

BETWEEN *the* TIDES

F r i e n d s o f F i t z g e r a l d M a r i n e R e s e r v e

June 2018

2018 FFMR Training Class

by Susan Evans

I am very pleased to announce that 16 students started the class at the beginning of February and 16 students graduated at the end of April. This is a first! Congratulations to all graduates: Candice Abellon, Ariel Bauman, Kylene Gilmore, Meredith Greene, John-Thomas Hanson, Travis Hanson, Tom Hart, Lynda Jacobsen, Deryck Marsh, Marcello Menjivar, Rachel Menjivar, Arianne Orr, Kacie Sorfleet, Jody Stewart, Gerry Sutkowski and Dan Woodard.

The 2018 Training Class was an amazingly talented group. Here's hoping they will be part of our volunteer naturalist group for many years to come. The class was a front runner with more than 52 hours of both class instruction and field work on the reef plus an additional six hours with mentors (shadowing tours, experiencing a different tidepool area and individualized mentoring with a current naturalist). Thank you to Roger Hoppes for heading up the mentor program this year and getting all the students to the finish line before graduation. Thank you also to all the mentors who ably led the students out on the reef.

Our wonderful instructors were again our pride and joy. Joseph Centoni taught 4 classes: 3 major Phylum, Tides/



Zonation and Tidepool Ecology; Irina Kogan: Geology; Jean Replicon: Mollusks; and Kathleen Dickey: Algae. Our own naturalists, Karen Madsen and Kris and Michael Liang, taught Marine Mammals and Bill Kennedy taught Worms, Bryozoan and Sponge. (Dr. Tom Niesen has been recuperating in Santa Rosa). Dr. Wes Burgess taught Evolution, Tom Ciotti gave an Historical Overview, Linda Ciotti helped with sign-ups and Ron Olsen and I filled in where needed with some algae, mollusk and tunicate games and instruction. Thank you to

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Ever wonder what the trainees are looking at under the pier? At far left are tunicates and bryozoan and at left, a 6-rayed juvenile bat star.

Friends of Fitzgerald Marine Reserve

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Moss Beach, CA 94038
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www.fitzgeraldreserve.org

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Our Mission:

To inspire the preservation of our unique intertidal environment through education and the support of research.

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FFMR Management Changes

Something Old, Something Blue, Something Worn, Something New

by Tom Ciotti

Old

Getting into the swing of the season a little early at its April 2018 meeting, the FFMR Board indulged in a bit of déjà vu and elected this author President again after a two year hiatus. I consider it a great honor to again serve as President of this outstanding organization.



Linda and Tom Ciotti

Blue

This turn of events occurred due to Kathleen Hayes's unexpected resignation from the Board because of the exigencies of her new job. Her work load and travel requirements simply didn't leave her with adequate time to continue as our President. We will miss her leadership, boundless energy, and drive and hope that someday she will be able to return to our Board. Thank you Kathleen!

Worn

Bill Kennedy and Hope Suchsland respectively agreed to continue as Secretary and Treasurer and the Board re-elected them to wear those mantles again in the ensuing year. Thank you Bill and Hope for your continuing service to FFMR. All current Board members were elected to serve an additional term on the Board.

Correction: The photo on the cover of the March 2018 issue is a sea lion skull in a shark's jaws.

New

To offset the déjà vu, the Board decided to inject some new blood into the system and elected Steve Slomka and Jeanette Hyer as new Board members. Both Steve and Jeanette are long-time, active volunteers. Welcome and thanks, Steve and Jeanette.

Moving Forward

With all these changes FFMR continues to fulfill its mission to preserve and protect FMR by encouraging marine education and research.

Our 2018 Volunteer Naturalist Training Class ended recently and we have sixteen new volunteer naturalists, many of whom are already participating in school tours. Special thanks go to Board member Susan Evans for managing the training class program, Board member Joseph Centoni for teaching many of the class sessions, and Board member Roger Hoppes for managing the field mentorship program for the trainees.

Our plans for 2018's Junior Naturalist Summer Camp are also complete and we hope to introduce the wonders of FMR to about fifteen 9 to 12 year olds. Thanks to Board member Linda Ciotti, volunteer naturalist Juliette Applewhite, and Ranger Katherine Wright for planning this year's camp.

Finally, on behalf of FFMR's Officers and Board members, a huge thank you to our donors and volunteers without whom our efforts to continue to preserve and protect FMR would not be possible. ♦

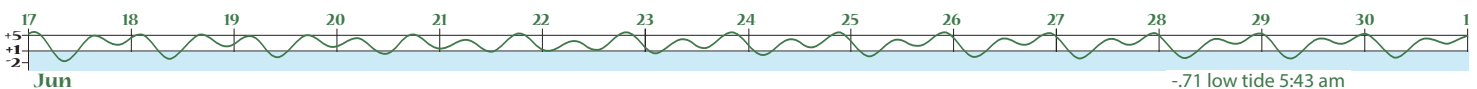
The graph displayed across the page bottoms shows tides for 6/17/18 to 11/3/18. Where the date appears is midnight. The reefs are accessible for exploring during low tides—at least +1 or below. This area is shaded light blue. See: <http://www.fitzgeraldreserve.org/newffmrsite/>

[lowtides/](#) and click on "Tides" for a more detailed tide chart.

