Tube foot mechanical properties in the sea urchin *Paracentrotus lividus* from habitats presenting a range of seawater velocities

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Intertidal rocky shores are considered as extremely stressful environments wherein benthic marine invertebrates are subjected to strong hydrodynamic forces due to wave action and likely to detach them from the substrate. Hydrodynamics is therefore one of the most important factors determining the survival and distribution of species as well as shaping benthic communities. To counteract these forces, many marine organisms have developed specialized structures, including adhesive organs. For instance, echinoids exhibit appendages known as tube feet or podia. Tube feet consist of a distal flat deformable disc that adheres to the substrate and that is connected to the skeleton through a cylindrical shaft called the stem. The aim of this study was to evaluate tube foot adhesive and mechanical properties in the sea urchin *Paracentrotus lividus* from three subpopulations exposed to different seawater velocities. In May 2013, adult sea urchins were collected from tide pools at 3 localities around the Crozon peninsula in Britany (France). These localities, Ilien, Morgat and Cap de la Chèvre, differ according to their hydrodynamic conditions, with mean water velocities of 9.1 ± 4.8cm.s^{-1}, 16.4 ± 5.3cm.s^{-1} and 44.9 ± 13.5cm.s^{-1}, respectively. Specimens were brought alive to the laboratory where morphometric as well as tenacity measurements were taken. A safety factor predicting the flow velocity at which sea urchins are prone to detach from the substrate was then calculated. In addition, traction tests were performed on tube feet in order to determine their mechanical properties, i.e. extensibility, strength, stiffness and toughness. Sea urchin size decreased with increasing water velocity and this trend was statistically significant. Attachment force and both whole individual and single tube foot tenacity increased with increasing flow velocity. All mechanical properties were also higher in the subpopulation where the highest flow velocity was recorded, but these differences were statistically significant only for extensibility and toughness. Safety factor analysis indicated that, if subjected to increasing hydrodynamic forces, sea urchins from Cap de la Chèvre would be the last to detach compared to individuals from the other two subpopulations. Thus the tube feet of *Paracentrotus lividus* show an intraspecific plasticity, their mechanical properties varying according to local seawater velocities which lead to a better attachment capacity in the most exposed habitat.