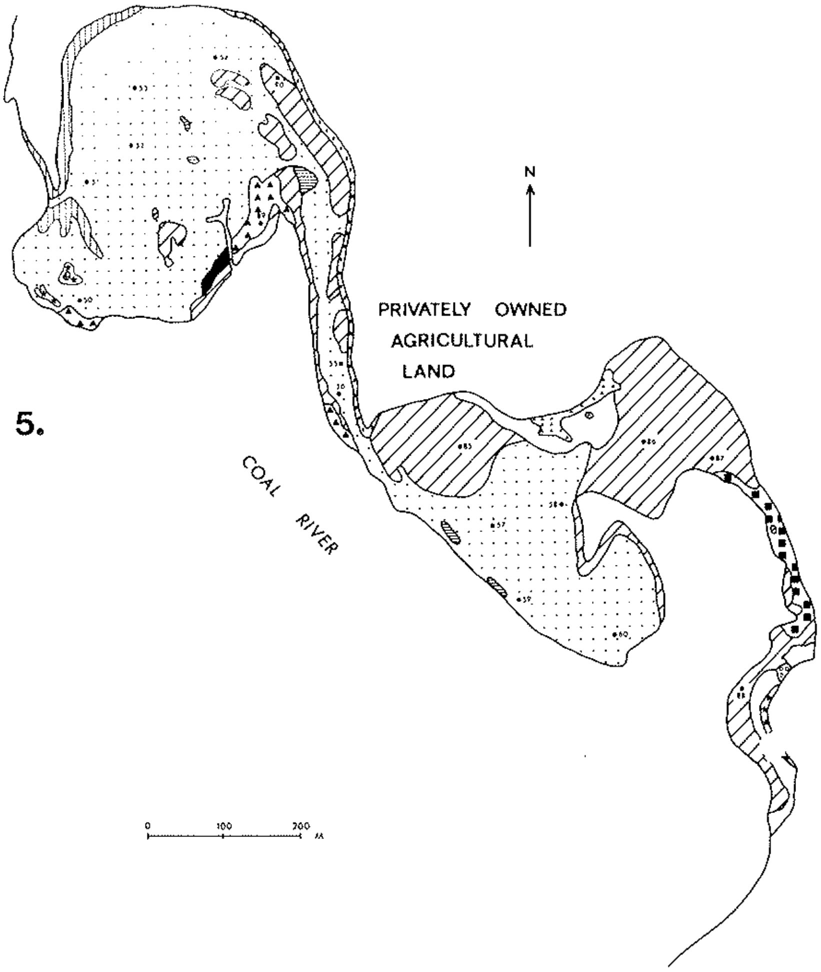


FIGURE 5 Dominance patterns in salt marsh 5 (Figure 3)

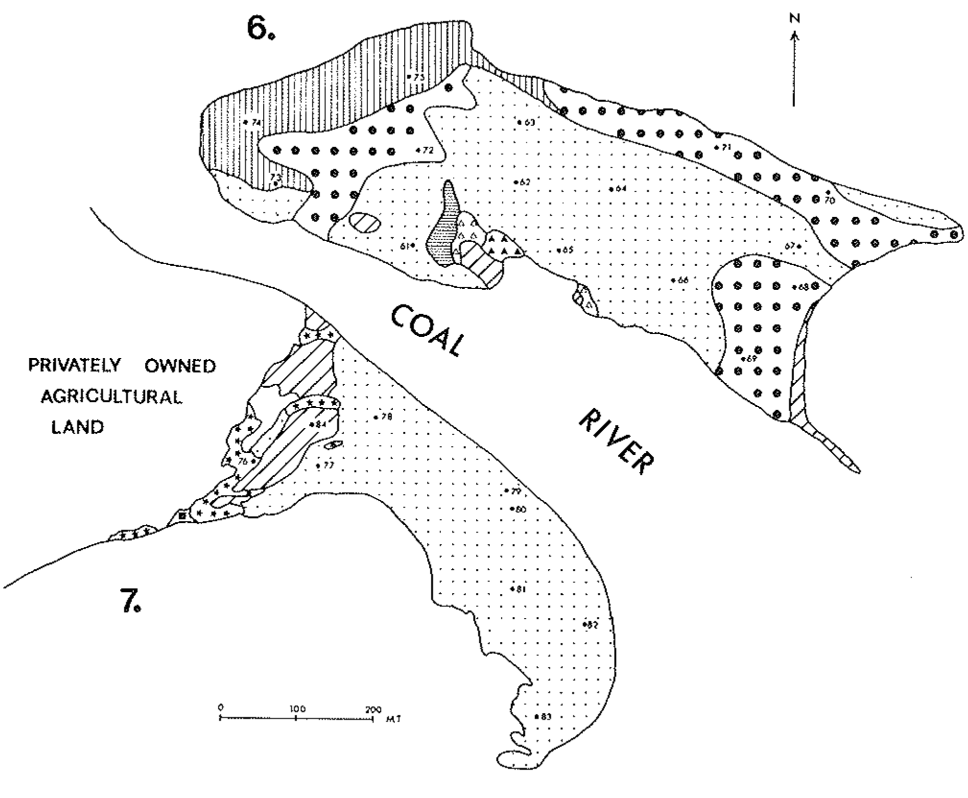


FIGURE 6 Dominance patterns in salt marshes 6 & 7 (Figure 3)

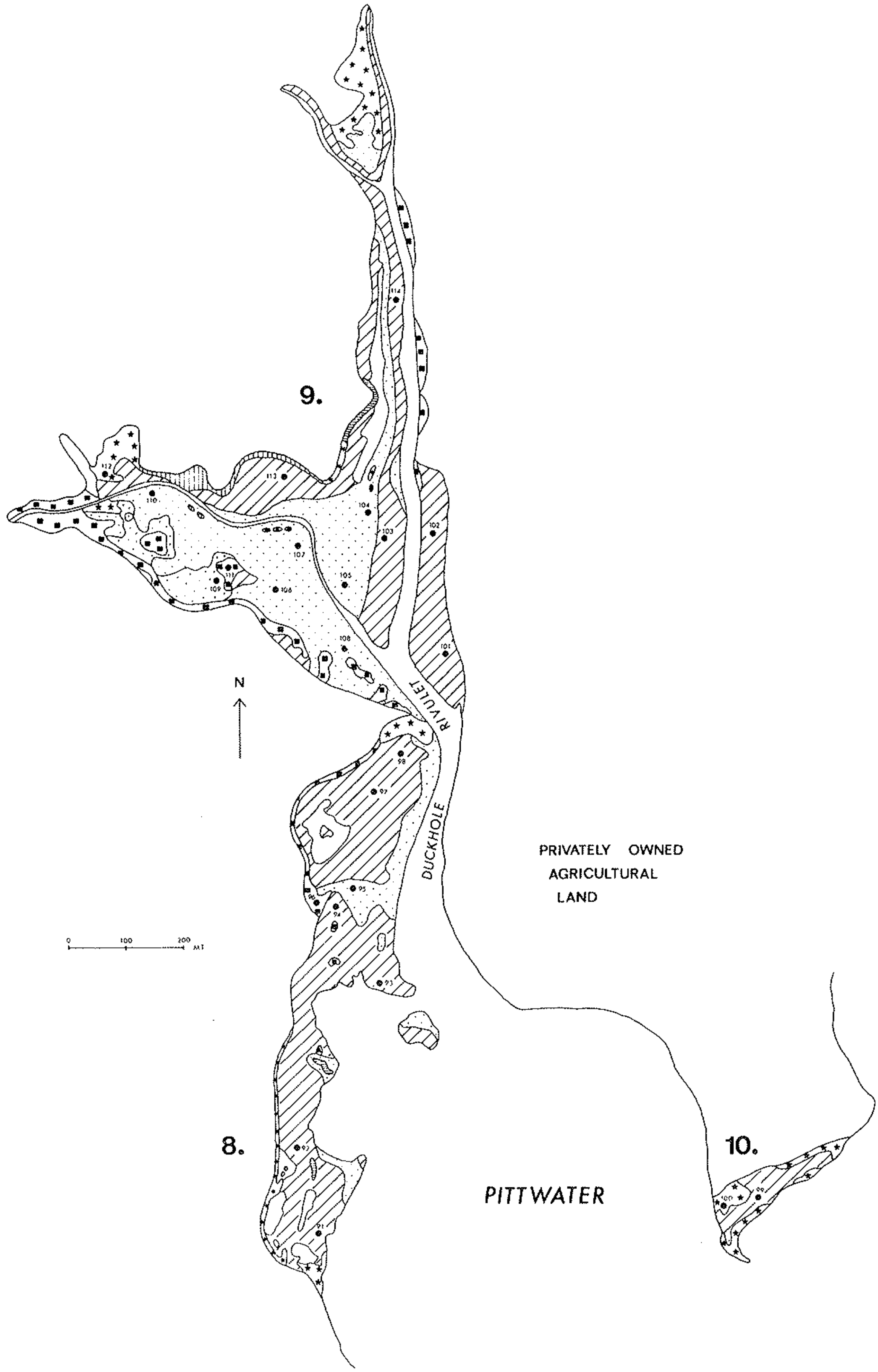


FIGURE 7 Dominance patterns in salt marshes 8-10 (Figure 3)

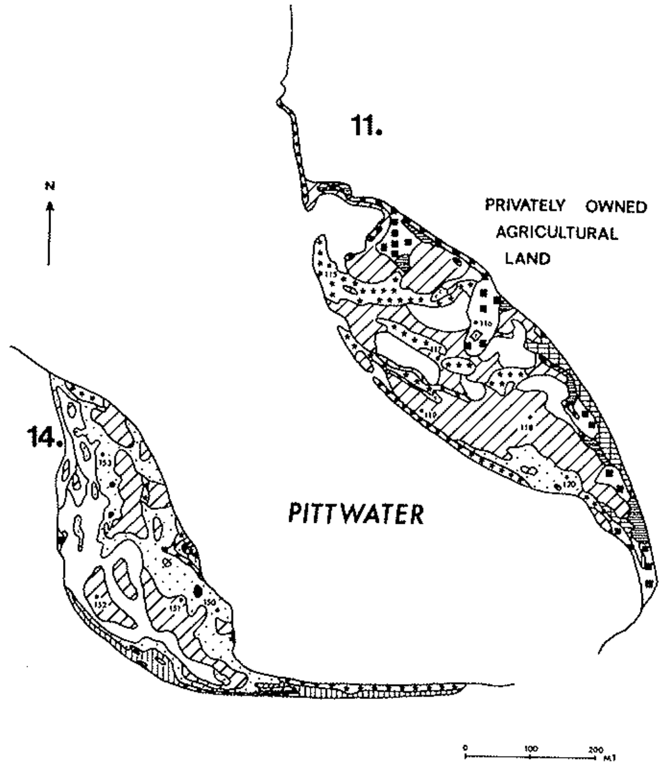


FIGURE 8 Dominance patterns in salt marshes 11 & 14 (Figure 3)

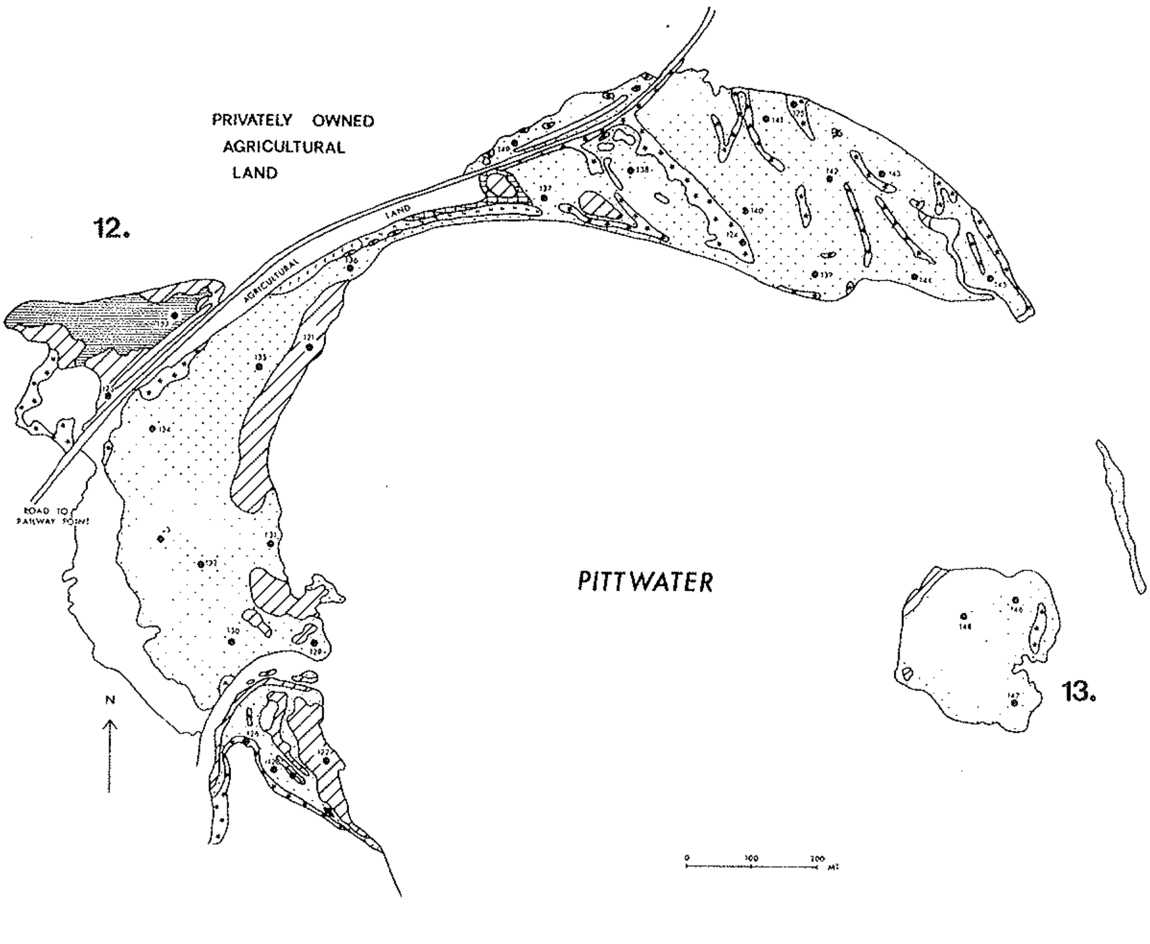


FIGURE 9 Dominance patterns in salt marshes 12 & 13 (Figure 3)

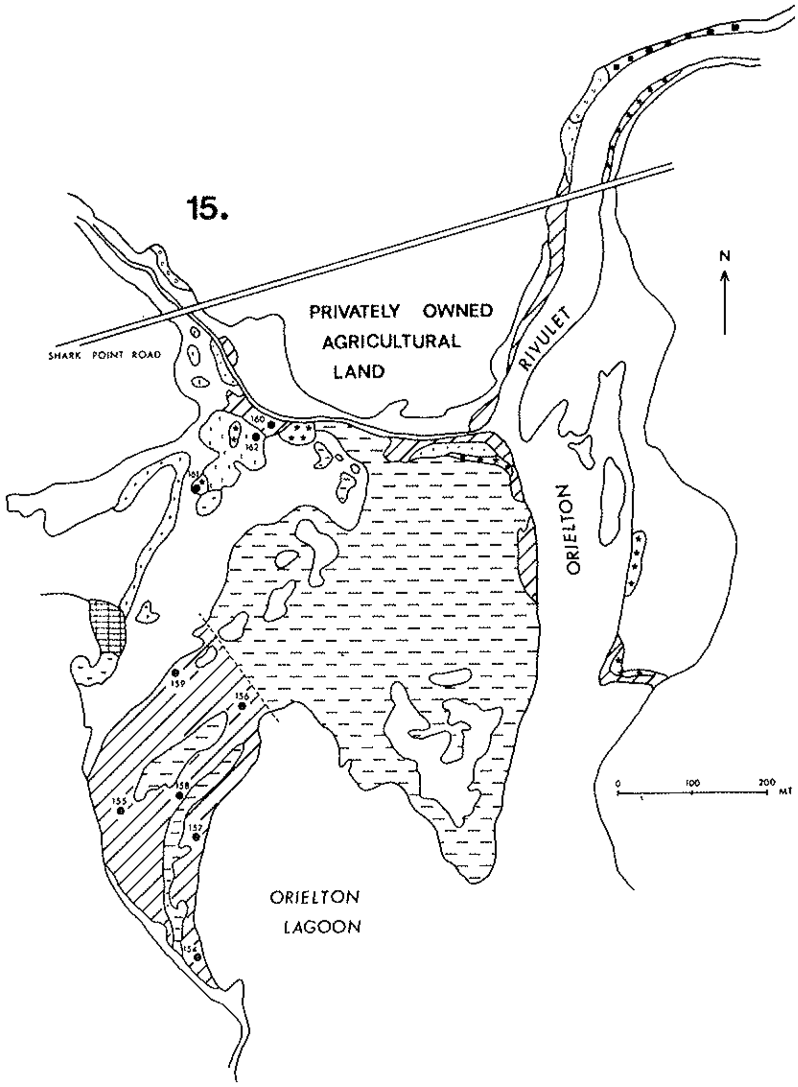


FIGURE 10 Dominance patterns in salt marsh 15 (Figure 3)

