Phytosociological Studies on the Salt Marshes of Tasmania

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Introduction

An island wide phytosociological investigation of Tasmanian salt marshes has not been carried out. Earlier studies by Bridgewater (1982), Adam (1981), as well as Harris and Kirkpatrick (1997), comprise selected salt marsh areas of Tasmania. Therefore, little is known about plant sociological significance of communities compared with those on the Australian mainland, as well as geographical variation and species occurrence. In addition, the native salt marsh communities are affected by introduced species such as *Plantago coronopus* or *Spartina anglica*, which can replace or alter natural processes. Besides, there is an increasing pressure on coastal areas and many salt marshes have been either destroyed or heavily modified. However, some 21% of the recorded plant species within the salt marshes of Tasmania are naturalised, whereas 79% belong to native plants. Consequently, the portion of naturalised species is much less than in the salt marshes of New Zealand, where some 49% of the recorded plant species are introduced (Haacks and Thannheiser 2003). Last but not least, there is the aspect of nature conservation. In order to protect the uniqueness of native salt marshes it is important to know as much as possible about the communities and succession within them.

Study Site and Methods

Physiographical overview

Tasmania was linked to the Australian mainland until the late Oligocene or early Miocene. Due to uplift and downwarping, as well as Quaternary sea-level change, Tasmania has been separated from the mainland several times since then. Towards the close of the Pleistocene (13 500 - 12 000 years BP), the 200 km wide Bass Strait re-formed and isolated Tasmania with an area of 67 895 km^2 from the mainland (Scanlon et al., 1990). Tectonic depression has resulted in a ria coastline, about half of which is sandy. In general, depositional plains at the coast are narrow (Williams 1974). Some 3% of the Tasmanian coastline comprises bays, lagoons, and estuaries or is sheltered behind islands. In these areas, fine marine sediments accumulate, a precondition for the development of salt marshes. Limiting factors to the development and extent of salt marshes include: lack of a wide submarine tidal flat, small amounts of fine material, and low tidal range. Soil profiles in coastal areas show a characteristic lamination: clay and sand layers alternating with humus (Kelletat 1994). The large amounts of sandy material within Tasmanian salt marshes is remarkable. However, large tracts of salt marsh vegetation are rare in Tasmania. There are fewer than 100 registered areas of coastal salt marsh larger than 1 ha. On the north coast there are only four sites: Stanley, Port Sorell, Tamar River Estuary, and Bridport. On the east and south-east coasts, large areas of salt marsh are much more common. Due to geomorphological conditions (cliffs), much of the west and south coast is not appropriate for the development of salt marshes and supports only fragmentary halophytic vegetation.

The climate of Tasmania is Humid-Temperate (following Köppen 1936). On the west coast, annual precipitation reaches 1 300 mm, with the maximum during winter, whereas on the east coast annual rainfall is less (1 000 mm) and equally distributed over the year (State of the Environment Tasmania 1996). On the north and northeast coasts, average annual precipitation of 600 mm and 782 mm, respectively, has been recorded (Harris and Kirkpatrick 1997). The climatic contrasts between east and west coasts are related to the extensive ocean fetch to the west and prevailing westerly winds. There are high rainfalls in the western Tasmanian ranges due to orographic effects with a consequent rainshadow effect in the east. There is no well-defined seasonality in rainfall, high average amounts occurring throughout the island in each month (Williams 1974). The coolest areas are the large central and smaller north-eastern plateaux, whereas the warmest areas are found along the coastline (Williams 1974). The cool Antarctic Current flows along the west coast while the East-Australian Current conveys warm water from tropical latitudes to the Tasmanian east coast throughout the year. Although growth of halophytic plants - as an azonal vegetation type (Schroeder 1998) - is not limited by climate (Adam 1990), it is greater on the east coast by the warm East-Australian Current. Furthermore, ocean currents are an important factor in spreading salt marsh species. For an example, *Euphorbia paralias* became established on Tasmanian coasts in the 1980s. Today, it is a common driftline plant on the north coast and is spreading southwards along the west coast. Seeds and fruits of *Euphorbia paralias* are carried by the East-Australian Current which occasionally enters Bass Strait and may even reach the northeast coast (Harris and Kirkpatrick 1997).

The flora of Tasmania

Tasmania is part of the Australian floristic kingdom. Much of the area is in the Tasmanian floristic region, while the northwest and northeast have been assigned to the Victorian floristic region (Kirkpatrick 1993). Repeated landlinks between Tasmania and the South-East-Australian mainland have permitted floristic and faunistic interchange. Overall, phytogeographical affinities are high with the Australian mainland, but there are considerable affinities with New Zealand and South America (Williams 1974). There are no endemic plant families in Tasmania, but 7% of the genera, as well as 20% of the species, are endemic (Bureau of Flora and Fauna 1981).

