Impacts of climate change on intertidal species, camouflage and predation

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Project description: Predator-prey relationships form key interactions in most ecosystems, and predation risk is a major selection pressure driving anti-predator adaptations, including camouflage to prevent detection. However, human induced changes to ecosystems, including climate change may have a significant impact on such relationships. For example, decreased snow cover due to rising temperatures risks compromising the camouflage of mammals living in high latitudes [1].

As a result of human actions, the oceans are undergoing changes in water properties (e.g. warming, acidification and deoxygenation), and the impacts on marine organism health and physiology has been the subject of much recent study. However, how these changes will affect key animal interactions and behaviour underpinning ecosystem structure and function is largely unknown. This project will investigate the impact of climate related environmental change on predator-prey relationships by studying how changes in the physico-chemical properties of seawater (temperature, pH, hypoxia) affect the camouflage of two common UK intertidal species: green shore crabs (Carcinus maenas), and rock gobies (Gobius paganellus). Both rely heavily on camouflage to avoid predators. Work undertaken in Stevens' lab (in prep) shows that gobies are capable of rapid (1-3 minutes) colour change on different substrates for camouflage. Juvenile shore crabs are also capable of less extreme colour changes, and as they moult individuals change colour to better match the background where they live. However, it is well known that colour change in fish is strongly influenced by temperature and stress, as is also true in some crabs. These influences may have a major effect on camouflage, and therefore vulnerability to predation. It has also been shown that changes in water properties due to climate change can affect reef fish behaviour from different rearing conditions, making them more vulnerable to predation [2].

This project will involve rearing gobies and crabs under highly controlled laboratory conditions (both at PML and CEC depending on the experiment), whereby factors such as water pH, temperature, and gas concentrations can be manipulated. PML already has a range of facilities to conduct this type of experiment. Gobies would subsequently be placed on different coloured backgrounds and the speed and accuracy of colour change and camouflage quantified to predator (avian and fish) vision using ultraviolet sensitive cameras. Similar experiments will be undertaken with crabs. In addition, crabs will be reared from juveniles for 4-6 moults on different backgrounds, and their ability to match backgrounds over time tested under different rearing conditions.

[1] Mills et al. 2013. Camouflage mismatch in seasonal coat color due to decreased snow duration. PNAS. 110: 7099-7100. [2] Allan et al. 2013. Elevated CO2 Affects Predator-Prey Interactions through Altered Performance. PloS one. 8 e58520.7360–7365.

Training opportunities: The project combines sensory ecology and predator vision, behavioural ecology, predator-prey interactions, intertidal ecology, and experimental approaches to understanding a natural system with work assessing the impacts of climate change and human impacts on the environment. Therefore, the student would receive training in a wide range of subject areas and associated skills. They will be trained in how to analyse and interpret animal behaviour, experimental design in the field and laboratory, computer modelling and analysis of animal vision (including MATLAB programming and image analysis), and how fundamental science questions can be applied to human problems. Training will also be given in animal husbandry and conducting lab experiments under controlled environmental conditions. The supervisors have established contacts with the Phil Munday fish behaviour lab (James Cook University, Australia) and will explore possibilities that the student can undertake working visits to this facility. The student will also interact with the PML communications team to learn how to communicate issues such as ocean acidification to a public audience.