

# The dynamic of tube feet controls the locomotion of sea stars

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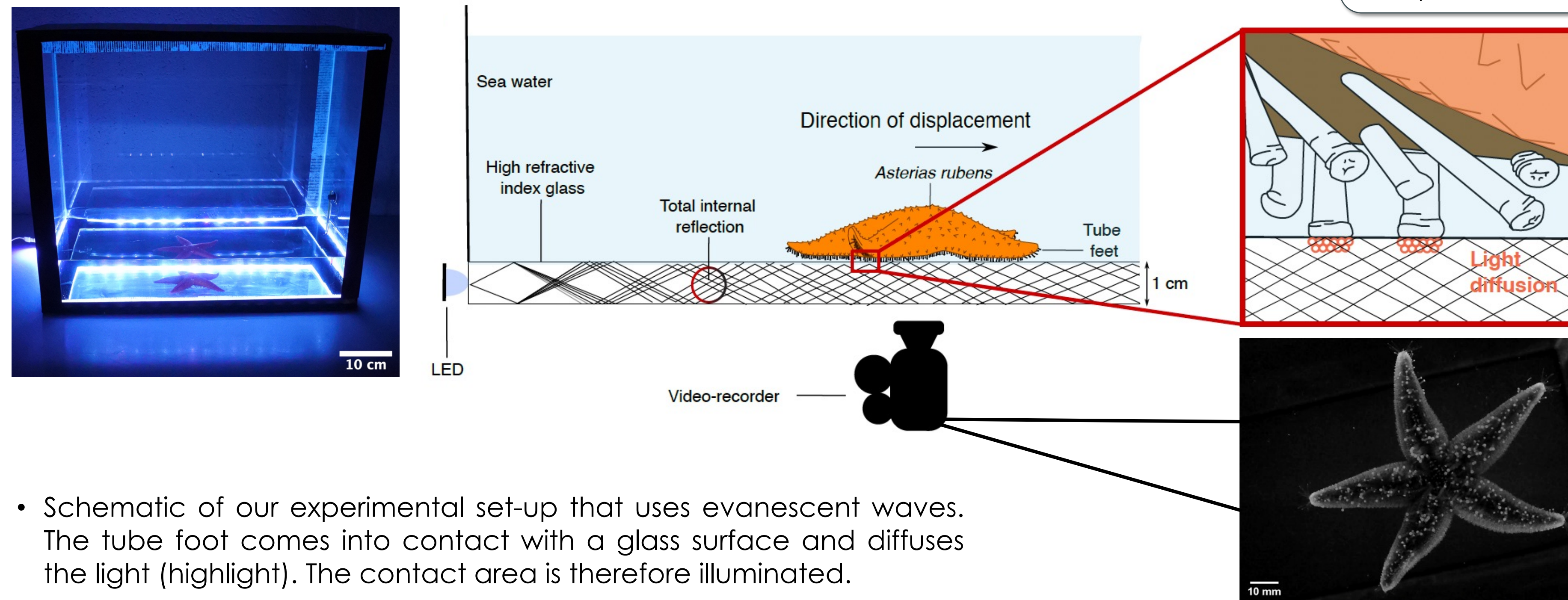
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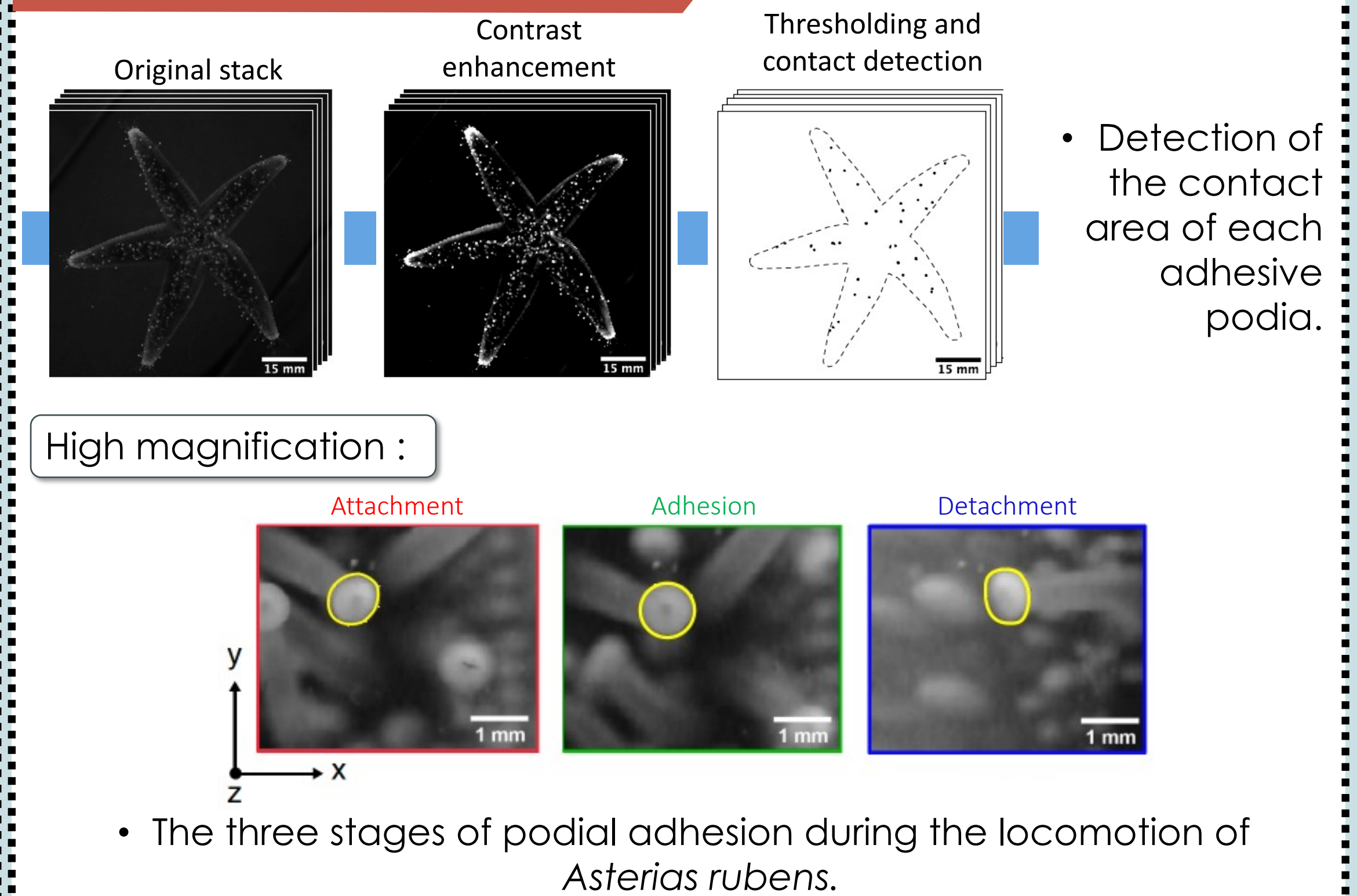
Even if for most of us sea stars seem motionless, they actually can move slowly to catch their prey or climb the rocks. Indeed, their oral surface is covered by many small and active tubular projections, known as tube feet or podia, connected to their water vascular system. The increase in internal pressure is translated into the elongation of the tube foot that subsequently comes in contact with the substrate and adheres transiently to it. Extension and retraction of the podia make possible the highly organized stepping movement by which the sea stars pull themselves along. While the operation and coordination of sea star tube feet have been studied extensively, the locomotion mechanism is still not fully understood.