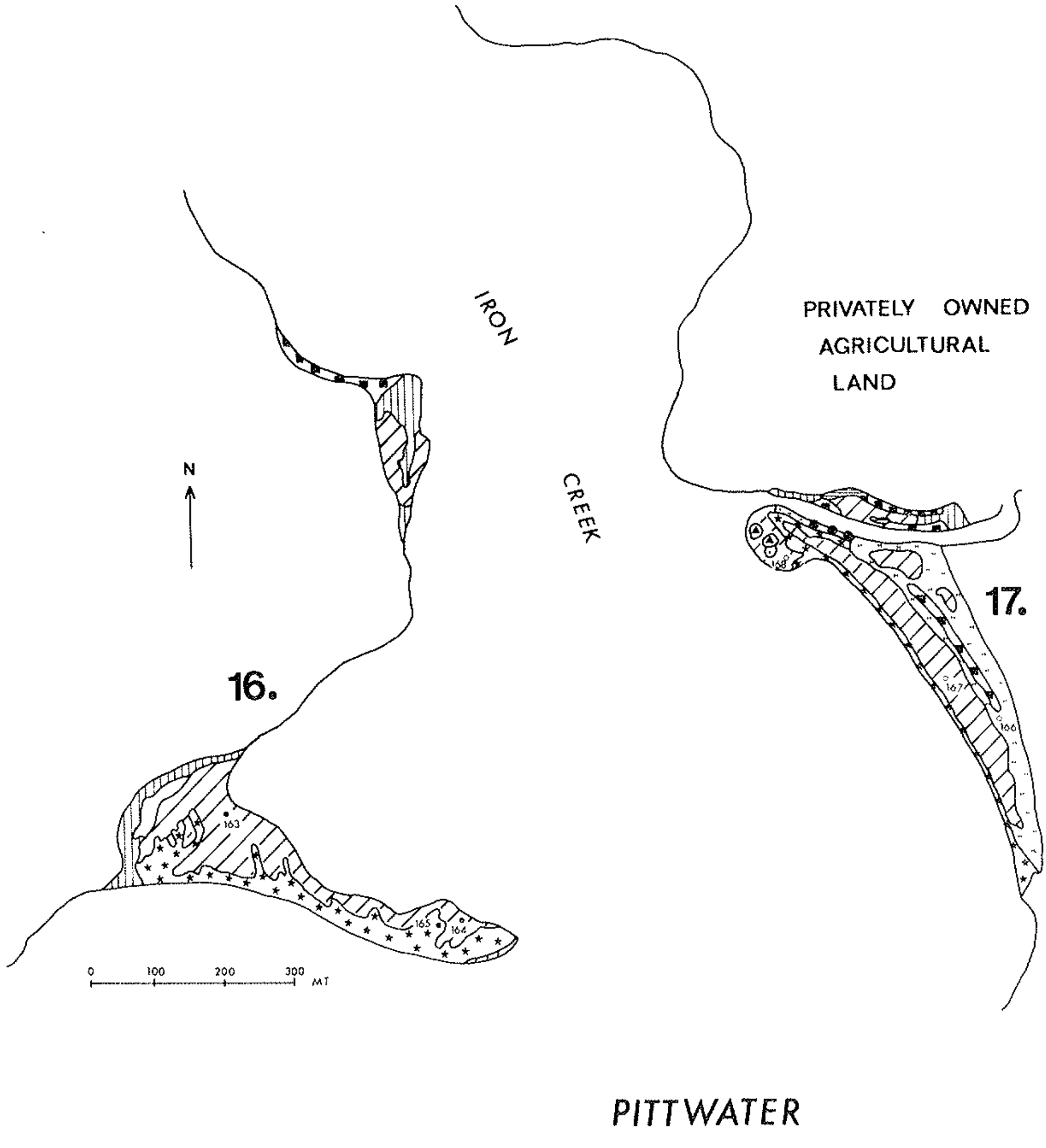


FIGURE 11 Dominance patterns in salt marshes 16 & 17 (Figure 3)

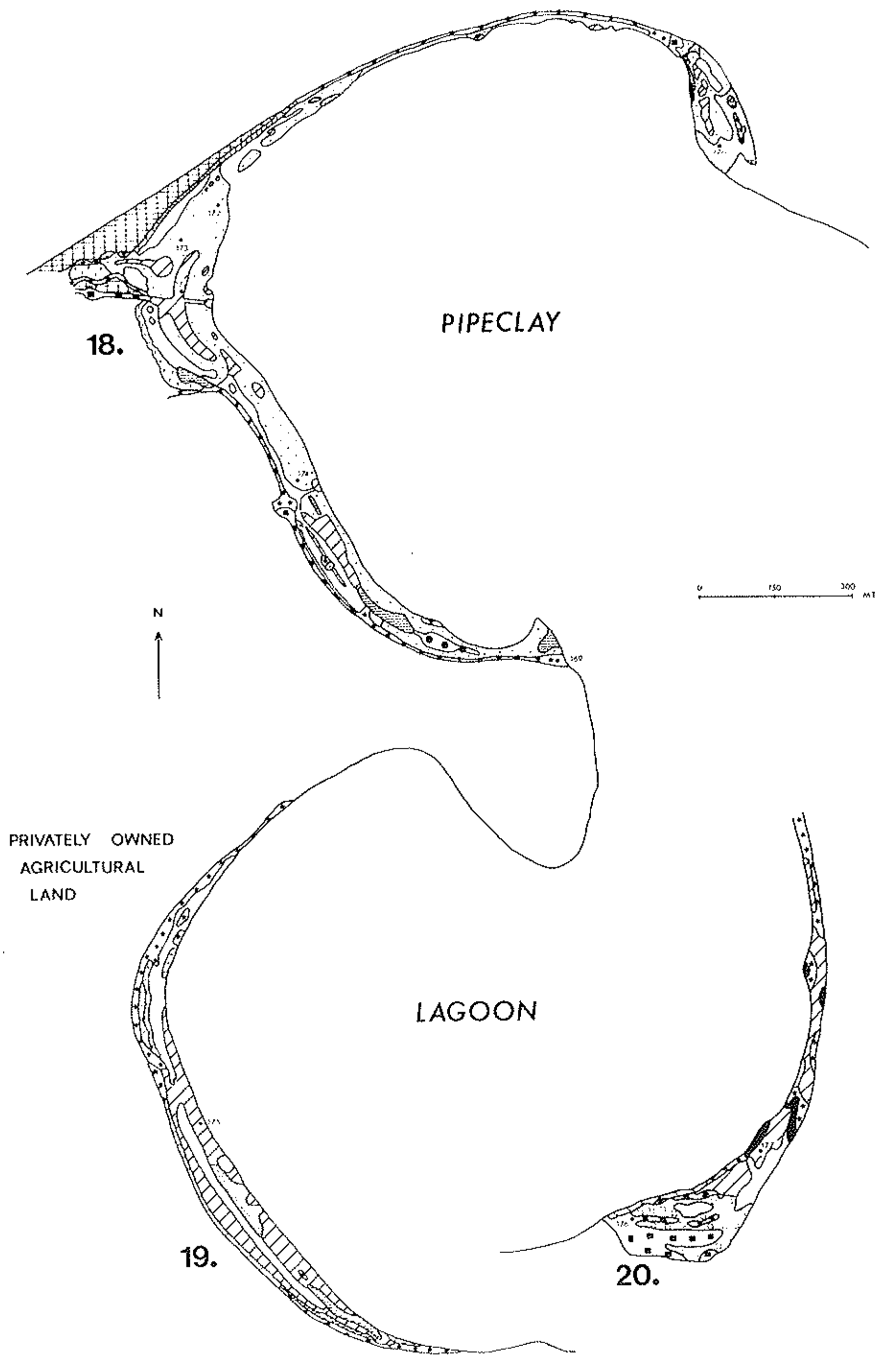


FIGURE 12 Dominance patterns in salt marshes 18-20 (Figure 3)

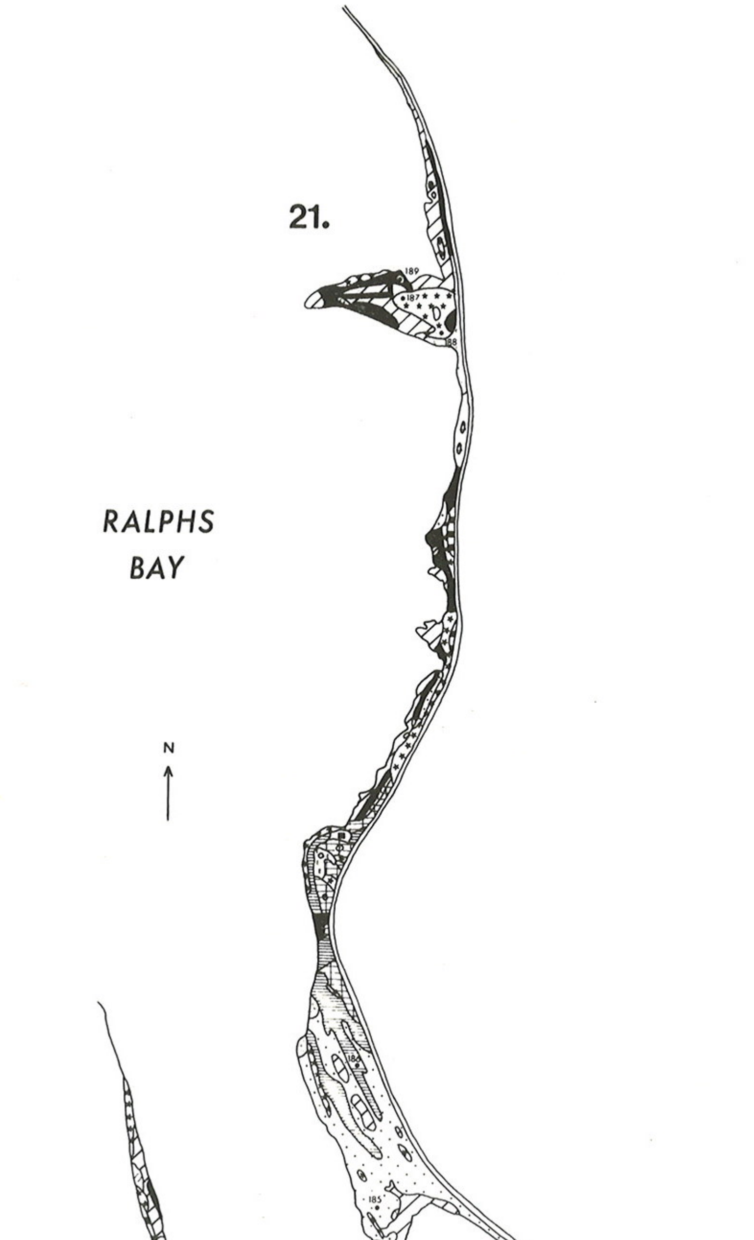


FIGURE 13 Dominance patterns in salt marshes 21 & 22 (Figure 3)

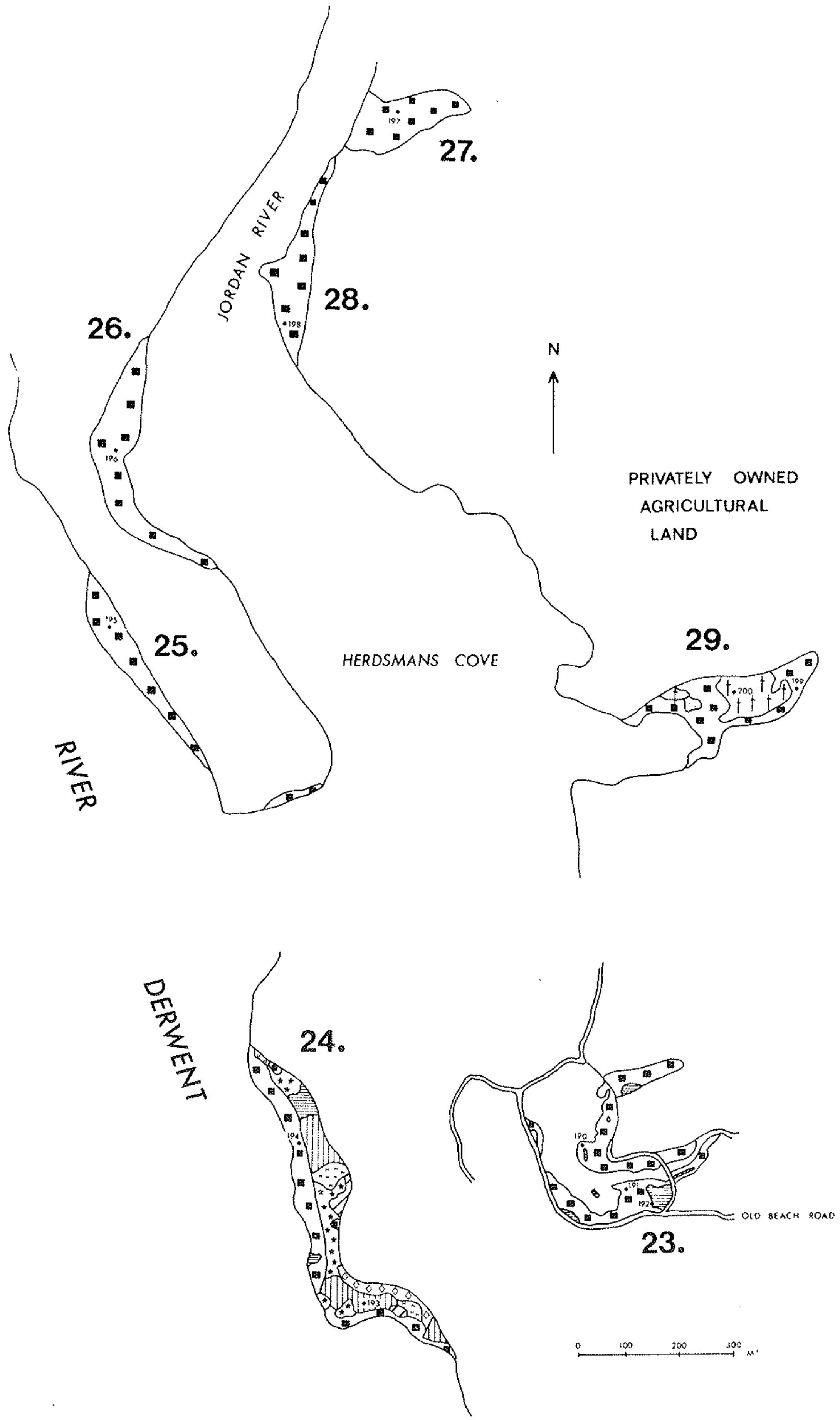


FIGURE 14 Dominance patterns in salt marshes 23-29 (Figure 3)

FIGURES 15-49 The Tasmanian distributions of thirty-five species characteristic of salt marsh. The large dots denote presence in a salt marsh. The small dots denote presence in other wetlands. The distribution of species in other habitats is not shown. The species are ordered alphabetically. Each map is labelled according to the species to which it refers.