The winter afternoon low tides change to morning low tides in April. There are almost equally low tides several days before and several days after the noted low tide dates. October will see a return to

The lowest tides this period are:

-0.71	6/28	5:43am
-1.64	7/13	5:30am
3rd lowest tide of 2018		
-1.20	8/11	5:11am
-.64	9/08	4:03am
-.51	10/27	7:22pm



Barnacles

by Sasha Greenawalt

Like its crustacean relatives, crabs and lobsters, barnacles have a hard exoskeleton and multiple segmented legs. These legs, however, no longer function as legs but have become specialized feeding and respiratory appendages. In addition to the exoskeleton, barnacles grow a hard outer shell; this outer shell is what is visible. The animals also have an opening at the top where the feeding and respiratory appendages are exposed to water. Barnacles are mostly hermaphroditic, and they cross-fertilize with their next-door neighbors.

Encrusted on ships, barnacles can cause enough drag to increase fuel consumption by 40 percent. Cement glands within the antennae produce the brown glue that fastens a barnacle to a hard surface. Acids and alkalis do not dissolve this incredibly strong glue that can hold the base of the shell to a surface long after the barnacle is dead. Dentists interested in the adhesive power of this glue have been trying to determine its composition.

Here are some of the barnacles you may see living at Fitzgerald Marine Reserve.

Common Acorn barnacle: *Balanus glandula*



photo: University of Puget Sound

This species is the most common intertidal barnacle in California, and it occurs in large patches, usually in the mid to upper tidal zone.

Acorn barnacles begin life as free swimming larvae. When the time comes to settle, the larvae “glue” their heads to hard surfaces, such as pilings, wharfs, ships, rocks or other hard-shelled animals. Barnacles spend the rest of their lives in this position—head down and feet up. The Acorn barnacle shell width ranges from 1/4 to 1/2 inch, and their color varies from white to light brown. They are volcano-shaped; that is, the shell has a larger base that tapers at the top. Plates can seal off the animal when it is exposed to air by low tides, preventing desiccation. The top opening is diamond shaped and sometimes when the plates are closed, a line appears down the middle of the top, at the juncture of the plates.

Buckshot barnacle or Small Acorn barnacle: *Chthamalus dalli* and *Chthamalus fissus*



Buckshot barnacles with one Acorn barnacle at bottom. photo: MarineBio.net

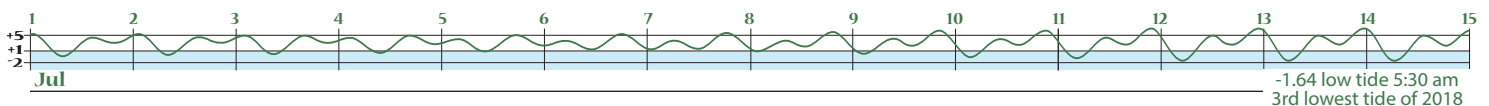
This barnacle closely resembles the Acorn except that it is much smaller (shell sizes range from 1/8 to 1/4 inch wide for adults), and it has an oval rather than a diamond-shaped opening. It can live on almost any surface that it can attach to: this includes many other animals such as limpets, snails, mussels and even other barnacles. When its inner plates are closed, sometimes cross-shaped lines appear on the top. Buckshot barnacles can settle in very high densities that can cover entire areas of rock.

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Barnacles *continued from previous page*

Thatched barnacle: *Semibalanus cariosus*



Thatched barnacles are usually found under ledges and on vertical surfaces. The volcano-shaped shell can be up to 2.4 inches in diameter, brownish green or greyish in color, with a rough or corrugated outer shell that has narrow ridges from the top to the base. The wall plates are composed of vertical tubelike ribs which become downward pointing, finger-like (“thatch-like”) projections. They are found in the middle to shallow intertidal.

Volcano or pink barnacle: *Tetraclita rubescens*



The Volcano barnacle shell has an average diameter of 1.5 inches, rarely 2. Its exoskeletal wall consists of four plates with no basal plate (all other local Acorn barnacles have six plates). The shells of adults are pink to reddish and appear thatched, while the shells of (uneroded) juveniles are white. They are common in middle to low intertidal zones on rocks exposed to strong surf. Their range appears to be moving farther into Northern California than previously noted.

photo: Liam O'Brien

Gooseneck barnacle: *Pollicipes polymerus*



Gooseneck barnacles are often seen in the exposed areas of the middle intertidal. They can be identified by several light-colored plates that form the top of a cone that sits on top of a dark stalk. These barnacles are typically found in large clumps and often in the midst of mussels. Gooseneck barnacles can grow several inches long depending on the conditions. Despite their strange appearance people like to eat them, especially in Europe, where they are farmed for consumption. ◆

photo: NOAA

Despite their strange appearance people like to eat them [gooseneck barnacles], especially in Europe, where they are farmed for consumption.