## Evanescent waves-based set-up

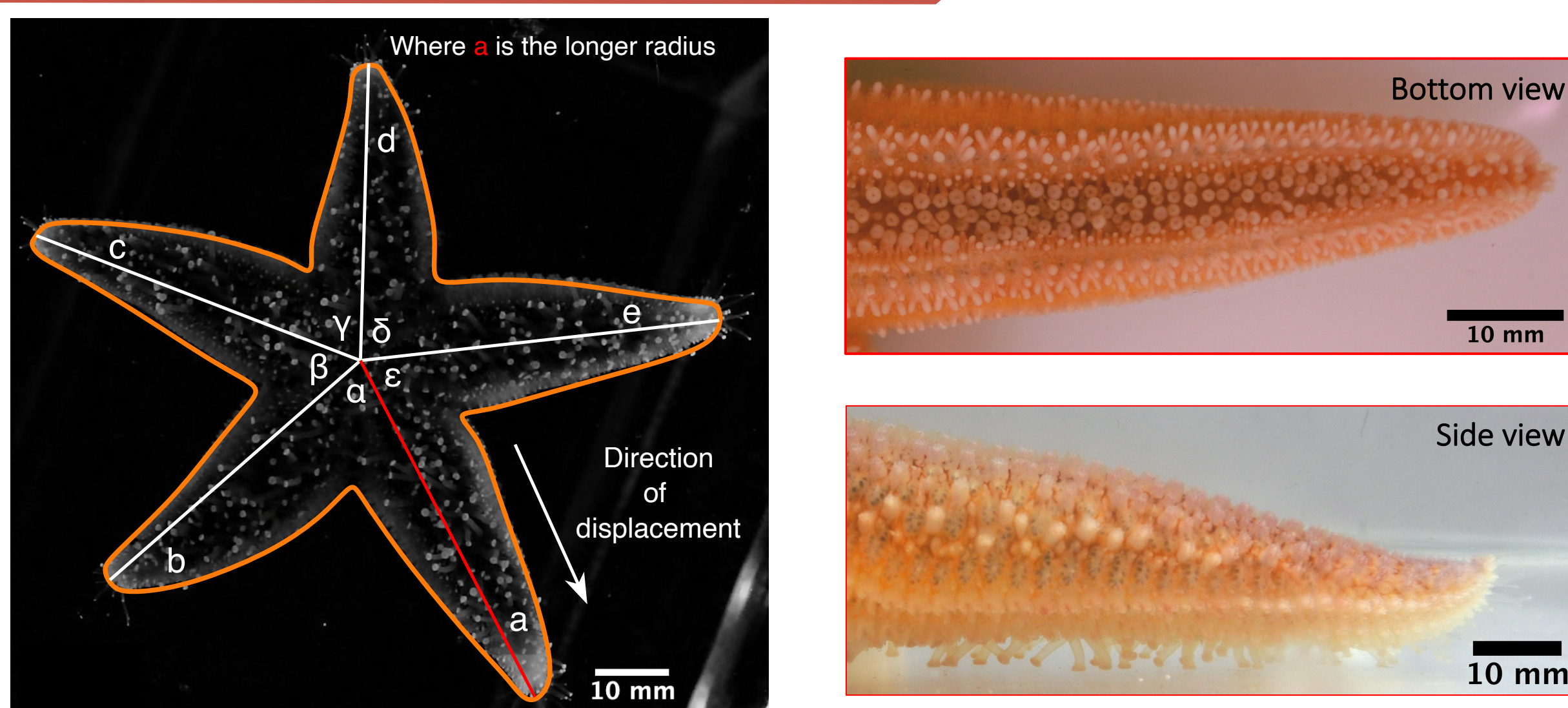


- Schematic of our experimental set-up that uses evanescent waves. The tube foot comes into contact with a glass surface and diffuses the light (highlight). The contact area is therefore illuminated.

