MASWA Newsletter

(March 2001)

ATTENTION: This months MASWA meeting is on Wednesday, **28th March**. Check your calendar, because it could be the day you receive this!!!

This Month's Meeting

The meeting is to be held at Tony Fiorentino's house. Tony has hosted about half-a-dozen MASWA meetings that I can remember and his aquarium always proves to be popular. Tony's aquarium has a dedicated equipment room built on to the back of the house, behind the display tank. This is pretty amazing and I think most hobbyists are green with envy after seeing this. And if that isn't enough to get you along, remember that Tony isn't known as Mr DIY for nothing (actually, he's also known as Mr Crowbar, but that's another story) – it's well worth coming along just to check out the amazing things that Tony does with acrylic!

Tony's address is **13 Andrews Court, Padbury**. The meeting will begin at **7.30pm**.

Last Month's Meeting

Last month's meeting was held at Jan Anderson's house. Jan has a beautiful tank in a sitting room at the front of the house. The tank is bay shaped, but is approximately 1500mm long, 700mm tall and 900mm wide. The tank holds around 900 litres. The rockwork in the tank is excellent with lots of swim-throughs and bombies. The tank also has a sand bed of around 85mm depth – some of this was live from Penguin Island – and this together with the rockwork contributes to a very natural looking setup. Jan feeds the fish 2 to 3 times a day and the corals get what the fish miss.

Jan has lots of gadgets and automatic devices helping with the maintenance of his tank. These include a cooling fan that turns on automaticlly when the water gets too hot, a sensor that detects if the tank has overflowed, another sensor that detects if the pumps have run dry, a timer that turns one powerhead on in the tank for 5 minutes out of very 30 and an electronic pH meter.

The tank is filtered using a gravity fed downdraft-style protein skimmer and a 25% water change is done every 40 days. The aquarium is lit for 10 hours a day via two 250W metal halide lamps and two 1200mm actinic fluoro's. Two Project 3300's provide a total water circulation rate of nearly 7000 litres per hour.

Did you know?

Dendronepthya sp. *corals feed mainly on phytoplankton. But, a recent theory put forth by hobby author Julian Sprung suggests that the spiny sclerites that make this genus of corals feel so prickly may act like velcro by snagging organic particles from the water. The particles may then be consumed directly through the surface of the coral.*

Update on MASWA Easter Trip **(Point Quobba - 13th to15th of April)**

For those who confirmed that they wanted to attend, next month's trip has been booked. We will be staying at the **Carnarvon Tourist Centre Caravan Park** (ph 9941 1438). The accomadation cost for the weekend will be $30 per person. The beds will not have any bed linen on them, so bring a sleeping bag, pillow and blanket (if you require one). Carnarvon is cooler at this time of the year, but its not usually cold. Even so, make sure you bring along something warm to wear in case it does get chilly at night. We will be organising who's car to take, etc at this month's meeting but keep in mind that all participants will be expected to share the cost of petrol used on the way there and back.

For those who haven't been on any of the past trips to Quobba, don't expect too much in the way of culinary delights along the way. It's a 10 to 12 hour trip (depending on who's driving) with no places to buy food except for the intermittent truck stops along the way. Sometimes the food at one stop just doesn't look that edible but it might be another one or two hours till the next one, so it's a good idea to bring supplies of various types of pre-packed junk food. Carnarvon town has more variety (but not a lot).

Did you know?

Hobby author and scientist, Dr Ronald Shimek, considers the following invertebrates virtually impossible to keep alive in captivity:

swimming medusae (jellyfish), nudibranchs (sea slugs), bryozoans (sea moss), hydrocorals, crinoids (feather stars) large sponges, large stony coral colonies, large crustaceans and large snails.

This is not to say that it is impossible to keep these, but unless you have the resources of a large public aquarium, these animals aren't likely to do anything more than rapidly die in your aquarium.

What behavior can we expect of octopuses?

