

2021



MEMBERSHIP

UPDATES

UC San Diego
SCRIPPS INSTITUTION OF OCEANOGRAPHY



THANK YOU

As a member of E.W. Scripps Associates, Friends of the Scripps Collections, and Friends of Birch Aquarium, you directly impact the work of Scripps Oceanography researchers and students and Birch Aquarium scientists and educators.

As one of the leading centers for ocean, Earth and atmospheric science research and education in the world, Scripps Institution of Oceanography and Birch Aquarium seek to identify solutions to our greatest environmental challenges and global conservation efforts. Your support empowers our talented scientists, researchers, aquarists and students on campus and in the field to advance climate research, preserve biodiversity and support the health and safety of communities worldwide.

MEMBERSHIP GROUPS

Scripps Institution of Oceanography at UC San Diego is one of the world's oldest, largest and most important centers for ocean, Earth and atmospheric science research, education and public service.

Since its beginnings, the institution has featured a public aquarium and outreach center – now Birch Aquarium at Scripps – to serve as a public exploration center, interpreting Scripps research and communicating scientific understanding.

E.W. SCRIPPS ASSOCIATES



E.W. Scripps Associates (EWSA) is a premier group of annual donors who make a difference in the global research conducted by Scripps Institution of Oceanography scientists. Members learn firsthand from Scripps scientists about the work they are supporting at Behind-the-Scenes events.

FRIENDS OF THE SCRIPPS COLLECTIONS



Friends of the Collections support the largest and most complete university-based oceanographic collection in the world. Comprised of millions of biological and geological marine specimens, the Scripps Oceanographic Collections are irreplaceable records of the state of the ocean environment at specific points in time over the past century. They tell a unique and evolving story of life on Earth and provide answers to questions about our planet's future.

FRIENDS OF BIRCH AQUARIUM

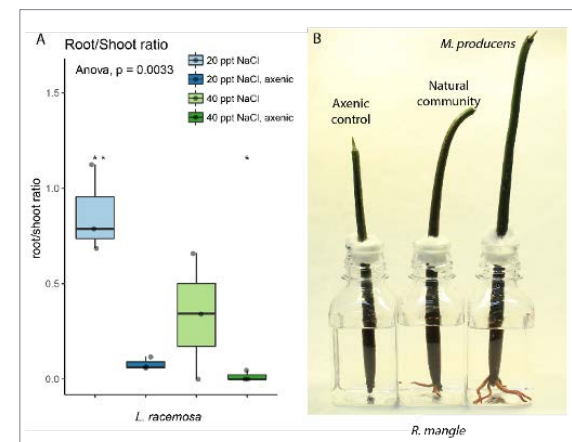


Friends of Birch Aquarium is a giving society grown from the legacy of Ellen Browning Scripps and Ellen's Circle. Continuing in these footsteps, Friends of Birch Aquarium furthers youth access and education through support of the aquarium's mission to connect understanding to protecting our ocean planet.

ESTABLISHING A MANGROVE MODEL SYSTEM

SUPPORTED BY E.W. SCRIPPS ASSOCIATES

In 2020-21, Scripps Institution of Oceanography researchers Sarah Allard and Jeff Bowman used E.W. Scripps Associates funding to make significant gains in establishing a model system for studying mangrove-microbe interactions. Their team identified a former darkroom in Sverdrup Hall on the Scripps campus and converted this space into a temperature- and humidity-controlled growth chamber.