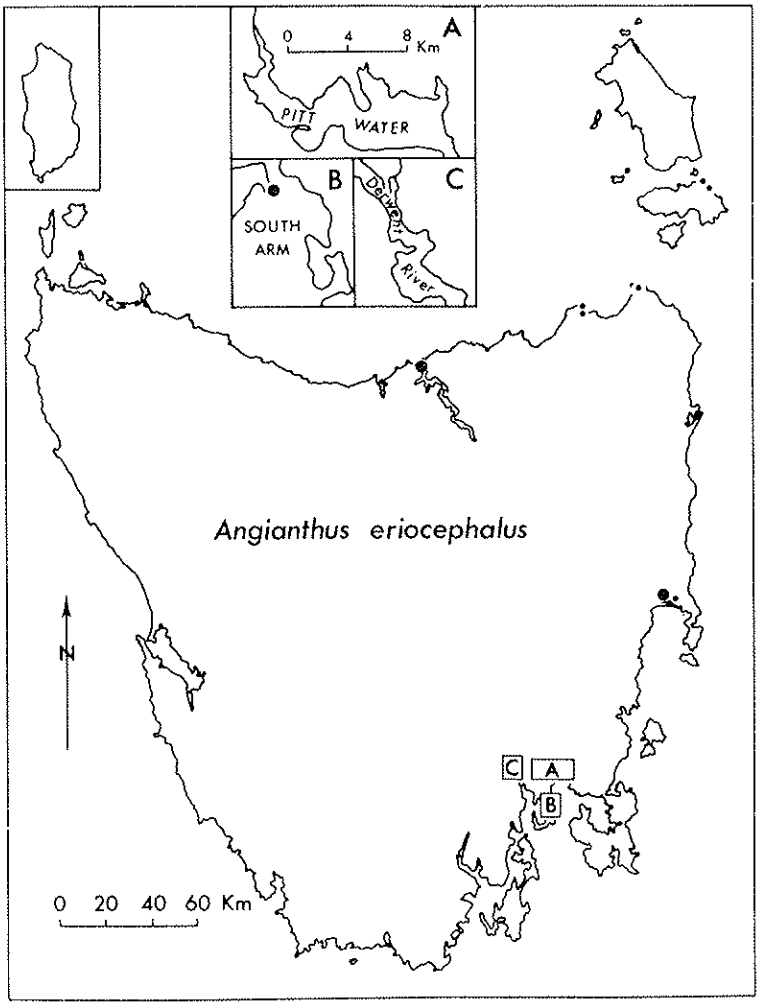


FIGURE 15

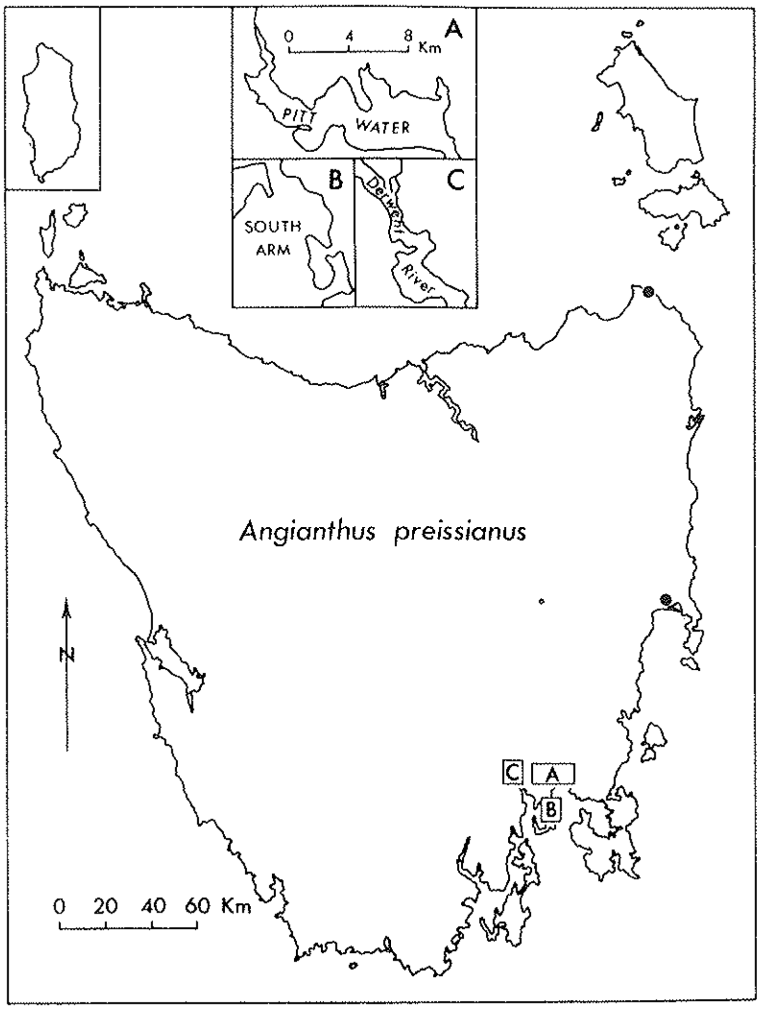


FIGURE 16

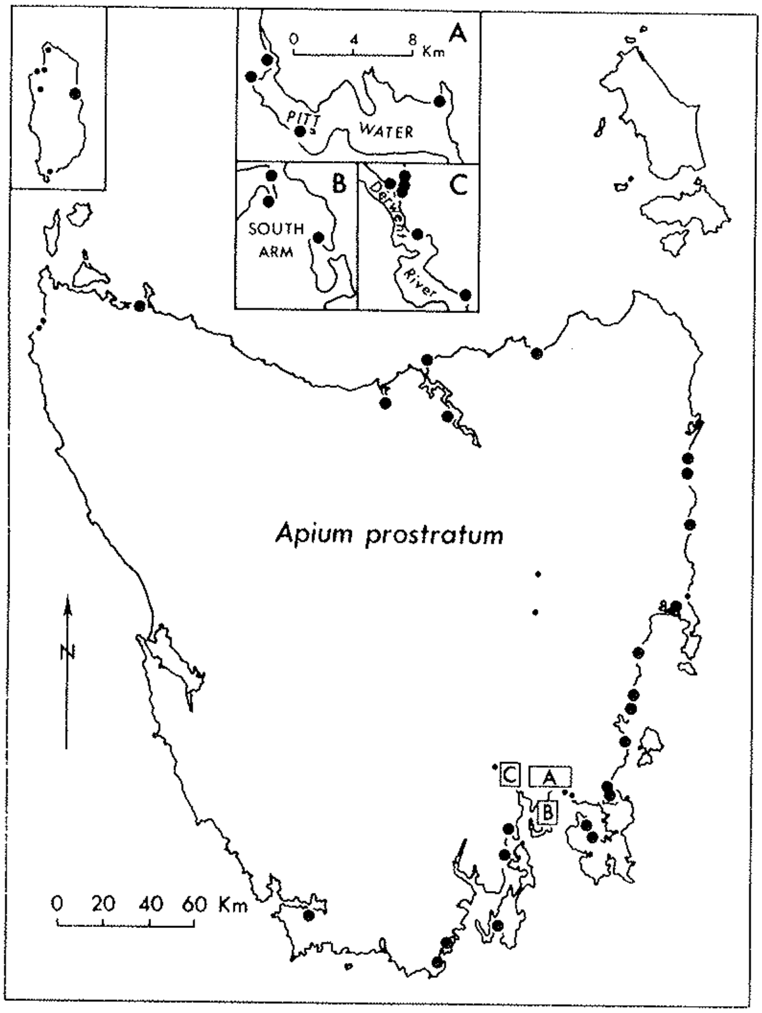
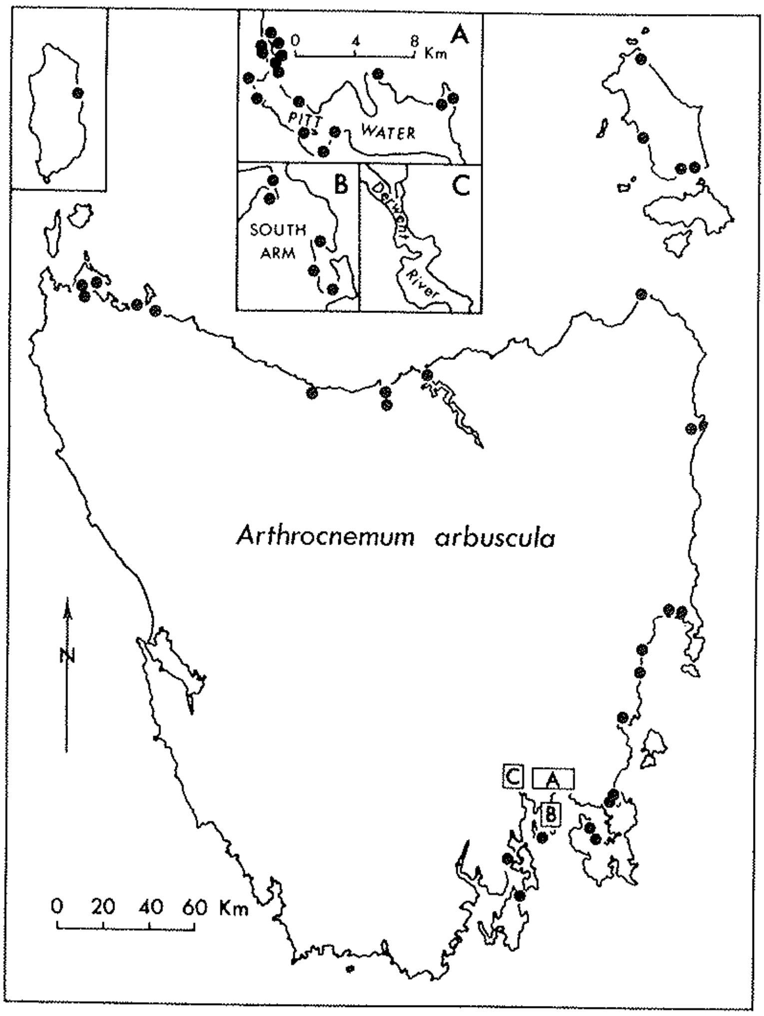


FIGURE 17



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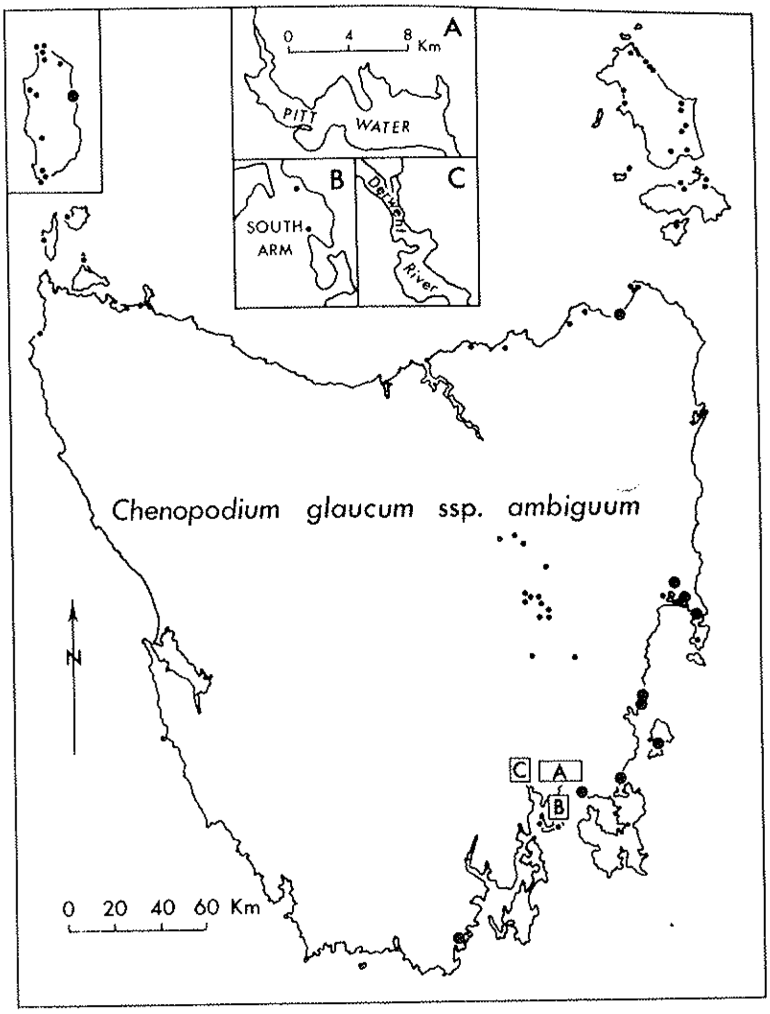
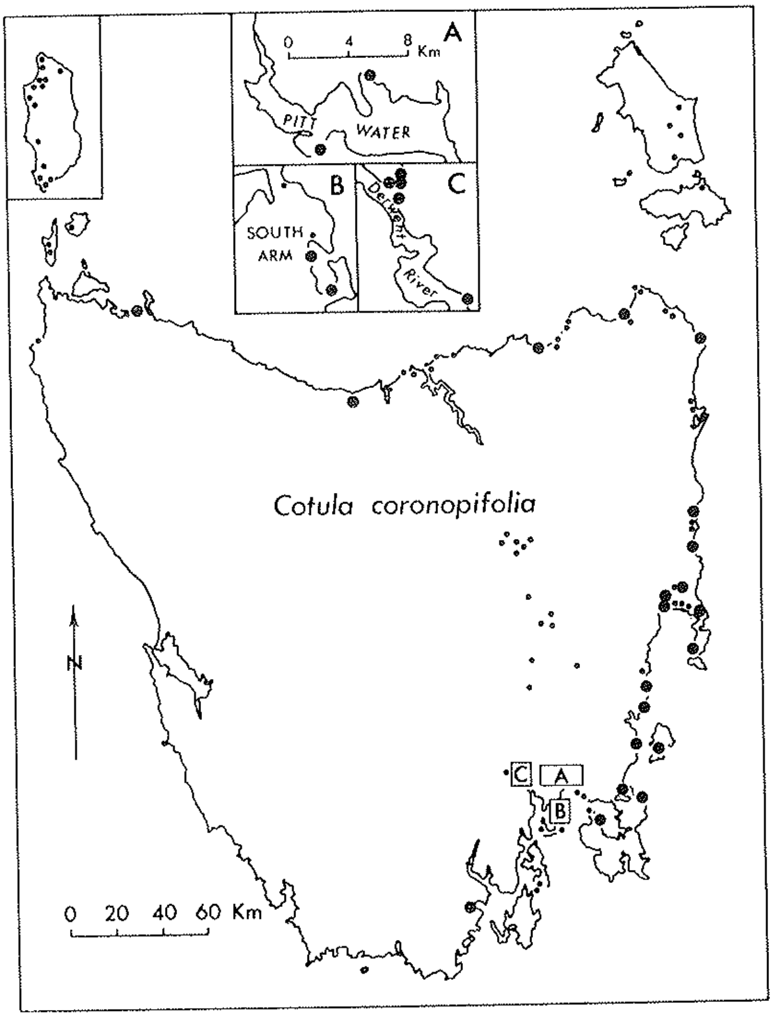


FIGURE 19



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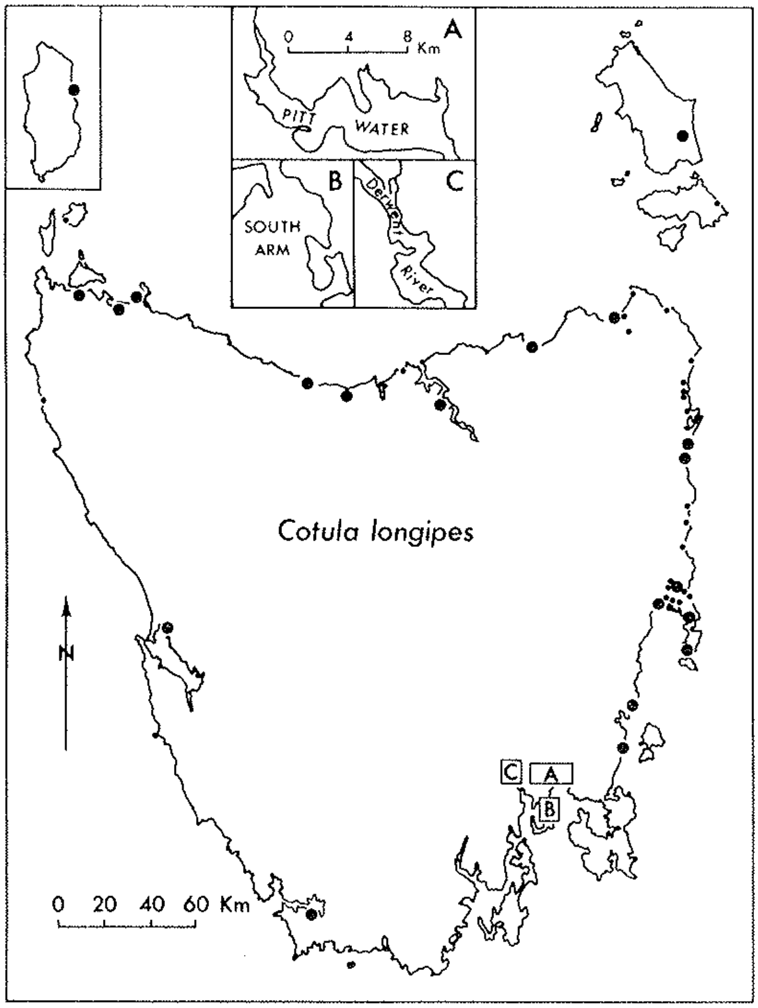


FIGURE 21

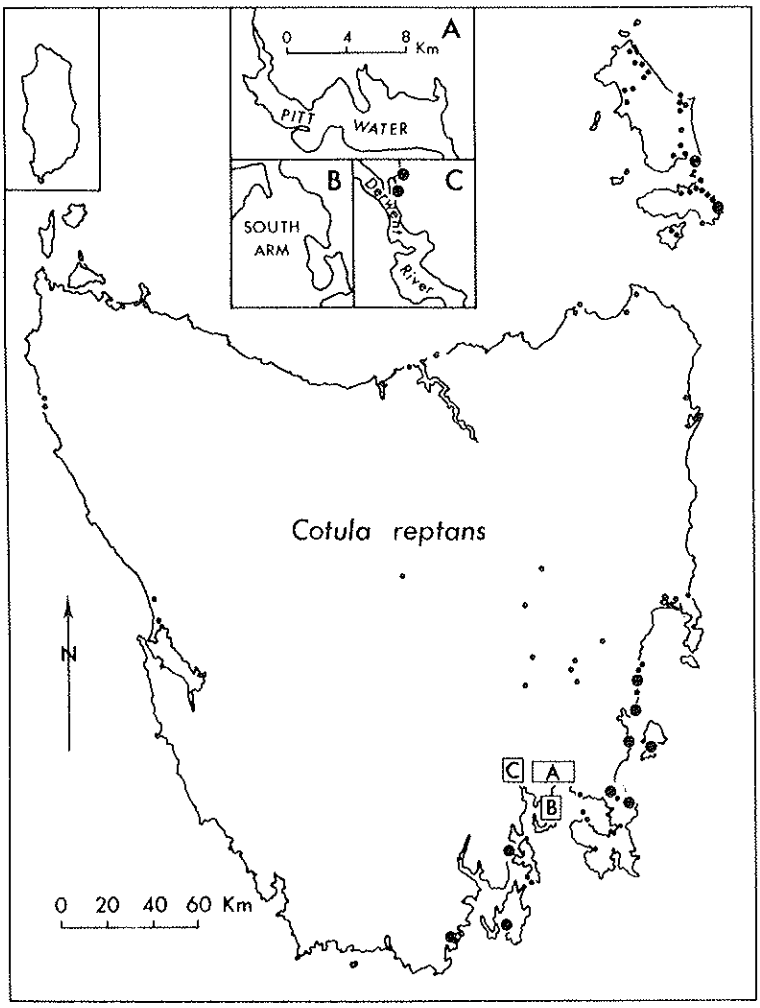


FIGURE 22

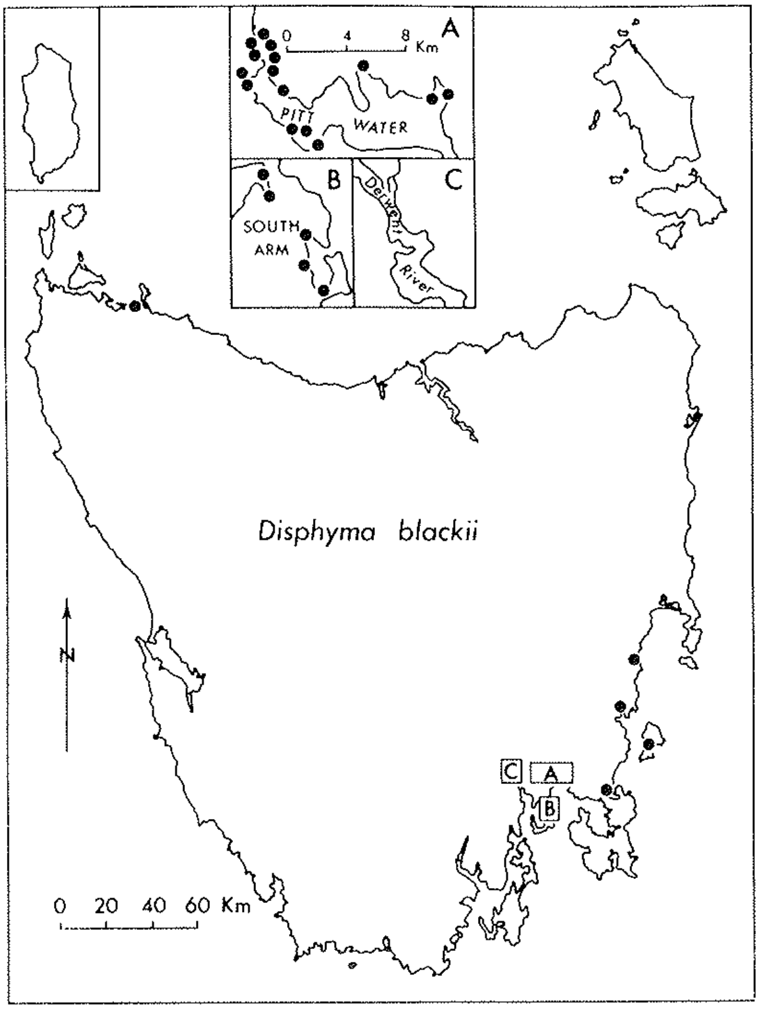


FIGURE 23

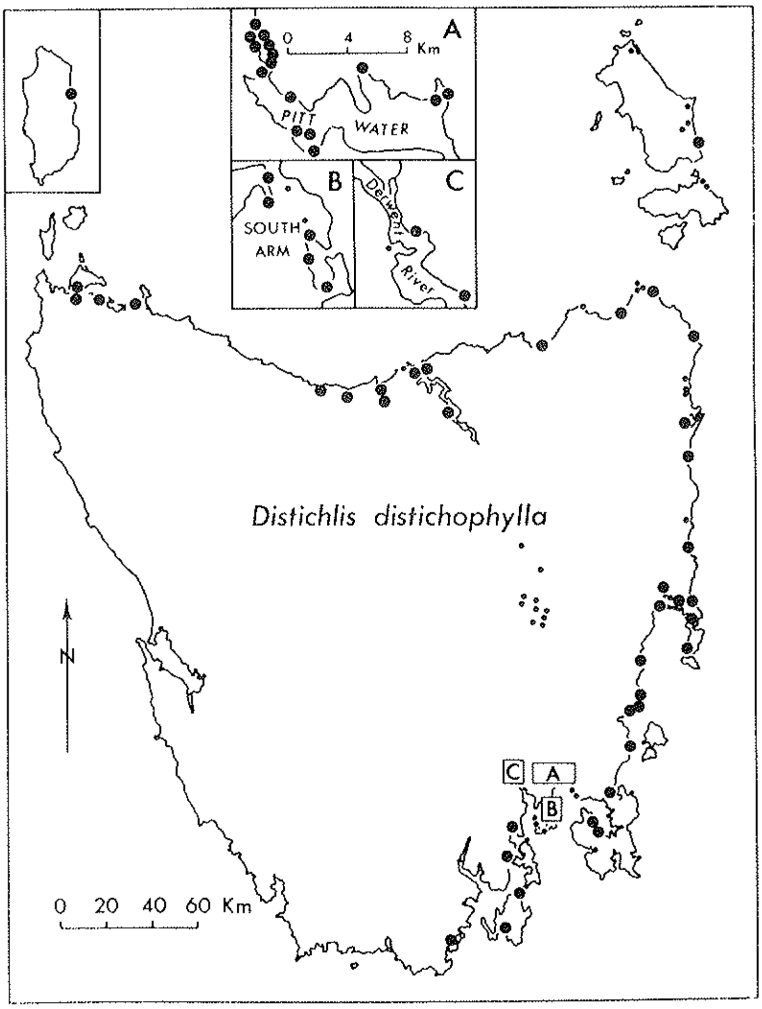
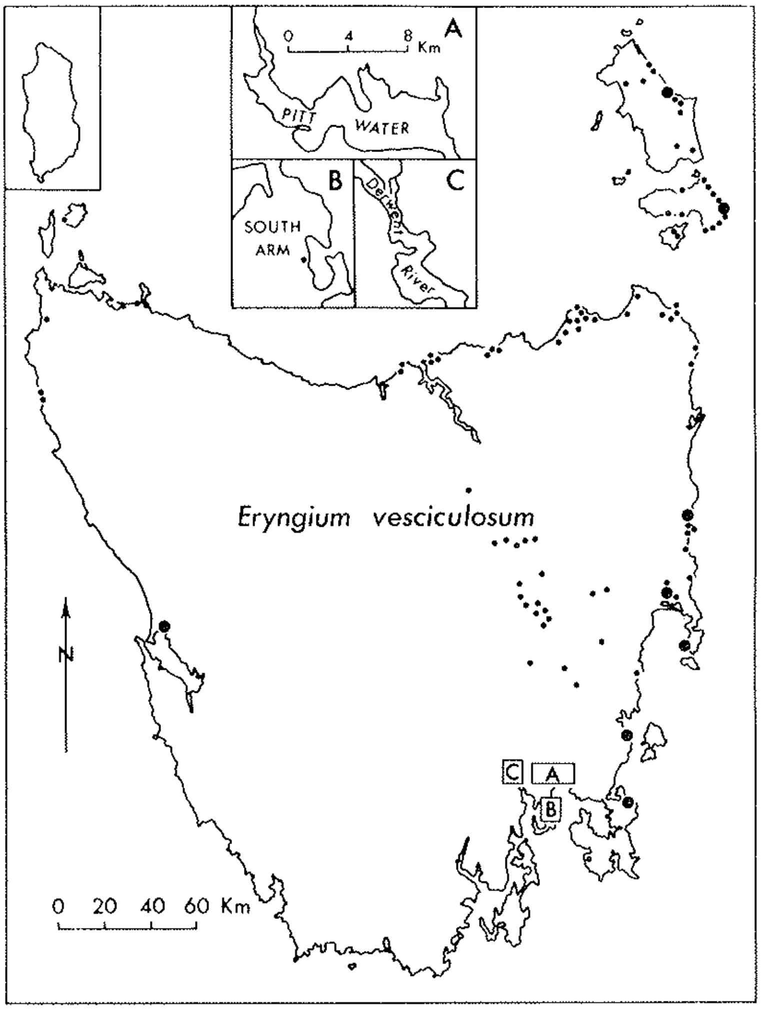


