

Chemotyping the lignin of *Posidonia* seagrasses

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A recent paper in Organic Geochemistry entitled "Radically different lignin composition in *Posidonia* species may link to differences in organic carbon sequestration capacity" discusses the remarkable difference in lignin chemistry between two kinds of "Neptune grass", i.e. *Posidonia oceanica* and *Posidonia australis*.

A recent paper in Organic Geochemistry entitled "Radically different lignin composition in *Posidonia* species may link to differences in organic carbon sequestration capacity" discusses the remarkable difference in lignin chemistry between two kinds of "Neptune grass", i.e. *Posidonia oceanica* and *Posidonia australis*.

Initial efforts using analytical pyrolysis techniques (Py-GC-MS and THM-GC-MS) showed that the endemic Mediterranean member of the *Posidonia* genus, *P. oceanica*, has abnormally high amounts of *p*-HBA (*para*-hydroxybenzoic acid) whereas the down-under variety does not. State-of-the-art lignin characterization in Seville (DFRC, 2D-NMR) showed that the *p*-HBA is part of the lignin backbone, and not glycosylated as initially expected, and *P. oceanica* is now the producer of the most extensively *p*-HBA-acylated lignin known in the Plant Kingdom.

Only the Mediterranean *Posidonia* (= *P. oceanica*) creates massive submarine peat deposits called mats. And only *P. oceanica* has *p*-HBA-burdened lignin. The paper in Organic Geochemistry discusses the likeliness of the peculiar lignin structure as the main cause of the differences in their potential to accumulate debris in mats: microbes would not be able to decompose it.

Here we will have a look at a bit of unpublished data on a third *Posidonia* species. More specifically, we discuss the composition of the sheath materials of *Posidonia sinuosa*, which is endemic to western and southern Australia. Contrary to *P. oceanica* and *P. australis*, for this species the molecular characterization was not performed for a range of anatomical sections of the seagrass (leaf blade, leaf sheath, rhizome, root) but for the leaf sheath only. This is the part where lignin is concentrated and therefore its analysis is thought to be representative of the lignin features of this plant species.

From the Py-GC-MS and THM-GC-MS data, the *P. sinuosa* is much more similar to its southern relative than to the Mediter-



Fig. 1. *Posidonia oceanica* mat deposits in Portlligat (Western Mediterranean). Photo: Kike Ballesteros

anean high-carbon accumulator (see figure below), but it probably contains slightly more *p*-HBA than *Posidonia australis*. *Posidonia sinuosa* is not capable of producing big mat deposits neither, and it is tempting to conclude that there is a link between the palatability of different species of *Posidonia* seagrasses (by microbes, that is) and the abundance of *p*-HBA in the lignin backbone, even though definitive evidence has yet to be presented.

In a similar fashion as land plants, *Posidonia* species are major sequesters of atmospheric carbon. Considering that they also manage to store it in millenary years old sea-peat deposits, storing many gigatons of carbon that would otherwise raise CO₂ pressures, it is not surprising that these seagrass habitats, which are, despite of the numerous governmental entities that have developed programs for their protection -including cultivation programs-, in dire need of conservation.

Even though the Australian and Mediterranean genera diverged tens of Millions ago (possible associated with the closure of the Tethys Sea), it is striking that members of the same family can have such a remarkable difference in the structure of their skeletons: lignin is not a minor chemical but it accounts for up to 30 % of the seagrasses dry weight and is the largest biomolecular constituent after holocelluloses.

FURTHER READING

[Evolutionary history of the seagrass genus *Posidonia*](#), by Tania Aires et al.

[Linking seed photosynthesis and evolution of the Australian and Mediterranean seagrass genus *Posidonia*](#), by David Celdran et al.

[Current conservation status](#) of *Posidonia* bed ecosystems defined by the EU (European Environment Agency).

[Posidonia cultivation at Aegadian Islands](#), and at the [Balearic Islands](#).

[Global carbon stocks in seagrass ecosystems](#), by James Fourqurean et al.

[Molecular composition of plant parts and sediment organic matter in a Mediterranean seagrass \(*Posidonia oceanica*\) mat](#), by Joeri Kaal et al.