## Time-lapse analysis

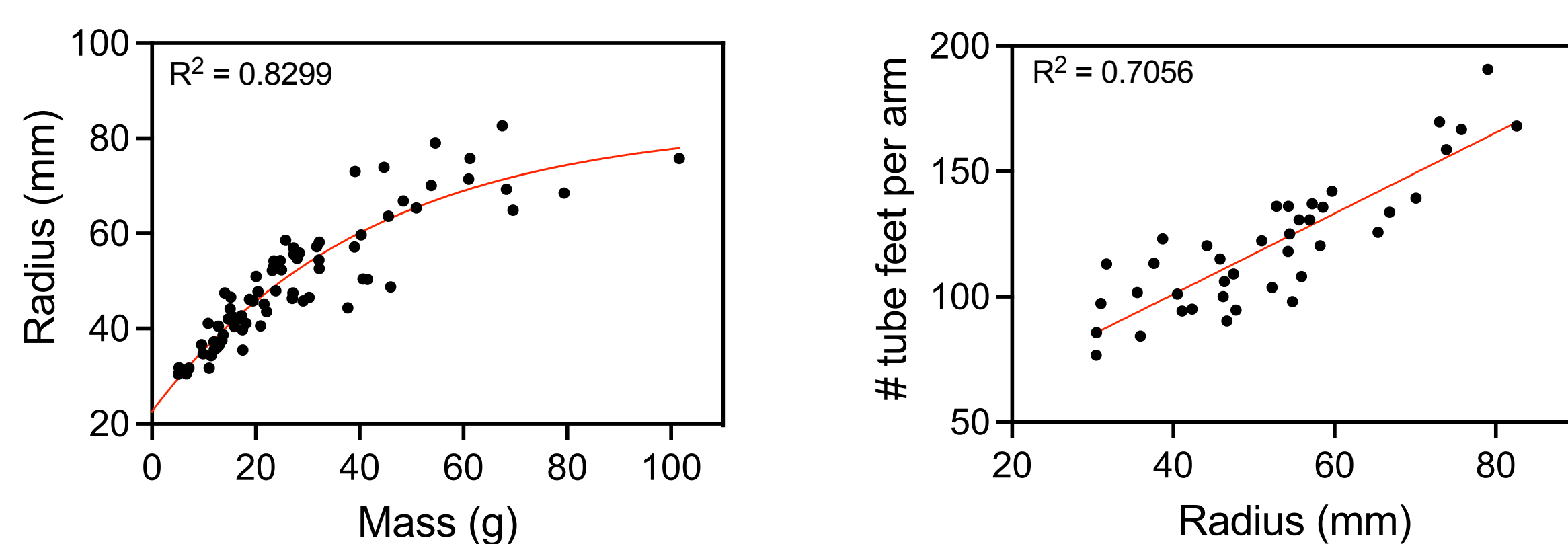


## Morphometric analysis



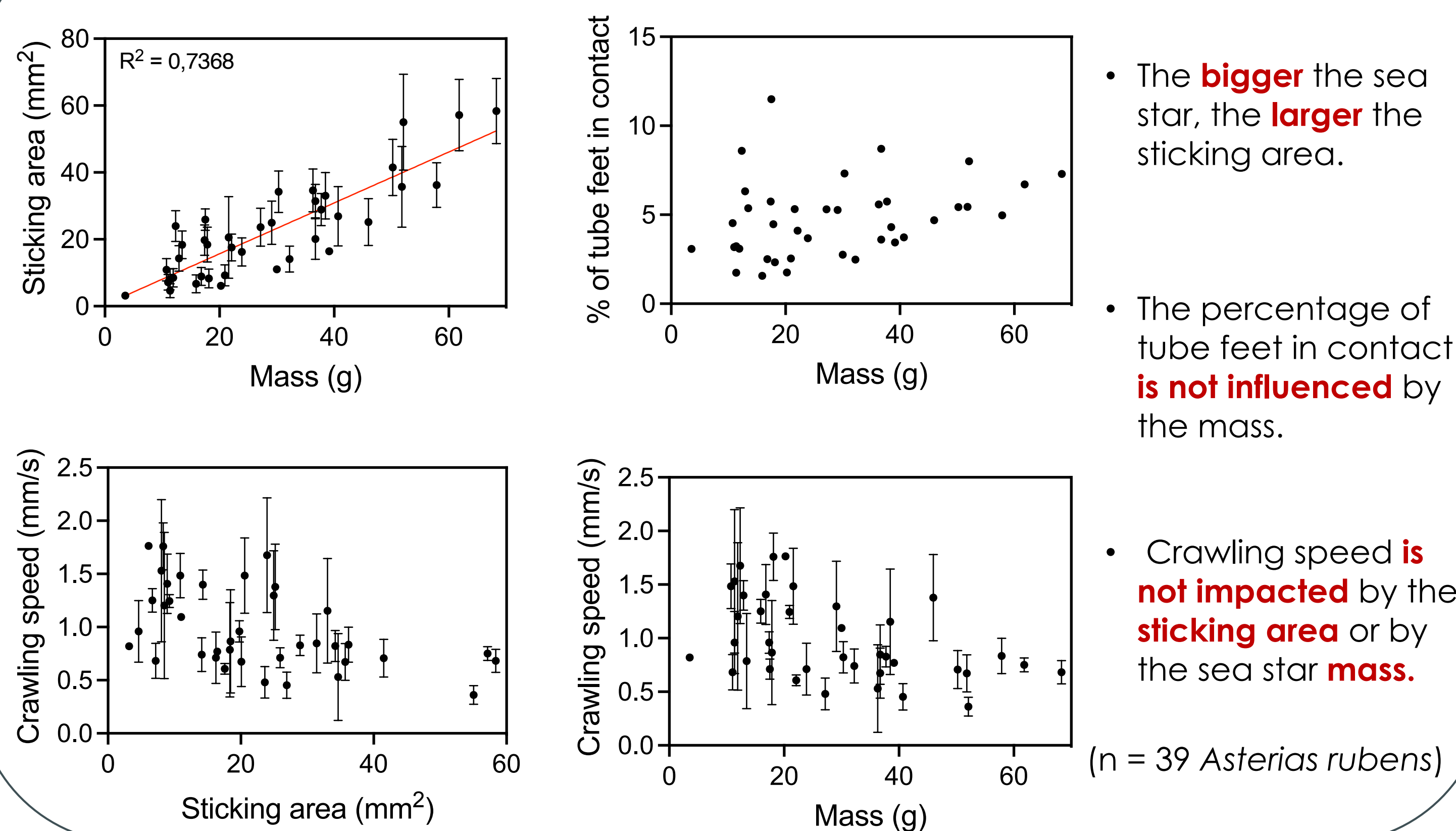
- Asterias rubens* oral surface is covered with **hundreds** of small hydraulic organs called tube feet.