FIGURE 24



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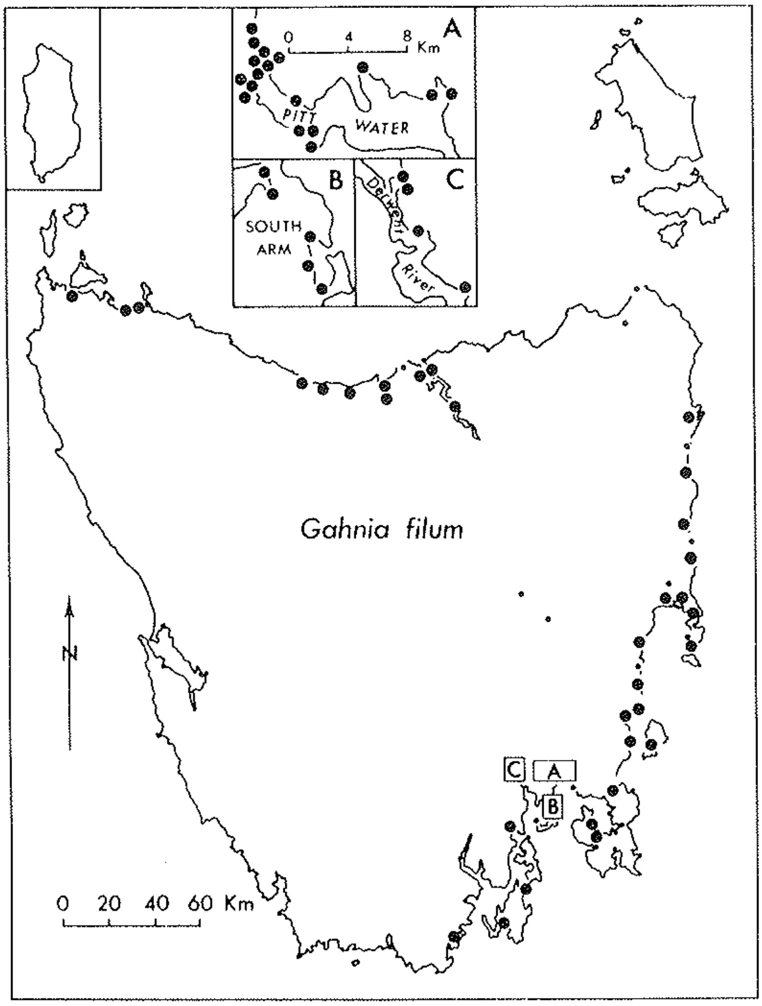

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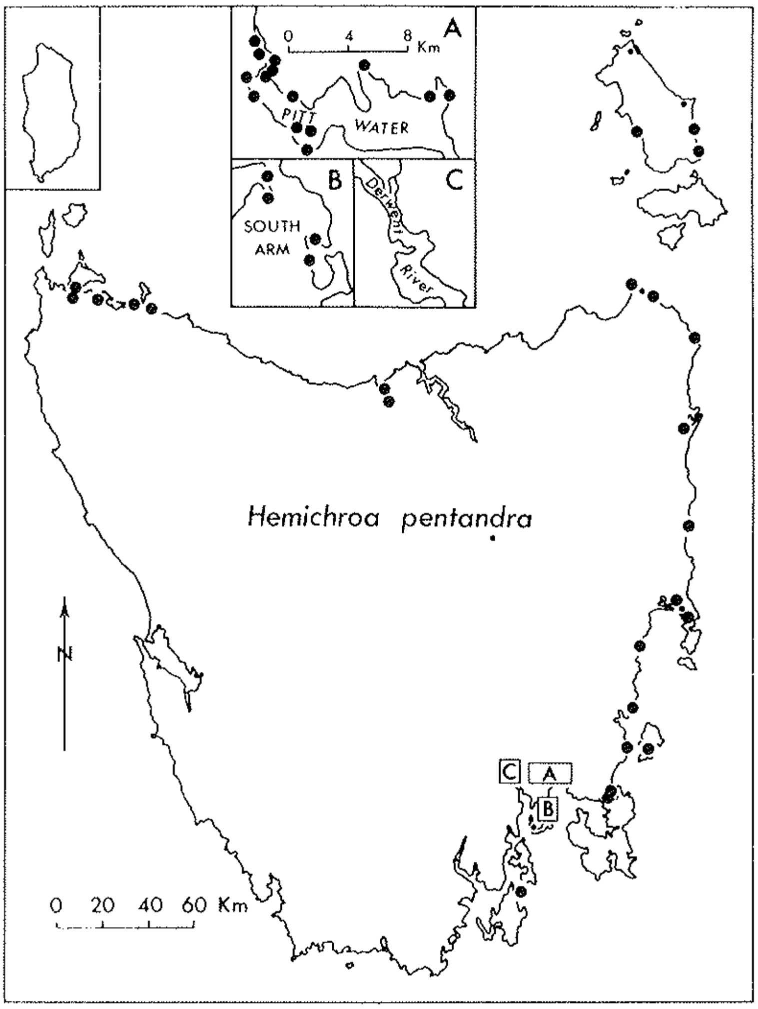

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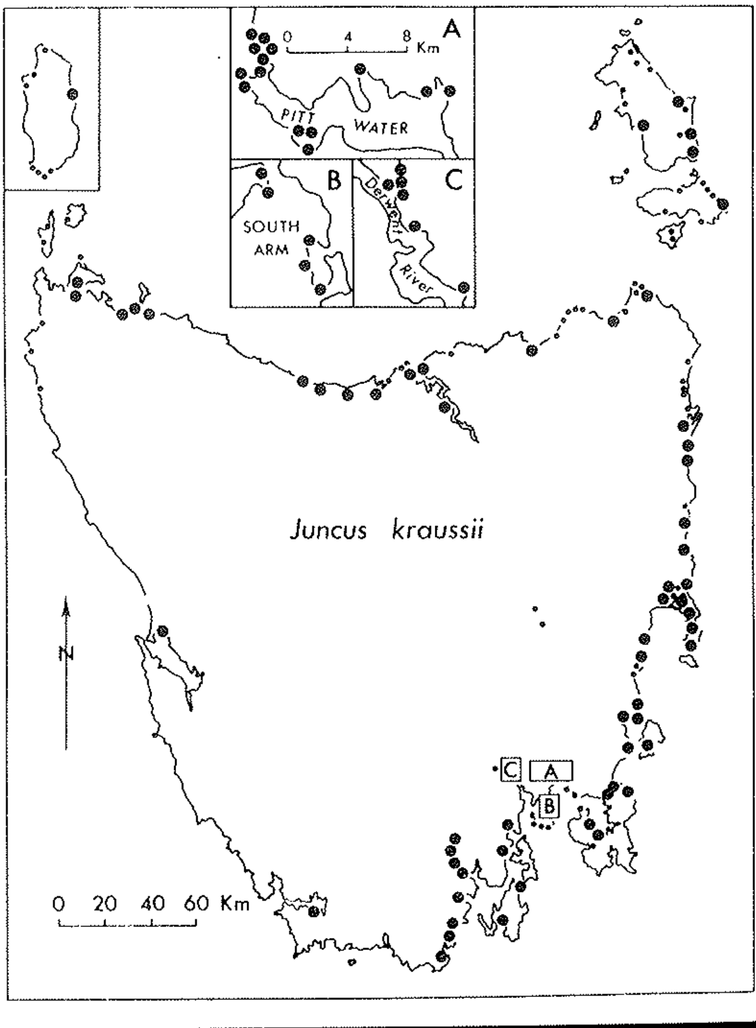

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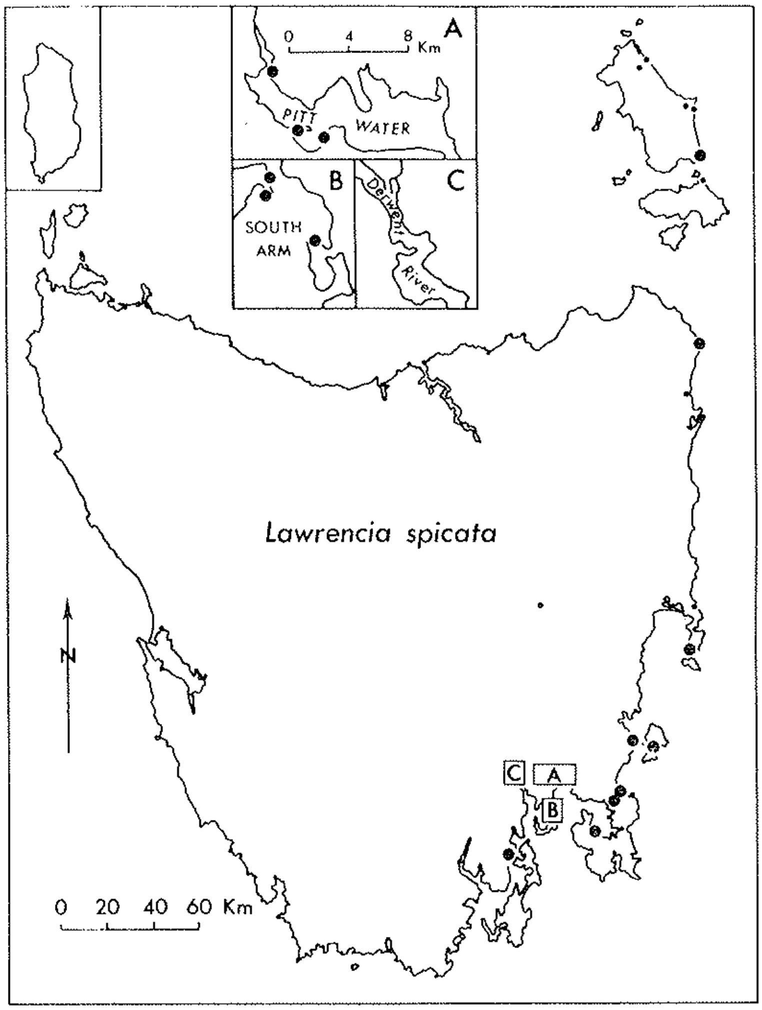

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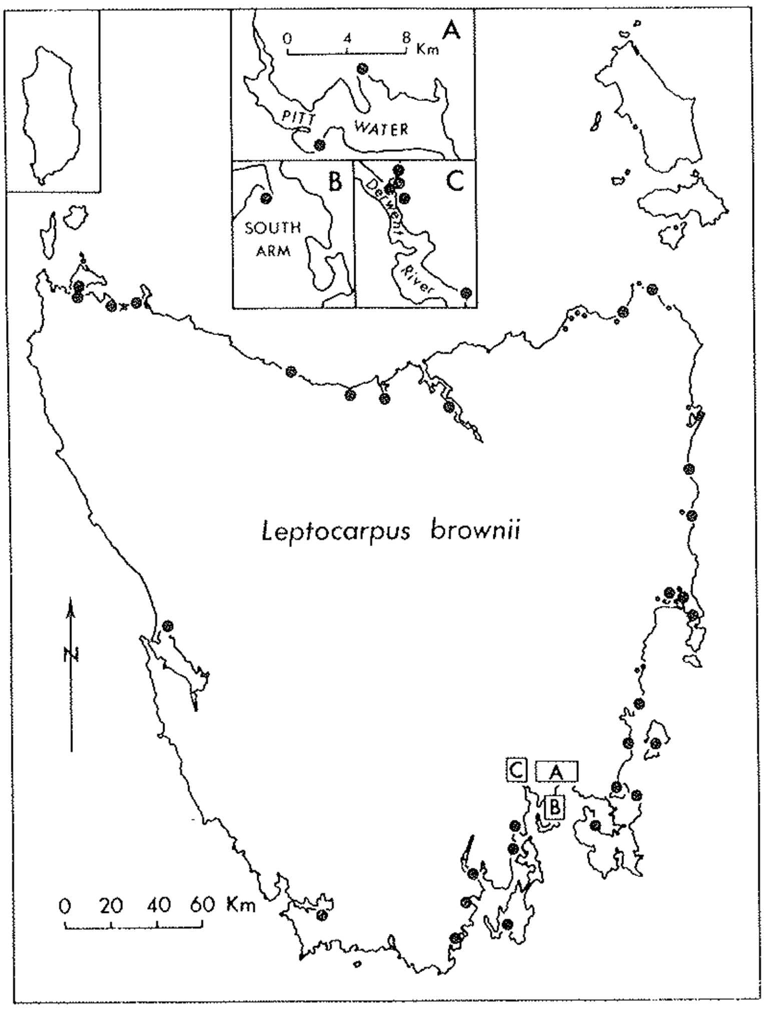

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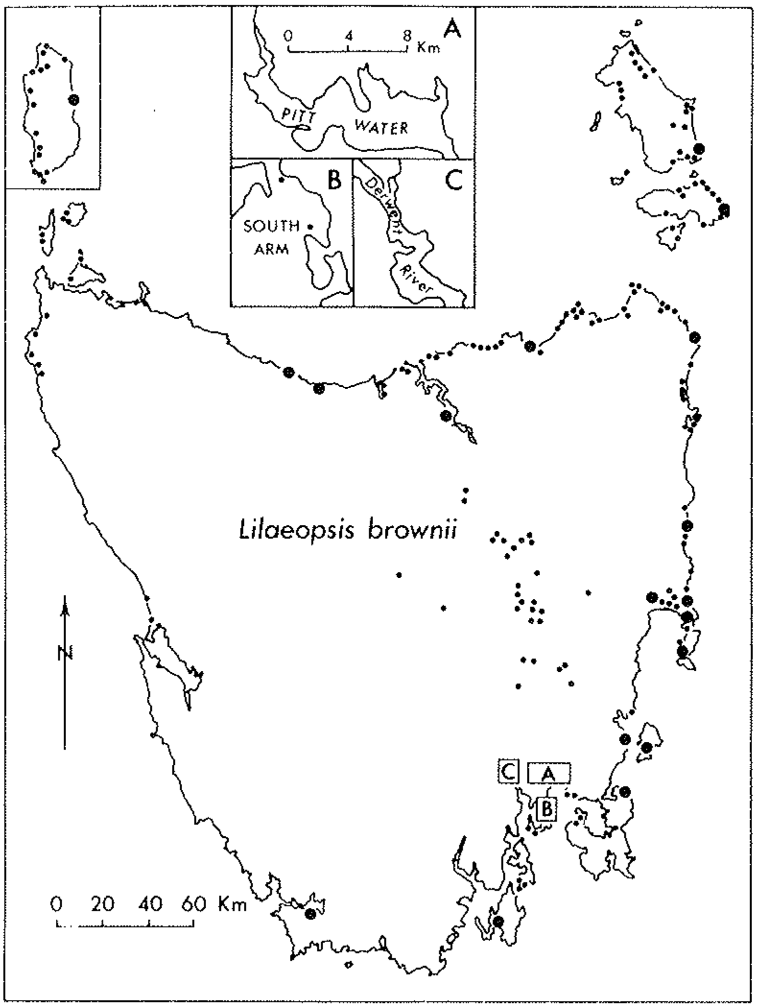

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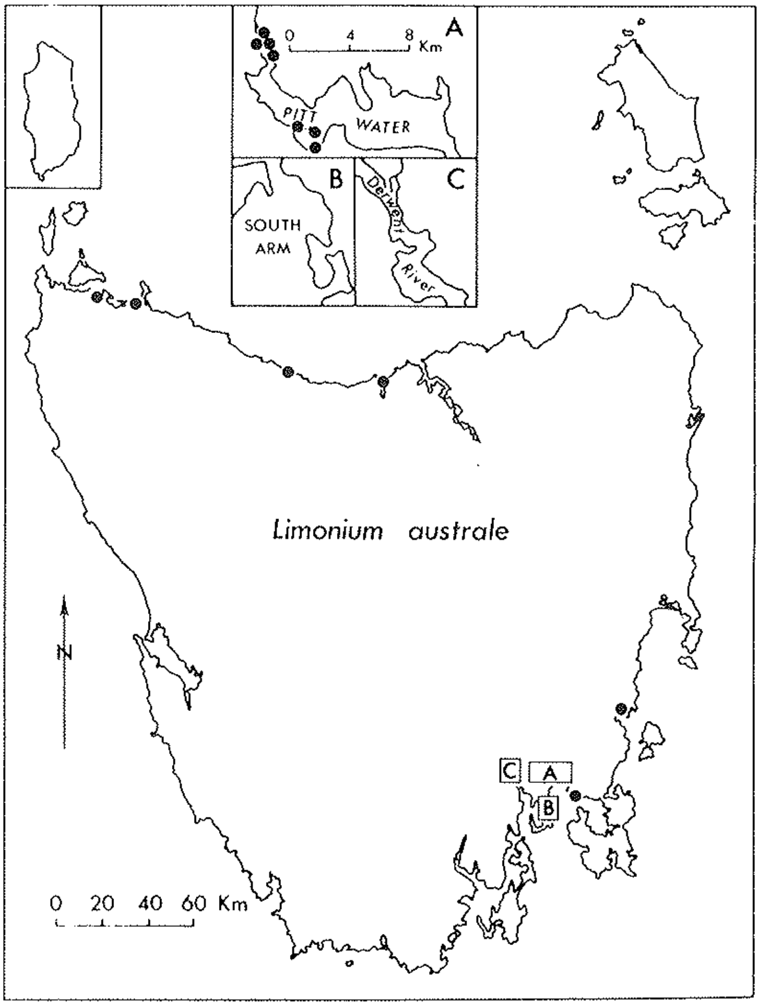