They are among the most delicious morsels the sea has to offer. Spain-recipes.com

Barnacles are so much more than I thought!



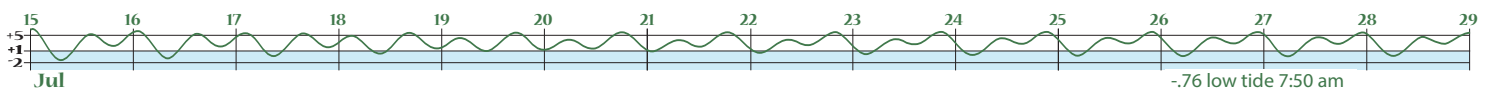
photo: Monterey Bay Aquarium



photo: University of Puget Sound

A note from Martie (designer): Sasha sent another Acorn barnacle photo (shown at far left), and when I looked at it I thought there was a flower-looking object stuck in it. No! It is feeding and those are its beautiful, feathery modified legs filter-feeding small plankton and other particles from the water. It's gorgeous. At near left is the usual photo one sees of an Acorn barnacle, the kind I always thought were just dead shells on the bottom of a boat that need to be scraped off (these just have their feeding legs closed in). To see the action of the feeding, check out one of these amazing videos:

- <https://www.arkive.org/acorn-barnacle/semibalanus-balanoides/video-00.html>
- <https://www.youtube.com/watch?v=9kQyZTid3nM>
- <https://www.youtube.com/watch?v=609ChAyR3yM>



Protecting San Vicente Creek Watershed

by Breann Liebermann, Sustainability Coordinator at San Mateo County

I work for the County of San Mateo and am based out of Redwood City, so I don't normally get to spend much time on the coast. However, I had the opportunity one morning to explore a coastal stream while conducting stream sampling. It was a good reminder of how amazing our coastal water resources are. One such coastal waterway is San Vicente Creek. Though the watershed is small (just 1.8 square miles), it's important to protect it, as it drains out to Fitzgerald Marine Reserve.

The County Office of Sustainability is working in collaboration with the San Mateo Resource Conservation District (RCD) and Golden Gate National Recreation Area (GGNRA) to address bacterial pollution in San Vicente Creek. Two current County initiatives include education/outreach and water quality monitoring.

Through its partnership with the RCD, the County is conducting education and outreach throughout the midcoast focused on dog waste. Dog waste, if not picked up, can get washed into the creek and ultimately end up in the ocean. A single dog produces more bacteria in one day than a person, a horse and a cow combined. By

picking up after our dogs, we can protect our coast to ensure that swimmers, surfers, boaters, and sea life are kept safe.

The County's outreach initiative launched in the summer of 2017 and will continue through summer 2019. One successful event so far was a pet waste cleanup last fall, in which volunteers picked up over 40 pounds of dog waste around San Vicente Creek, and at Wavecrest Open Space with the help of Coastside Land Trust volunteers.

Dog bag dispensers have been very popular, and were passed out at several coastal events.

Other outreach activities have included email and Facebook alerts reminding dog owners to pick up pet waste before it rains, and lessons to students on watersheds and stormwater. Stay tuned for future events! ◆



The final leg of San Vicente Creek's journey to the ocean



These pet waste stations near Fitzgerald Marine Reserve make it convenient to clean up after your pet.

Water Quality Monitoring Program

Another exciting initiative is the water quality monitoring program, which is a multi-year effort that will help identify sources of bacterial pollution in the San Vicente Creek watershed, and specific areas to focus on. The program started in the summer of 2017 and will continue through 2022.

Water samples are collected at various sites throughout the watershed by the RCD during both the wet and dry seasons. Sources of bacteria in the watershed likely include waste from horses, dogs, humans (such as septic systems that aren't maintained or sanitary sewer overflows), and wildlife. The County is already conducting activities to address bacterial pollution and some of these sources by increasing catch basin cleaning and street sweeping, and investigating illicit discharges. Meanwhile while the RCD is work-

ing with property owners to implement best management practices. For example, to address any potential horse waste pollution, GGNRA, in collaboration with the RCD and the equestrian facilities operators, is developing and implementing short and long term best-management practices.

To learn more about these efforts and water quality in San Vicente Creek, explore the following websites:

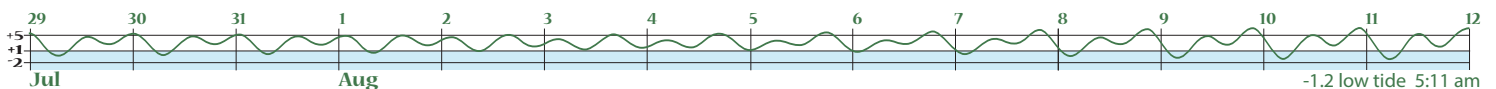
https://www.waterboards.ca.gov/rwqcb2/water_issues/programs/TMDLs/san_vicente_fitzgerald_pathogens.html

<http://www.smcsustainability.org/energy-water/stormwater/>

<http://www.sanmateorcd.org/project/water-quality/>

A single dog produces more bacteria in one day than a person, a horse and a cow combined.

