Science AMA Series: I'm Rich Ross, husbandry biologist specializing in cephalopods and coral. It's World Octopus Day, AMA!

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Abstract

Hey Reddit! I'm Rich Ross, a husbandry biologist specializing in cephalopods and coral at the California Academy of Sciences' Steinhart Aquarium. I keep weird and unique animals thriving and breeding in aquariums, as well as do fieldwork on coral spawning and animal-collection for display and animal-behavior studies. Cephalopods are the coolest animals on the planet (3 hearts, blue blood, ring-shaped brain, related to snails, like something from a Harryhausen movie and secretly plotting to take over the world), and I've been working with them for almost 20 years. I was the first to close the lifecycle of the dwarf cuttlefish, and my colleagues and I recently published a paper on the breeding and behavior of the currently undescribed Larger Pacific Striped Octopus—an octopus that does things very differently from other octopuses (like beak-to-beak mating). I'll be answering questions starting at 10 a.m. PT/1 p.m. ET, and you can find me anytime on Twitter or packhead.net. Also accepting questions about juggling, martial arts, glassblowing, and hairless dogs. It is 12:11 and I have to run to do some work stuff. I'll check back in tonight around 6 pm Pacific Time to answer any follow ups or questions I missed. Thanks! 8pm, I think I got everyone, I'll check back again tomorrow.

the WINNOWER

REDDIT

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RICH_ROSS R/SCIENCE

ABSTRACT

Hey Reddit! I'm Rich Ross, a husbandry biologist specializing in cephalopods and coral at the California Academy of Sciences' Steinhart Aquarium. I keep weird and unique animals thriving and breeding in aquariums, as well as do fieldwork on coral spawning and animal-collection for display and animal-behavior studies. Cephalopods are the coolest animals on the planet (3 hearts, blue blood, ring-shaped brain, related to snails, like something from a Harryhausen movie and secretly plotting to take over the world), and I've been working with them for almost 20 years. I was the first to close the lifecycle of the dwarf cuttlefish, and my colleagues and I recently published a paper on the breeding and behavior of the currently undescribed Larger Pacific Striped Octopus—an octopus that does things very differently from other octopuses (like beak-to-beak mating).
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Is it possible to "decode" the cuttlefish colour communication system? How complex is it?

iorgfeflkd
I think it should be possible to get a better idea of what they are 'saying' to each other. I don't think we have a great idea about how complex it is yet...it could be really basic and emotional, or more complex. I wish we knew. Being able to communicate differently on two sides of its body is really really interesting. Needs a lot more study - like everything ceph related.

I work for a large aquarium!

I have been told that housing cuttlefish is too impractical due to their husbandry needs. What makes this different from our Octopus and our Nautilus?

aquaneer
Traditionally, aquariums have displayed Sepia officinalis, which need cooler water and get pretty big, 30 cm. As they get bigger they also can start to fight. So, you need a largish tank, and then you need extra tanks to house the animals that you are going to need to separate to avoid fighting and cannibalism. They can also be difficult to wean onto non live foods. HOWEVER, the breakthroughs in the last decade with smaller species like the Dwarf Cuttlefish, Sepia bandensis, mean much of the husbandry is scaled down because they are small. I think the real issue most aquariums have with cuttles is their short life spans, about a year, so to keep them on display long term you also have to

breed them. Here is a link to a paper on keeping and breeding dwarf cuttles - http://packedhead.net/2010/display-husbandry-and-breeding-of-dwarf-cuttle/ The best thing about them is that they don't try to escape like octos do. There have also been breakthroughs in keeping and breeding Flamboyant cuttles, though in general, they seem more sensitive than Dwarf cuttles. At this point, Dwarf Cuttles are pretty bullet proof.

Is it true that an Octopus has to focus on a tentacle in order to control it? How much autonomy do the tentacles have? If they have any autonomy how complex and what are the behaviors of the unattended tentacles?

publicout
It appears that octo arms have their own ganglia that will do general control of the each arm, with subroutines for searching for prey or just being aware of their surroundings. When an arm is removed it keeps on doing stuff. It seems the main brain can take over and control each arm more specifically. I don't know how that change in control works, but sure is cool.