Phytosociological approach

In the year 1998, the plant species of the salt marshes were recorded and classified by sampling plots following the floristic-sociological method of Braun-Blanquet (1964). The vegetation types are named after the dominant species. Altogether 150 plots were sampled. Samples were taken of all types of salt marshes. The location of the plots was chosen depending on the structure and homogeneity of the investigated plant stands. An average plot size of 9 m^2 was chosen. Each community is represented by a constancy table. The taxa are listed with their constancy class in each community. Constancy class + means present in less than 5% of the records, I means present in less than 20%, II present in 20-40%, III present in 40-60%, IV present in 60-80% and V in more than 80%. The nomenclature of vascular plant species follows Curtis, Curtis and Morris (1963-1994) and Buchanan (1995).

Discussed Results

Within the Tasmanian salt marshes 43 vascular species were recorded. Dune plants such as *Spinifex sericeus* which are accidentally brought into the salt marshes were not regarded. The bulk are also found on the Australian mainland and in New Zealand. Together with Victoria and the southwest coast of Western Australia, the salt marsh vegetation of Tasmania is the most diverse in Australasia (IPIECA 1994). This reflects the general phenomenon of increasing complexity and diversity of temperate salt marshes with latitude (Saenger et al., 1977). Of the naturalised species, only *Plantago coronopus* and *Spartina anglica* are capable of forming dense stands which can be regarded as plant communities. Based upon field studies within the region, 16 vegetation units could be identified by the authors. They are represented in Table 1, where 12 associations and 4 communities are united. At present, information for the 4 communities is too sparse for statements about their sociological significance. In some cases, particularly for introduced species like *Plantago coronopus*, the neutral term "community" is preferred (Thannheiser and Holland 1994). Large area differentiation in the distribution of the recognised phytocoenoses was not evident, but small area physiognomic differentiation was evident: low salt marsh (Figure 1), which resembles typical salt meadows, and salt marsh with shrubs and rushes (high salt marsh, Figure 2). The first contains 10 vegetation units that are found in all salt marshes. The second is characterised by 6 vegetation units and occurs in higher parts of the investigated salt marshes.

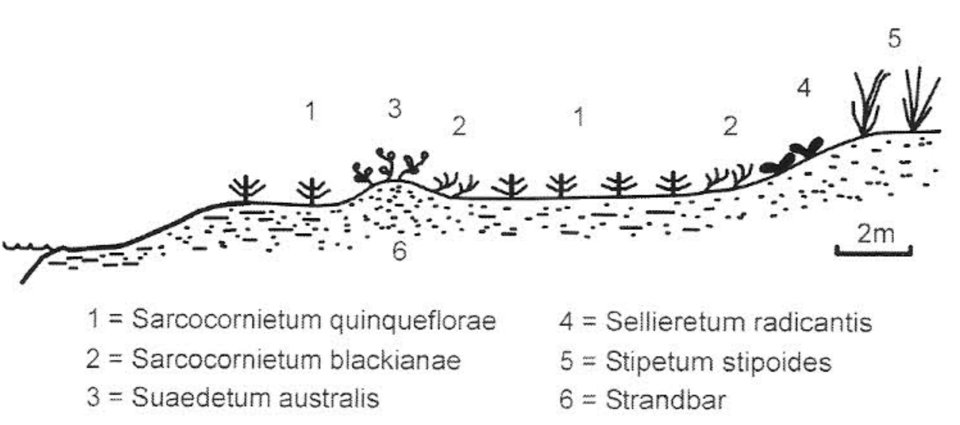

Figure 1: Diagram showing the zonation in salt marshes of Ralphs Bay (11.03.1998).