*Editors' note:
Dog owners:
We thank you for cleaning up after your pets! Please encourage your friends to help keep the reserve's water safe for its residents.*



2018 FFMR Training Class *continued from page 1*

*Thank you
and happy tidepooling
to the graduates of the
2018 FFMR
Training Class!!*

Ron Olsen for weekly transporting and setting up the projector and screen (even for the students' bird reports!), mentoring and always lending a helping hand. Thank you to Elaine Reade, Carol Davies and Darrick Emil for being part of a panel Q and A session on leading tours. Many thanks also to Patti Miller who copied the binders and Paul Gator who provided the low tide sheet.

The graduates of the class of 2018 come from a variety of walks of life. Some occupations include: actor, photographer, attorney, teacher, physician, ranger, film maker, and university administrator. Many have a love for marine

biology, snorkeling, scuba diving, sailing and surfing. Students have travelled to Hawaii, Belize, South Africa, Panama, Galapagos, Uganda, Greece, Great Barrier Reef, New Zealand and Egypt. We gave them an ocean of information and I'm sure they will be giving back an ocean of information to all of us for years to come! Thank you and happy tidepooling to the graduates of the 2018 FFMR Training Class!!

Editors' Note: Thank you, Susan Evans, for taking on the enormous amount of work that managing this project entails. ♦



Candice Abellon, Rachel Menjivar, Marcello Menjivar, Jody Stewart, Kylene Gilmore, Arianne Orr, Linda Ciotti, Dan Woodard, Meredith Greene, Tom Ciotti, Kacie Sorfleet, Roger Hoppes, Deryck Marsh



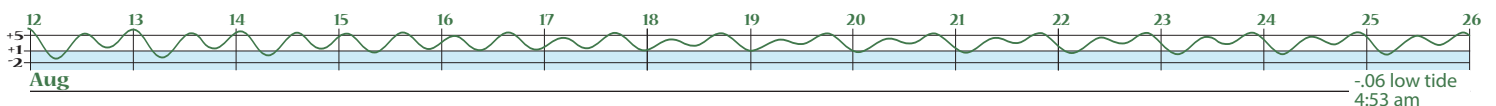
Dan Woodard, Jody Stewart, Meredith Greene, Ariel Bauman



*Back: Deryck Marsh, Ron Olson, Meredith Greene, Marcello Menjivar, John-Thomas Hanson, Susan Evans, Kylene Gilmore, Kacie Sorfleet, Arianne Orr
Front (crouched): Candice Abellon, Ariel Bauman, Jeanette Hyer*



In the classroom: serious learning takes place here, to everyone's enjoyment.



Dave Hankin, FFMR Docent

After 40 years of full-time employment, I officially retired at the end of 2017. That explains why you may have seen me around the reserve more often this year than you might have previously. I spent most of my career in market research and database analytics. My last full-time position was with a California headquartered health insurance company where I got the opportunity to build a customer experience measurement and feedback capability. Perhaps my fondest professional memory was helping to bring healthcare coverage to hundreds of thousands of Californians who had none prior to Obamacare.

Born in Baltimore, Maryland, I developed a love for being on or near the water at an early age, spending a fair bit of time canoeing the region's rivers and fishing the Chesapeake Bay. Education led me to the University of Pennsylvania in Philadelphia where I majored in business and to the Harvard Business School in Boston. In between, I married my high school sweetheart, Cheryl. Along the way we were blessed with two daughters who in turn have given us three lovely grandchildren. One lives in Brooklyn (with husband & granddaughter #1) and the other in Cupertino (with husband and granddaughter #2 and grandson #1).

While not spending much time on the water as an undergraduate (except for watching the rowing meets) we made up for it in grad school, spending a fair bit of time on Cape Cod and the New England seacoast, consuming lobsters from the source! Work took me to Chicago, Toronto, Boston, and ultimately Northern California. We lived next to Lake Michigan in Chicago, enjoyed walking the lakeside and Toronto Harbor Islands in Toronto, and resumed the search for New England's best lobster.

When we finally moved to the Bay area, we initially lived in Silicon Valley. We soon found ourselves spending frequent weekends "over the hill" and near the ocean. We also took a number of vacations up and down the north coast exploring tidepools and towns from Fort Bragg to Big Sur. I have vivid memories of our first visit to Fitzgerald. After exploring the tidepools, we walked along the bluffs. It was after a winter storm and the surge had pulled away most of the sand along one stretch of beach.

The sound of the surf pounding on the cobble beach was unearthly.

As a medical condition made a warmer climate uncomfortable, we began to search for a place to live coastside. We were delighted when our agent showed us a property about a quarter of a mile east of the reserve with tidepool views from our front windows; we moved into the house in 2005 and have been living there happily ever after!