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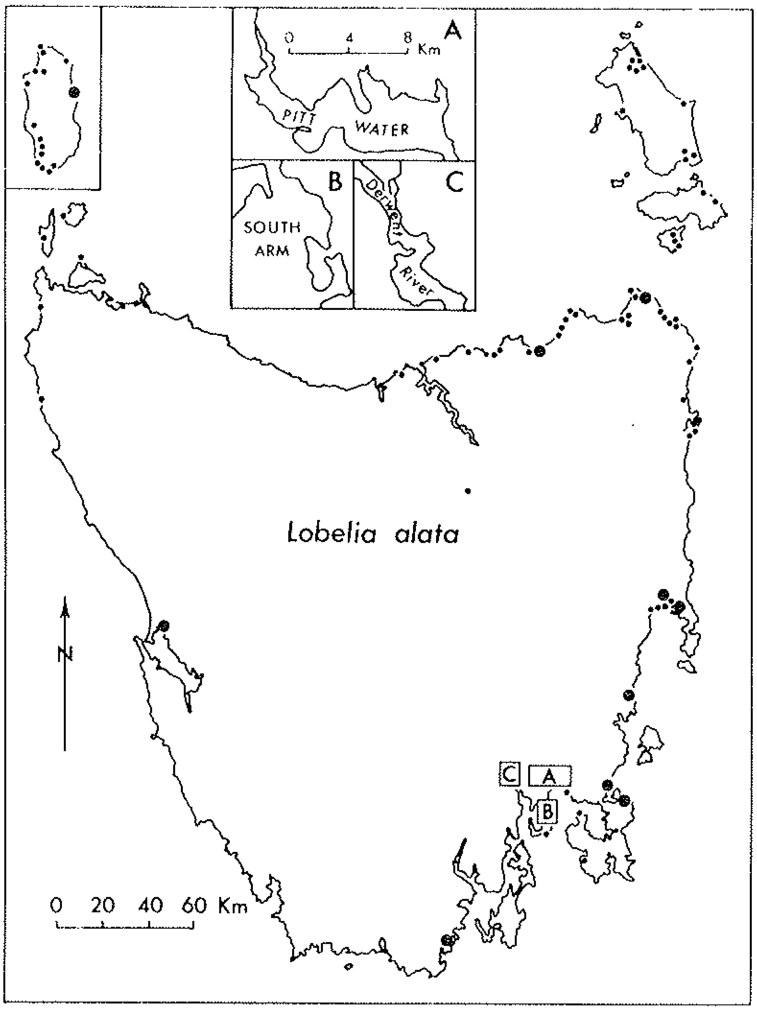

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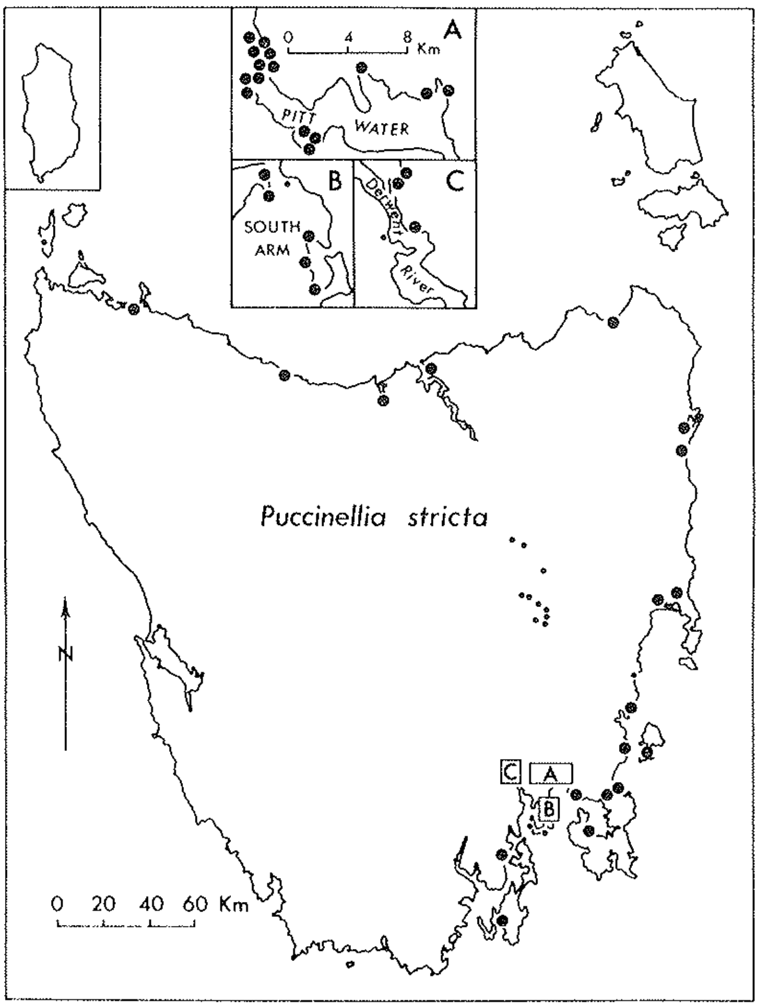

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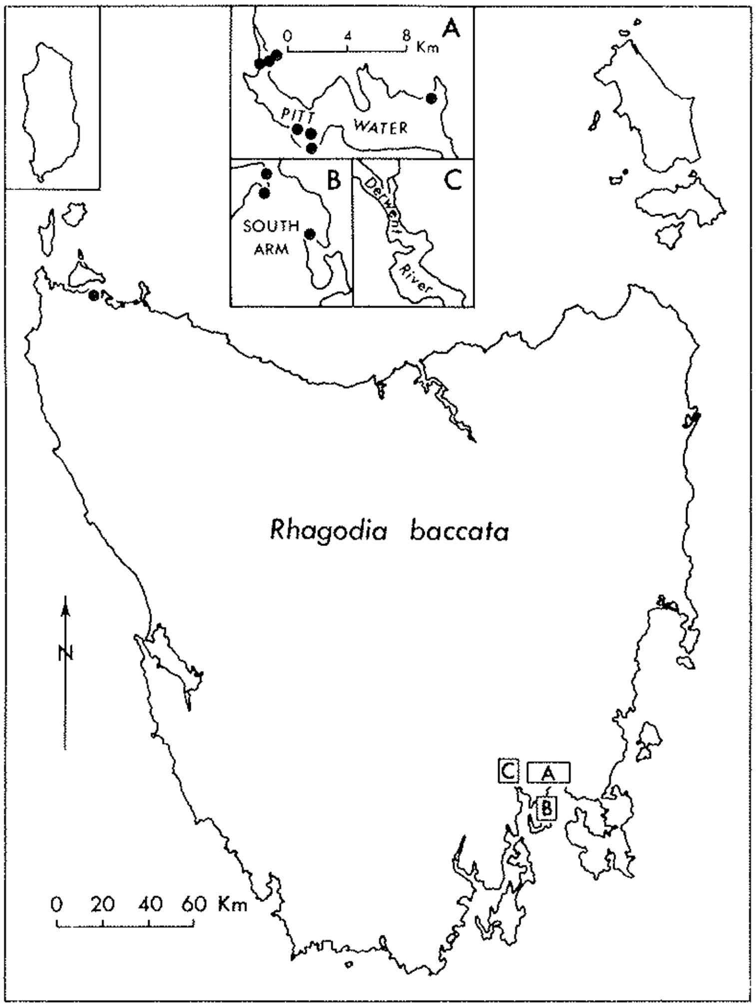

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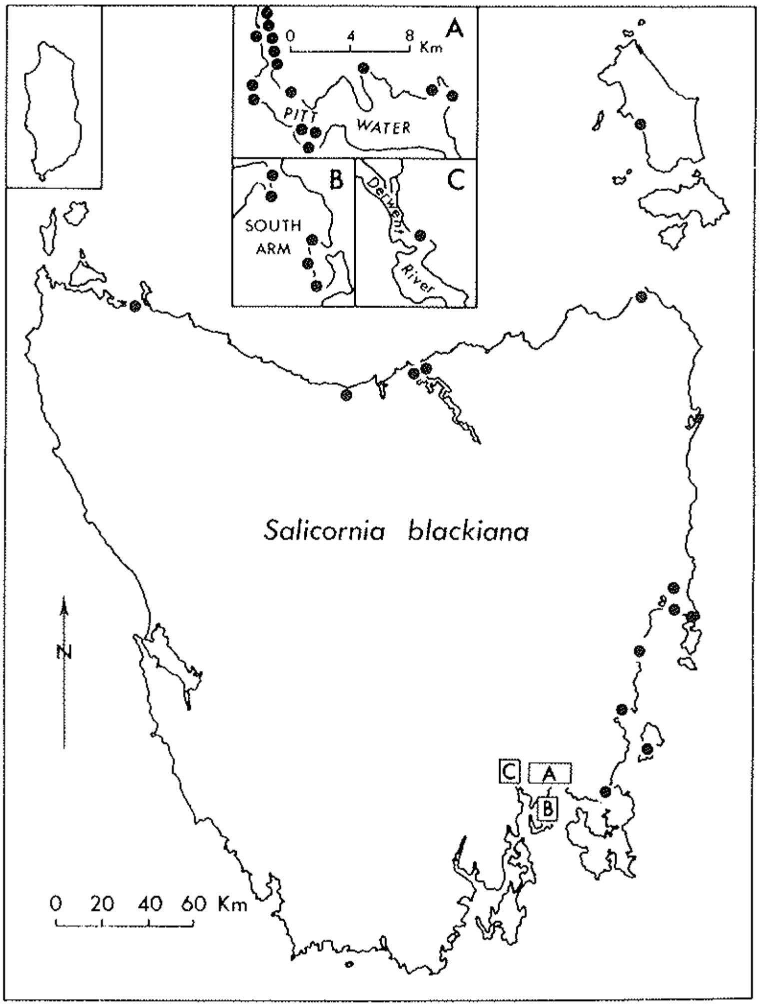

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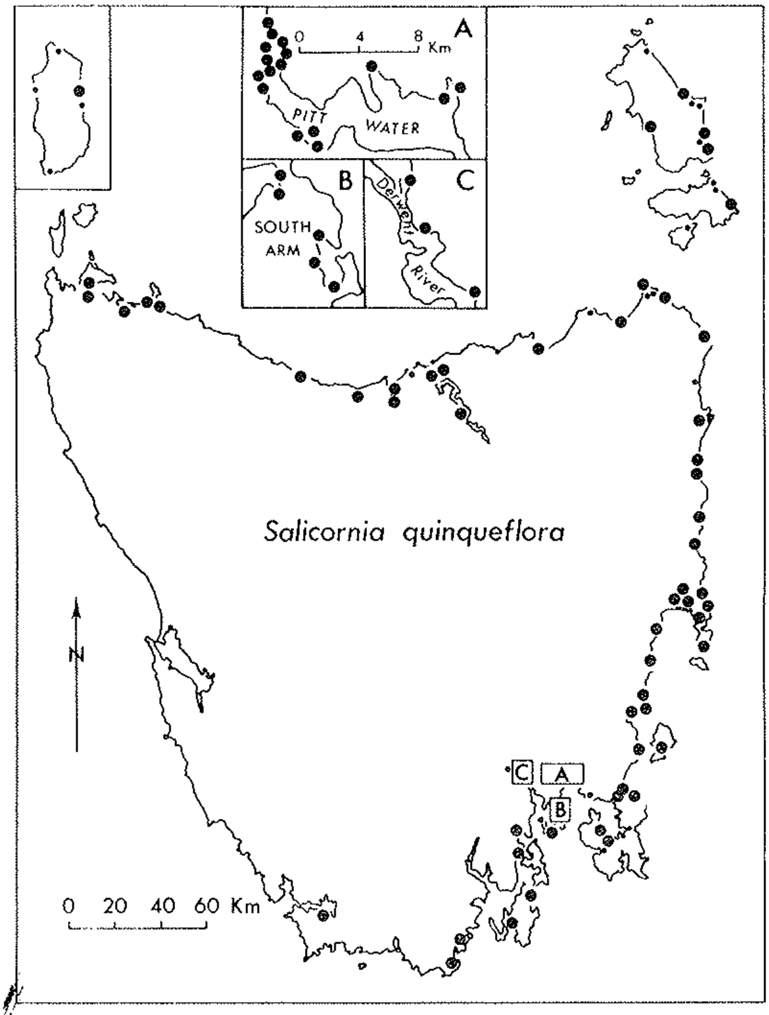

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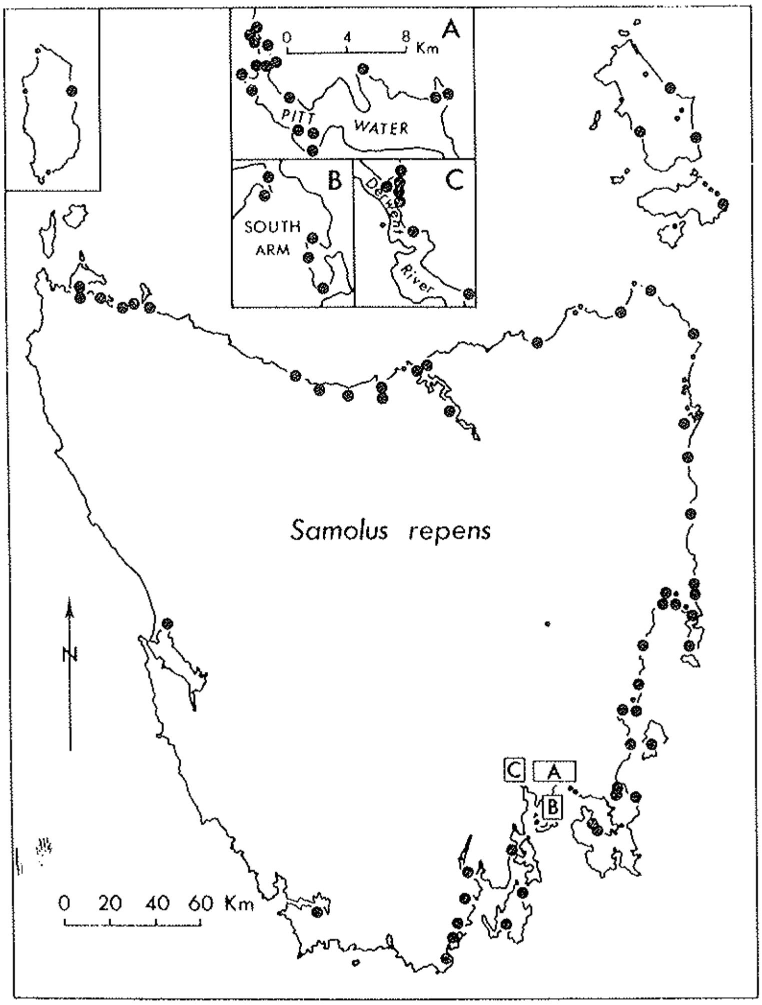

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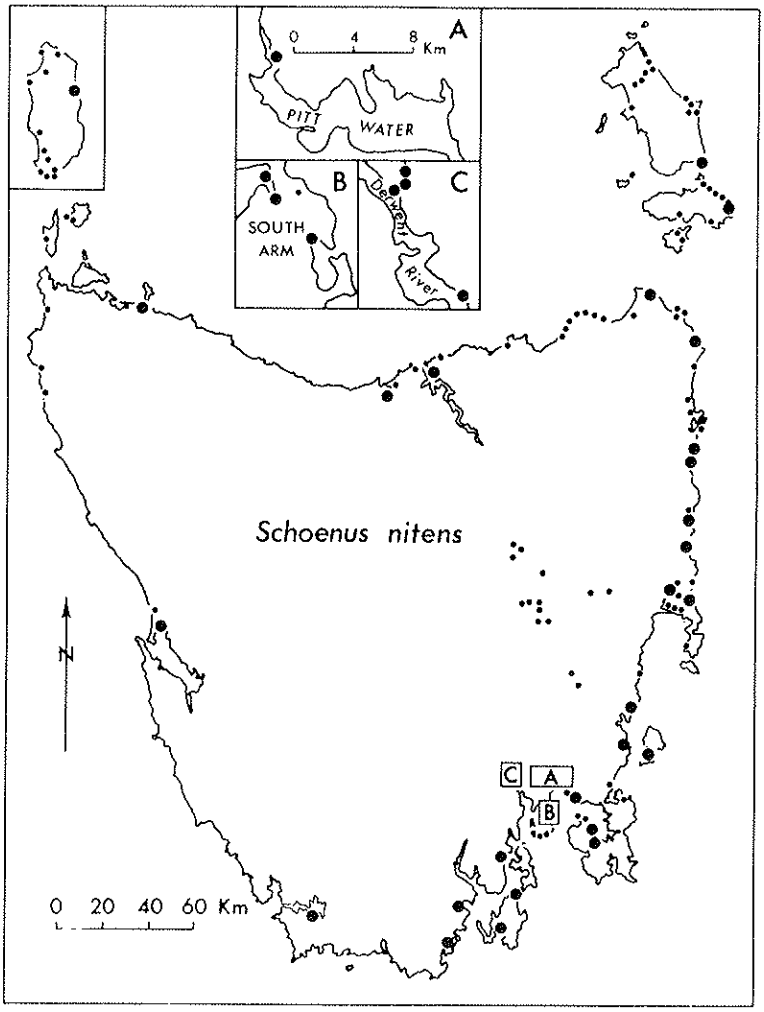