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(This article was first published on The Cephalopod Page (http://is.dal.ca/~ceph/TCP/). For anyone interested in octopuses, squid and cuttlefish, I really recommend this site – its absolutely fascinating! The article is reprinted here with the kind permission of the authors Jennifer A. Mather and Roland C. Anderson – Ed)

Everyone agrees that the Cephalopods are unique among the invertebrates in the extent of their intelligence. Yet little is known about how they use that intelligence. Work since the studies of Young and Wells have shown that they learn well, that they keep the knowledge that they acquire and that they can make fine discriminations based on this learning. But what do they do with this learning, how do they use this capacity? There are a lot of things that they do with their intelligence (see Mather, 1995, *Advances in the Study of Behavior*. 24, 316-353). Still, to talk about this use we have to use terms usually associated with vertebrates. Some of the terms now applied here for octopuses are navigation, tool use, personality and play.

NAVIGATION AND SPATIAL MAPS

Humans have known for thousands of years that the soft-bodied octopus uses different kinds of hiding places. Depending on the animal's size, these can be snail or clam shells, discarded beer bottles or sheltered niches in or under rocks. It has even been suggested that they build walls in front of the homes. But we've only recently realized that octopuses stay in these homes for periods of days and even weeks, that they go out to hunt and return home from quite a distance, sometimes after a long period of time. That makes the octopus a Central Place Forager, like many small mammals (see Stephen and Krebs, 1986, *Foraging Theory*). It also means that, like these mammals and some birds, they are using spatial memory to return home and they must be using some set of cues to navigate around their sea-bottom environment.

Mather traced young *Octopus vulgaris* in Bermuda on many of these hunting excursions and returns. In addition to going out and coming back home repeatedly, octopuses also seemed to cover different parts of their home range one after another on subsequent hunts and days (Mather, 1991, *Journal of Comparative Physiology A 168*, 491-497). This suggests they may have both Reference Memory for places where food might be found and Working Memory for where they had already hunted.

How do they navigate? Many snail species also go out foraging on the rocks, but they follow their outbound mucus trails to get back to their sheltered niche in a crevice (Chelazzi et al, 1985, *Biological Bulletin 168*, 214-221). Octopuses didn't do that, they often returned at a different angle from the one that they left the home by. Also, on long-distance returns they usually jetted mantle-first through the water. A series of disruptions of the foraging trail showed that they could make detours and suggested they were using vision to follow prominent features of the landscape of the rocky bottom. Lab studies of *Octopus rubescens* were difficult because the octopuses were intimidated by the open circular testing area, one of them never 'got used to it' and swam in panicked circles for a month of testing. However, results suggested that this species could learn to go to a landmark, and that they could also learn to head in a given direction to a place where the landmark had previously been.

The suggestion that octopuses navigate using spatial memory is a tantalizing one, but much more could be done to prove how it all works. Research on mammals, birds and insects such as bees has shown the cues that they learn to use and some of the mechanism behind the learning, the ways that they record and use the cues. There is a controversy as to whether each group relies simply on learning cues or whether they actually make a 'spatial map' inside their head to assist in finding their way around. With more work, we could ask the same questions of octopuses' navigation.

TOOL USE

With their eight long flexible arms and suckers to grasp small items, it would not be surprising that octopuses would manipulate their environment (J. Mather will have an article published this year in *Journal of Comparative Psychology* on the patterns of actions and positions in use of the arms). One of the manipulations that used to be thought of as a human specialty is tool use. With more investigation, we have found that many animals, from fishing herons to ant-catching chimpanzees and egg- smashing vultures, use tools. Tool use is sometimes simple and fixed, not always a sign of intelligence, yet its range and flexibility gives us some indication when an intelligent animal is using this technique.

(Beck 1980, *Animal Tool Behavior: the Use and Manufacture of Tools By Animals*) defined tool use precisely. To be a tool user, an animal had to modify, carry or manipulate an item that was external to itself before using it to effect some change on the environment. Mather first noticed octopuses using rocks as tools in a very simple way. *Octopus vulgaris* in Bermuda, occupying those homes mentioned above, often selected an area that wasn't 'perfect' in terms of size or area of opening. After settling in and clearing out sand, moving small rocks and pulling algae off the rocks, an octopus would often be left with a large entrance. It would go out from the home, pick up small rocks and bring them back to the home, piling them up at the entrance. By Beck's definition, these rocks were tools. When she correlated den opening area with number of rocks, there was a significant relationship--the bigger the hole, the more rocks were brought (Mather, 1994, *Journal of Zoology 233*, 359-368).