The other fact I discovered along the way was that I didn't do well immersed in cold water which pretty much ruled out the traditional coastside water sports. I looked for an activity that would keep me close to the water but not in it and found it about 11 years ago when I read a notice advertising the FFMR naturalist training classes. I completed the training and did my best to sign up for as many

tours as possible. I was limited to the weekends however and wasn't able to participate as much as I wanted to. That changed drastically at the beginning of 2018. I have been on a majority of the tours so far this year, presented "Tide

Pools" to three 2nd grade classes (granddaughter #2 among them), and have signed up as a counselor for the FMR camp in June. With luck, I will go on my first nudibranch hunt next week!

I had to think a bit when asked about what I enjoy most about being an FFMR naturalist. I think it boils down to the pleasure I get when I show or explain something new to a person on the tidepools. The responses I get can range from an adult's raised eyebrow to a 3rd grader's "WoW!!"—all are satisfying. To that end, I have also developed my bluff talk incorporating physics, geology, history, literature, and archeology!

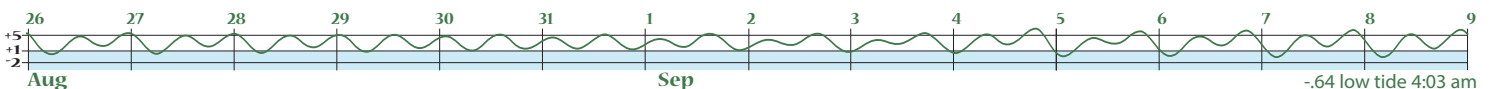
My FMR naturalist experience also led me to my new volunteer activity as a San Francisco Zoo Docent. I graduated from their training program at the end of April. The zoo's busy summer season fits in nicely with the FMR quiet period. I think I am going to be able to put in a fair amount of time at both. Last but not least, the SF Zoo Docents have signed up for an FMR tour in mid-January, 2019. I think a reciprocal visit may be in the works.

I look forward to seeing all of you out on the tidepools! ♦



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Harbor Seals in FMR

Linda Ciotti provided the following information:

The latest harbor seal counts from the Beach Watch program which is part of Greater Farallones Association follows. The counts are conducted between Weinke Way in Moss Beach to Pillar Point:

April 27 203 Adults and Immatures
81 Pups
May 3 130 Adults and Immatures
61 Pups

These are snapshot counts. It is possible that the April 29 Dream Machine event that brought in many

planes and increased visitor presence may have impacted the local populations.

Once again you are reminded that we are privileged to have our reserve continually honored as a haulout site for the harbor seals. Visitors must stay 300 feet from these shy animals. Any disturbance of harbor seals or sighting of a sick or abandoned pup should be reported. Please contact:

Park Rangers: 650-728-3594
Marine Mammal Center: 415-289-7350



Rob Cala captured this wonderful photo of a mother and pup. His comment: "Happiness. Resting mom and pup seal faces in a warm haulout."



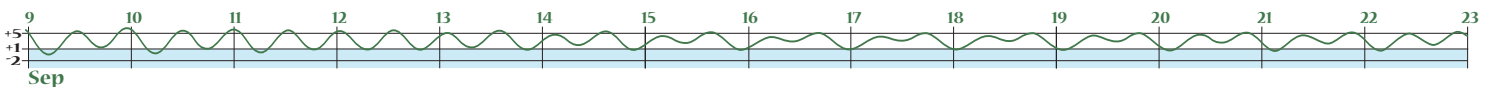
On March 25, Kris Liang and park rangers performed a seal rescue at FMR. Peter Eugster photographed the action. He commented that he was impressed with the speed and efficiency of the response by the rescue team.

Help document coastal biodiversity



Help document coastal biodiversity by taking part in Snapshot Cal Coast, over the week of June 13th-20th.

We need you to get out the coast, search for as many animals, plants, and seaweeds as you can find, and share photos of your discoveries on the website and app iNaturalist. The California Academy of Sciences leads Snapshot Cal Coast with support from the California Ocean Protection Council, the Marine Protected Area Collaborative Network and partners up and down the state. Learn more here: <https://www.calacademy.org/calcoast> or if you have questions email: citizenscience@calacademy.org ◆



Squid Empire

by Danna Staaf reviewed by Janet Pelinka

When I was young I longed for a pet dog but animals were not allowed in the apartment we lived in at the time. That didn't prevent me from coaxing home a stray, mangy creature that I enticed to hang around by feeding him dog food I purchased with my allowance at the local store. My children went through the typical menagerie that included a rat, a hamster, a guinea pig, rabbits, and eventually a dog. I always dreamed of having a horse, but wisdom prevailed and I provided my children with riding lessons instead. But we never had visions of owning a pet cephalopod!

Not so Danna Staaf. When she was ten she was enthralled by the giant Pacific octopus she saw while visiting the Monterey Bay Aquarium. Her father helped her acquire a small octopus and install a saltwater aquarium. She says she, "became known at school as 'the girl with the pet octopus.'" Her insatiable desire for more cephalopod knowledge along with years of studying squid reproductive habits at Hopkins Marine Station culminated many years later in a PhD from Stanford University in invertebrate biology. She ultimately chose a career of science writing.