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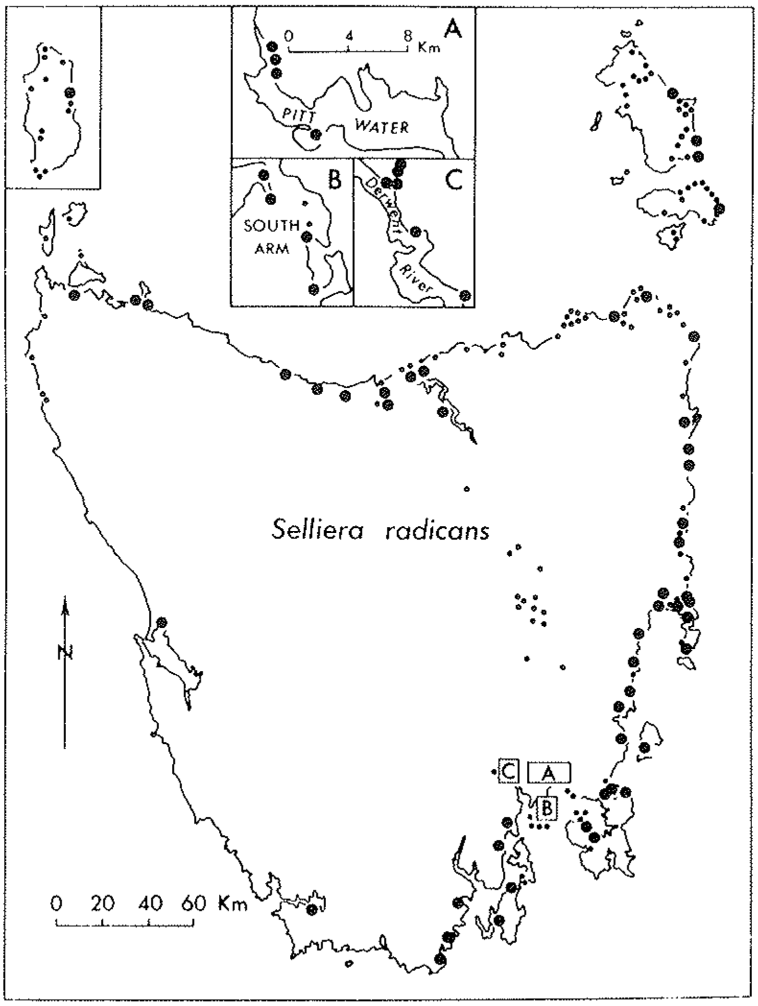

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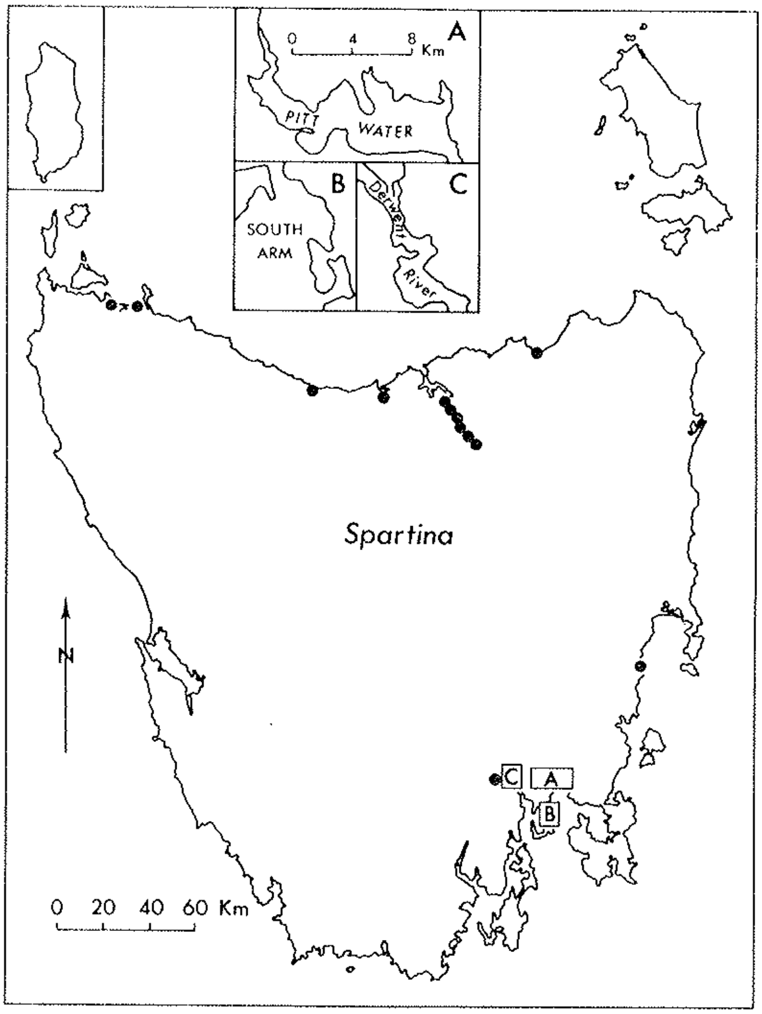

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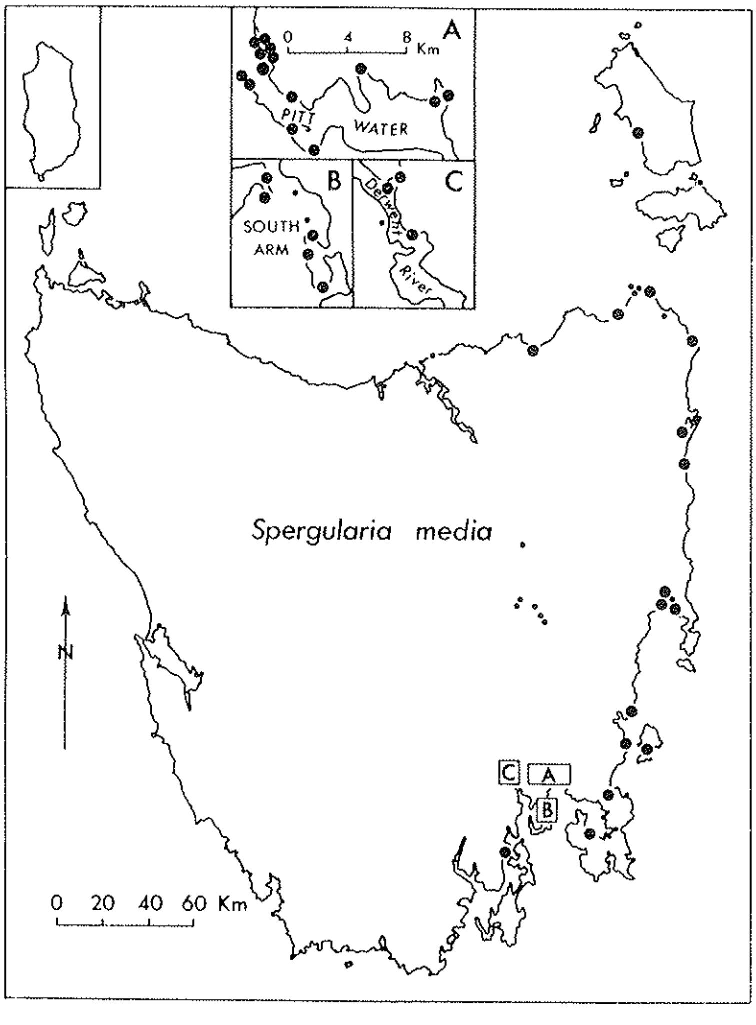

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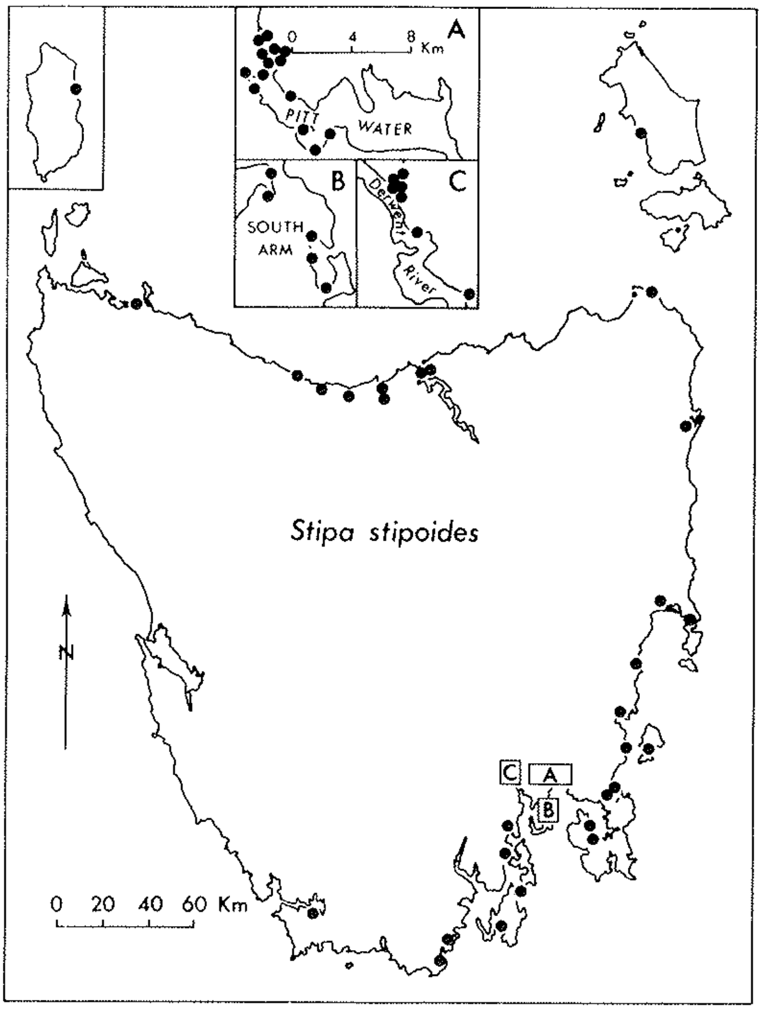
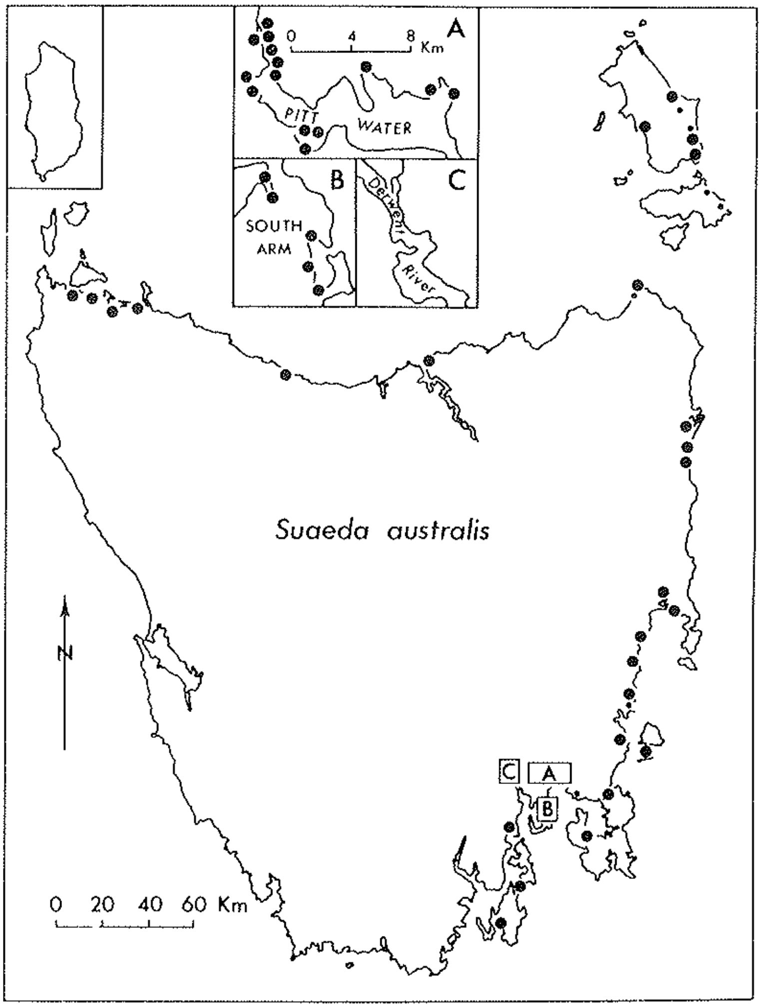


FIGURE 43



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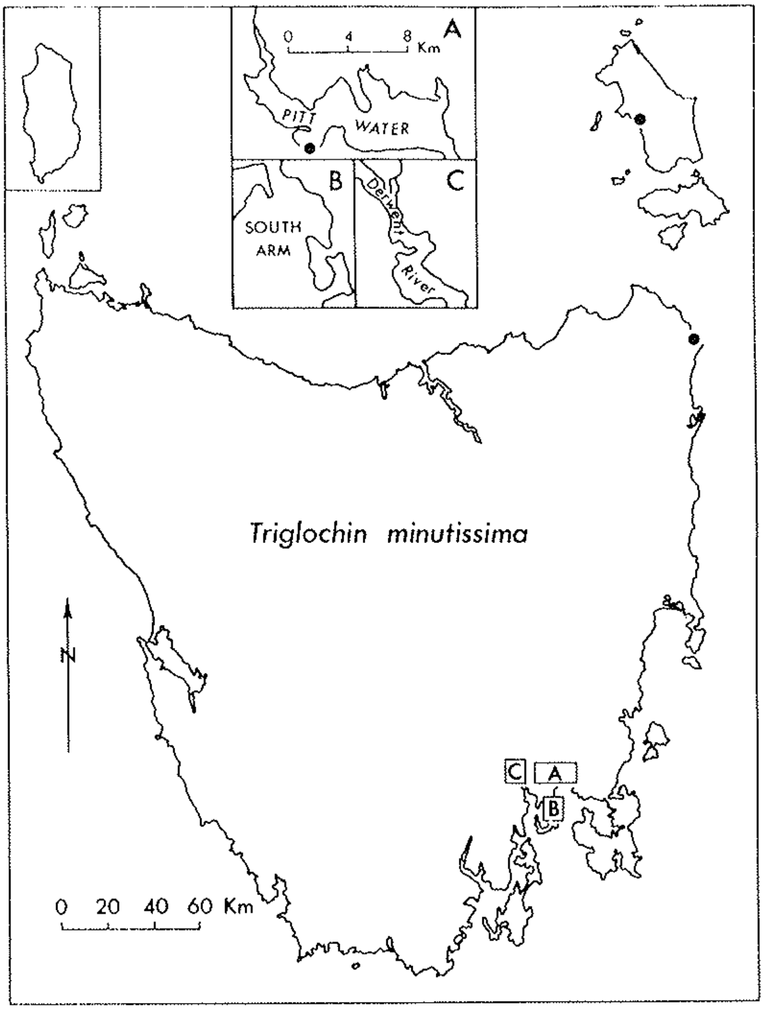

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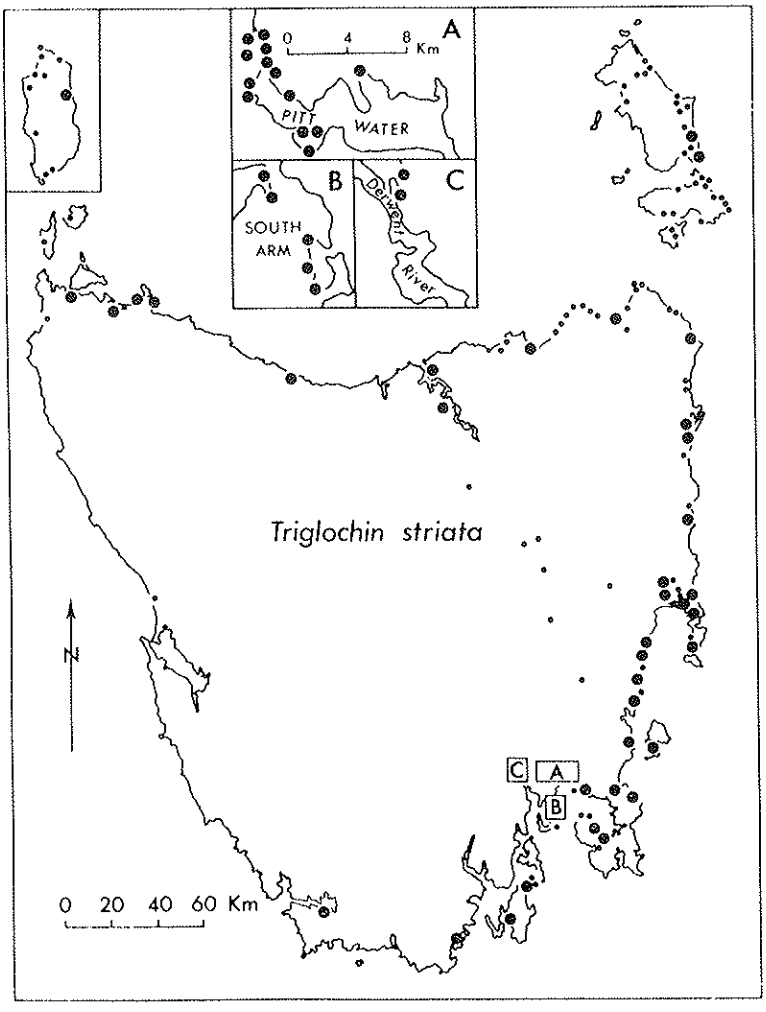

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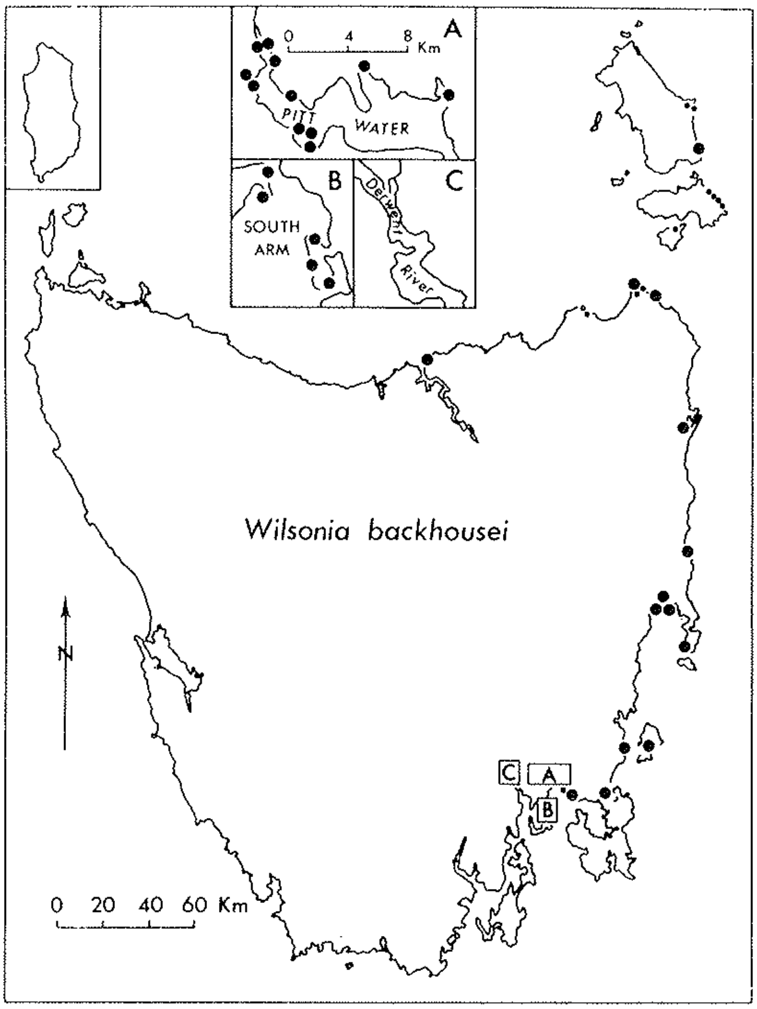