How sensitive are cephalopods to ocean acidification? Are cuttlefish more vulnerable due to their cuttlebones, or can they protect themselves from their local water conditions?

Have you ever blown any glass vessels shaped as cephalopods? If so, were they used as enrichment habitats for those in your care?

Thanks!

Nihla
There is talk of doing an ocean acidification study of cuttlefish, because calcification seems to be impacted by the acidification - other mullusk shells have been shown to become brittle or not develop correctly in more acidic conditions. Since the cuttlfish have calcium cuttlebones, we want to see how the development of the cuttlebones is impacted by acidification, but I don't think anyone has done the study yet. We wanted to do this study years ago, but you know time, resources and money! I have made some glass cephs which are pretty cool. I have also made a lot of custom octopus dens of different sizes and shapes, often with 'inner folds' to give the octopus a sense of security. These have worked pretty well and allow us to see what the octopus is doing in its den, and if there is a clutch of eggs to be able to observe development.

Tough going up against Stephen Hawking with this AMA. I feel for you.

I've always thought octopi are the coolest creatures. What is your favorite fact about them and where do you see there future as climate and ecosystems change?

donotbelieveit
Stephen who? Ha! An honor to be associated with him in any way (I love the screenshot I have of his AMA above this one). Octopuses are the coolest creatures! My favorite fact about them is that they have a ring shaped brain that the esophagus passes through, so if they try to pass a piece of food that is to large it could bump their brain. BTW - octopuses is more correct than octopi, but octopi is acceptable. If you want to be super correct, you would say octopodes because of the greek root, but, from experience, if you say octopodes, people will hit you.

I've always been intrigued by the high level of intelligence and the very short life span of cuttlefish. What are your thoughts?

clsbabe

Intelligence is hard one to try to quantify, but they do do (haha do do) things that seem smart - how they hunt and how they avoid predators, and they are communicating with each other. The short life span is a bummer, but they grow so fast that they are able to pack a whole lot into their short life. I would love to be able to quantify their intelligence better so we have a better idea of what is actually going on in their ring shaped brains. Imagine if they are aware of their own mortality.

Hello!

So, because you have to culture these animals in indoor systems, what water quality parameters do you have trouble keeping up with that are important for your octopus species? Especially with regards to reproduction (nevermind survival). Does your facility utilize treated natural sea water or do you guys have your own in-house "brew"?

feedmahfish
Salinity, temp, pH, nitrite, nitrate, ammonia, calcium, magnesium, alkalinity are the main parameters that we care about. If you have a saltwater thumb these parameters aren't all that difficult to stay on top of. Keeping the water quality good and the aquascape naturalistic helps keep the animals comfortable and mating. The like to mate, a lot, so getting them to mate isn't that difficult (with octos, generally, you have to beware of cannibalism so we generally chaperone them pretty closely when mating them). Far more difficult is getting the right food for the larvae. At our facility we mix up our own saltwater mix, which allows us to tweak the parameters to what we think is best.

Do you feel any coral plug transplant technique has any chance at measurable significant change in areas decimated by various diseases (white band, etc)?

Currently, what is the most promising research in coral? As of now most things are looking pretty negative.

avboden
I think there is great chance of coral transplants via plugs or fragmentation of being successful. This is one of the ways that corals propagate naturally. The real issue is what is causing the disease that is causing the problem in the first place. If that isn't under control, it might not be possible for corals to make a comeback in that area. It may also be possible to out plant enough coral to get out in front of the disease or problem. The Coral Restoration Foundation in FL is doing great work growing endangered Staghorn and Elkhorn corals and replanting them on reefs, and that is pretty exciting stuff. The most exciting research to me is about coral sexual reproduction because once we crack it wide open, we will have access to many more pieces of coral to out plant than we can generate with asexual methods. I know if feels negative, but I like to remember that we are really only recently turning out attention to the problem and to the understand of corals in general, so I think we are going to figure a bunch of stuff out. When I feel down because of all the bummer news, I like to remember that humans are really really clever and that we tend to figure out ways to think ourselves out of problems.