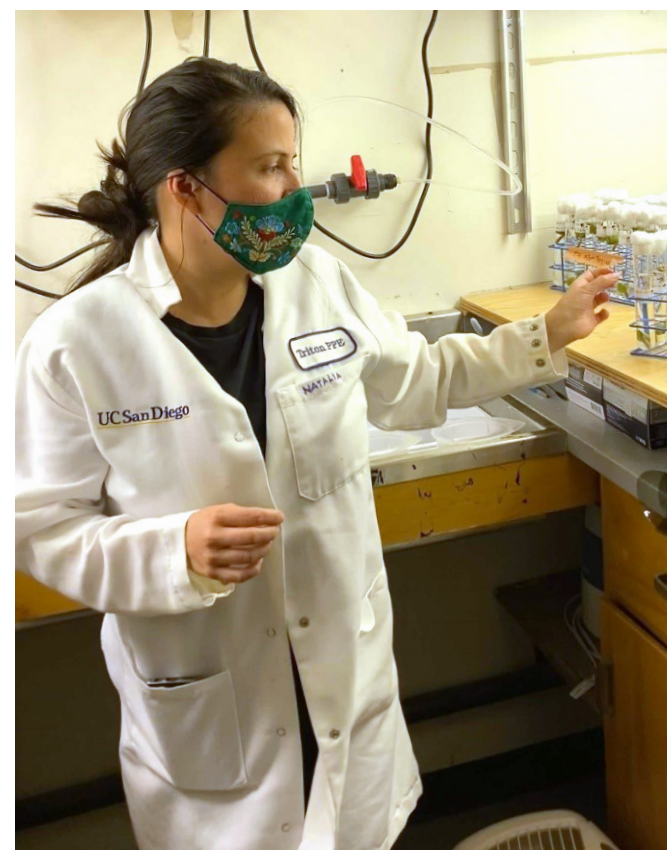
▲ Preliminary work with *L. racemosa* and *R. mangle*. A) The influence of PGP bacteria on growth at low (20 ppt NaCl) and high (40 ppt NaCl) salinity. B) The influence of *M. Producers* compared to the natural community and axenic control.

A pilot experiment with a small number of propagules of the mangrove species *Rhizophora mangle* and *Laguncularia racemosa* evaluated the suitability of the space after modification. Because most plant-microbe symbiosis take place in association with roots and to accommodate the large size of mangrove propagules, the team modified fabricated ecosystems – called EcoFABS, which were originally designed for experiments on smaller plants – to facilitate reproducible study of the mangrove root

▶ Doctoral student Natalia Erazo checks on propagules of the mangrove *R. laguncularia* in the mangrove growth chamber, colloquially named the mangrove mansion.

system. The pilot demonstrated that mangroves could grow with strict controls on the microbial community. However, the team also identified several modifications needed for the plant growth chamber to work at the scale needed for future experiments. After further modifications, a larger-scale test of the growth chamber began in September 2021, and they have shared their modifications with the EcoFAB team for possible future development.

In collaboration with Smithsonian Institute Scientist Emeritus Ilka Feller, doctoral student Natalia Erazo, and Professor Bowman collected nearly 600 mangrove propagules from field sites in Florida during a three-day excursion. After an extensive quarantine and sorting to eliminate pests, they initiated an experiment on the propagules to evaluate the impact of microbial community structure on salinity tolerance with the mangrove species *L. racemosa* and *Avicennia germinans*. The experiment will continue for the next several weeks until the propagules root and begin to show strong growth trends.



SPATIAL VARIABILITY OF BOTTOM TEMPERATURE IN COASTAL WATERS

SUPPORTED BY E.W. SCRIPPS ASSOCIATES

In 2020-21, funding from the E.W. Scripps Associates enabled Scripps Oceanography researcher Shaun Johnston to purchase 48 compact temperature loggers. Temperature variability in nearshore waters is largely due to shoaling semidiurnal internal waves, which often steepen from sinusoidal waves into bores and transport water and properties across-shore. The semidiurnal variability of bottom temperature is due to internal waves of similar magnitude to the annual cycle, but unappreciated. Their cross-shore transport impacts the ecology of coastal waters and biological patchiness. These internal tide processes often occur from spring to fall, when the stratification is stronger and these tides and shoaling waves are not uniform along the coast.

While surface temperature is routinely measured from satellite and shore stations, there is a gap in sustained measurements of high-frequency subsurface temperature over a wide area of coastal waters suitable to answer questions about long-term changes in the internal wave field. This gap can be filled in part by deploying a network of compact temperature loggers, which will also complement existing time series measurements conducted by the Southern California Coastal Ocean Observing System (SCCOOS). These sensors can measure every one or two seconds for a year but must be recovered to download the data.

Funding from EWSA was used to develop a proposal as a component of SCCOOS to make a citizen science network of diver emplaced temperature loggers around San Diego. Several divers and dive sites were identified but were delayed by COVID-19. However, several loggers were placed near Point Loma and Palos Verdes for one year. These loggers will be recovered and replaced in November 2021.

▶ A T logger placed by Point Loma and Palos Verdes.