FIGURE 47

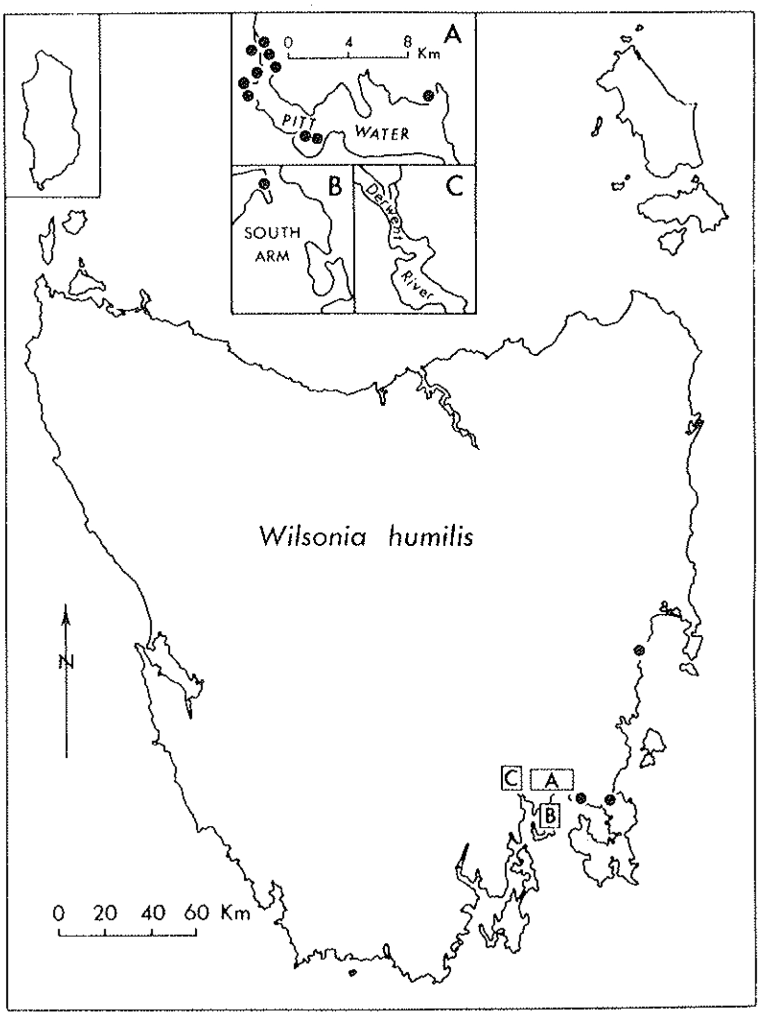


FIGURE 48

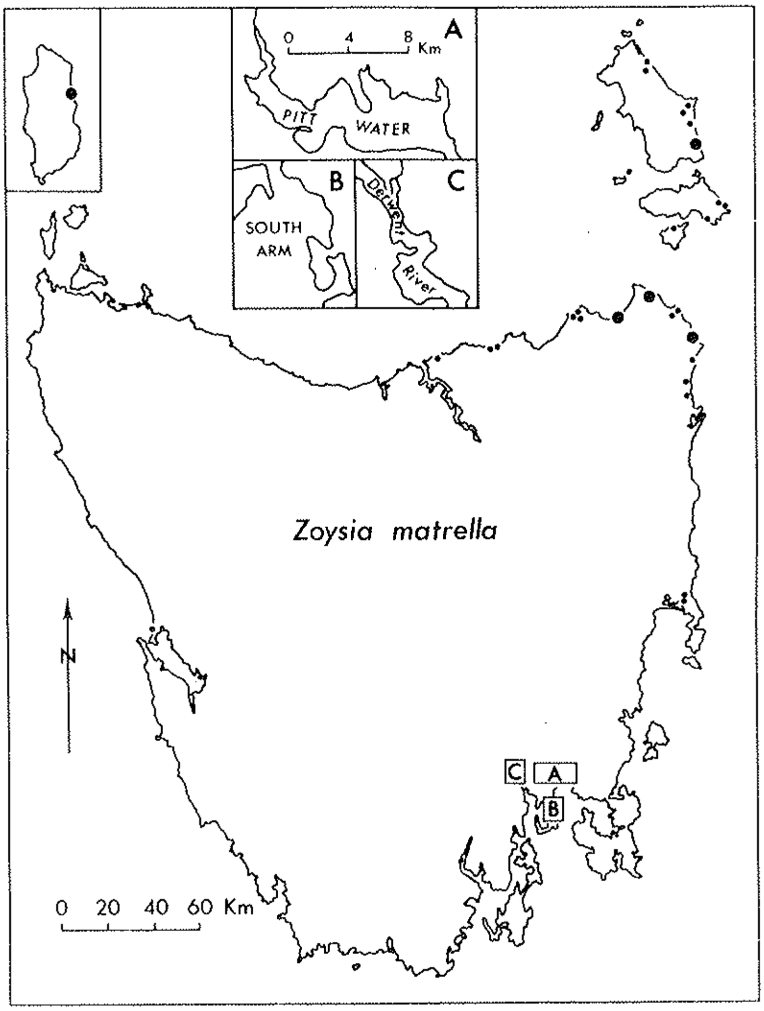
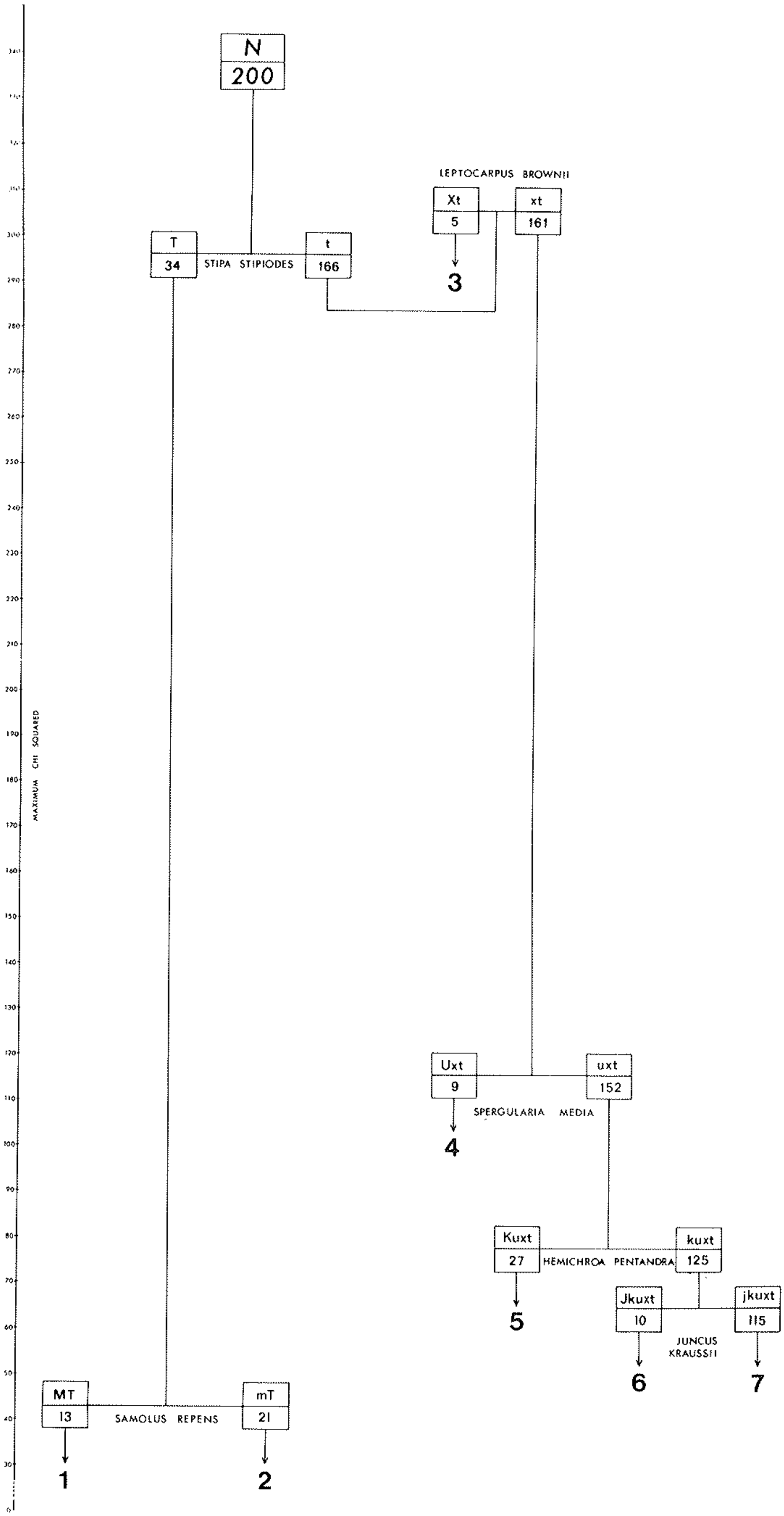

0 4 8 Km
A
PITT WATER
B
SOUTH ARM
C
Derwent River
Zoysia matrella
N
0 20 40 60 Km
C
A
B

FIGURE 49

FIGURE 50 Dendrogram for the association analysis. The values on the vertical axis are the highest sum of significant chi-squared values at each division.


MAXIMUM CHI SQUARED
N
200
T
34
STIPA STIPIODES
t
166
LEPTOCARPUS BROWNII
Xt
5
xt
161
3
Uxt
9
uxt
152
SPERGULARIA MEDIA
4
Kuxt
27
HEMICHROA PENTANDRA
kuxt
125
5
Jkuxt
10
jkuxt
115
JUNCUS KRAUSSII
6
7
MT
13
SAMOLUS REPENS
mT
21
1
2

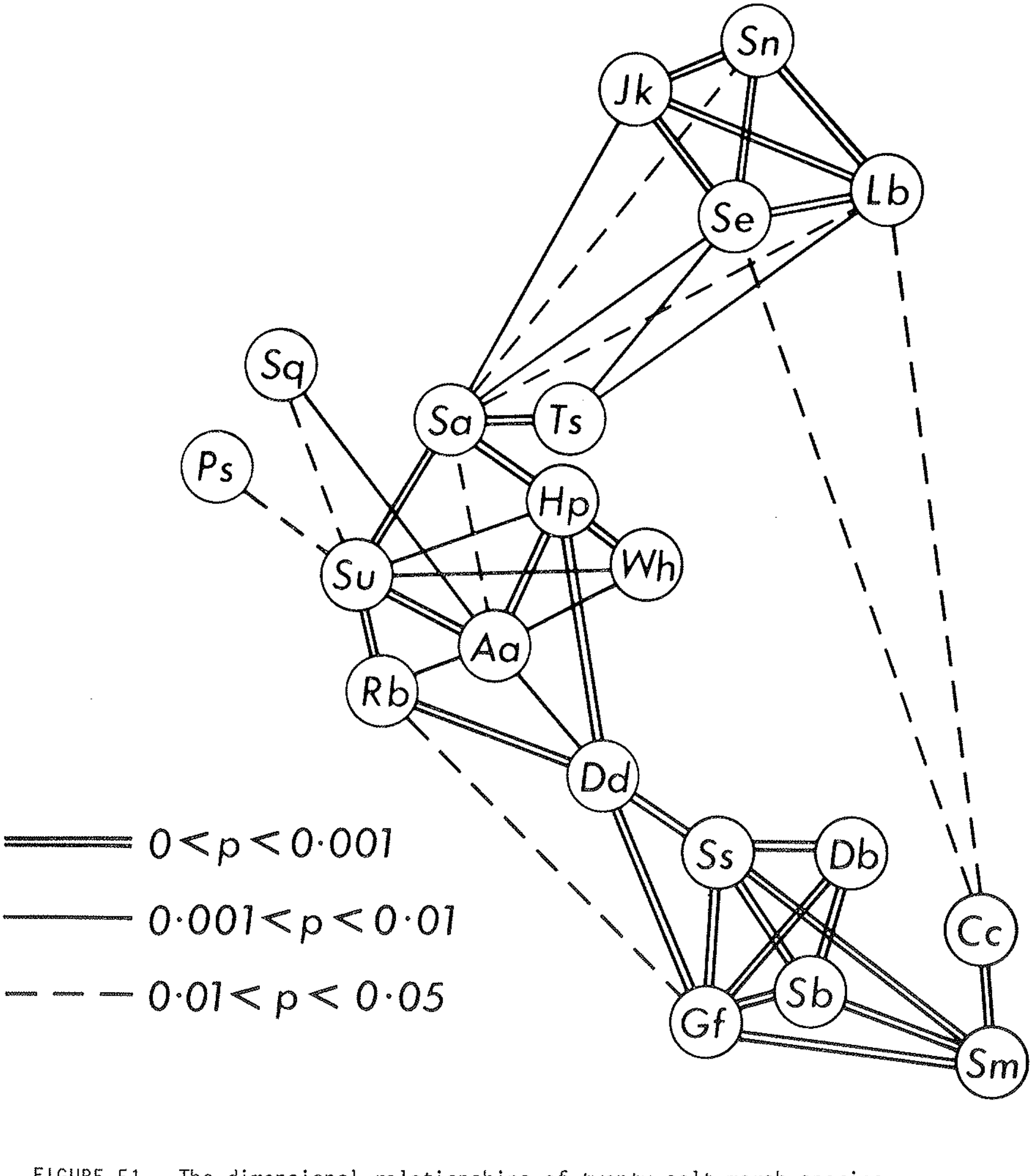


FIGURE 51 The dimensional relationships of twenty salt marsh species. Linkage indicates that species occur together significantly more often than could be expected through chance. Aa = *Arthrocnemum arbuscula*, Cc = *Cotula coronopifolia*, Db = *Disphyma blackii*, Dd = *Distichlis distichophylla*, Gf = *Gahnia filum*, Hp = *Hemichroa pentandra*, Jk = *Juncus kraussii*, Lb = *Leptocarpus brownii*, Ps = *Puccinellia stricta*, Rb = *Rhagodia baccata*, Sa = *Samolus repens*, Sb = *Salicornia blackiana*, Se = *Selliera radicans*, Sm = *Spergularia media*, Sn = *Schoenus nitens*, Sq = *Salicornia quinqueflora*, Ss = *Stipa stipoides*, Su = *Suaeda australis*, Ts = *Triglochin striata*, Wh = *Wilsonia humilis*.

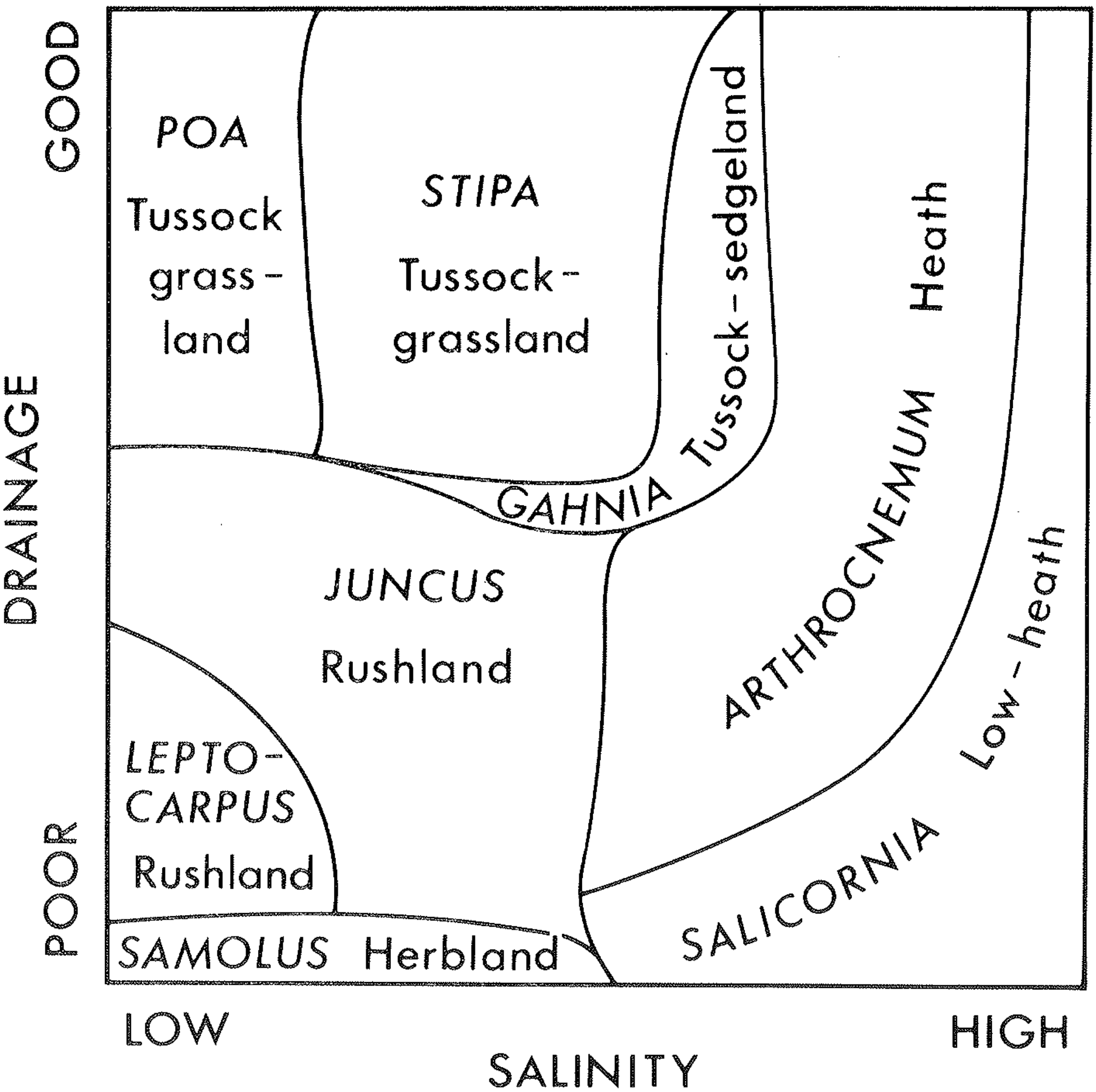


FIGURE 52 Schematic diagram of the environmental relationships of the major salt marsh communities

