

A review of biodiversity in wetlands with organic sediments on the Swan Coastal Plain, Western Australia, with an emphasis on aquatic invertebrates

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Abstract

Wetlands on the Swan Coastal Plain with sediments composed largely of organic matter include those with soft oozes, largely derived from decaying phytoplankton, and those with coarser peaty sediments derived from vascular plants. The former appear to have a flora and fauna very similar to wetlands with mineral dominated sediments. Peat deposits on the Swan Coastal Plain are not common but occur where permanent moisture, during past or present climatic regimes, has allowed production of plant material to exceed decomposition. Active peat deposition is largely restricted to *Baumea* and *Melaleuca* dominated swamps and a small number of mound springs. These wetlands tend to support species of aquatic invertebrates that are rare or absent elsewhere in the region and which frequently represent outlier populations of species more common in less xeric regions. This is also true of some plant species occurring on the mound springs. Fire can dramatically alter such wetlands when it burns the organic sediments and poses a threat to their biota.

Keywords: peat, biodiversity, aquatic invertebrates, Swan Coastal Plain wetlands

Introduction

All wetland sediments contain organic matter, derived from dead and decaying animals and plants. Under certain conditions, generally involving low oxygen concentrations in permanently moist situations, this material accumulates faster than it decomposes and can come to compose almost the entire wetland bottom, sometimes to a depth of several metres (Clymo 1983). Organic sediments of Swan Coastal Plain (SCP) wetlands range from fine silty oozes of deeper lakes derived from phytoplankton production settling out on the lake bottom to that formed by coarser organic matter, usually called peat. The peat is derived from decaying vascular plant material that accumulates in shallow swamps or in stands of sedges fringing open lakes (herbaceous peats *sensu* Kivenen 1977). A particular type of peat-based wetland on the Swan Coastal Plain are the mound springs that occur along the eastern edge of the Bassendean Sands that have formed due to localised peat build-up around groundwater discharge points at the boundary between the permeable Bassendean Sands and the impermeable Guildford Clays (Knott & Jasinska 1998). Active peat deposition is otherwise largely restricted to wetlands with dense stands of *Baumea* but substantial peat deposits are rare on the SCP. Semeniuk & Semeniuk (2005, this issue) provide a review of the extent and formation of organic wetland sediments in the region. Wetlands with organic sediments, especially those with peat sediments, are often characterised by coloured water, low pH, low productivity, dense vegetation, shade, shallow depths and perennial moisture (albeit subsurface moisture where surface water is only

present seasonally). These characteristics, probably more so than the immediate effects of the physical presence of organic matter, influence the composition of the biota and can lead to biological communities that are distinct from those in other types of wetlands. The summer drying of surface sediments in many of these wetlands makes them prone to fire, resulting in loss of organic matter and other chemical and physical changes (see Horwitz & Sommer 2005, this issue).

The following review of biodiversity in organic wetlands of the Swan Coastal Plain was produced for a workshop on Preventing Burning in Organic Wetlands organised by Edith Cowan University and Fire and Emergency Services Association. I will concentrate on the aquatic invertebrates and provide brief comment on some aspects of the flora and waterbirds, although terrestrial and edaphic invertebrates are also likely to be diverse and to show some association with humic soils around wetlands.

Aquatic invertebrates

A recent review of aquatic invertebrates recorded from the Swan Coastal Plain identified 332 taxa (Horwitz, unpublished manuscript), some of which are likely to represent multiple species (*e.g.*, unidentified nematodes, copepods, water mites and some dipteran families). In addition, while rotifers represent 15–20 % of invertebrates present in other regions of WA (Halse *et al.* 2000; Pinder *et al.* 2004) they have received virtually no attention on the Swan Coastal Plain. Some other microinvertebrates, such as chydond cladocerans are also poorly surveyed. This, and the fact that a relatively small number of wetlands have been thoroughly surveyed,

suggests that the number of species inhabiting the region's wetlands is likely to be in excess of 500. However, few of the known species are restricted to the Swan Coastal Plain and only about 15 % are even endemic to south-west Western Australia (P. Horwitz, Edith Cowan University, unpublished manuscript).