Table 1: Constancy table of vegetation units in the salt marshes of Tasmania

Number association or community	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Number of surveys	5	5	5	5	5	10	21	7	11	12	17	14	9	5	8	5
Characteristic species of associations and communities:																
Zostera muelleri	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ruppia polycarpa	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spartina anglica	.	.	V	.	.	.	.	.	.	.	.	+	.	.	.	.
Puccinellia stricta	.	.	.	V	.	I	+	.	.	II	.	.	.	.	.	.
Plantago coronopus	.	.	.	II	V	.	.	III	.	I	.	I	III	II	.	.
Sarcocornia blackiana	.	.	.	.	.	V	+	I	+	I	I	I	III	III	I	.
Sarcocornia quinqueflora	.	.	.	II	II	II	V	III	II	IV	IV	II	IV	III	IV	II
Distichlis distichophylla	.	.	.	.	II	+	.	V	+	I	II	III	II	II	I	II
Samolus repens	.	.	.	.	.	+	I	I	V	III	III	I	I	II	I	II
Selliera radicans	.	.	.	.	.	.	+	.	II	V	I	II	II	II	.	I
Suaeda australis	.	.	.	.	.	.	I	.	I	I	V	+	II	I	III	I
Juncus kraussii ssp. australis	.	.	.	.	.	.	+	I	+	II	+	V	III	II	I	I
Stipa stipoides	.	.	.	.	.	.	+	I	.	I	+	.	V	I	I	I
Gahnia filum	.	.	.	.	.	.	.	.	.	II	.	.	II	V	III	.
Sclerostegia arbuscula	.	.	.	.	.	.	+	.	II	.	.	.	.	I	V	.
Leptocarpus brownii	.	.	.	.	.	.	.	.	+	.	.	+	I	.	.	V
Characteristic species of higher units and accompaning species:																
Disphyma crassifolia	.	.	.	.	+	II	+	I	.	I	+	.	.	I	I	.
Spergularia media	.	.	.	II	I	I	.	II	.	.	.	.	.	II	.	.
Deyeuxia cf. densa	.	.	.	I	.	.	.	I	.	+	.	.	.	.	.	.
Isolepis aucklandica	.	.	.	.	+	.	.	.	+	.	.	+	.	.	.	.
Festuca arundinaceae	.	.	.	.	+	.	.	I	.	.	.	.	.	.	.	.
Atriplex prostrata	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.
Isolepis nodosa	.	.	.	.	.	.	+	.	.	.	.	I	.	.	.	.
Triglochin striatum	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.
Limonium australe	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I	.
Elymus farctus ssp. borealis	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Juncus pauciflora	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.
Cakile maritima	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Chenopodium glaucum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.

[a]

[a] 1 = Zosteretum muelleri, 2 = Ruppietum polycarpae, 3 = Spartinetum anglicae, 4 = Puccinellietum strictae, 5 = Plantago coronopus-com., 6 = Sarcocornietum blackianae, 7 = Sarcocornietum quinqueflorae, 8 = Distichlis distichophylla-com., 9 = Samoletum repentis, 10 = Sellieretum radicantis, 11 = Suadetum australis, 12 = Juncetum kraussii, 13 = Stipetum stipoides, 14 = Gahnia filum-com., 15 = Sclerostegietum arbusculae, 16 = Leptocarpus brownii-com.

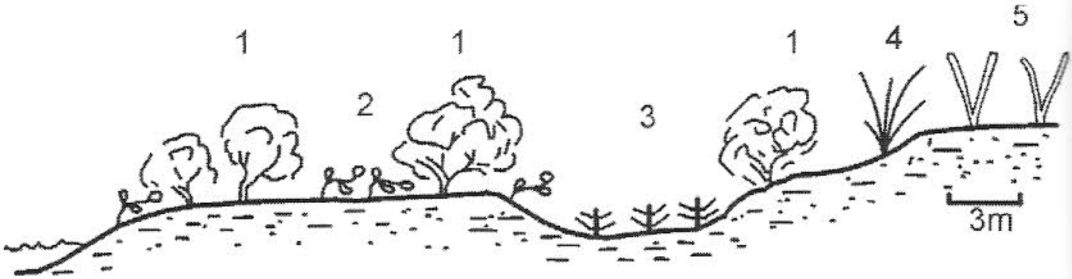

Figure 2: Diagram showing the zonation in salt marshes near Pittwater (11.03.1998).

The vegetation cover of Tasmanian salt marshes is heterogeneous. Thick, herbaceous vegetation carpets the area and alternates with patchy meadow and shrubby stands (Figure 3). Like salt marshes on the mainland, Tasmania's salt marshes lack the extensive dominance of grasses found in north temperate regions (Adam 1981). Furthermore, the communities are species poor and dominated by one or two species. Although the vegetation appears natural, closer inspection shows that more than half has been influenced by introduced grazing animals (Figure 4).

Only few botanical publications refer to Tasmanian salt marshes. Kirkpatrick and Glasby (1981) focus on salt marsh vegetation in bays near Hobart. The investigated sites on Pitt Water and the flanks of the Derwent River have been affected by construction of bridges and the water has become brackish. The study does not represent the undisturbed and therefore natural character of halophytic phytocoenoses. Furthermore, as Thannheiser (1998)reported, the vegetation cover had changed in Pipe Clay Lagoon and Ralphs Bay during the last 20 years. The only plant sociological publication dealing with coastal salt marsh in southern Australia is that of Bridgewater (1982), who carried out studies in Tasmania and distinguished several associations for the first time.