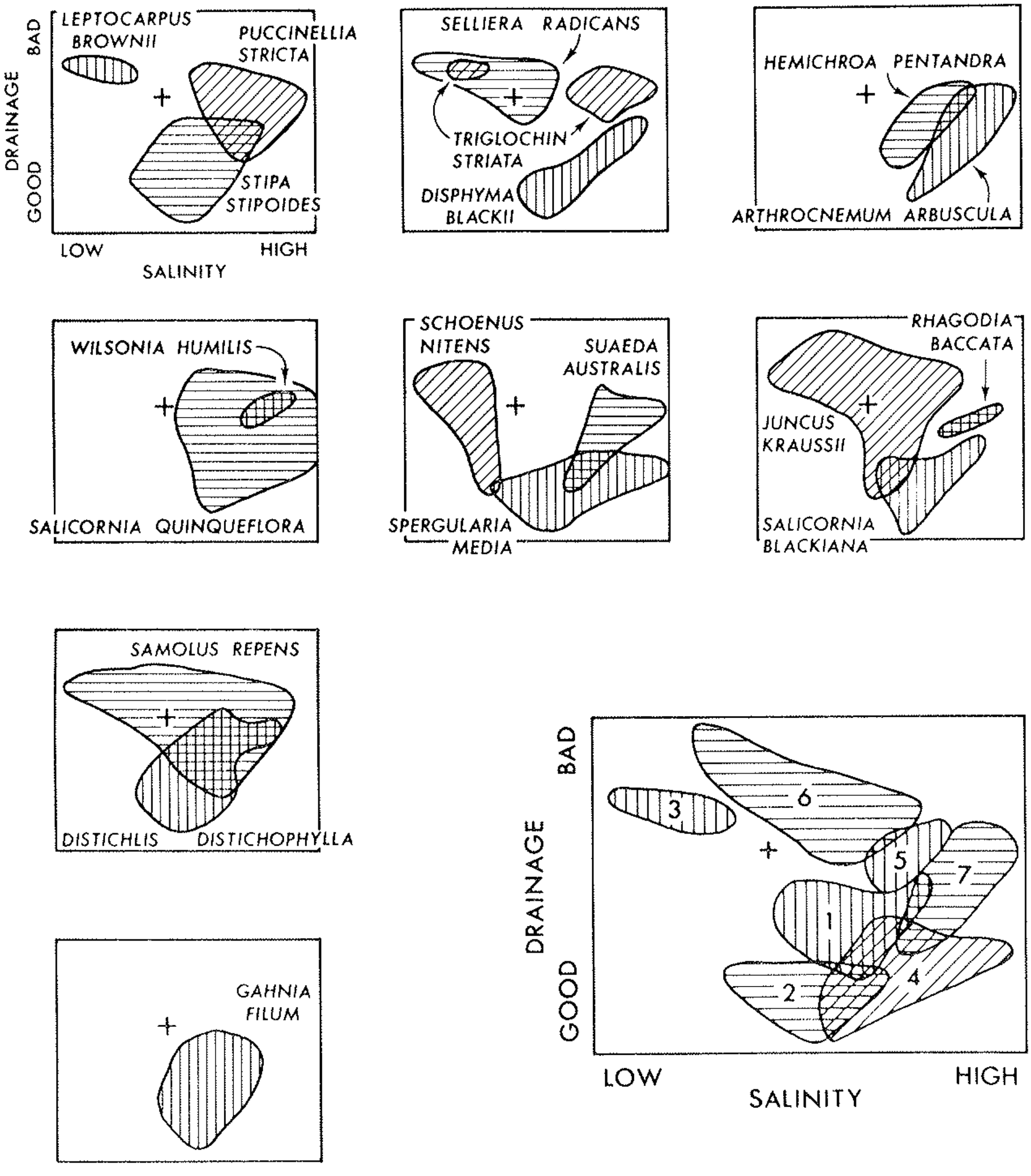


FIGURE 53 The distributions of the classificatory groups and some major salt marsh species on the two dimensional indirect ordination

Conservation Status of Salt Marshes

Formation and community conservation

Of an estimated 3300 ha of salt marsh in Tasmania (figure obtained from maps produced by the Tasmanian Conservation Trust Coastal Survey) less than 100 ha (3 percent) are secure within State Reserves (land owned and solely managed by the Tasmanian National Parks and Wildlife Service). Small areas of fringing salt marsh occur within Bathurst Harbour and New River Lagoon in the South West National Park, and other small areas of salt marsh are found in the Asbestos Range National Park, Maria Island National Park, Freycinet National Park and the Bruny Neck Game Reserve. Sandspit River, Moulting Lagoon, Cape Portland, Tamar River, Southport Lagoon and Sea Elephant wildlife sanctuaries also include small areas of salt marsh, but their security of status is poor. The Oyster Cove Conservation area falls within the same class.

All the species that define the dominance-structure groupings are found in at least one State Reserve (Appendix, Table 2). However, it is not known whether *Suaeda australis, Hemichroa pentandra, Disphyma blackii* and *Wilsonia backhousei* dominate communities in the reserves in which they occur. The communities they define are restricted in area in the region mapped in detail and may not occur widely. Of the major communities (Figure 52) only *Arthrocnemum arbuscula* heath is found in less than two State Reserves (Table 2). It is found on the islands in Port Sorell recently included in the Asbestos Range National Park. It is also found in two wildlife sanctuaries (Table 2).

Species conservation

The most poorly reserved group of species is that confined to the salt marsh formation; a not surprising result given the low degree of reservation of the formation. *Wilsonia humilis* is not found in any reserve and *Arthrocnemum arbuscula, Salicornia blackiana* and *Limonium australe* are found in only one reserve each (Appendix). The only other species that are both abundant and widespread in salt marshes and confined to one State Reserve are *Suaeda australis, Puccinellia stricta* and *Zoysia matrella* (Appendix). Of the species occurring occasionally in salt marsh *Angianthus preissianus, Wilsonia rotundifolia, Scirpus pungens, Juncus revolutus* and *Triglochin centrocarpa* are not known from any State Reserve. However, the conservation of these species would be best achieved in other vegetation types.

Reservation recommendations

The specialized salt marsh environment is relatively resistant to those edge effects that can so readily change the nature of formations such as heathland (Kirkpatrick, 1977b). Thus, relatively small reserves are viable, even if abutted by developed land, as long as firing and grazing can be prevented. On the available information the best location for the extension of reservation of salt marsh is Pitt Water where *Arthrocnemum arbuscula* heath is widespread and all but one of the poorly reserved and unreserved species that are abundant in or confined to salt marsh have large populations. The reservation of an appropriately chosen 70 ha of the Pitt Water marshes would bring the proportion of reservation of Tasmanian salt marsh to five per cent, would leave no major salt marsh species outside the State Reserve system and would help safeguard the future of the area as one of the most important habitats for migratory waterbirds (Wall, 1975).

The value of salt marshes as part of the complicated estuarine food web would suggest that further reservation would be desirable, especially given the low economic opportunity cost attached to their reservation and the importance of estuarine-breeding fish to the Tasmanian economy.

Conservation problems

The reservation status of salt marsh communities and species would have little importance if salt marsh were rendered secure by economic uselessness, and were not influenced by events in its hinterland. However, the following activities have been demonstrated capable of either destroying or modifying the nature of salt marsh:

1. Landfill

The major loss of salt marsh to landfilling has been through rubbish tips which are subsequently covered by soil and grassed. For example, the tip at Ulverstone was formerly an *Arthrocnemum* and *Stipa* marsh. Road widening and straightening has also destroyed salt marsh in Tasmania, as at Lauderdale and Old Beach. Any great loss to landfill can be expected to be largely confined to salt marshes close to cities and large towns. However, the important Pitt Water marshes fall into this class.

2. Catchment modification

A reduction of the load of streams through the construction of dams may in the longterm lead to a reduction of the area of some salt marshes where there is a delicate balance between deposition and erosion. However, in Tasmania it is probably more likely that salt marshes have been extending as a result of increased erosion caused by agricultural, forestry and mining activities in their hinterlands.

3. Fire

Fire followed by grazing is capable of eliminating *Arthrocnemum arbuscula* from marshes. However, the succulent nature of *A. arbuscula* makes the occurrence of fire in this community rare, and the more frequently ignited tussock sedgeland and tussock grassland recover well vegetatively.

4. Grazing

Sheep and cattle are often run on salt marshes. Their trampling and grazing drastically reduces the abundance of *Arthrocnemum*, and may eliminate some native species and introduce exotic species. For example, *Limonium australe* seems to be restricted to marshes and parts of marshes where grazing does not take place. *Salicornia quinqueflora* low open-heath or *Juncus kraussii* open-rushland replaces *A. arbuscula* heath in heavily grazed situations. In some areas grazing may be responsible for a bare zone at the rear of marshes. This bare zone is invariably absent in ungrazed marshes.

5. Off-road vehicles

Marshes used by off-road vehicle enthusiasts suffer a severe reduction in plant cover. The marshes on the western side of the mouth of the Carlton River have suffered severely from this cause.

6. Exotic species invasion

The specialized salt marsh environment excludes most exotic species, except in the transition zone to uninundated land where *Plantago coronopus* is almost universally present and introduced grass species can often be found. *Spartina* x *townsendii*, an hybrid marsh grass, has been introduced at several points along the Tasmanian coast (Figure 41). It is capable of forming a dense sward covering all of the intertidal zone thus altering tidal flow patterns (Phillips, 1975), but does not substantially invade the native salt marsh which occurs at slightly higher elevation. Nevertheless the spread of this species is undesirable from the point of view of the native biota that exploits mudflats in the intertidal zone. The clump of the species on the Bridgewater Causeway has been destroyed, a desirable fate for other small populations. The Tamar and Little Swanport Lagoon occurrences may be too well-established to allow eradication.

CONCLUSION

The Tasmanian saltmarshes have a similar species and community composition to those in humid southeastern Australia (Barson and Calder, 1976; Bridgewater, 1975). Only four of the thirty-one higher plant species listed by Bridgewater (1975) as identifying species of the communities and subcommunities of Westernport Bay are not recorded from Tasmanian salt marsh, and only one, the white mangrove (*Avicennia marina*) is absent from Tasmania. The only Tasmanian endemic species found at all widely in salt marsh is *Lilaeopsis brownii*, an inconspicuous herb.

The absence of mangroves from the Tasmanian low energy coasts is most probably the result of exclusion because of frost susceptibility. The southernmost mangroves in Australia, at Corner Inlet, have suffered damage by frost, and the frost climate is considerably more severe in all parts of Tasmania than in southern Victoria.

While Tasmanian salt marsh seems in no immediate danger of destruction, incorporation of further areas in the State Reserve system seems desirable for the conservation of species and communities and further depletion of the area of salt marsh through actions such as land reclamation would seem best discouraged.

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APPENDIX

Species observed in Tasmanian salt marsh: their distribution and reservation status

Species	Distribution[1]	Reservation[2]
MONOCOTYLEDONEAE		
CYPERACEAE		
Baumea juncea R.Br. (Palla)	o	
Eleocharis acuta R.Br.	o	
Gahnia filum (Labill.) F. Muell.	a	AR,F,M,R*
G. trifida Labill.	o	O*
Schoenus nitens (R.Br.) Poir.	a	AR,G,LO*,M,MW,O*,R*,SW
Scirpus pungens Vahl (syn. *S. americanus*)	o	
S. cernuus Vahl	o	F,O*,SE*,SW
S. inundatus (R.Br.) Poir.	o	LO*,R*
S. nodosus Rottb.	a	AR,O*,SW
JUNCACEAE		
Juncus kraussii Hochst. (syn. *J. maritimus*)	a	F,G,LO*,M,R*,SE*,SW
J. pallidus R.Br.	o	O*
J. planifolius R.Br.	o	
J. revolutus R.Br.	o	
JUNCAGINACEAE		
Triglochin centrocarpa Hook.	o	
T. minutissima F. Muell.	a	L,MW
T. striata Ruiz & Pav.	c	M,SW,MW,SE
POACEAE		
Agrostis aemula R.Br.	o	
A. avenacea J.F. Gmel.	o	LO*
A. billardieri R.Br.	o	
+ *A. stolonifera* L.	o	
Distichlis distichophylla (Labill.) Fassett	a	F,G,M,MW,R*,SE*
+ *Festuca arundinacea* Schreb.	o	
+ *Parapholis incurva* (L.) C.E. Hubbard	o	
+ *Poa annua* L.	o	
P. labillardieri Steud.	o	G
P. poiformis (Labill.) Druce	o	O*,R*,SW
+ *Polypogon monspeliensis* (L.) Desf.	o	
Puccinellia stricta (Hook.f.) C. Blom	c	O*,M
+ *Spartina townsendii* H. & J. Groves	c	
Stipa stipoides (Hook.) Veldkamp	a	AR,G,O*,M,SE*,SW
+ *Vulpia megalura* (Nutt.) Rydb.	o	
Zoysia matrella (L.) E.D. Merrill	c	MW,SE*

RESTIONACEAE		
Leptocarpus brownii Hook. f.	o	
DICOTYLEDONES		
APIACEAE		
Apium prostratum Vent.	a	G,M,O*,R*,SE*,SW
Eryngium vesiculosum Labill.	o	
Lilaeopsis brownii A.W. Hill	a	F,LB,LO*,M,MW,R*,SE*,SW
ASTERACEAE		
Angianthus eriocephalus Benth.	a	GR,SW
A. preissianus (Steetz) Benth.	a	
Brachycome graminea (Labill.) F. Muell.	a	M,MW
Centipeda minima (L.) A.Br. & Aschers	o	
Cotula coronopifolia L.	a	F,G,MW,M,R*
C. longipes (Hook.f.) W.M. Curtis	a	R*,SE*,SW
C. reptans Benth.	a	LO*,M,O*,R*
+ *Gnaphalium candidissimum*	o	
CARYOPHYLLACEAE		
Spergularia media (L.) Presl.	c	G,M,O*,MW,R*
CHENOPODIACEAE		
Arthrocnemum arbuscula (R.Br.) Moq.	c	AR,CP*,O*,SE*
Atriplex cinerea Poir.	o	SE*
+ *A. hastata* L.	o	
A. paludosa R.Br.	o	
Chenopodium glaucum ssp. *ambiguum* (R.Br.) Murr. & Thell. ex Thell.	a	F,LO*,M,SE*
Hemichroa pentandra R.Br.	c	AR,CP,*,LO*,M,R*,MW
Rhagodia baccata (Labill.) Moq.	a	M
Salicornia blackiana Ulbrich	c	CP,M,R*
S. quinqueflora Bunge ex Ung. Sternb.	a	AR,CP*,F,LO*,M,MW,R*, SE*,SW
Suaeda australis (R.Br.) Moq.	c	CP*,LO*,M,R*
CONVULVULACEAE		
Cuscuta tasmanica Engelm.	a	LB,MW
Wilsonia backhousei Hook.f.	c	F,M,R*
W. humilis R.Br.	c	
W. rotundifolia Hook.	o	
FICOIDEAE		
+ *Carpobrotus edulis* (L.) N.E.Br.	o	
C. rossii Schwartes	o	R*

Disphyma blackii R.J. Chinnock (Syn. *D. australe*)	a	AR,F,M,MW,SW
Tetragonia implexicoma (Miq.) Hook.f.	o	M
GENTIANACEAE		
Sebaea albidiflora F. Muell.	o	M
GOODENIACEAE		
Selliera radicans Cav.	a	AR,F,G,LO*,M,MW,O*,R*, SE*,SW
LOBELIACEAE		
Lobelia alata Labill.	a	LO*,M,R*,SE*,SW
Pratia platycalyx (F. Muell.) Benth	a	MCW,TH
MALVACEAE		
Lawrencia spicata Hook.	c	F,LO*,M,MW,O*
PLANTAGINACEAE		
+ *Plantago coronopus* L.	a	
PLUMBAGINACEAE		
Limonium australe (R.Br.) Kuntze	c	AR
POLYGONACEAE		
Rumex brownii Campd.	o	M,R
PRIMULACEAE		
Samolus repens Pers.	a	AR,F,G,M,MW,O*,R*,SE*, SW
RUBIACEAE		
Nertera depressa Banks & Soland	o	SW
SCROPHULARIACEAE		
Mimulus repens R.Br.	a	F,LO*,M,SE*

[1] c = almost totally confined or totally confined to saltmarsh
a = common in saltmarsh and common elsewhere
o = occasional on saltmarsh margins

[2] AR = Asbestos Range National Park
CP = Cape Portland Wildlife Sanctuary
F = Freycinet National Park
G = Green Point Nature Reserve
GR = Gordon River State Reserve
L = Labillardiere State Reserve
LB = Lime Bay Nature Reserve
LO = Logan Lagoon Wildlife Sanctuary
M = Maria Island National Park
MCW = Mt. Cameron West Aboriginal Site
MW = Mt. William National Park
O = Oyster Cove Conservation Area
R = Sandspit River Wildlife Sanctuary
SE = Sea Elephant Wildlife Sanctuary
SW = South West National Park
TH = Three Hummock Island Nature Reserve

Reservation status is not shown for introduced species and is only shown for species classified as o where they are specifically recorded from saltmarsh in a reserve.

+ Introduced species
* Reserve not under the full control of the National Parks and Wildlife Service.

TABLE I

The percentage frequency of species in
the classificatory groups

Species	1	2	3	4	5	6	7
Cotula coronopifolia			20	33			
Leptocarpus brownii			100				
Schoenus nitens			80				
Selliera radicans			80				
Triglochin striata			60		15	20	14
Juncus kraussii	23	14	80	4	100		
Samolus repens	100		100		96	80	35
Stipa stipoides	100	100					
Disphyma blackii	23	76		44			11
Salicornia blackiana	38	57		33			
Spergularia media	8	71		100			
Salicornia quinqueflora	85			77	100	50	99
Hemichroa pentandra	38				100		
Arthrocnemum arbuscula	62	19		11	89		50
Gahnia filum	69	48		11	7		
Suaeda australia	31	10		11	52	10	21
Distichlis distichophylla	31	38			26	10	3
Plantago coronopus					11		
Wilsonia humilis				22	11		
Puccinellia stricta					4		
Rhagodia baccata	15	38					

TABLE II

The reservation status of the native communities defined by dominance and structure

Community	Reserve[1]									
	R	SE	CP	OC	M	F	MW	SW	AR	GP
1. *Arthrocnemum arbuscula* heath	–	x	x	–	–	–	–	–	x	–
2. *Suaeda australis* heath	x	–	–	–	x?	–	–	–	–	–
3. *Salicornia quinqueflora* low open-heath	x	x	x	x	x	–	x	–	x	–
4. *Salicornia blackiana* low open-heath	x	–	–	–	x	–	–	–	–	–
5. *Hemichroa pentandra* low heath	–	–	–	–	x?	–	x?	–	x?	–
6. *Disphyma blackii* low open-heath	–	–	–	–	x?	–	–	–	–	–
7. *Stipa stipoides* tussock grassland	–	x	–	x	x	–	–	x	x	–
8. *Distichlis distichophylla* closed-grassland	x	–	–	–	–	–	x	–	–	–
9. *Puccinellia stricta* open-grassland	–	–	–	–	x	–	–	–	–	–
10. *Gahnia filum* tussock sedgeland	x	–	–	–	x	–	–	–	x	–
11. *Juncus kraussii* open-rushland	x	x	–	–	x	x	–	x	–	x
12. *Leptocarpus brownii* open-rushland	–	x	–	–	–	–	–	x	–	–
13. *Wilsonia backhousei* herbfield	–	x	–	–	x?	–	–	–	–	–
14. *Samolus repens* herbfield	–	x	–	–	–	–	x	x	–	–

1 R = Sandspit River Wildlife Sanctuary*
SE = Sea Elephant Wildlife Sanctuary*
CP = Cape Portland Wildlife Sanctuary*
OC = Oyster Cove Conservation Area*
M = Maria Island National Park
F = Freycinet National Park
MW = Mt. William National Park
SW = South West National Park
AR = Asbestos Range National Park
GP = Green Point Nature Reserve

* Not subject to total control of the Tasmanian National Parks and Wildlife Service