On the role of *Posidonia oceanica* on Mediterranean beaches

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Robert G. Dean
Robert A. Dalrymple

Robert A. Dalrymple
Mallorca, 2009

Robert G. Dean
Tarragona, 2011
Mediterranean beaches are not different from others beaches around the world, but their nature and behaviour are strongly influenced by:

- the absence of significant tides (microtidal environment) – 20 cm
- a temperate – low energy wave climate
- the presence of the endemic seagrass *Posidonia oceanica*
- and a high relative abundance of biogenous sands

10 years of active research at IMEDEA and SOCIB on Balearic Islands beaches, addressing beach variability, sediment mass balance, beach erosion, wave climate, seagrass effects on beach dynamics, beach safety and rip currents among others...

The aim of this talk is to review the present knowledge on the role of *Posidonia oceanica* in Mediterranean beaches
• *Posidonia oceanica* is an endemic reef-building seagrass widespread along Mediterranean nearshore sandy and rocky bottoms.

• It loses leaves in autumn and leaf litter can be found mainly along sandy coasts forming wedge structures of few to several meters in thick that 80’s French authors denominated *banquettes*. 
This has lead an intensive debate focused on the role of seagrass berms (banquettes) in the beach face protection following earlier works from Boudouresque and Jeudy de Grissac (1984).
Factory of biogenic sediments

Influence on sediment budget

shore

beach

> shoreface

nearshore

offshore

> foreshore

swash zone

surf zone

> shore breaker zone

surf zone

> bar breaker zone

transition zone

management policy and human erosion

Influence on beach profile adjustment and wave attenuation (reef effect)

Banquettes erosion protective role

But there are other roles apart from seagrass berm beach protection...
### Cala Millor Beach (NE Mallorca)

- **Length and location**: 2 km, NE Mallorca
- **Beach type and main interest**: Urban (rips)
- **Equipment**: 1 SIRENA stations (5 cameras), 1 Weather station, 1 AWAC
- **Operation**: 05.2011 – to present

### Son Bou Beach (S Menorca)

- **Length and location**: 2.5 km, SW Menorca
- **Beach type and main interest**: Natural (reefs)
- **Equipment**: 1 SIRENA stations (5 cameras), 1 Weather station, 1 AWAC
- **Operation**: 10.2011 – to present

### Platja de Palma

- **Length and location**: 5 km, SW Mallorca
- **Beach type and main interest**: Urban
- **Equipment**: 3 SIRENA stations (15 cameras), 1 Weather station, 1 AWAC
- **Operation**: 09.2011 – to present

### Santa Eulària

- **Length and location**: 0.5 km, SE Eivissa
- **Beach type and main interest**: Urban, inlet
- **Equipment**: 1 SIRENA stations (4 cameras), 1 Weather station, 1 AWAC
- **Operation**: In mind 2013
Beach length 2000 m, $H_s < 1$ m, $H_{12} 2.5$ m, waves from NE and ESE; biogenic medium to fine sands, 2 phi.

$Posidonia oceanica$ seagrass from 6 to 35 m in depth.
SON BOU BEACH

- Beach length 2000 m, $H_s < 1$ m, $H_{12} 2.5$ m, waves from E-SE and SW; biogenic coarse sand to medium sands, 1.8 ph
- *Posidonia oceanica* seagrass from 5 to 35 m in depth.
Things that we know we know:

There is an hydrodynamical control on the upper limit of *Posidonia oceanica*. Near-bottom orbital velocity of between 38 and 42 cm s\(^{-1}\) appear as a determinant of the upper depth limit of *P. oceanica*.

Infantes, Terrados, Orfila, Cañellas, Álvarez-Ellacuría (2009), Wave energy and the upper depth limit distribution of *Posidonia oceanica*. Botanica Marina 52
Mean wave conditions propagated over the beach resulted in wave heights between 0.2 and 0.4 m, with significant wave breaking in the shallow sandy area (0.5 to 1 m in depth) and $U_b$ up to 110 cm s⁻¹.