Do octopus have any complex or interesting mating rituals? How sociable are they usually - I imagine some being like spiders?

yoosanaim
Oh yeah they have crazy mating habits. The Larger Pacific Striped Octopus (we recently published a paper about their behavior and mating) do it very differently than most other octopus by mating in a beak to beak position. This position seems dangerous because that makes both the male and female vulnerable to each other in terms of potential cannibalism. Most octos try to keep their mouth parts away from each other while mating to make escape easier if things go south. Usually, octopus are

loners, but there are a few, including the Larger Pacific Striped Octopus that seem 'social', found in groups of 40 or more. We need to do field work to follow up on this.

Just how smart are octopuses?

lucundus
That is a really really hard thing to pin down. You hear all kinds of comparisons like 'as smart as a three year old child', but I don't really know what that is supposed to mean, and such comparisons make me nervous. Plus, some octopuses seem smart, while other seem, well, not so much. I would love a way to really determine and compare intelligence.

Can you expand on the beak to beak mating? How does that work and why do you think it evolved (i.e. are there any advantages in their environments to that over more common methods?)

firedrops
Oh, the beak to beak mating is the coolest thing ever. You can see video of it here http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0134152#sec013 It isn't only the beak to beak part that is exciting, but also how they line up their arms and suckers. When they mate they look like a crazy ball of wiggly tentacles. It works just like regular mating - male octopus have a specialized arm, third on the right if looking from above) that transfers the spermataphore to the female. Basically, the male sticks that arm into the females mantle and the sperm packet moves over to the female. Most octopus do this from as far away as possible, some with just the arm and nothing else touching the female...so they can make a quick get away if things go all praying mantis. So the beak to beak is really weird, because it puts both the male and female in the most dangerous position. Why they are doing this we don't exactly know yet (field research is needed!) but it might have to do with the social aspect of this species - they seem to occur in stable groups of 30-40 animals. Another difference is that the LPSO doesn't just lay one clutch of eggs and then die after they hatch, instead they can lay eggs concurrently for 5 or more months. This means that a female protecting eggs can still mate, and will sit at the entrance of her den with her suckers and mouth exposed in what might be a defensive position, which is halfway to the beak to beak mating position.

WOAH, I missed that last sentence about hairless dogs.

Those are real?

Now I must google.

Edit: Wow, yes there are hairless dogs.

questions

When and why were these dogs bred? Same reason as cats - allergy purposes?

How exactly do you get a hairless breed? Are those Chinese crested dogs that naturally have lesser amounts of hair selectively bred?

Was there gene manipulation?

Any chance on a larger dog breed that's hairless - my friend LOVES DOGS but can't have one because her husband is wildly allergic.

How much do they cost?

Are there any health problems related to those breeds?

Like with hairless cats do you have to be careful about how cold it is outside when you take them for walks?

Thanks!

aquaneer
The Peruvian Inca Orchid is an old breed and we don't know why they were originally bred. I assume because they are super cool and ancient peoples were obsessed with being hip. They come in three sizes, we have one that is 35 pounds which is on the small end of the large size. You can get them by breeding for the trait, just like pug noses. The hairlessness is recessive. They are commercially available and can be rescued. They tend to have less teeth that goes along with the hairless gene.

Rich! How's it going? Layman question out of curiosity: What is the most dangerous Octopus? Also, you mention glass blowing. Have you seen Dale Chihuly's work? Amazing stuff that always reminded me of octopus.

covertPixel
As far as we know, the most dangerous would be the Blue Ring Octopus because its bite can contain tetrodotoxin, which is bad bad news. It shuts down your muscles and makes you seem dead, but CPR can bring you back. Anyone keeping these animals - why would you do that - should have a sign on the tank and in their wallet that says 'if you find me unconscious and not breathing by this tank, give me a lot of CPR' and then more details. Another dangerous octopus is the Larger Pacific Striped Octopus because it is so cute it will steal your heart forever. Awwww. Chihuly's work is great. He is a rockstar.