### *Asterias rubens* morphology



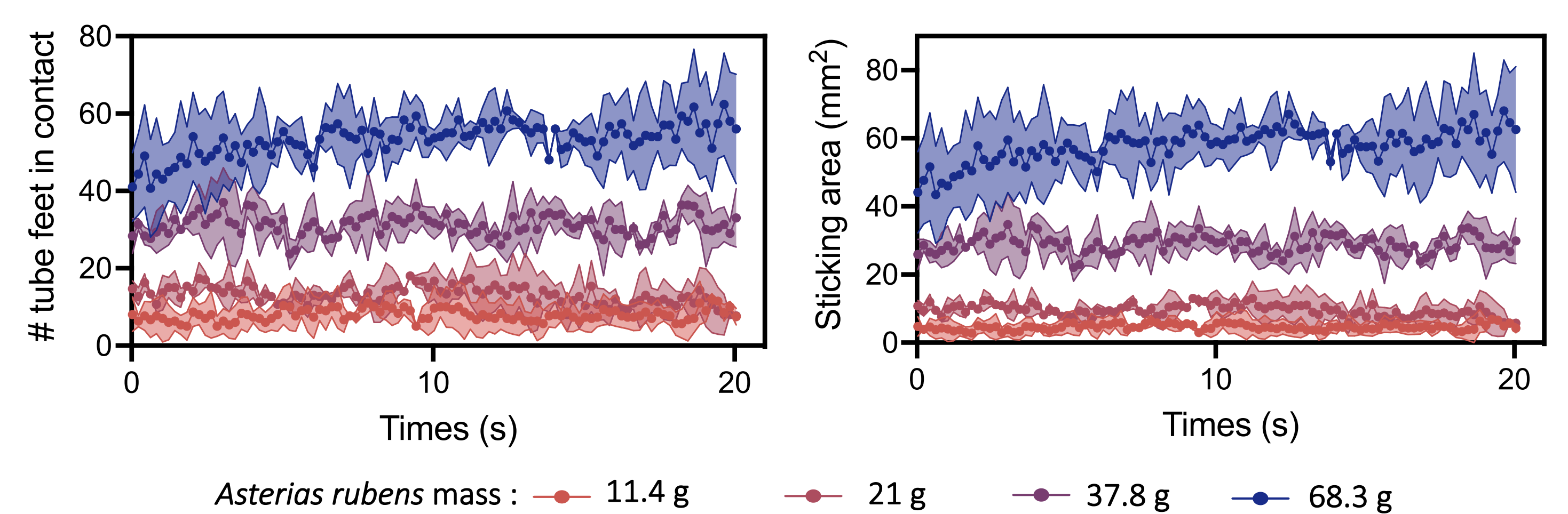
- The **heavier** the sea star, the **larger** its radius (n = 74 *Asterias rubens*) and the **more tube feet** on the oral surface (n = 40 *Asterias rubens*).