Staaf still loves cephalopods, especially squid. In the very opening paragraph of Chapter One, Staaf's admiration of and respect for squid is unveiled:

Jet-propelled and flight-capable, iridescent and elastic, squid are a true marvel of nature. They're fast: they can swim twice as fast as an Olympic champion, shoot their tentacles out in less time than it takes you to blink and alter their appearance at literally the speed of thought. They're flashy: some grow luminous lures at the ends of their arms, others squirt self-portraits in ink, and their skin creates any color from vivid red to iridescent blue.

In *Squid Empire* Ms. Staaf ambitiously pieces together the entire evolution of cephalopods and offers theories on how they managed to survive Earth's major extinction events after suffering almost complete annihilation. And what a fascinating tale she offers, passionately filled with careful detail and playful humor.

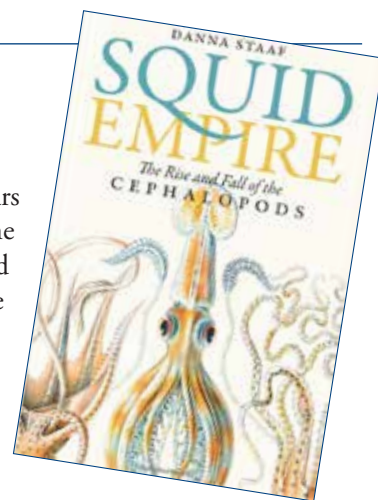
It all began around 500 million years ago, according to fossil records, when the first shelled animals were crawling around the ocean floor searching for food. It was the innovation of a buoyant shell that allowed the cephalopod to rise from the bottom to become, as many researchers believe, the ocean's major predator of the time. The shells were mostly straight and long, from 30 centimeters to two meters. One did reach around 3.5 meters in length, so long that it had to fill one of its chambers with heavy metals so it could swim horizontally instead of, as Staff describes, "...bobbing around like an awkward exclamation point."

For thousands of years, the cephalopods that dominated the oceans were the ammonites. Their abundance is evidenced in fossil records, and the countless shells they left behind have given scientists a useful geologic time stamp. But their dominance ended shortly after the end-Cretaceous extinction when almost all dinosaurs died off (birds being the exception). However, coleoids and nautilids continued to evolve through the Cenozoic and gave us the animals we know today—the octopus, squid, cuttlefish and nautilus.

As the author points out, there are numerous cuttlefish fossils and a few octopus fossils that substantiate their Cenozoic existence. But even though scientists are certain that squid existed throughout the Cenozoic era, no squid shell remnants have been uncovered. It seems that after squid shed the buoyant part of their shells, ammonia became instrumental in keeping the squid buoyant. As ammonia is a base, Staaf explains, an unfortunate side effect of all of this is that neither an acidic environment nor calcium phosphate (typically the agents of fossilization) are available when squid die; thus, their remains do not fossilize.

The author leaves us with the news that survey data show that the cephalopod population is increasing. Possible explanations for this are the cephalopods' ability to adapt to their environment and their rapid growth, which could possibly accelerate with global warming. Also

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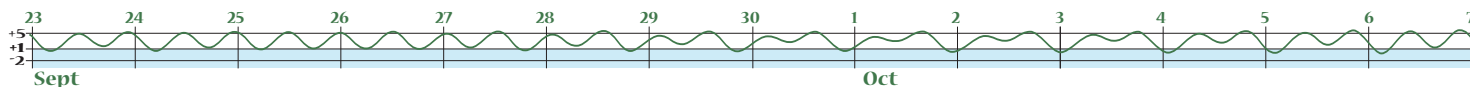


Ammonite



*A slab of rock containing many small ammonite fossils is often referred to as "Marston Magna Marble."
www.fossilera.com*

...after squid shed the buoyant part of their shells, ammonia became instrumental in keeping the squid buoyant...when squid die...their remains do not fossilize



Sea Star Update

by Sasha Greenawalt

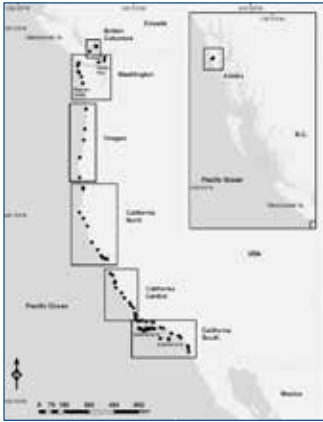
Having found the presumed culprit behind the Sea Star Wasting Disease, (SSWD), the densovirus, marine researchers are turning toward questions such as: What made this virus so virulent at this time? Did something in the environment change? What happens when a keystone predator is taken from its home? What are the chances of recovery? Their emphasis is on *Pisaster ochraceus*, the purple sea star that was the keystone species in its intertidal environment and that has had an extreme decline due to SSWD.