MARINE VERTEBRATES COLLECTION

SUPPORTED BY FRIENDS OF THE COLLECTIONS

The Marine Vertebrate Collection (MVC) had a productive 2020-21 year despite the COVID-19 shutdown. Collection Manager Ben Frable was able to assist over two dozen researchers around the world with loans of MVC specimens and gifts of tissue for genetic analyses. This included specimen loans in support of the National Science Foundation's (NSF) open vertebrates (oVert) grant focused on collecting CT scans of nearly all vertebrate genera. Specimen loans such as these were not possible for many museum collections because, unlike Scripps Oceanography, most institutions did not allow staff access to their collections during the shutdown. Frable also participated in two cruises studying deep-sea ecosystems off coastal California with Professor Anela Choy aboard the R/V *Sally Ride* and R/V *Roger Revelle*. He provided expertise in identifying deep-sea fishes and added many rare specimens to the MVC.

Frable led two publications, the first describing the large cigarfish. The second reidentified a 70-year-old crestfish specimen collected 900 km off Midway Atoll as the fourth known *Platyberyx rhyton*, expanding its known range 3,400 km from Japan into the central Pacific. Frable and Emeritus Collection Manager H.J. Walker also assisted with a study that developed a genetic database of fishes of the California Current ecosystem. This database will serve many research purposes ranging from classifying market samples to identifying environmental DNA from seawater.

Curator and Professor Phillip Hastings described a new species of tube blenny found only at Isla del Coco off the coast of Costa Rica. The restricted distribution of this tiny species inspired the common name of pandemic

blenny and the scientific name *Coralliozetus clausus* from the same root as claustrophobia. He also was one of several collaborators on a paper revising the classification of more than 180 species of clingfishes, small cryptic fishes found around the world that have modified fins for clinging to the substrate even in strong surge zones.

Two master's students in the lab completed their degree requirements. Ashley Nicoll, MA '21, studied deep-water fish communities in the La Jolla canyon using a novel autonomous lander equipped with lights, video camera and environmental sensors. In addition to documenting the fishes at different depths in the canyon, she recorded the presence of a rare prickly shark and showed that flatfish larvae make diurnal depth migrations. Jimjohn Milan, MA '21, studied the anatomy and behavior of a local goby called the longjaw mudsucker. In comparison to the sarcastic fringehead that also has enormously long jaws, their jaws grow more rapidly than other parts of their body and both species grow to a larger body size than related species resulting in extraordinarily long jaws.

Philip Hastings, Collection Curator
Benjamin Frable, Collection Manager

Recently graduated master's student
Ashley Nicoll, MA '21, with her
underwater lander. ▼



▲ The reidentified crestfish specimen, *Platyberyx rhyton*.

PELAGIC INVERTEBRATE COLLECTION

SUPPORTED BY FRIENDS OF THE COLLECTIONS

In 2020-21, the Pelagic Invertebrate Collection (PIC) lab members adapted to changing circumstances and worked to maintain the vitality of their research, education and outreach mission despite the realities of the pandemic. Although on-site work was limited during much of the year, the team was able to work remotely until in-lab activities could resume. While teleworking, the lab members connected with incoming students and researchers through virtual tours and presentations. Additionally, the team turned their attention to PIC databases, where student assistants were essential in adding locality and other collection metadata to approximately 3,000 cataloged reference specimens. Upon partial return to the laboratory, 2,200 whole plankton samples and 3,000 reference specimens were successfully curated.

Donor support to the Friends of the Collections continues to be extremely valuable in allowing the team to provide the collection resources needed for training and mentoring students in scientific collections, taxonomic diversity and oceanography. A few of our PIC undergraduate lab assistants engaged in independent oceanographic research over the past year. In summer 2020, Nicolas Concha-Saiz '21 received a Research Experience for Undergraduates (REU) opportunity with the California Current Ecosystem Long Term Ecological Research (CCE LTER) program. He analyzed differences in elemental composition (nitrogen, carbon and moisture percentages) of several pelagic invertebrates as a means to understand their roles in the pelagic food web, and subsequently returned to the PIC to make valuable contributions to curatorial efforts.

Abby Lindemood '21 began a master's program with Scripps this fall to address the species diversity of copepods (a common group of zooplankton found off the Scripps Pier) and will test the efficacy of eDNA (environmental DNA) as a tool to detect their diversity. UC San Diego undergraduate Jewliet Carrington '22 came on board to assist with PIC sample curation and databasing. Collection Manager Linsey Sala has continued to facilitate use of samples, data and equipment for teaching and research purposes. The team welcomed PIC's new Faculty Curator Moira Décima who specializes in zooplankton ecology, trophic dynamics and biogeochemistry.