Do you have an Octopus aquarium at home? I think that would be kind of neat to have, if even possible.

Puckfan21
It is possible, but needs study, planning and understanding of what the animal needs. To do it, you need to really want to do it and be willing to do what it takes. Check out the animal care section of the cephalopod website www.tonmo.com for more information - a great resource filled with great people and great information.

Hi Rich. Cephalopods and anthozoans top the list of animals that interest me, and I hope to make a career out of studying them. What can I do as an undergrad to improve my chances of success in being accepted to and doing well in a marine biology graduate program? The people I've spoken to working in marine sciences have told me that the more computer science I can learn, the better.

GroktheCube
I don't know how helpful I am in this arena because I snuck in here by being largely self taught. I suppose it really depends on what you want to study and how. Computer science seems to be more and more important in all aspects of all the pies I have my fingers in so that makes sense. If you are interested in studying the animals, having practical experience on keeping them alive and thriving is important as it is not easy and experience is the best teacher. So, practically, I would intern or volunteer at a public aquarium and see what they are doing.

Hello! My friend was curious as to what your day-to-day looks like. Thanks for the ama!

SamMee514
Cool question! Wake up and 5 am, and check all the home aquariums. Go to work. Do morning rounds on all the animals and exhibits under my care. Check email. Make sure all exhibits are ready to be

viewed by the public. Feed everyone. Work on any larger scale projects. Go to meetings. Scuba dive in the larger exhibits to clean, arrange, and observe. Make sure anything breeding is doing well, check on larvae and juveniles for heath and feeding response. Promote the idea of more field work. Check email again. Do paper work and data tracking. More meetings. More work on upcoming projects. Do afternoon rounds and feeds. Leave work. Pick up kid. Go home and feed all the animals at home. Best day ever!

There are the world's smallest octopuses, and the world's largest, but which are the most interesting?

mcdonaldstrump
They one you are having the most success with is the most interesting. Big ones are great, but take more resources to keep. Small ones are great, but can be hard to see. I love them all.

How do octopuses digest crabs and other crustaceans? Is their hard shell digestible?

crazytoe
The octopus mouth parts include a parrot like beak and a radula, which is a cheese grater like tongue. Generally, the octo will either break open the shell of the prey item by biting through it with the beak or drilling through the shell to get at the yummies inside. Once the meat is exposed, they take larger bites of it with the beak, and then 'chew' the chunks down to more digestible size with the radula. When done eating, most octos will clean up the remaining shell pieces, and move them outside of their den.

What is your favorite sea creature?

TheMan0fSteel
Larger Pacific Striped Octopus

What future discovery do you or anyone in your field hope to make that would revolutionize what we know about our oceans and reefs?

Vonstracity
I think a fuller understanding of what larval animals eat before they settle would be hugely helpful.

Does the sadly short lifespan of aquarium octopi effect your work? Are there certain things you would like to try/study that the lifespan hinders?

Pkock
The short lifespan is problematic because we only have a short time to study each animal, and a bunch of time is spent either breeding more, collecting more, or finding a source for more. A lot of my work is trying to close life cycles, and it would be so much easier if these animals bred and lived for a decade instead of generally a year. The short life span hinders almost everything, but is kinda great for short term studies.

Why are they so much more intelligent than other inverts? It's an abstract question, I know.

ExtraWingyScapula
Because not only do the need to eat a lot, but almost everything in the ocean thinks they are delicious! So, they either need to be finding ways to eat or not be eaten - and mating somewhere in there too. To avoid being eaten a snail closes up its shell, an octopus needs to find a place to hide, or not be seen in the first place. I like to say seemingly intelligent, because it makes me feel less dogmatic.