The most comprehensive study of wetland invertebrates was undertaken by Davis *et al* (1993) and aimed, in part, to classify SCP wetlands on the basis of their invertebrate fauna and to relate patterns of invertebrate occurrence to environmental variables. A cluster analysis of wetlands based on invertebrate community composition produced several groups of wetlands, including one consisting primarily of coloured and/or seasonal wetlands. Colour of the water (due to dissolved humic substances), hydrological seasonality, pH, nutrient concentration and salinity were all correlated with invertebrate community composition. Some sediment organic content data was collected by Davis *et al* (1993) but were not used in their analyses and could not be sourced for this workshop. However, peat-based wetlands tend to be seasonal and to have coloured waters with low pH, more so than wetlands with fine lacustrine organic sediments (mud, organic ooze and periphyton) or mineral sediments, so are likely to contain a distinctive, though variable, suite of species. In the study by Davis *et al* (1993), no species were restricted to coloured seasonal wetlands but some, such as the copepod *Calamoecia attenuata* and an oribatid water mite were more likely to occur in such wetlands than elsewhere. Some open lacustrine wetlands, such as Lakes Goollellal and Thomson, have sediment with moderately high organic content (Davis *et al.*, 2003). However, there is little evidence that they have invertebrate faunas distinct from otherwise similar wetlands with mineral sediments. The following discussion is thus restricted to the more peat-based swamps and springs. More recent studies of peat swamps and mound springs have shown that some have unusual elements in their invertebrate faunas, including species that are otherwise rarely recorded on the SCP and some which appear to represent northern outliers from more mesic south-west distributions.

A survey of invertebrates of Lake Tamworth, a sedge swamp with deep (>1 m) peat sediment near Baldy, undertaken as part of an impact statement for a peat mining proposal, found 48 species of macroinvertebrates, most of which are common on the Swan Coastal Plain and occur in other types of wetlands (Streamtec Pty Ltd 1991). Exceptions were the caddisflies *Ecnomina sentosa* (Ecnomidae) and an unidentified species of Philopotamidae. These insects, typical of streams in the Jarrah Forest and far south-west, have not been recorded elsewhere on the SCP, other than one record of the *E. sentosa* from a river near Busselton (Sutcliffe 2003), so their presence in this swamp needs to be verified. An acidic coloured swamp in Melaleuca Park on the Gnaragar Mound near Bullsbrook, with a less substantial layer of peat (< 10 cm) overlying peaty sand (to 20 cm), is home to a population of the Black Striped Minnow (*Galaxias nigrostriata*) (Knott *et al* 2002). This is 350km north of its main area of distribution: between Augusta and Albany where it also inhabits acidic peat swamps (Morgan *et al* 1996). Its persistence at this site was

attributed to the highly coloured water which allowed cool temperatures to persist at depth (< 16° C during the day in late spring 1995) and the presence of a spring which kept a small part of the wetland permanently moist during summer. Knott *et al* (2002) also found numerous chydorid cladocerans at this site, including a species of *Rak*. The latter was originally identified as *Rak obtusus*, believed at the time to otherwise only occur in similar habitats near Northcliffe in WA and in eastern Australia. However, the Northcliffe specimens are now known to be an undescribed species and the Melaleuca Park *Rak* could be different again since two other undescribed species are known from south-west WA (R Shiel, Adelaide University, pers. comm.). The genus has not been reported from elsewhere on the SCP but few studies have reliably sampled microcrustacea in the region.

The peat-forming mound springs on the eastern edge of the Gnaragar groundwater mound are listed as a Threatened Ecological Community (English & Blyth 2000) under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. This recognition is largely based on their aquatic invertebrate communities. Two of these, plus several other springs (some of which also had peat deposits at their discharge points), were sampled by Jasinska & Knott (1994). These were found to have diverse and heterogeneous invertebrate assemblages: the total of 147 species included 84 that occurred in the springs with peat and 54 found only in such springs. Jasinska & Knott (1994) indicated that some of the species occurring in the peaty springs had not been recorded in other SCP wetlands and there appeared to be a particularly high diversity of copepods (including *Paracyclops* spp. which appear to be uncommon in lacustrine wetlands of the SCP). Unfortunately, taxonomic impediments, including a lack of consistent morphospecies coding between research groups, prevent detailed comparisons with other SCP studies. Some, such as the ostracod attributed to *Darwinula* (this genus has since been revised and split into several genera), may be widespread in the source groundwater aquifer. Jasinska (1998) and Pinder (2003) added to the species lists for the mound springs (including one not sampled previously), recording new species of water mites (including the first WA records of Anisitellidae and a new genus of Aturidae) and the hydrophilid beetle *Coelostoma ?fabrieii*, which is uncommon on the SCP. Two species of dragonflies collected from these springs are also rare on the SCP but relatively common in the Jarrah Forest and Warren regions (Sutcliffe 2003): *Archaeosynthemis ?leachi* which inhabits permanent streams, boggy seepages and swamps and *Austrogomphus lateralis*, which mostly inhabits permanent streams and swamps (Watson 1962; Sutcliffe 2003). Similarly, *Ecnomina* sp. AV18, was collected from one of these springs but is otherwise known only from peaty swamps of the southern Darling Range, Warren region and south-coast (Sutcliffe 2003). The mosquito *Culiseta atra*, which most frequently occurs in coloured standing water bodies with decaying vegetation, also occurs in these springs but not in more open lakes of the SCP.

