HONDURAS DISSERTATION/THESIS PROJECT

HO29 Tracking the fine-scale movement of coral reef fish in response to natural and artificial cues

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The natural movement of coral reef organisms is an important area of research because it sheds light on how habitat influences their behaviour, how they utilise reef resources and how they respond to changing habitat, amongst others. In turn, behavioural research helps answer questions about the complex web of ecological interactions that exist in such hyperdiverse ecosystems, and how a changing planet influences these behaviours. For example, a recent study from the Indo-Pacific showed how aggressive behaviour in coral reef butterflyfish changes after mass coral bleaching events.

There are a number of existing methods for tracking the movement of fish. Catch and release allows for more accurate estimates of population size, similar to mark-recapture methods in terrestrial systems, and to document where certain species and individuals are found in relation to previous captures. This is often combined with tagging, where physical tags are attached to individual fish, allowing easy recognition when recaptured in future. The type and design of tags can vary, from the least sophisticated visual tags which are attached externally and rely on being physically recognised by researchers, to the more sophisticated passive integrated transponder (PIT) tags that are inserted under the skin of a fish. The PIT tags are passive and so do not require batteries, but when a scanner is passed near the tag it recognises the scanner and its unique identification number. This is similar technology to that used in pet microchips. A third method is acoustic telemetry, which use tags that "ping" information to hydrophones. By using multiple hydrophones and comparing the time delay between the ping reaching each one, the location of the tag can be estimated accurately. These methods are valuable tools for coral reef scientists, but they are more useful when studying larger scale movements of fish, for example between sites and habitats.

Coral reef behavioural research has historically relied on *in situ* observations by SCUBA divers or snorkellers, and in fact many scientists still use this approach. Organisms of interest are searched for and identified, and then their behaviour recorded while the human observer waits nearby or follows them across the reef. These observations are typically time restricted based on the limitations of SCUBA diving, but they also risk complications caused by passive human presence. Research has shown that the presence of nearby SCUBA divers can alter the natural behaviour of coral reef fish, and that this impact can vary based on how acclimatised a particular fish (or community of fishes) is to the presence of divers. This means researchers have to be particularly careful to minimise these effects, for example by maintaining a minimum distance or selecting study species that do not show these responses. Alternatively, thanks to the recent improvements in availability of cost effective underwater videography, many researchers have also moved to using remotely deployed video observations.

Video observations are now a widely used and valuable tool for coral reef scientists, but they also have their own limitations. Firstly, they rely on the study species or behaviour being restricted to a small enough area of reef to cover with a stationary camera or a series of stationary cameras.

Secondly, they provide a simple two-dimensional view of the behaviour being observed. This can be restrictive in many ways, for example it prohibits the measurement of movement and location with any degree of accuracy.

The concept of stereo-video has existed for several decades, and is based around the idea that a pair of cameras can essentially function like human eyes providing certain parameters (e.g. the exact angle between the cameras) are known. This allows depth perception and position of objects to be accurately quantified. On coral reefs, stereo-video is now a well-established method for conducting surveys of fish populations, whereby a researcher swims along a reef with a stereo-video system recording the fish community as they go. Specialist software can then be used to analyse the footage and record not only the number and species of fish encountered, but also measure their length to a high degree of accuracy, which allows biomass to be estimated. The underlying mathematics of this method is relatively simple: by having synchronised footage from two (stereo) cameras that have been calibrated, the exact position of any object can be given as an XYZ coordinate. In the case of fish length, one XYZ coordinate is taken for the nose of the fish and another at the tip of the tail, and the distance between those two points gives the total length.

However, this same concept could also be applied to the precise study of fish location and behaviour. By using stationary stereo-video systems, an area of reef could be filmed for a fixed time period. For individual fish of interest, an XYZ coordinate could then be taken at pre-determined time intervals over the course of the recording. This would give a precise location for each fish at each time point, and allow movement to be tracked. Operation Wallacea scientists are pioneering this method, and students on this project will have the unique opportunity to be involved in the development of a brand new technique that has the potential to be used widely by the coral reef research community. There is also the potential to combine this new method with Operation Wallacea's existing 3D modelling technique to overlay fish movement patterns onto computer reconstructions of the underlying reef architecture. Individual projects could include (i) mapping damselfish territories in three dimensions and exploring how they change between different habitats or population densities, (ii) how reef cleaners and their clients utilise cleaning stations in three dimensions, (iii) how reef fish move across reef surfaces of different habitat qualities.

Recommended Reading

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