The halophytic marsh vegetation of Tasmania resembles that of New Zealand (Chapman 1959; Adam 1981; Thannheiser and Holland 1994; Dickinson and Mark 1999), and the two islands have much in common, especially in their climate and flora. Like in New Zealand, Tasmania's salt marsh vege-

Figure 3: Diagram showing the zonation in salt marshes of Blackman Bay (22.03.1998).

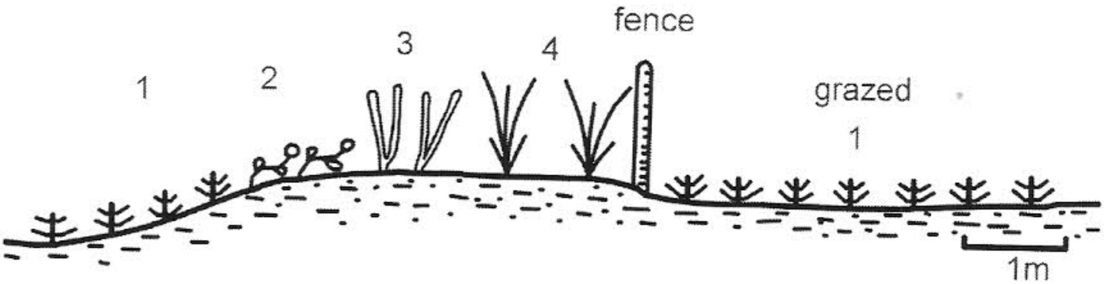

Figure 4: Diagram showing the zonation in salt marshes of St. Helens Inlet (18.03.1998).

tation grows above mean high-tide level, and is not always flooded at spring tide, but is occasionally submerged during storm tides. In contrast to the Holarctic, the lower parts of Tasmania's salt marshes do not comprise matted meadows but are rather heterogeneous mosaics with islands of other vegetation. Those "islands" are assembled from herbs (species of *Sarcocornia* sp., *Selliera radicans*, *Samolus repens*, and *Suaeda australis*), which form dense carpets by stoloniferous growth and enable the island to withstand marine erosion. The establishment of these species is important for the persistence of salt marshes. Where there is a dense carpet of plants, additional and already present silty material is stabilised. On flat, undisturbed beaches, there is usually development of arcuate sequences of plant communities arrayed parallel to the coast. The more a marsh grows and remains undisturbed by tides, the more its phytocoenoses alter and stands of *Juncus*, *Leptocarpus*, *Sclerostegia*, *Stipa*, and *Gahnia* species become frequent. The transition to inland vegetation is seldom sharp because halophytic and glycophytic plants can grow in mixed stands. However, there is the difficulty of defining the upper limits of salt marsh vegetation, which also applies to Tasmanian salt marshes (Adam 1981).

Low salt marsh communities

This vegetation type is characterised by relatively small plants and contains herbaceous plants as well as grasses. It comprises 10 vegetation units (*Zosteretum muelleri*, *Ruppietum polycarpae*, *Puccinellietum strictae*, *Sarcocornietum blackianae*, *Sarcocornietum quinqueflorae*, *Samoletum repentis*, *Sellieretum radicantis*, *Suaedetum australis*, *Distichlis distichophylla*-community, and *Plantago coronopus*-community). The endemic eel-grass, *Zostera muelleri* (Figure 5) tends to be a pioneer in the sublittoral zone. Monospecific stands of this species resemble closely related associations of the Northern Hemisphere. The association *Zosteretum muelleri* is found only in sheltered bays with small ocean current velocity (Thannheiser 2003) as depicted in Figure 6. In Tasmania, *Ruppia polycarpa* was found in a small lagoon behind a spit without direct contact to the sea (Figures 7 and 8). The endemic community is monospecific and can be regarded as an association *Ruppietum polycarpae* (Thannheiser 2003). It corresponds with related *Ruppia* associations of the Holarctic.