### *Asterias rubens* locomotion



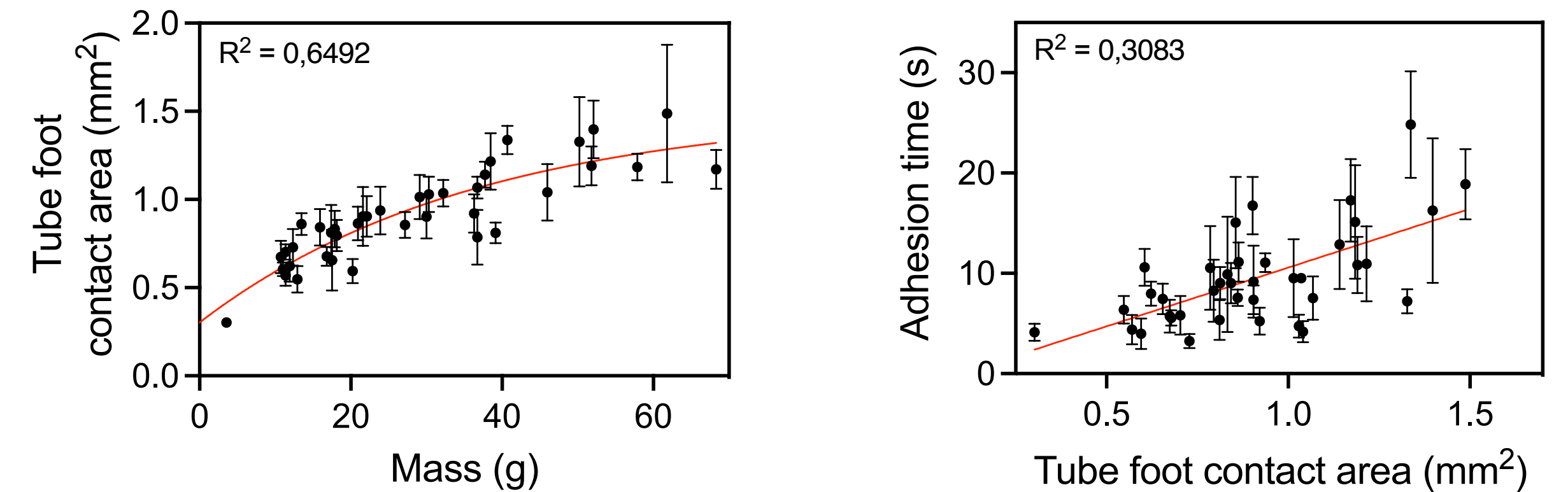
- The **bigger** the sea star, the **larger** the sticking area.
- The percentage of tube feet in contact **is not influenced** by the mass.
- Crawling speed **is not impacted** by the sticking area or by the sea star mass.

