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# TAY SALT MARSH SEDIMENT FABRICS

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## ABSTRACT

*Silts trapped within broken stems of the reed Phragmites communis form plugs which fall to the marsh floor as organic decay destroys the stem. The plugs form cylindrical plant-wrapped nodules within the sediments. Such structures have formerly been attributed to infilled roots, but the reed rhizomes of the Tay marshes collapse after death and are flatteneded, not filled.*

## INTRODUCTION

In the 250 hectares of Phragmites communis marshes which dominate the northern shores of the upper Tay estuary of the east coast of Scotland (Fig. 1), reed densities normally range between 90 and 150 stems per m$^2$. The brackish water reed Phragmites characteristically grows to heights of 2.5–4 m above the marsh surface during the period April to September, after which the shoots die back (Ingram *et al.*, 1980). The empty stems or canes are susceptible to damage through wind and wave activity, although the latter is restricted by the 1–4 km wide tidal flats which front the marshes. Along the marsh-tidal flat border, 45–65% of the stems are snapped off; fracturing is concentrated in the weak areas between well defined growth nodes, which are normally spaced at intervals of about 15 cm. The broken stems are swept away by the tidal waters. The reeds are used for roof thatching, and during harvesting all stems are cut to within 20 cms of the sediment surface. On the outer edge of the marsh a 5 m wide zone is left uncut for environmental protection.

The cut stems, 1–2 cm in diameter, are exposed to subsequent flooding by tidal waters. The diurnal tide range is 3.5–5 m in the Tay estuary, and this leads to inundaiton of the Phragmites marsh by up to 1.5 m of water. The tidal waters contain suspended sediments in concentrations ranging from 20 mg/l to 250 mg/l in the nearby principal channels, but the concentrations are generally more homogeneous at 20–40 mg/l in the suspensions off the marsh margin during most high water **periods.**