$P. oceanica$ is not present in areas with velocities higher than 38–42 cm s⁻¹. This velocity interval might be considered a first estimate of the threshold near-bottom orbital velocity that allows the $P. oceanica$ to occur in Cala Millor.
Things that we know we know:

The presence of a *Posidonia oceanica* in the nearshore conditions the shape of equilibrium profiles. Higher Dean equilibrium model A parameters indicate higher dissipation over *P. oceanica* meadows.

Seasonal profile low variability and equilibrium induced by *Posidonia oceanica* meadows.

Equilibrium profiles are more reflective than slopes predicted by Dean equilibrium profile, indicating wave dissipation by the seagrass meadow.

\[ h = Ax^m \]

- \[ A_e = 0.27 \text{ to } 0.35 \]
- \[ A_t = 0.067 \]
- \[ m_e = 0.57 \text{ to } 0.60 \]
- \[ m_t = 0.44 \]
Things that we know we know:

Root mean squared wave height (Hrms) is reduced by around 50% for incident waves of 1.1m propagating over ~1000 m of a meadow of *P. oceanica* with shoot density of ~600 shoots m⁻².

This study suggests that for incident waves with 0.5 m ≤ Hrms,0 ≤ 1.5 m and 4 s ≤ Tp ≤ 10 s propagating over a constant depth h = 8 m, the wave attenuation per wavelength for ks ≈ 0.42 m (corresponding to our meadow with N ≈ 600 shoots m−2 and lv ≈ 0.8 m) ranges between 1.5 and 3.5%. As a general trend, the greater the wave height and period, the greater is the attenuation per wavelength; also, the shallower the water depth, the greater is the attenuation.
Things that we know we know:

**Posidonia oceanica** meadows controls the beach variability and sediment exchange at annual basis

Gómez-Pujol, Orfila, Álvarez-Ellacuría, Tintoré (2011), Controls on sediment dynamics and medium-term morphological change in a barred microtidal beach (Cala Millor, Mallorca, Western Mediterranean). Geomorphology, 132.
Effect of *P. oceanica* meadows as reef-like barrier controlling sediment exchange and beach variability.
SIRENA images show that banquettes deposits occur following storm waves (Hs > 1m) and larger volumes appear early in waves winter season because there is a highest availability of leas litter. Banquettes use to be removed in low wave energy conditions.

**Variable:**

- Absence / Presence of banquettes at some point of the beach
Winter conditions

large and continuous banquettes

Summer conditions

patchy and minor entity banquettes
Cala Millor Beach (NE Mallorca)
70 EVENTS ANALYZED OF *P. OCEANICA* BANQUETTES IN TWO SANDY MEDITERRANEAN SEMI-EXPOSED BEACHES:

- Accumulation of banquettes relies to seagrass ecology and physical factors such as winds, currents and winds.

- Images show that banquettes deposits occur following storm waves (*Hs* > 1m) and larger volumes appear early in waves winter season because there is a highest availability of leas litter.

- Banquettes use to be removed in low wave energy conditions***

- When storms arrive to the beach the do not use to find an organic barrier that protect and the only mechanism for wave dissipation is the beach profile adjustment.
Short-medium term:
• Link between ecological dynamics and seasonal effects on wave attenuation and beach variability
• Improve models and physical based approach to empirical observations
• Explore the type of waves that dismantle seagrass berms (banquettes)

Long term:
• Explore the variability of shoreline and/or beach profile and the seagrass meadow evolution. What is the role of seagrass meadow in the long term (decades) beach evolution?
Factory of biogenic sediments

P. oceanica play an important role in many coastal processes...

Influence on sediment budget

Management policy and human erosion

Banquetttes erosion protective role

Influence on beach profile adjustment and wave attenuation (reef effect)
thanks!