Biology: uniformity and diversity

Investigating how bivalves feed

Prof Evan Ward, University of Connecticut
I have a rule that says 'Never work on anything you can't eat'. And that's why enjoy eating seafood that I do. But oysters and clams and scallops all become very important in the human food chain. And out here in New London, Connecticut we've become known for our love of seafood like oysters.

Narrator:
Evan Ward is a Biologist who has more than a gastronomic interest in seafood.

Prof Evan Ward
If I'm eating this animal I want to know what it is eating. I'm most interested in how they feed, and also what they're feeding on. What they're rejecting and what they're actually ingesting. Bivalves eat predominantly phytoplankton, the plants of the sea. And if you look at these different groups of oysters and clams and scallops, each has a slightly different gill structure. And they feed in slightly different ways. So it's important to study them individually, as individual organisms.

Look at these mussels; they're attached to a rock. And like most bivalves they can move very little. Unlike fishes and copapods, which can graze in one location, and then if the food gets scarce they can move to another location. Bivalves are more or less at the mercy of the waves that crawl over them.

Narrator
To view the feeding structures, you need to look inside.

Prof Evan Ward
Here is the open mussel, and you can see the gills now. Here they run from the posterior of the animal up to the anterior. And the gills are the structures that actually capture the particles. The particles are captured on the gills and taken to the margins and then transferred anterially up to the labial palps. The labial palps are important feeding structures which surround the mouth. The particles are captured on the gill, and then are transported down the gill to these labial palps which probably sort the material to some degree and also get rid of excess mucus. And then wanted particles the animal wants to feed, then are transferred to the mouth for ingestion.

Narrator:
The feeding habits or minute organisms like copapods are hard to see with the naked eye. Evan Ward had the bright idea of using advanced medical technology to reveal how his bivalves feed.

Prof Evan Ward
Here is the endoscope here. This is the rod lens, which is attached to the endoscope. This is actually the insertion probe which goes into the animal and this is connected to an adaptor, which increases the magnification of the image. The light for the endoscope comes from a light box and provides cold light at the end of the endoscope, so there's no heat involved. No heat to disturb the animal. We're going to feed the muscles a bit of micro-algae, and this will help stimulate them to start feeding and then we'll be able to visualise the gill and capture process on the gills

Narrator: Evan's muscles are making a meal of some natural red algae and some artificial green polystyrene beads.

Prof Evan Ward
The reason we use these is because they show up against the gill very well. And you will be able to see them on the video. Let me show you what I mean. So now in this view, we can see the frontal surface of the gill. We can see also the particles moving down the frontal surface of those filaments. And this is by mucocilary processes. And they move down in this case, to the ventral margin of the gill. And you can see them entering the ventral margin. And as they enter the ventral margin of the gill, that's the ventral food track that they enter, or food groove. They're incorporated into a mucus strain. Can you see that happening there? And now these particles once incorporated in the mucus strain are transported anterially towards the labial palps. In this case from the right to the left, in this shot. And you can see those moving along quite nicely.

Now lets move over a little bit more and we'll go to the labial palps. The labial palps are important in processing the mucus string. And here in this shot you can start seeing that the string is actually pulled from the ventral groove of the gill. And it's pulled by the labial palpes. And that food string is taken down between the palps. And the palps, the ciliary action on the palps actually disperses the individual particles that were trapped in that mucus string. Once those particles are dispersed, the animal then can select on those individual particles. Unwanted material then is rejected as pseudo faeces and the material the animal wants to ingest is then taken to the mouth.

Narrator
Like all discerning eaters, oysters and other filter feeders are choosy about what they allow into their mouths.

Prof Evan Ward
Now my interest in oysters has to do with not only how fast they feed but also do they discriminate between particles. Do they eat everything that comes their way or do they actually select certain particles over others? And these questions are important, not only for oysters in the natural environment, natural populations, but also for people that are trying to raise oysters; oyster farmers who need to formulate diets that will produce an oyster that grows the fastest. So how do we do this? How do we look at these questions? Well again we go back to the endoscope technique.

Prof Evan Ward
So the probe is in position. Now I'm going to insert the probe between the valves of the oyster. I've added to this chamber a mixture of algal cells and detrital particles and what you're seeing now is that the gill of the oyster is separating those particles. It's selecting some particles to take ventrally to that ventral food groove just like the muscle has, and other particles it's taking in dorsally, so the material in the dorsal food groove is predominantly the algal cells, the material that's the higher quality. The materials that's being transported in the ventral food groove has a very different colour, it's a light straw colour. This material predominantly is the detrital particles, so the animal is selecting between the algal cells and the detrital particles.

Narrator
Bivalves have good reasons to select some particles other than others.

Prof Evan Ward
This is the stomach of the bivalve and extending from the stomach are these sacks, the so-called digestive diverticulum. And what happens is particles enter the stomach and enter these sacks and once these sacks are filled no additional particles can enter until the digestive cycle of the sack is completed, which can take between nine to eleven hours, sometimes even more, so consequently energetically its beneficial for the bivalve to pack these sacks, these digestive diverticula, with high quality particles, and try and eliminate as many low-quality particles as possible.