Thanks for taking time to answer questions.

One observation I have made is the apparent success of octopuses relative to other animals in the deep ocean. There are many of the so-called "dumbo" octopus grimpoteuthis sp? in the deep water column and many little benthic, often purple, ones that I can't identify.

My question is, why are they so successful in the extreme environments. Or, alternately, am I biased because they are so charismatic?

Wrathchilde
My pleasure! Thanks for asking. Cephs are successful in at every level of the ocean. Someone once claimed that the mass of cephs on the planet would be more than the mass of fish - I don't know if that is true or not, but it doesn't seem as impossible. I think they are successful because they are so good at eating and avoiding being eaten. They are an incredibly successful group in general. And they are incredibly charismatic which is one of the reasons people want to claim they are intelligent.

Why do they have a ring shaped brain?

PM_ME_FACTS
I am not sure. I'll do some digging.

Hello! Thanks so much for doing this! I'm a marine science undergrad student, and your research is exactly the type of stuff I'd like to do. Do you have any advice for finding good programs/researchers to work with? How would you recommend breaking into the field?

What's the one question you're hoping you get the chance to answer today?

loveallison
This question is the one I want to answer most today! I came to the field in an odd way, so my advice is based on my experience. So, get experience - intern or volunteer at a public aquarium. I think more and more, the important thing about this research is going to be keeping the animals alive long term in the lab, and doing so is as much of an art as a science so nothing is going to substitute for experience in that arena.

What is the most bizarre or unique action you've ever seen from a mimic octopus?

Thank you!

rasouddress
I love when they make themselves look huge basically saying get away from me. I am on the fence if they are truly mimicking other animals or not.

Hey Rich! You were one of the two people I wanted to meet and macna and I didn't get the chance to say hello. Your work with cephalopods and corals is everything that I dream of.

My questions for you: how did you start your career in public aquaria? What advice would you give to an undergraduate working on a natural science degree that is interested in marine science and aquaria?

Cydan
Thanks! Make sure we meet at the next conference. If you are interested in working in aquaria, intern or volunteer at a public aquarium. Nothing is going to substitute for experience because keeping

saltwater animals is as much an art as a science and you need to develop a saltwater thumb.

Is there any possibility of sustainable closed-system aquaculture of octopus, squid or other cephalopods in order to take pressure off of wild stocks? As I understand it, most of the commercially valuable ceph species are heavily overgarvested. Thank you!

akhotsharks454
I think we are finding that most food animals are being over harvested. Lots of people are working on how to mass culture cephalopods and I think we are going to figure it out. Small and medium scale, we can culture the heck out of cuttlefish right now, so it is possible. Most octopuses are harder to culture because of the sensitive larval stage of the hatchlings. The problem is going to be economics - it may always be more cost effective to just catch animals instead of breeding them, but we likely have to be more careful with that luxury.

Octopus are often considered one of the world's most intelligent invertebrates. However, it is often not considered as a top predator or a keystone species. Any thoughts on why that is?

homicidaldonut
I think this is likely due to how much we don't know about these animals and the ocean environment in general. Octopus are fantastic predators.

Thank you for doing this AMA! After today, what are some academic sources/references we can go to and learn more about cephalapods? Books, websites, mailing-list serves, journals?

jay314271
I could go to www.TONMO.com, your jumping off place to connect to all things cephy.

How many new species are discovered (on average) every year?

jay314271
Something like 15000 new species a year in general. In cephs, I am not sure. There are less people working on them and it seems to talk longer to ID them. That said, there seem to be plenty that have not been discovered!

I hear it's hard to keep squids because they tend to kill themselves jetting into the glass when they get startled. Is this accurate?

atomfullerene
That has been one of the issues keeping squid in captivity, thought it seems that we can get past that and train them to be calm. Other problems include shorter life span and getting them enough food. The eat a lot. Really. A lot.

