Swarming motility is restricted to a narrow range of water matric potential

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Swarming motility is restricted to a narrow range of matric water potential

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Introduction

Many environmental and pathogenic bacteria present swarming motility by which a population spreads rapidly over a hydrated surface, aided by the excretion of biosurfactant(s). If this behavior is easily observable on 'soft' agar plates, the physical conditions that support swarming are still ill-defined, obscuring our appreciation of its environmental significance. The degree of surface hydration (traditionally set by the agar concentration in swarming plates) is certainly amongst the most important controlling parameters.

Aims

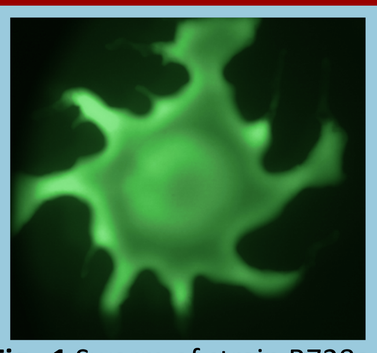

Fig. 1 Swarm of strain B728a gfp on swarming agar

- Rigorously quantify the matric potential range that supports swarming on an agar gel in several pseudomonads;
- Measure how matric potential modulates the expansion rate of swarms;
- Determine how surfactant-non-producing mutants are affected in their spatial dynamic.

Materials & Methods

Physical conditions (Fig. 2):

- control of matric potential (range: [-2;0] kPa) with the **P**orous **S**urface **M**odel (Dechesne *et al*., 2008);
- cells inoculated onto an agar slab: provides a smooth surface, as in traditional swarming plates.

The agar slab gains or loses water as a function of the matric potential imposed by the PSM, indicating successful control of the wetness of the system (data not shown).

Fig. 2 Agar slab-PSM

Organisms tested and media used

Organism	Medium
Pseudomonas sp. DSS73 *gfp*	FAB citrate 5 mM
P. æruginosa PA14	Modified M9 (dextrose + casamino acids)
P. syringæ B728a *gfp*	SWM

Observation & quantification of microbial spatial dynamics

Capture of GFP signal with a stereomicroscope and image analysis to quantify colony/swarm diameter and expansion rate.

Matric potential controls swarming in DSS73

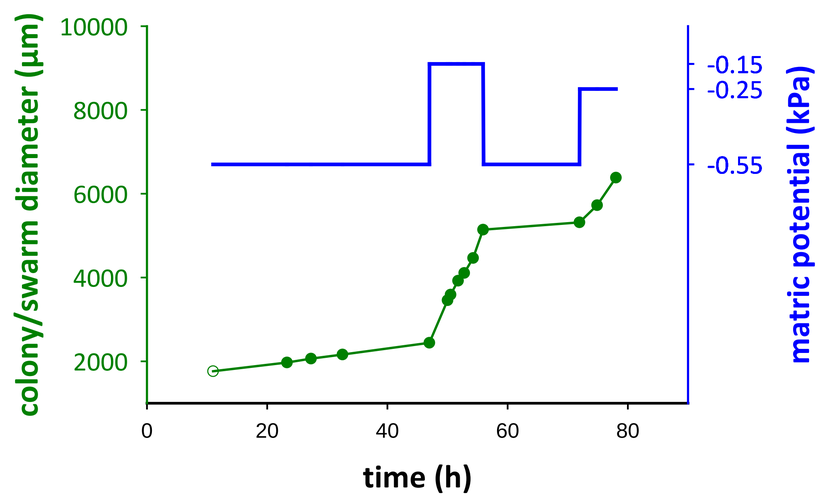

Fig. 3 Spatial dynamic of one DSS73 colony (left axis) as affected by the matric potential imposed via the PSM (right axis)

- slow colony expansion when matric potential = -0.55 kPa;
- tendril formation and fast expansion (i.e., swarming) triggered at matric potentials ≥ -0.25 kPa.

Restricted swarming in PA14 & B728a

- swarming in these strains restricted to very wet conditions (> -0.07 kPa)
- limited differences between WT and surfactant non-producers.

WT *vs* surfactant non-producer in -1.2 – 0 kPa range

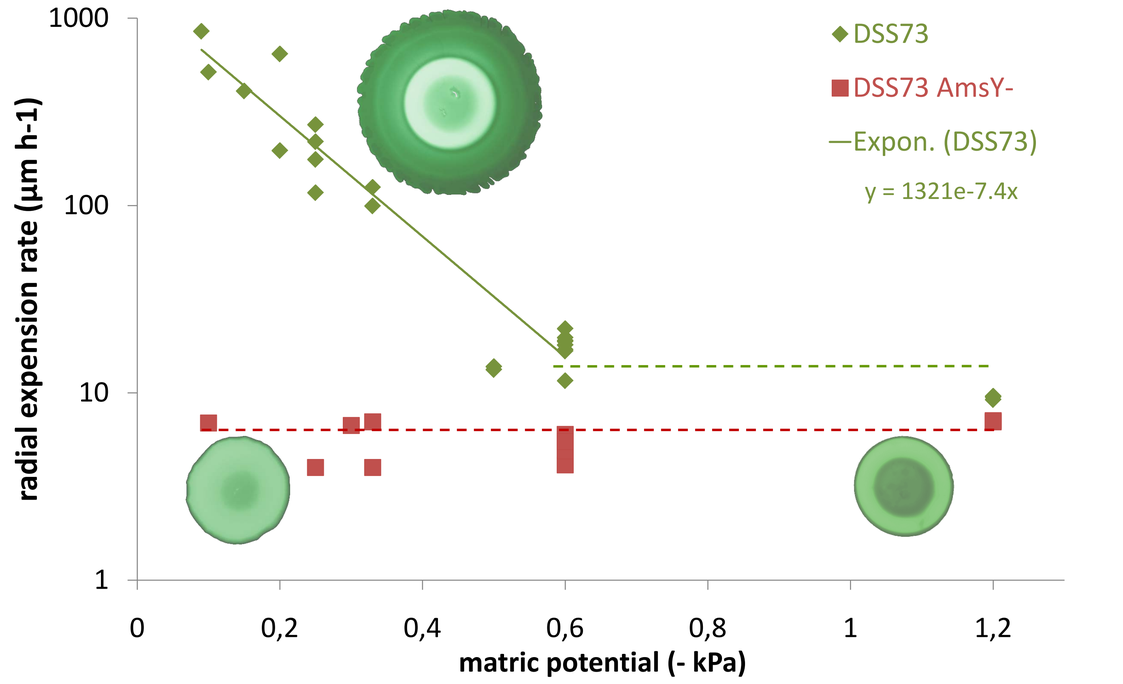

Fig. 4 Radial expansion rate of DSS73 and DSS73 AmsY$^-$, its isogenic surfactant non producing mutant, as affected by the matric potential imposed via the PSM

- swarming in the WT only observed close to water saturation (> -0.5 kPa)
- above this threshold, swarming velocity increases exponentially with increasing matric potential;
- swarming is never observed for the mutant unable to produce the surfactant amphisin.

Conclusions

- Swarming restricted to near saturation conditions:
  ⟹ environmental occurrence of swarming probably limited.
- Variability in threshold wetness for swarming in the genus *Pseudomonas;*
- Dispersal rate affected by biosurfactant production.

Reference:
Dechesne, A., Or, D., Gülez, G. & Smets, B. F. (2008) *Appl. Environ. Microbiol.* 74, 5195-5200.

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