Thinking on the definition of tool use brought us to octopus water jetting. Molluscs have a water-filled mantle cavity, and all the Cephalopods have a muscular siphon to expel the water from this area. Squid use it very successfully for jet propulsion swimming, especially to escape from fish predators. But the octopus species in the family Octopoda in particular are not as streamlined. Their arms are larger and the jet of water has less propulsive force. What they do with water from this jet propulsion is use it in many different ways, including as a tool.

Remember the definition of tool use is to transport something external to the animal, to modify it somehow and to use it to effect a change on the environment or itself. Archer fish use water this way. They spit it from their mouth into the air and knock small insects off overhanging tree branches. When the insect falls into the water, the fish eats it. Octopuses also use water but in a variety of ways that change their environment.

One way octopuses use water as a tool is to change the niches that they find in the landscape to make them into suitable shelter, into homes. An octopus will find a 'likely' place, but it is usually clogged with sand and the shape may not be appropriate. It will gather sand and small rocks into the area under the arm web and carry them out to the entrance of the home. Once there, it will tilt up the web, let go with the suckers and jet it all away with a blast of water from the siphon. For a smaller amount of material it may not carry but just jet water at it, much as we would sweep with a broom.

A second way octopuses use water as a tool is to get rid of what could be described as nuisances. After capturing crab prey, the octopus will usually kill them and hold one or several under the arm web, dissolve the cartilage holding the joints together, digest out the meat, and keep the exoskeleton bits. When it's finished, it will take the remains to the den entrance and jet the lot out into what becomes a midden. If a scavenging Serranid fish comes by to eat these remains, the octopus may jet a blast of water to remove the 'pest' from the vicinity (Mather, 1992, *Marine Behaviour and Physiology 19*, 175-182). This water jet can be aimed also at a curious observer or researcher, as has happened to both of us when removing bits of prey remains to catalogue them, or just getting a hand too close to the octopus.

What all this means is that the octopus has a lot of flexibility in using the water all around it to change its environment, that it can compute the effect of what is really a current for respiration and use it in a lot of ways. We discovered that this water jet could be used in a behaviour that's really far from what is expected of an invertebrate. Octopuses can use the water jet to play, too.

PLAY

Like other terms covered here this one is expected to apply to vertebrates, almost always mammals and birds. Fagen (*Animal Play Behaviour*, 1981) describes play as similar to acts occurring in functional contexts but exaggerated and more likely to contain repetitions, as well as having no immediate biological function. We took on the challenge of deciding whether the term might also be applied to the octopuses.

Play is an interesting area of behaviour, hard to define although we all know it when we see it. One category that seemed to apply to octopuses was exploratory play, including the manipulation of objects by an animal. With repeated exploration of an object, we hoped to see the octopuses change focus as Hutt described in *Play, Exploration and Territory in Mammals* (1966) from 'what does this object do?' to 'what can I do with this object?'. Octopuses are well known for exploring and manipulating objects, so this seemed a likely transition.

We gave *Octopus dofleini* at the Seattle Aquarium a simple object, a floating pill bottle that moved a little in the water inflow, to investigate during ten trials over five days. Notice that we didn't expect all the octopuses to play with it, because they have the individual variation that led us earlier to describe their 'personalities'.

If you are going to evaluate a controversial area of behaviour in a new group of animals, you have to set pretty clear criteria. We decided that to be playing with the bottle, an octopus would have to show a behaviour different from their first action, involving manipulation of the object, with simple actions and prolonged for over five minutes. All the octopuses grabbed the pill bottle and brought it to the mouth at the first trial, as if it were prospective food.

Several of the octopuses did something quite different on later trials in their series; they jetted water at the toy. This water manipulation is quite common for octopuses removing shell remains and nuisance scavengers, so that isn't automatically play. But two octopuses went farther. The saw the bottle circling in the intake gyre at the far end of the tank and aimed water jets that made it circle the tank and come back to them for further jets. One octopus set it up so that the toy circled the tank for a round trip of 2 minutes, the other made a more direct return every 30 seconds. All instances continued over 10 minutes, and the longest was 23. If a human were doing this, someone would say we were bouncing a ball.

It's interesting that the water jet is what octopuses use for play. Why not the arms, which can move in any pattern they want? Maybe it is because the brain of the octopus doesn't need to get information about what the arms are doing, it's mostly local control. Maybe it is because no one has looked--the challenge is out there.

The differences in reaction of the eight octopuses reminded us that individual variation is so large that you can't really talk about 'the' octopus.