On the outer edges of marshes, the native *Puccinellia stricta* (Figure 8) occurs sporadically. Only on the east coast (Figure 6) does it become dominant, forming salt meadows such as might be found in Europe. Its dominance is related to sandy salt marsh soils which favour the development

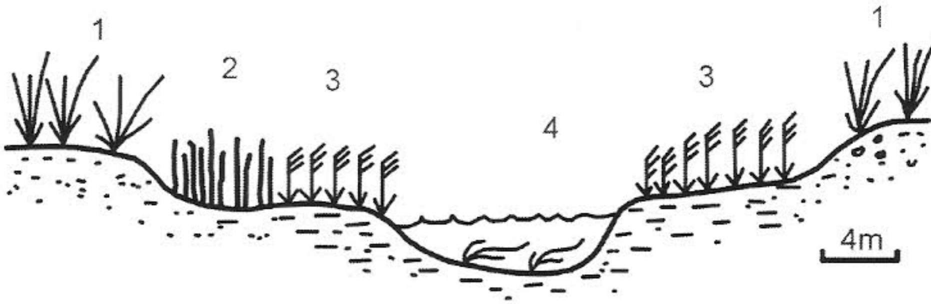

Figure 5: Diagram showing the zonation in salt marshes near Bridport (17.03.1998).

of *Puccinellia* and inhibit *Spartina* (Chapman 1977). Stands of *Puccinellia stricta* on the mainland were described by Bridgewater (1982) as *Puccinellietum strictae*. This association is also found in New Zealand (Thannheiser & Holland 1994). On salt marshes with low vegetation resembling salt meadows, perennial glassworts (*Sarcocornia quinqueflora* and *S. blackiana*) are frequently found. The mainland glasswort-associations have been described by Bridgewater (1982) as *Sarcocornietum quinqueflorae* and *Sarcocornietum blackianae*. *Sarcocornietum blackianae* is usually on higher ground than *Sarcocornietum quinqueflorae* (Figure 1), and both are widespread throughout Tasmania (Figure 6).

Dense stoloniferous carpets are formed by *Samolus repens* and *Selliera radicans* with *Samolus* colonising lower areas of salt marshes (Figures 7 and 9). Zonation is evident but mixed stands can occur. Adam et al., (1988) found both communities in the coastal salt marshes of New South Wales. Likewise Thannheiser & Holland (1994) found them in New Zealand and depicted them in a constancy table. Haacks (2003) described both stands in New Zealand as the associations *Samoletum repentis* and *Sellierietum radicantis* respectively. As shown in Figure 6, both are widespread. *Samolus repens* and *Selliera radicans* are typical of salt meadows within the Australian floristic area and it seems reasonable to follow Bridgewater (1982) who termed this class of salt meadow *Samolo-Suaedetea*. Besides glasswort, *Suaeda australis* is the most frequent plant in Tasmanian salt marshes. Based on 17 phytosociological records, *Suaeda australis* characterises the association *Suaedetum australis*, described by Thannheiser (2003). Figure 6