Hi! I used to work as an intern at Monterey Bay Aquarium. How did you work your way up to your current job? Also do you keep an aquarium at home?

Pazdispenser
Before my current job I was active in the hobbyist aquarium world farming coral and closing the lifecycle of Sepia bandensis in my spare room. I started volunteering at the Steinhart Aquarium when my daughter started school, and did a good job and worked my way in. I have a reef tank that has a total of 300 gallons (150 display and 150 in life support) as well as about 300 gallons of tanks in my secret home lab.

[deleted]

[deleted]
I don't know about angering an octopus, but I have startled them, or upset them by catching them for various reasons and sometimes it can take a bit of time for them to stop being upset.

Hi!

I saw a video where you jumped on top of a whale shark in the Atlanta aquarium. It was a rather hot video, I enjoyed it very much.

Are you more attracted to whales or cephs?

Thank you.

Ixodie
Ha! I missed the shark! I am equally attracted to whales and cephs. Here is that hot video: https://vimeo.com/77008614

Hi Rich! I am an aspiring cephalopod specialist, and I've been doing independent research into cephalopod intelligence for a while now. I did my undergrad thesis on cephalopods and I plan to go to graduate school to study them in the future. I share your deep passion for weird, intelligent marine animals, and I was wondering what advice you would give a recent graduate regarding pursuing a career in cephalopod science?

Perceptivestudent
Go to www.TONMO.com and network with all the people there. The only reason I am publishing with such great co authors is through meeting them and getting to know them on that site.

Hey Dr Rich.

What do you know about breeding squid in an aquaculture environment?

I have seen heaps of live squid in tanks in hong kong and was wondering if they were live caught or bred.

Live and fresh squid is the best bait for fishing in our area and while they are plentiful to catch your self you can spend most of a morning sometimes catching them one at a time. It would be great to just scoop a few dozen out of the tank.

malawisativa
Most, if not all of market squid is wild caught - to the best of my knowledge. Among the issues of raising them is feeding them. The eat a lot (A LOT) and as they grow they need bigger and bigger food.

What advice would you give to someone looking to potentially enter the biological husbandry field?

Barack_O_Mama
Get experience keeping animals alive. Set up and learn on your own tanks in your own way, breed everything you can and then when you are looking for a job, you know a bunch of stuff. Intern and volunteer at a public aquarium. Experience is gold.

Hi Rich! I heard you are a really prolific juggler. How many octopus do you think you could juggle at one time?

Also, if you could juggle any octopus in the world which one would you choose?

PirateP3t3
I could juggle 5 octopus at a time if they would stay ball shaped. I might be able to flash 7. If I could juggle any octopus in the world it would be one named billy.

Hello!

Are there any experiences you can share about larval rearing of cephs? Also: what sort of enrichment strategies have you found to be best with octos?

sporophytebryophyte
The key to larval rearing is generally thought to be food. Finding the right foods is not easy. That said, it may not be food, it may be other things light light or flow that may help trigger a feeding response, but I think it is finding the right prey item that moves the right way. The cephs that don't have a larval stage are much easier as they are just kind of miniature adults. The larval ones, well, they are frustrating! Any enrichment is good. I have done a lot from putting mirrors in tanks to stuffing food into a whiffle ball to screw top jars to letting an octopus watch you tube to acclimate it to the action of people (it seemed to like Big Trouble in Little China a lot).

So a clown, a glassblower, and an octopus walk into a bar....

Finish the joke please.

Ixodie
and we call the act 'the Aristocrats!'.

What octopus would you recommend as a pet?

thedanimalw
Keeping an octopus is not something to be entered into lightly. Keeping saltwater aquaria is not easy on its own, and adding an octopus on top of that compounds the difficulty. If you are interested in keeping an octopus, I suggest a getting some saltwater experience with captive bred/cultured saltwater fish and corals, and once you feel comfortable and successful with that look into octopuses and their needs. www.TONMO.com is a great resource of all thing cehpy, including animal care and selection.