PERSONALITIES

Volunteers at the Seattle Aquarium were the ones who gave Anderson a clue that octopuses were so different from one another. They gave names to individuals of only three species of all the animals there, and one was the octopuses. There were some interesting names, like Lucretia McEvil and Devil and Emily Dickinson. Again, there have been studies of personalities in animals but they are usually on mammals, although there have been studies on fish, too (see the *Handbook of Comparative Psychology*, which is to be published in a couple of months, for an entry on Individual Differences by Mather).

Testing for individual difference is a contrast to the usual lab investigation. Instead of giving animals different trials and experimental conditions and looking for average response, you give them all simple situations and look for differences in responses. We chose *Octopus rubescens* and gave them the situations of Alerting (by opening the tank lid), Threat (by touching them with a probe) and Feeding (by giving them a crab).

We recorded nineteen behaviours in three situations and put them to some formidable tests. To find variation, you submit the numbers to factor analysis and then principal components analysis. The results sort into groups of responses and these predict Dimensions on which individuals vary. The choice of names is subjective, but the octopuses varied on three dimensions that we chose to call Activity, Reactivity and Avoidance (they are similar to those found in fish and mammals). We could take any octopus and make a 'personality profile' for it on these dimensions (see the article in *Journal of Comparative Psychology 107*, 336-340, 1993).

Does this mean octopuses have personalities? The answer is a qualified yes. The difference seemed to be long-lasting, but we didn't study that. We don't know anything about where the differences come from. Was a shy octopus scarred by experiences in the planktonic stages? Or is it strongly due to genetic heritage, as Burghardt (1974, *Behaviour 52*, 202-225) found for snakes? What difference does it make to foraging success, habitat preference, ability to find a mate? There's lots to learn.

One thing we have thought of is that this variability may underline much of what has been shown above about octopus intellectual capacity. Without the differences, octopuses could not adapt and learn. Individual differences are very useful for a soft-bodied animal like the octopus that has to live by its wits. They also help individuals track a varying environment (see *The Beak of the Finch by Weiner* (1995) for an excellent demonstration on birds in the Galapagos). The underwater near- shore environment is very varied, especially in the tropical coral reefs. The ability to do new behaviours or see things in new ways may allow the octopus to navigate around the bottom, to observe others, to use tools and even to play, and thus to thrive even when it seems to have little protection against predators.

What next? There's a lot out there to do. While octopuses are solitary, some of the squid are not; what's their social organization? There are questions just touched and still unresolved as to whether squid and octopuses recognize each other as individuals and whether they recognize individual humans. We have been getting more interested in the communication system they set up by changing colours and patterns on their skin. There is a whole area of tactile and chemical recognition, just skimmed because we humans are such visual animals and so haven't studied it much or well. If octopuses don't use vision much for finding prey, what are the cues and how are they used? And there's an intriguing question of how much octopuses know where they are and even what their arms are doing. There's lots to do!

Credits

The text of this article was written by J. Mather and R. Anderson. Minor editing by J.W.

References

See text.

Articles Reference

Mather J. A. and Anderson R. C. 1998 What behavior can we expect of octopuses? In: The Cephalopod Page. Wood, J. B. Ed.

Upcoming Meetings

March 28th:	**Tony Fiorentino** **13 Andrews Court** **Padbury**
April 25th:	Grant Magill
May 30th:	Frank Krause
June 27th:	David Bloch
July 25th:	Wayne Mothershaw
August 29th:	Darren Collins

MASWA's World Wide Web address
The website is temporarily offline.

Newsletter and General Inquiries
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aquatech@opera.iinet.net.au
or phone on (08) 9375 2438 a/h

MASWA Membership
Currently MASWA requests an annual $22 donation from adult members, $11 from Junior members. This covers the cost of newsletters, drinks, nibbles and other costs associated with the society. Members will receive information sheets and discounts on some products.

Friends in Common
Jan Anderson, Lissa Beaufond, David Bloch, Darren & Raqual Collins, Nathan Cope, Andy Dolphin, Tony Fiorentino, Paul Groves, Sid Harrison, Frank & Ben Krause, David Lee, Grant Magill, Phil & Caron Melvin, Wayne Mothershaw, John Ryan, Phil Searle, Ronald Tan, Paul Tayler, Greg Weryk.
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