Some of the scientists' work is presented in the March 20, 2018 article titled "Large-scale impacts of sea star wasting disease (SSWD) on intertidal sea stars and implications for recovery," published in the journal PLoS ONE. The lead author is C. Melissa Miner and it is available online. The studies were conducted mostly by MARINE, a consortium of 18 groups (including state, federal, university and private organizations) that conduct yearly coordinated monitoring of intertidal community parameters. MARINE has been working with a standardized set of monitoring protocols to study community dynamics in rocky intertidal systems for up to 25 years.

For this study scientists monitored populations of *P. ochraceus* at 90 rocky intertidal sites spanning the North American Pacific coast, from southeast Alaska to San Diego County, California. *P. ochraceus* were counted, measured, and (beginning in 2013) assigned to disease categories, at Long Term Monitoring (LTM) sites (see map) annually or semiannually.

All populations in California were in decline by 2014 at all LTM sites. Population declines generally occurred earlier and were typically more severe in the southern regions as compared to northern regions. Percent decline of stars in adult sizes exceeded 75% at all but one southern site, and >99% at over half of the sites in the southern regions. In the north, it varied; populations declined by at least 75% at 80% of sites, but only 2 of the sites had a decline of >99%.

There was a hope that studies of this data would provide material from which to develop predictive models. Miner says "An underlying goal of this coordinated effort would be to develop better forecasting tools for disease events." She comments on the two factors which she says "stand out" with potential for predicting



Long-term Monitoring sites

There is...reason to believe that these characteristics will enable cephalopods to evolve under global climate change, enabling them to avoid becoming extinct, and ultimately giving rise to new forms adapted to a new "greenhouse world."

Squid Empire *continued from previous page*

overfishing could be a contributor by removing the large fish that feed on coleoids.

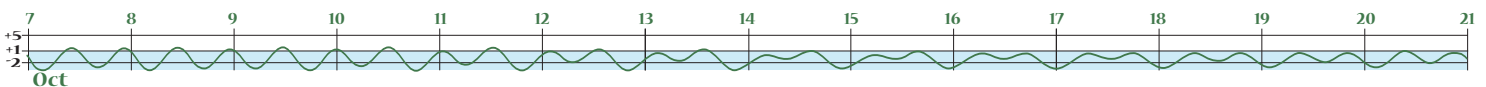
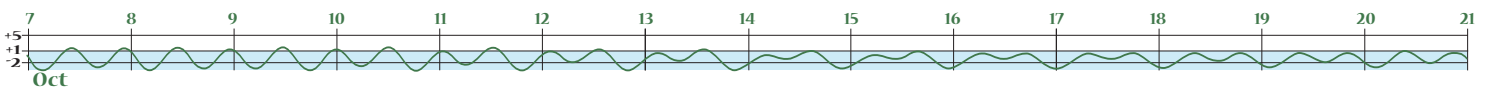
The cephalopod boom was noted as early as 2014 by Jose Xavier of the University of Coimbra, Portugal, and Staaf quotes a paper he wrote at that time:

Cephalopods evolved from an ancestral mollusk in the Cambrian. They have survived major extinction events... Although some cephalopod groups... became extinct in geological time, the coleoids have survived and radiated. Their life history traits have adapted them for ecological opportunism and provide them with the potential to quickly evolve in response to new selection pressures. There is, therefore, reason to believe that these

characteristics will enable cephalopods to evolve under global climate change, enabling them to avoid becoming extinct, and ultimately giving rise to new forms adapted to a new "greenhouse world."

So as this epic adventure ends, Staaf's enthusiasm for cephalopods continues on. The development of new laboratory equipment and technologies that opens the field of cephalopods to new discovery excites her. And she is heartened by the number of new students entering the field of paleontology. She remarks, "...I can't wait to see what the future will tell us about the past."

And now, armed with newly acquired knowledge and appreciation for cephalopods, I'm off with great enthusiasm to the Monterey Bay Aquarium to view their exhibit of these magnificent creatures. ♦



➔ disease among sea stars, population density and water temperature. There was no evidence from these studies that higher sea star densities were associated with more dramatic declines. The more densely populated north had only modest declines compared to the less densely populated south. And temperature? Miner's data indicate that "while there is no strong evidence to support elevated seawater temperatures as a factor contributing to the initial emergence of SSWD, sustained anomalously high temperatures in 2014 and 2015 might have exacerbated the disease's impact." The data do show that the intensity of the outbreak was higher in warmer-water southern regions relative to cooler northern areas. So the specter of the threat of higher sea water temperatures still lurks.

Without knowing the etiology and mode of transmission of SSWD, scientists are very limited in their ability to model future outbreaks, and their ability to predict the trajectory of recovery for any given site or region is also limited. Miner claims that the epidemic "... illustrate[s] the importance of surveillance of natural populations as one element of an integrated approach to marine disease ecology."

The absence of *P. ochraceus* continues to impact the intertidal community, and the organisms with the most to gain or lose in this case are the purple sea urchin (*Strongylocentrotus purpuratus*), the California mussel (*Mytilus californianus*) and the giant kelp (*Macrocystis pyrifera*).