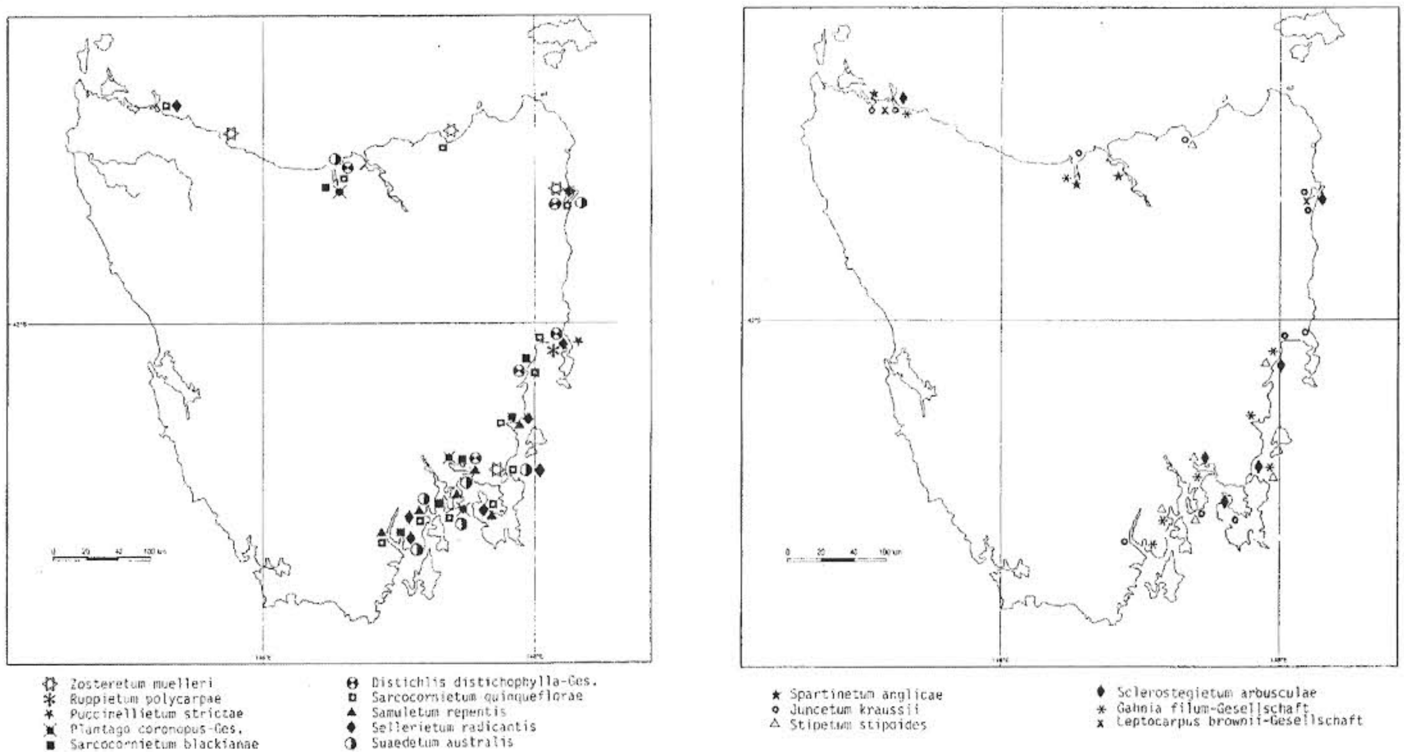

Figure 6: Distribution of the vegetation units of the salt marshes in Tasmania.

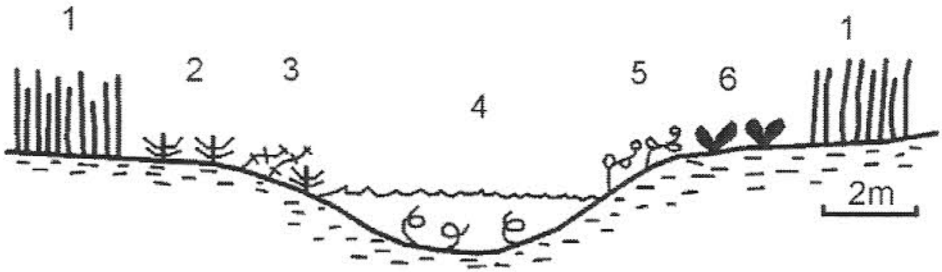

Figure 7: Diagram showing the zonation in salt marshes of Bagot Point (21.03.1998).

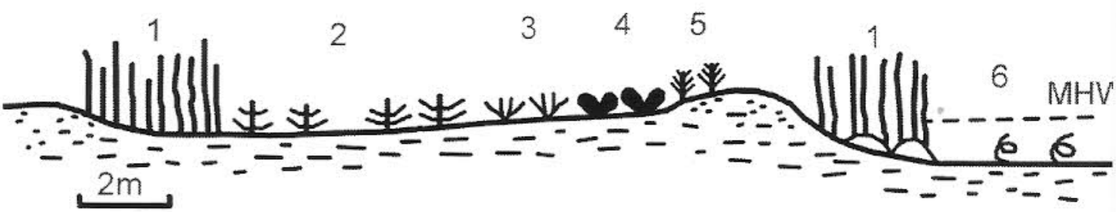

Figure 8: Diagram showing the zonation in salt marshes of Moulting Lagoon (20.03.1998).

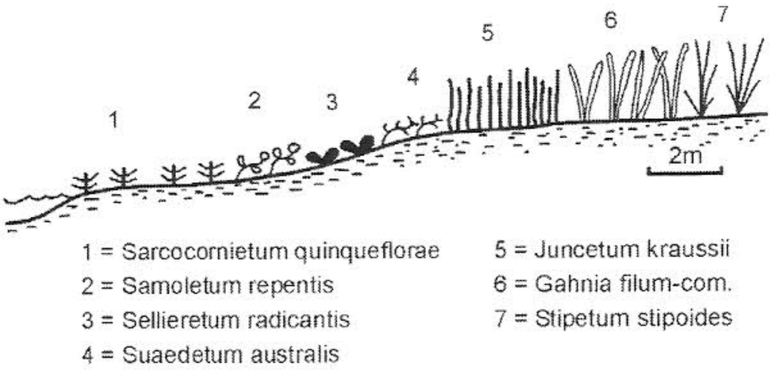

Figure 9: Diagram showing the zonation in salt marshes near Cygnet (24.03.1998).