Similar organic mound springs on the western slopes of the Dandaragan Plateau near the town of Three

Springs have also been shown to have populations of invertebrates, including the dragonfly *Archaeosynthemis occidentalis*, an undescribed chironomid (non-biting midge) and two phreodrilid oligochaetes, that otherwise occur much further south (Pinder 2002; Pinder & Penniford 2002) and to have communities unlike those found in other wetland types of the region (Pinder *et al.*, 2004). *Culiseta atra* also occurs in these mound springs, well north of other published populations. These springs are also recognised as a Threatened Ecological Community (recovery plan in preparation) and are prone to damage by fire.

In summary, vegetated swamps and springs with peat deposits provide habitat for a range of aquatic invertebrates that appear to be uncommon or absent in other types of wetlands on the SCP, though more survey work is required to document the extent of this. In particular, the aquatic microinvertebrate fauna (rotifers, ostracods, copepods and cladocerans) is poorly surveyed on the SCP. These groups are turning out to be very diverse and endemic in south-western Australia, with numerous new species being described from dystrophic and/or ephemeral wetlands of the far south-west (*e.g.*, Frey 1991; Segers & Shiel 2003). Similar wetlands of the Swan Coastal Plain may also contain undescribed microfaunal diversity.

Waterbirds

All 116 waterbirds known from south-western Australia have been reported from the SCP. A quantitative survey by Storey *et al.* (1993) recorded 79 species and found that those SCP wetlands with high richness and abundance of waterbirds tended to be the deeper, larger wetlands with high productivity, low colour and plenty of fringing emergent vegetation. Sediment characteristics were not measured in that survey but peat wetlands are generally not characterised by these correlates of high waterbird usage. In particular, peat swamps are generally not productive enough to provide sufficient food resources for rearing young and many are shallow with little open water so are unsuitable for supporting large numbers of ducks. Halse *et al.* (1993) found many waterbirds to be positively associated with deep permanent wetlands but few associated with shallow seasonal wetlands in south-western Australia. Several species were positively associated with extensive sedges, including bitterns (Australasian and little), crakes (Baillon's, spotted, spotless), musk ducks, purple swamphens, reed warblers and little grassbirds. These species are particularly likely to be associated with vegetated peat swamps of the SCP.

Flora

Of the wetlands with active peat deposition on the SCP, the mound springs have the most interesting plant communities. These wetlands, dominated by *Melaleuca raphiophylla* over sedges, especially *Cyathochaeta teretifolia*, have now mostly dried up or have been excavated (to create farm dams) or have been cleared of vegetation (English & Blyth 2000) and some have been damaged by fire. These are mostly recognised as a

Threatened Ecological Community for their distinct invertebrate fauna, but the three remaining occurrences also contain a number of plant species that are either highly disjunct or are south-west WA or Darling Range species that are otherwise uncommon on the SCP.

Examples include several liverworts (*e.g.*, *Gleobelobryum ungriculatum*), ferns and fern allies (*Cyclosorus interruptus* and *Lycopodiella serpentina*), orchids (*Corybas dilatatus*), sedges (*Cyathochaeta teretifolia* and *Empodisma gracillimum*), shrubs (*Hibbertia perfoliata* and *Boronia molloyae*) and trees (*Homalosperinum firmum*). *Hibbertia perfoliata* was presumed to have become extinct on the SCP until found on these mound springs recently. These mound springs are prone to fires, especially in dry years, destroying the peat and allowing weed invasion. Extraction of water from the Gnangara Mound may exacerbate this threat if the hydrology of the springs is affected.

Accumulation of coarse organic material also occurs in swamps dominated by *Baumea* sedges but, unlike the mound springs, these wetlands do not seem to support plant species that are particularly rare on the SCP or outside of their core ranges.

Conclusions

Most plant and animal species that inhabit wetlands with peaty sediments of the SCP are widespread and occur in other types of wetlands on the plain and usually elsewhere. However, for a range of species that are otherwise rare or absent on the SCP, such wetlands provide moist refuges in a generally xeric region. These are mostly species whose distributions are otherwise either broad but disjunct or centred on more mesic parts of the south-west. Fire can destroy the organic sediments and lead to significant changes to the physical and chemical nature of peat-based wetlands and is thus a significant threat to their biodiversity and to the continued occurrence of numerous individual species on the SCP.

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