## Tube feet dynamic is the key



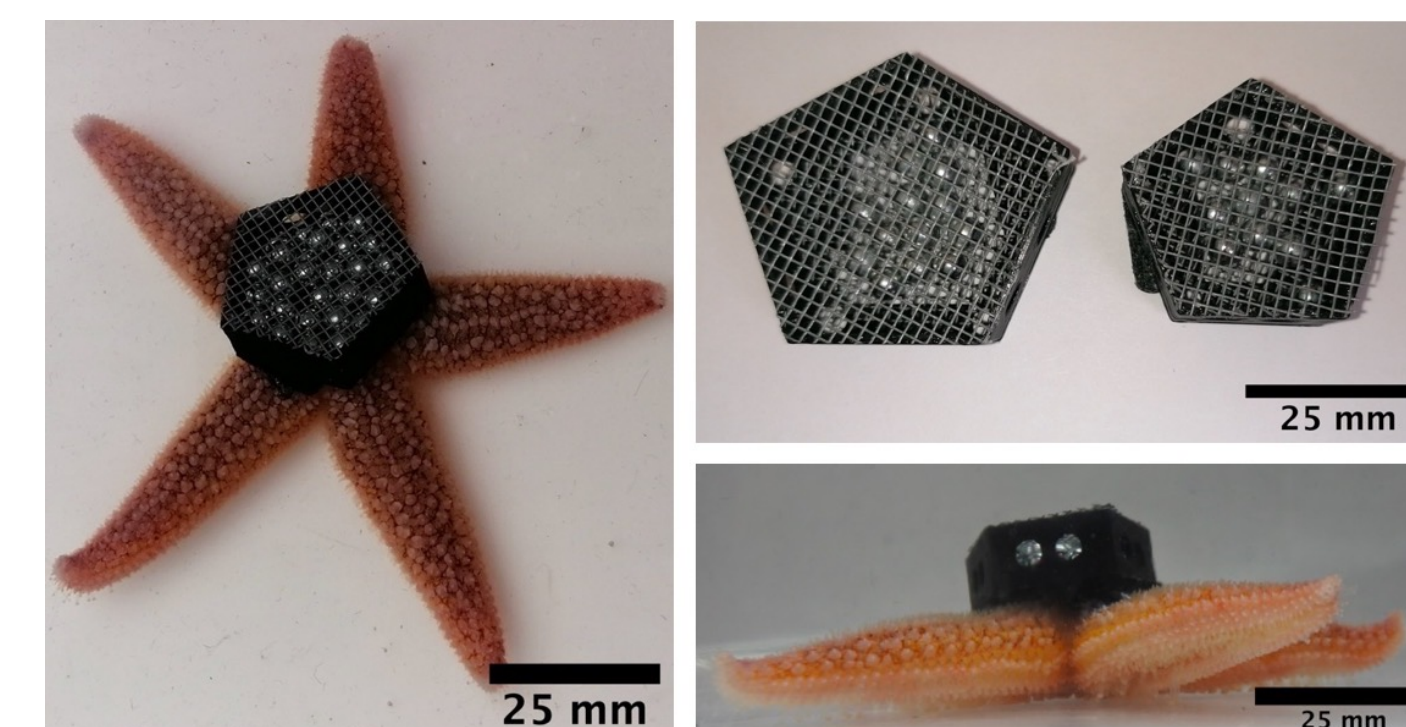
- The **number of tube feet in contact** as well as the **sticking area** during *Asterias rubens* locomotion.