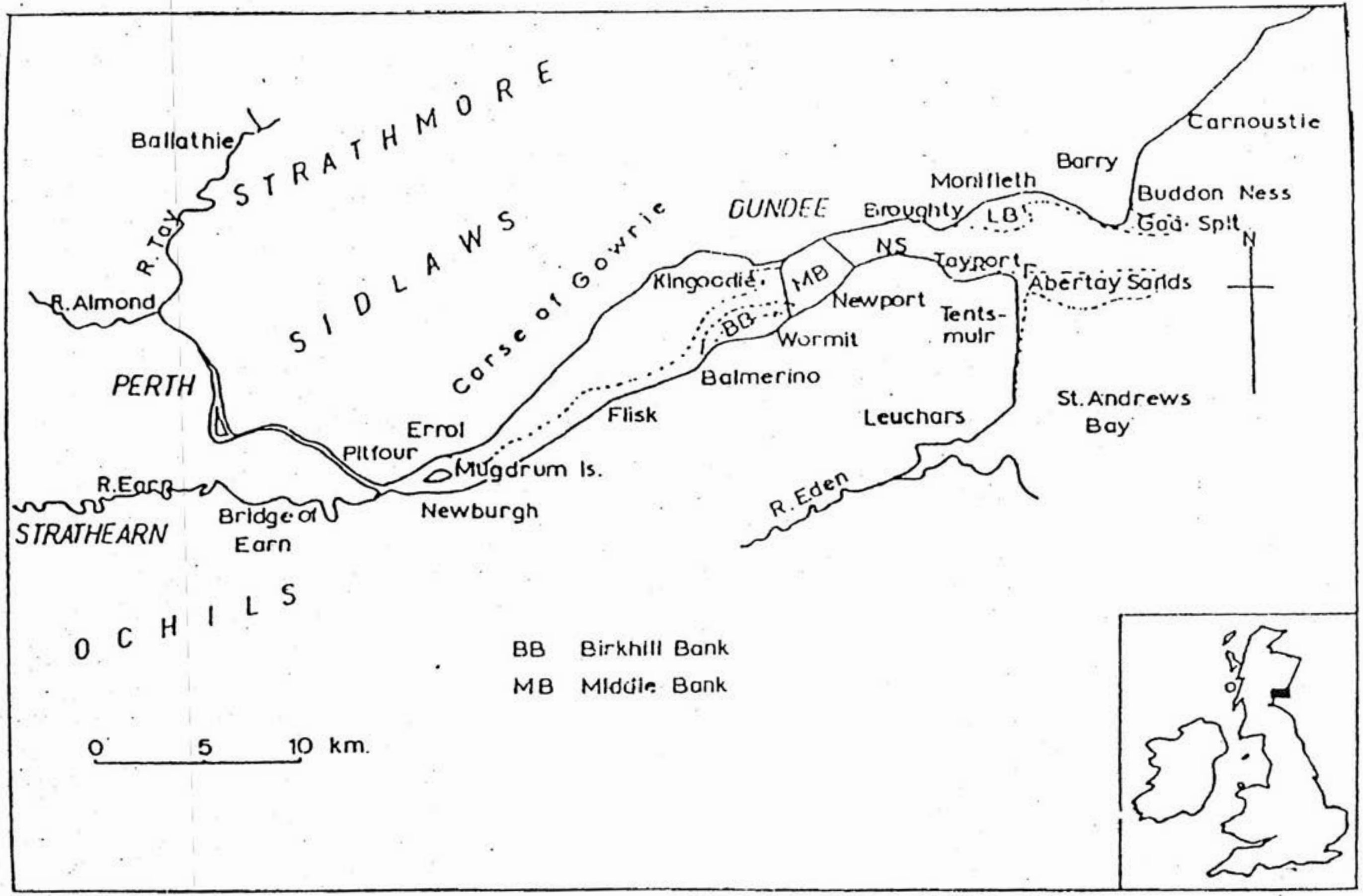


Fig. 1. A general locality map of the Tay estuary (after Buller *et al.*, 1971).

## SEDIMENTATION WITHIN REED STEMS

From these very gently moving tidal waters suspended sediment particles settle within the marshes. Some particles fall to the marsh floor to accumulate around the bases of the stems but other material accumulates within the broken stems (Fig. 2). Sediments retained within the stems show median diameters of 18–38 μm and have between 20 and 35% content of organic matter. Depending upon the depth of inundation and the degree of stirring of the waters by wind or wave activity, daily increments of 0.01 to 0.07 g per stem are entrapped; the average is 0.04 g per stem (Alizai and McManus, 1980). Measurements were carried out during only relatively calm conditions, and in severe storms the weights added may rise substantially above the maximum determined here.

In individual stems plugs of sediment accumulate during the winter, the plug-fill weights depending partly upon the length and diameter of the stem available for entrapment. Thus by late spring individual reed stems may contain an average of 12 g of sediment, and some contain much more (20 g maximum measured). The material entrapped is well layered and has the opportunity to dry out partly between tides. Thus, but the start of the next growth season, in which completely new stems are generated, partly hardened sediment-filled plugs are present in the older defunct stems, particularly along the channel/ward margin of the marsh.

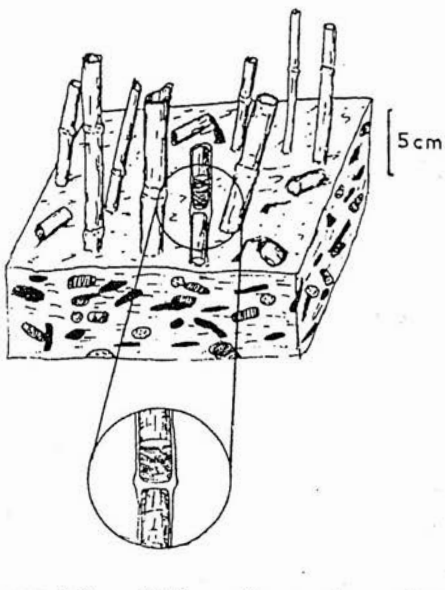


Fig. 2. Diagrammatic representation of *Phragmites* marsh surface illustrating standing and collapsed stems. Below the surface black cavites are from empty roots and textured nodules from stem-collapse masses. Both are lined with vegetable matter.

## REED STEM COLLAPSE 'NODULES'

The reed stem, especially that part beneath the plug, becomes weakened by rotting and decay, so that ultimately the sediment plug enrapped by organic matter falls to the marsh surface. The soft, low density marsh surface muds are readily displaced and part to permit the wrapped and partly hardened plug to sink into the sediment surface, to become incorporated as a separate, quite recognisable entity within the sediments. Many plugs retain the veneer of plant matter around the hardened and usually layered core. The layering results from the variation of grain sizes buoyed up in the waters under different dynamic conditions.