shows how widespread this association is on the Tasmanian coast. The phytocenoses *Distichlis distichophylla*-community and *Plantago coronopus*-community cannot be regarded as associations from the data. It seems, however, that the *Distichlis distichophylla*-community is close to the *Triglochino-Distichlietum* of Bridgewater (1982). The *Plantago coronopus*-community prefers soil with sandy and stony substrate. In the vertical zonation of the salt marshes, it occurs above the typical salt marsh vegetation and will be periodically flooded. It is noteworthy that the community prefers edges of terraces, where components of the littoral fringe are frequently deposited. The greyish colour of the small rosettes, by which it differs conspicuously from the otherwise green salt meadows, is very typical for the community. The *Plantago coronopus*-community is very resistent to trampling; because of the low habit of the stand-forming species, it is hardly browsed.

High salt marsh communities

The second vegetation type is characterised by taller plants and contains rushes, grasses, reeds and shrubby plants. Six vegetation units (*Juncetum kraussii*, *Spartinetum anglicae*, *Sclerostegietum arbusculae*, *Stipetum stipoides*, *Gahnia filum*-community and *Leptocarpus brownii*-community) are common on higher ground (Figure 3), and *Juncetum kraussii* forms large patches in the outer and lower parts (Figure 7). This phytocoenose is widespread in Tasmanian salt marshes (Figure 6). The *Juncetum kraussii* was demonstrated by Bridgewater (1982) from South-Australia (including Tasmania) through a phytosociological table. In 1974, Chapman mentioned a *Juncetum* *maritimi australiensis* from New Zealand synonymous with the Australian *Juncetum kraussii* (see Thannheiser & Holland 1994). In river mouths on the north coast, the introduced cord-grass *Spartina anglica* (Figures 5 and 6) grows in dense stands. In these areas the tidal range is higher and the supply of nutrients brought down by rivers is significant. It seems reasonable to regard monospecific stands as *Spartinetum anglicae* (Corrillon 1953). The first introduction of *Spartina anglica* into Tasmania took place in 1927 but definite establishment was not reported until 1947 (Adams 1981). Due to its extreme flooding tolerance, Adams (1981) suggested a posing threat of invasion to the uppermost part of eel-grass beds. Furthermore, *Spartina* spreads quickly even through higher regions of salt marshes (Figure 5).

The shrubby association, *Sclerostegium arbusculae*, was described by Bridgewater (1982) for the first time in South Australia (including Tasmania), and supported by a plant sociological table. *Sclerostegia arbuscula* is a chenopod and grows to 2 m (Figure 3). Because of this plant, the salt marshes of Tasmania resemble the Japanese semi-mangrove (*Hibiscetum hamabo*) in their physiognomy. The *Sclerostegietum arbusculae* is widespread in Tasmania (Figure 6). In general, such a shrubby association is typical for arid and semi-arid tropical and subtropical coasts, respectively (Adam, 1990). The boundary between halophytic coastal vegetation and glycophytic inland vegetation is characterised by two vegetation units, *Gahnia filum*-communitiy and *Stipetum stipoides*. That reflects a marine influence and they occur in strips parallel to the coast (Figure 9). Typically, a girdle of *Stipetum stipoidis* forms the highest phytocoenose in coastal salt marsh. The *Gahnia filum*-community grows mostly on lower ground than *Stipetum stipoides*. For Tasmania and the south coast of Australia, Bridgewater (1982) obtained a phytosociological table with five records of *Stipetum stipoidis* virtually coinciding with our nine Tasmanian records. Figure 6 shows that both phytocoenoses are widespread in Tasmania. The phytocenoses *Leptocarpus brownii*-community cannot be regarded as associations from the data. The native restionad *Leptocarpus brownii*-community needs further investigation. This phytocoenose resembles the *Apodasmia similis*-community of New Zealand physiognomically as well as ecologically. *Apodasmia similis* is the new name for *Leptocarpus similis* according to the revision by Briggs and Johnson (1998).

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References

Adam, P. 1981: Australian Saltmarshes, *Journal of the Coast and Wetlands Society*, 1(1), 8-10.

Adam, P., Wilson, N.C. and Huntley, B. 1988: The phytosociology of coastal salt marsh vegetation in New South Wales, *Journal of the Coast and Wetlands Society*, 7(2), 35-66.

Adam, P. 1990: *Saltmarsh ecology*. Cambridge University Press, New York, Sydney

Braun-Blanquet, J. 1964: *Pflanzensoziologie*. Grundzüge der Vegetationskunde. 3. ed., Wien

Bridgewater, P.B. 1982: Phytosociology of coastal salt marshes in the mediterranean climate region of Australia, *Phytocoenologia*, 10, 257-296.

