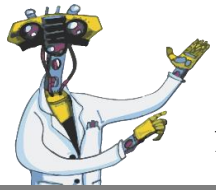

Ecology and Evolution

Tutorial: The Ecology and Evolution video tutorial can be found on the MEDDLE for Multiple Drivers Research YouTube channel.

Speakers: Gretchen Hofmann, University of California, Santa Barbara, USA

Morgan Kelly, Louisiana State University, USA

Video: Christina McGraw, University of Otago, New Zealand

Transcripts: Rebecca Zitoun, University of Otago, New Zealand

Resources: The complete resources for the *Best Practice Guide for Multiple Drivers Marine Research* are available on the MEDDLE website.

0:00 – *Introduction (Gretchen Hofmann)*

In the field of global change biology right now, there are many interesting things happening. And there are probably two things that are going on: one is borrowing technology from other fields and disciplines, and two is sort of a rediscovery of old questions that we have had in biology and evolution for quite some time. So for example, there was a paper published in Nature a little while ago and it was kind of a news item and it was called 'Evology'. It was about how ecologists used to think that "*Oh evolution doesn't matter to me*" and "*I don't have to worry about that discipline*", but in fact the by-line of the article was "*but they were wrong*".

Text (0:32): "Ecologists used to think that evolution was too slow to affect their studies – they were wrong" (Nature 554, 19-21 (2018))

So in some systems things that are going on on the ecological side can eventually change the evolutionary trajectory of the population.

Text (0:44): Ecology can change the evolutionary trajectory of the population.

So for example, I study kelp forest in California right now and the kelp themselves are like bioreactors – these marine plants that take in CO_2 and release oxygen – they change the chemistry of the water and by doing that they can also change the physiology of the animals. You might have things that are as different as the quality of food which changes. So a predator then is getting a different kind of food quality, or in a climate change context food migrates and disappears.

We look at how ecology could drive evolution. This this is a really big thing to think about, because it fits really well into global change biology, especially in the oceans.

Text (1:24): How can ecology drive evolution?

And in another project that we have been working on in there - we call it '*Who's your mommy*', because those ocean conditions change how females make their eggs and how they then condition their progeny for future conditions. The inspiration for this project really came from Morgan Kelly, who worked with us a few years ago and she opened up this can of worms '*Who's your daddy*'. Sires, male sea urchins, who had been exposed to a lot of low pH conditions, the sire's progeny, their baby sea urchin kids, were a little bit tougher in the face of low pH and upwelling conditions that we see in California. Some of these observations are really important ecologically, but they are very important in terms of thinking about other things that you would not expect like food security in food systems. But Morgan has really been the person who has brought evolution, borrowing from other fields and population biology, into global change science.

Text (2:33): Brining tools from evolution and population biology into global change science.

2:37 – *Ecology affects evolution; evolution affects ecology (Morgan Kelly)*

In my lab at the Louisiana State University, we like to think of evolution and ecology, these two processes that feedback with one another. Ecology affects evolutions and evolution affects ecology.

Text (2:44): Ecology affects evolution; evolution affects ecology.

And right now, we are working with oysters, American oysters, and this is a phenomenally important fishery in Louisiana. And right now they [oysters] are threatened by climate change, mostly by the fact that climate change is increasing the amount of freshwater that oysters experience.

Oysters can deal with a lot of variability, but they are not freshwater animals, they do live in the ocean. And so they [oysters] are really stressed out by having a lot of freshwater. And right now, climate change is causing our regions, which get these really big rain falls events that dump huge amounts of freshwater into estuaries where oysters live. A couple of years ago we got 24 inches of rain over just 2 days and in some of the oyster populations that we monitor the salinity went down to fresh, it was like they were living in a lake. And they can actually handle that for a little bit of time, they just close up and kind of wait for the bad conditions to stop, but while they are all closed up they are not eating and if they are not eating they are not able to fatten up and get ready to have babies. And so this really affects their reproduction.

One of the things we are trying to understand is if different populations of oysters might differ in their ability to deal with that freshwater stress and whether their history of exposure to freshwater – once again '*Who's your daddy*' and '*Who's your mommy*' in the case of oysters. So, does whether or not your parents live somewhere with a lot of freshwater affect your ability to deal with freshwater stress in the future? And that is really important because it might affect which populations we focus on for conservation and it might also affect how we decide to restore these populations, because when we go to restore a population we might breed oysters in a hatchery and then put their progeny back into the wild. And we want to choose parents that are going to be the toughest and most able to deal with that freshwater.

4:51 – *Challenges and opportunities (Gretchen Hofmann and Morgan Kelly)*

Gretchen Hofmann: So you know we have been talking a little bit about how ecology pushes evolution. Sometimes scientists call it ecological-evolutionary dynamics. And it is all playing out in a global change context right now in marine systems. I am just wondering Morgan, what do you think is the horizon for this? What are some of the most important experiments we can be doing? And what are some of the challenges to early career scientist, who are coming into this right now?

Morgan Kelly: That is a great question. I think it is really important to continue to think about variation among individuals and the species we work on.

Text (5:23): It is important to consider variation among individuals

You know we look at oysters and we might think that every oyster looks exactly like every other oyster, but every oyster is an individual and some of them are really good at dealing with stress and some of them are not so good at dealing with stress. And so we need to find new ways to measure variation among individuals and really consider the history of the populations that we work on and how that might inform which populations and which individuals are most able to deal with climate change stress.

Text (5:39): We need to find new ways to measure variation among individuals.

Gretchen Hofmann: So do you think that borrowing theory from population biology that is going to be the heart of doing that better or are there [other] approaches?

Morgan Kelly: Yes, I think we need to borrow theory from population biology and we also have some really exciting new techniques that we can borrow from fields like medicine and evolutionary genetics to measure and test differences among populations.

Gretchen Hofmann: Good. Exciting times. It is a challenge, but we are building the tools and we are recruiting the scientists we need to address these global problems.