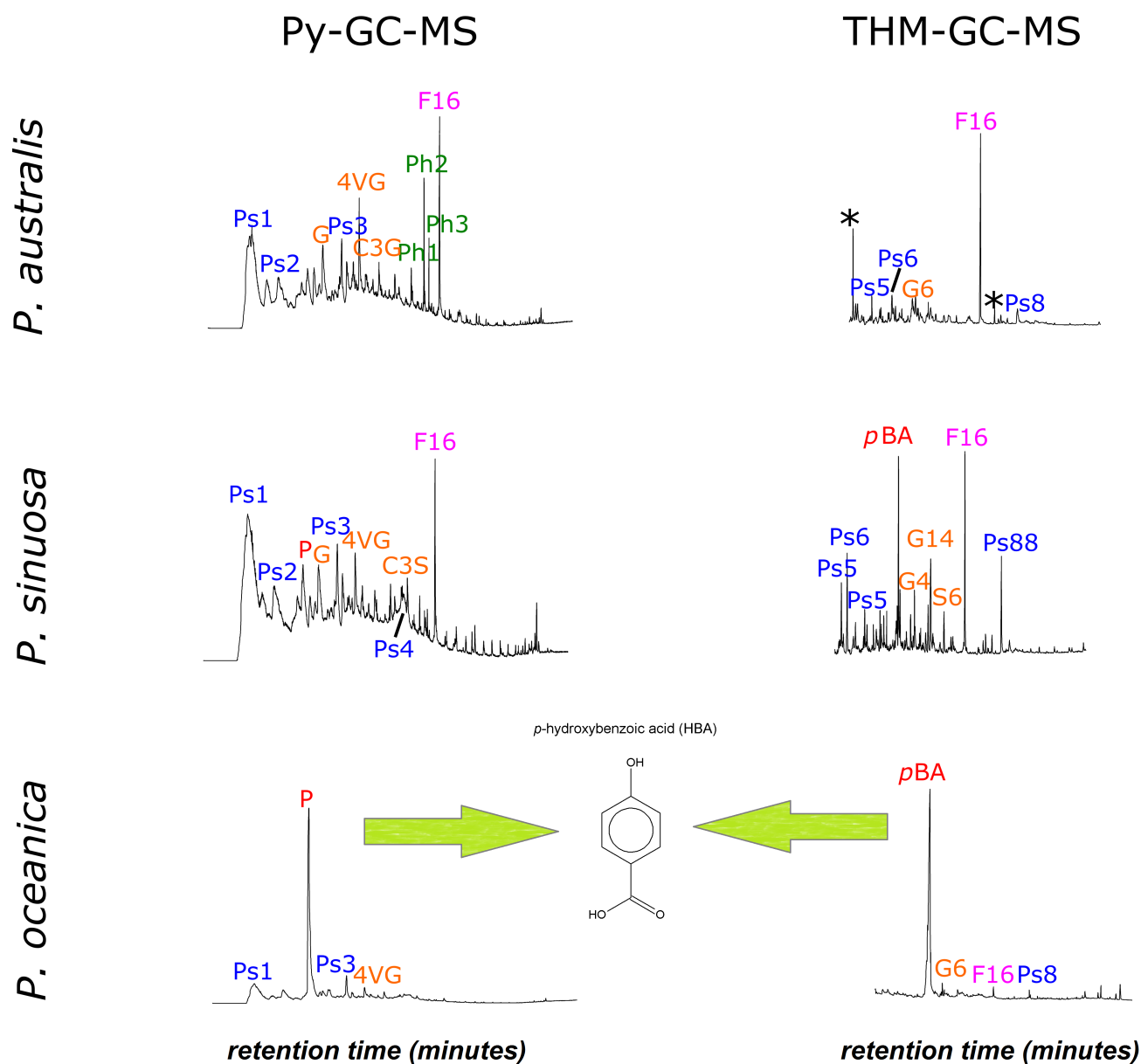


Fig. 2. Pyrolysis-GC-MS and THM-GC-MS total ion current chromatograms of *P. australis*, *P. sinuosa* and *P. oceanica*, showing that only *P. oceanica* is prolific of *p*-HBA derivatives upon analytical pyrolysis (but *P. sinuosa* has more than *P. australis*). Symbols: F₁₆= C₁₆-fatty acid, G= guaiacols, P= phenol, Ps= polysaccharide, Ph1= isoprenoid chlorophyll product, pBA= *p*-hydroxybenzoic acid methyl ester, * = contamination (TMAH products and column bleed).