Briggs, B.G. and Johnson, L.A.S. 1998: New combinations arising from a new classification on non-African Restionaceae, *Telopea* 8, 21.

Buchanan, A.M. 1995: A census of the vascular plants of Tasmania. *Tasmanian Herbarium Occasional Publ.* 5, 1-93, Hobart.

Chapman, V.J. 1959: Salt Marshes and Ecological Terminology. *Vegetation* 8 (4), 215-234.

Chapman, V.J. 1974: *Salt marshes and salt deserts of the world*, Lehre.

Chapman, V.J. 1977: Introduction, in van der Maarel (ed), *Wet coastal ecosystems. Ecosystems of the World 1*, Amsterdam, New York, 1-29.

Curtis, W.M. 1963: *The student's flora of Tasmania, Part 2 (Angiospermae: Lythraceae to Epacridaceae)*, Hobart, 225-474.

Curtis, W.M. 1993 reprinted: *The student's flora of Tasmania, Part 3 (Angiospermae: Plumbaginaceae to Salicaceae)*, Hobart, 465-661.

Curtis, W.M. and Morris D.I. 1993 reprinted: *The student's flora of Tasmania, Part 1 (Angiospermae: Ranunculaceae to Myrtaceae)*, Hobart, 1-239.

Curtis, W.M. and Morris D.I. 1994: *The student's flora of Tasmania, Part 4B (Angiospermae: Alismataceae to Burmanniaceae)*, Hobart, 1-459.

Dickinson, K.J.M. and Mark, A.F. 1999: Interpreting ecological patterns in an intact estuary, Southwest New Zealand World Heritage Area. *Journal of Biogeography* 26 (4), 913-932.

Haacks, M. and Thannheiser, D. 2003: The salt-marsh vegetation of New Zealand, *Phytocoenologia* 33(2), 267-288.

Haacks, M. 2003 (in press): *Die Küstenvegetation von Neuseeland*, Mitteilungen der Geographischen Gesellschaft Hamburg, Band 95. Stuttgart.

Harris, S. and Kirkpatrick, J.B. 1997: *The Coastal Vegetation of Northeast Tasmania*, Records of the Queen Victoria Museum and Art Gallery, 103, 121-132.

IPIECA 1994: *Biological Impacts of Oil Pollution: Saltmarshes.* IPIECA Report No. 6, International Petroleum Industry Environmental Conservation Association, London.

Kelletat, D. 1994: Der Einfluss von Riesentangen auf die Küstenformuung in Tasmanien und Neuseeland, *Geoökodynamik* 15, 1-28.

Kirkpatrick, J.B. 1993: Dry coastal ecosystems of southeastern Australia, in van der Maarel, E (ed), *Dry coastal ecosystems. Africa, America, Asia and Oceania. Ecosystems of the World 2B*, Amsterdam, New York, 273-288.

Kirkpatrick, J.B. and Glasby, J. 1981: Salt marshes in Tasmania - Distribution, Community Composition and Conservation. *Dept. of Geography, University of Tasmania, Occasional Paper* No. 8, Hobart.

Köppen, W. 1936: *Das geographische System der Klimate*, Berlin, Nachdruck Nendeln 1972

Saenger, P.M., Specht, M., Specht, R.L. and Chapman, V.J. 1977: Mangal and coastal salt-marsh communities in Australasia, in Chapman, V. J. (ed), *Wet Coastal Ecosystems. Ecosystems of the World 1*, Amsterdam, Oxford, New York, 293-345.

Scanlon A.P., Fish, G.J. and Yaxley, M.L. 1990: *Behind the scenery.- Tasmania's landforms and geology*, Department of Education and the Arts, Tasmania Australia.

Schroeder, F.G. 1998: *Lehrbuch der Pflanzengeographie.* Quelle & Meyer Verlag, Wiesbaden.

State of the Environment Tasmania 1996: *Volume 1 Conditions and trends, State of the Environment Unit*, Hobart.

Thannheiser, D. and Holland, P. 1994: The plant communities of New Zealand salt meadows, *Global Ecology and Biogeography Letters*, 4, 107-115.

Thannheiser, D. 2003: Neuere Pflanzenassoziationen in den Salzmarschen Tasmaniens, *Hamburger Vegetationsgeographische Mitteilungen* 17: 73-79.

Williams, W.D. 1974: Introduction, in Williams, W.D. (ed), *Biogeography and Ecology in Tasmania*, The Hague.