A favorite food of the sea star is the sea urchin, and a favorite food of the sea urchin is the giant kelp. And the reduction of the kelp beds presents a huge problem for many animals, including many invertebrates and small fish that hide and eat in the kelp forest. Kelp forests north of the Bay Area to the Oregon border have shrunk to unprecedented levels (by more than 90% since 2008), according to marine biologist Cynthia Catton of the California Department of Fish and Wildlife (DFW). With the sea stars in decline, the urchins, says Catton, "went on a kelp-eating rampage. They form these feeding fronts and they just munch through everywhere

they're walking." The situation is so dire that the DFW is recruiting divers to remove thousands of urchins from the sea bed, to see if the kelp will recover. Even if the experiments with restoration of kelp forest succeed, the problem of restoring the entire coastline is vast.

Sea stars also love to feed on mussels and in the absence of sea star predation, mussels were predicted to expand closer to the water. Indeed, this is what is being observed by Monica Moritsch, who is a student of Pete Raimondi, professor of ecology and environmental biology at UC Santa Cruz. She has been studying mussel beds for the last few years, and says that, "Mussel beds have expanded down the rock at many locations around Monterey Bay

and elsewhere. The lower limit of the mussel bed has expanded down toward the water from 10-40 cm in elevation. The empty spaces in the bed are filling in and patches below the edge of the bed are growing larger. All of this makes the mussel bed about 10% bigger in 2017 than it was in 2014 just after the start of sea star wasting."

So the mussels and urchins are enjoying a feast. And the sea stars? Beachgoers at FMR report seeing a number of sea stars again that are mostly juveniles. Many would like to know if this is an indication that the sea stars have escaped extinction. The latest LTM data reports high numbers of juveniles recorded north of Point Conception and few to no juveniles at sites on the southern California mainland and the California Channel Islands. Low levels of SSWD-symptomatic sea stars are still present throughout their range, so the outlook for population recovery is uncertain.

But evidence of recruitment and persistence of juvenile *P. ochraceus* at some sites give hope for recovery in at least a portion of the sea star's range—the northern areas. ♦

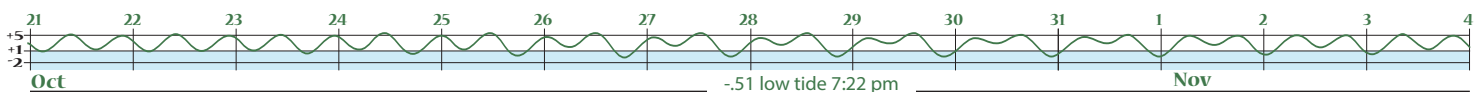
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Beachgoers at FMR report seeing a number of purple sea stars again that are mostly juveniles.

*...persistence of juvenile *P. ochraceus* at some sites gives hope for recovery in at least a portion of the sea star's range...*



A proliferation of sea urchins.



Danna Staaf, author of our reviewed book, *Squid Empire*, calls herself a: Cephalopodiatrist extraordinaire. Sucker for squid.

In her blog she writes about one of her favorite cephalopods.



Citron/Wikipedia CC BY-SA-3.0

BEST CEPHALOPOD: Vampire squid (*Vampyroteuthis infernalis*)

RATING: five stars, four weird fins, two snot-covered filaments

REVIEW: Where do I even start? Named like a nightmare, these animals are in fact peaceful blue-eyed grazers. They defend themselves by inversion and, if that doesn't work, with a dazzling light show. They like to keep scientists guessing—despite the “squid” in their name, their anatomy reveals that they're more like a kind of octopus. And they're very patient parents.

FUN FACT: Vampire squid are born with one pair of fins, then grow a second pair and eventually lose their “baby fins.” (Does the “fin fairy” put money under their pillows?)

LOCATION: The Deep Sea—yeah, pretty much all of it

Pacifica's EcoFest

by Janet Pelinka

FFMR was represented by Sasha Greenawalt and Jan Pelinka at the April EcoFest event held in Pacifica. Our booth displayed animal pelts and skeletons borrowed from the FMR ranger hut. The theme focused on sea stars so we displayed photos and information about the stars that may be seen at the reserve. Rob Cala's large photos provided a stunning backdrop. It was a busy day as we passed out our colorful bookmarks and promoted the importance of our work.

This event is put on yearly by the Pacifica Beach Coalition. It begins in the morning with eco-friendly projects all along the coast including trash pick up on beaches, parks and streets as well as planting, habitat restoration, gardening and more. The afternoon EcoFest features scores of environmental booths, family activities, a petting zoo, food and local entertainment and guest speakers.

If you didn't make it this year, look for this fun eco-event next year! ◆



Friends of Fitzgerald Marine Reserve

Membership Secretary, P.O. Box 669, Moss Beach, CA 94038, or through our website: www.fitzgeraldreserve.org

Contribution Levels:

- \$25 \$100 \$1000
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