## CONCLUSION

Although many researchers have referred to burrows and root mottles in marsh sediments, few detailed studies of their development or of the assmblages are available for areas outside the marshes of California, North Carolina and Gorgia (Frey and Basan, 1978). Most of these are related to Juncus (Edwards and Frey, 1977) or Spartina marshes (Gallagher, 1974) rather than to the more brackish water Phragmites marshes.

In many areas marsh sediments are intensely bioturbated and no laminati is present, but elsewhere trenches, cores or peels reveal marsh sediments to have a lumpy or nodular texture with wavy lamination (Evans, 1965; Coleman and Gagliano, 1965; Reineck, 1970; Pestrong, 1972; Roberts and Graves, 1972). Small masses of sediment with circular or partially cylindrical cross sections occur within the irregularly laminated deposits.

In most cases the 'nodules' are of sediments of identical particle sizes to those of the host sediments and these are most frequently referred to as infilled root systems. In the Tay estuary the reed systems collapse as the organic matter decays, so that they are preserved only as thin streaks of organic debris; whereas the infilled stems, alone, have the ability to fill with sediment and form recognisable entities with preservation potential.

In some marsh sequences, sandy cylindrical bodies occur within the normal marsh muds, as along the northern shore of the Eden estuary which is also on the Scottish east coast. In such sites the material entrapped within the reeds is seen to be of medium to fine sand, although directly landward of a muddy tidal flat. Strong wave motion carries sand in suspension from the open North Sea during severe weather, and the laterally restricted muddy flats are swept clean of sand during the falling tide. We have observed similar sand entrapment in open fractured plant stems in lagoonal marshes behind barrier beach ridges north of the Gironde estuary (France), along the shores of Lake Maggiore (Italy) and on the banks of the Mississippi and Atchafalaya Rivers (U.S.A.).

In consequence, it is suggested that the mechanism of entrapment of silt and sand in open stems may be more important for the development of the nodular marsh sediment textures seen in some cores than the root systems.

Furthermore the retention of sediment within the stems appears to be a hitherto unrecognised and significant contributor to the siltation induced by

Phragmites. Volumetrically it may be as important as the more traditional 'baffling' effect of the stems. The effect on deposit fabrics is locally very significant.

## REFERENCES


Alizai, S.A.K. & McManus, J., 1980. The significance of Reed Beds on siltation in the Estuary. Proc. Roy. Soc. Edinb, B, 78, 1—14.

Coleman, J.M. & Gagliano, S.M., 1965. Sedimentary structures: Mississippi River deltaic plain. in Middleton, G.B., (ed.) Primary Sedimentary Structures and their hydrodynamic interpretation. Spec. Publ. 12, Soc. Econ. Palaeont. Mineral. Tulsa, 133—148.

Edwards, J.M. & Frey, R.W., 1977. Substrate characteristics within a Holocene salt marsh, Sapelo Island, Georgia. Senckenberg. Marit. 9, 215—259.

Frey. R.W. & Basan, P.B., 1978. Coastal Salt Marshes. in Davis, R.A. (ed). Coastal Sedimentary Environments. Springer-Verlag, New York, 102—169.

Evans. G., 1965. Intertidal flat sediments and their environments of deposition in the Wash. Quart. J. Geol. Soc. London 121, 209—245.

Gallagher, J.L., 1974. Sampling macro-oroganic matter profiles in salt marsh plant root zones. Soil Sci. Amer. Proc. 38, 155—155.

Ingram, H.A.P., Barclay, A.M., Coupar, A.M., Glover, J.G., Lynch, B.M. & Sprent, J.I., 1980. Phragmites performance in Reed Beds in the Tay Estuary. Proc. Roy. Soc. Edinb. B, 78, 89—108.

Pestrong. R., 1972. Tidal flat sedimentation at Cooley Landing, southwest San Francisco Bay. Sed. Geol. 8, 251—288.

Reineck, H.E. (Ed.), 1970. Das Watt. Waldemar Kramer, Frankfurt am Main, 142 00.

Roberts, H.H. & Graves, W.E., 1972. Thermoluminescence: A tool for the environmental analysis of recent sediment cores. J. Sediment. Petrol. 42, 146—149.