### Tube feet adhesion

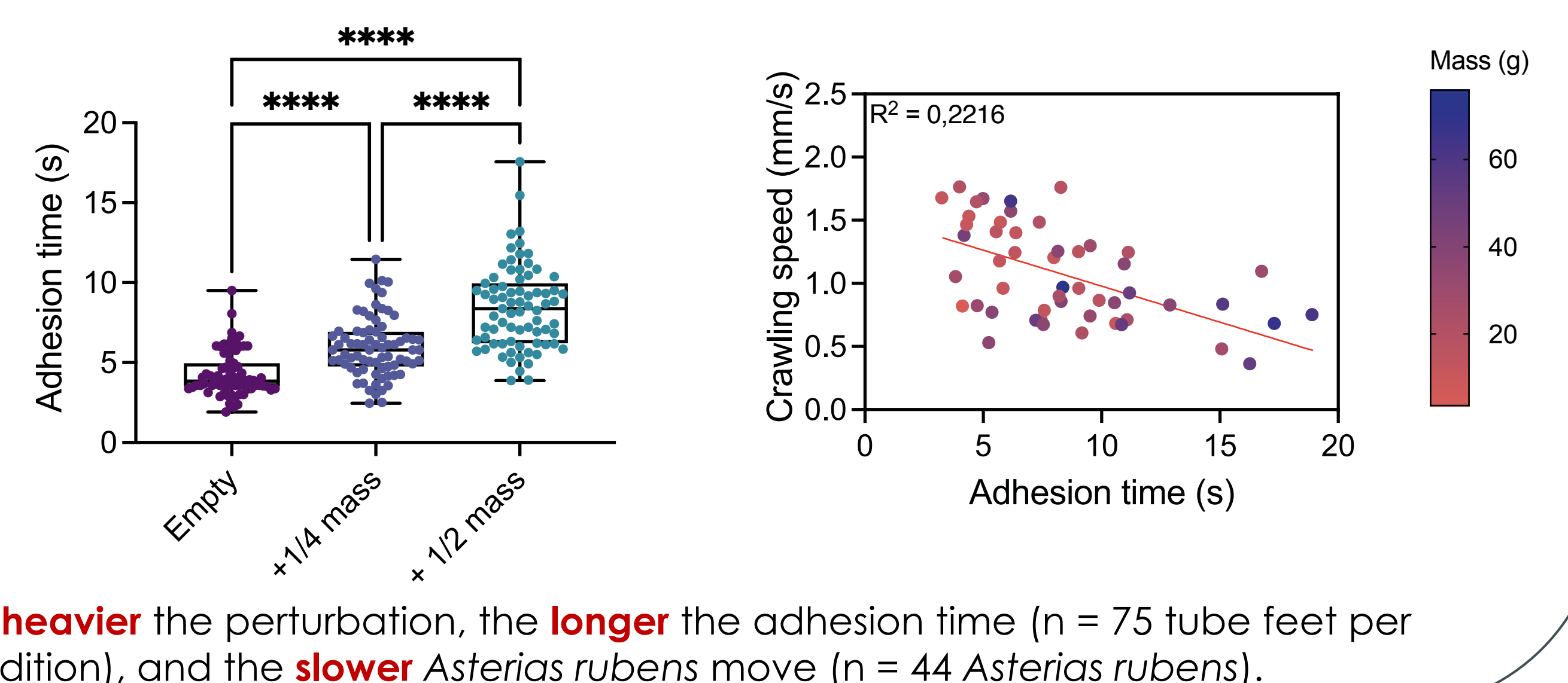


- The **bigger** the sea star, the **larger** the tube feet contact area and the **longer** the adhesion time (n = 46 *Asterias rubens*).

### Tube feet perturbation



- Photography of our 3D-printed harness alone and equipped on *Asterias rubens*.



- The **heavier** the perturbation, the **longer** the adhesion time (n = 75 tube feet per condition), and the **slower** *Asterias rubens* move (n = 44 *Asterias rubens*).

## Conclusion

The overarching goal of this project was to figure out the parameters that truly impact sea star locomotion. Interestingly, we find out that the crawling speed is **inversely proportional** to tube foot adhesion time. In the long term, we aim to develop a **biomechanical model of sea star locomotion** based on our measurement of tube feet dynamics.

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