▲ Pelagic red crab or tuna crab, *Pleuroncodes planipes*.

The use of the archived PIC material also resulted in numerous peer-reviewed scientific publications. Some examples include evaluating and advancing approaches in zooplankton DNA metabarcoding, analyzing how *euphausiid* (krill) populations respond to different types of El Niño events, testing the sensitivity of mathematical models of ocean ecosystems to the formulation of grazing by zooplankton, demonstrating the critical importance of sustaining ocean measurements over multiple decades in order to understand climate change impacts on the coastal ocean, assessing spawning patterns of the California market squid, and identifying mechanisms responsible for the episodic range expansion of pelagic red crabs (tuna crabs).



◀ Cephalopod specimens in the queue to be digitized from the family *Pyroteuthidae*, the fire squid.

Mark Ohman (PIC) and Greg Rouse (BIC) were awarded a National Science Foundation DigIn grant to digitize holdings of marine invertebrates in collaboration with other collections and museums in the United States. This project will bring tens of thousands of invertebrate reference specimens online for the research and education communities. Student assistants are a key part of this effort.

Mark Ohman, Collection Curator
Moira Décima, Faculty Curator
Linsey Sala, Collection Manager

BENTHIC INVERTEBRATE COLLECTION

SUPPORTED BY FRIENDS OF THE COLLECTIONS

Thanks to donor support from Friends of the Collections, the Benthic Invertebrate Collection acquired 941 new specimens, digitally catalogued 1,156 existing specimens, and supported 11 new scientific publications, resulting in the description of 10 species new to science. These discoveries included three species of deep-sea mussels, named in memory of Friends of the Collections Bill and Nancy Schneider (*Bathymodiolus billschneideri*, *B. nancyschneiderae*) and in memory of Robert "Chuck" Earlougher (*B. earlougheri*) by collections supporters Jan and Jim Hawkins. The publication describing these mussels was led by doctoral student Marina McCowin in the Rouse lab.



▲ A new species of deep-sea mussel, *Bathymodiolus nancyschneiderae*.

Also among the new species were *Laminatubus paulbrooksi* and *Laminatubus joycebrooksae*, deep-sea feather-duster worms named in honor of longtime Friends of the Collections Paul and Joyce Brooks. These worms are abundant at methane seeps off the Pacific margin of Costa Rica, where *L. paulbrooksi* uses methane for nutrition thanks to symbiotic bacteria growing on its feathery white crown. In fact, *L. paulbrooksi* is one of the first reported examples of a marine invertebrate with externally hosted methane-eating bacteria, an unusual but effective feeding strategy. These newly discovered species are important in keeping methane, a potent greenhouse gas, out of the atmosphere and in enhancing our understanding of beneficial animal-bacterial relationships.

Greg Rouse, Collection Curator
Charlotte Seid, Collection Manager

In the fall of 2020, Curator Greg Rouse along with Professors Lisa Levin and Paul Jensen conducted a deep-sea expedition exploring benthic communities and their biopharmaceutical potential off southern California aboard the E/V *Nautilus* with the ROVs *Hercules* and *Argus*. This research cruise investigated the invertebrates, microbes and minerals hidden just offshore of Los Angeles and San Diego. The team explored the baseline biodiversity of these habitats and their potential benefits to humanity. Southern California's seafloor contains minerals with economic applications in fertilizers, electronics and green energy technologies, and the animals and microbes living in this habitat are prospective sources of new biomedical discoveries. In particular, many benthic invertebrates such as sponges and corals produce bioactive molecules that could inspire new therapeutics for cancer and other diseases. The expedition collected 179 specimens deposited in the Benthic Invertebrate Collection, and the resulting research will help inform responsible stewardship of these important local habitats.



▲ Two new species of deep-sea feather-duster worms, *Laminatubus joycebrooksae* (left, removed from its protective tube to show detail) and *L. paulbrooksi* (right, shown inside its tube).

GEOLOGICAL COLLECTION

SUPPORTED BY FRIENDS OF THE COLLECTIONS



▲ Pandemic coring program in Mission Bay marsh.



Despite the COVID-19 shutdown, the Geological Collection team managed to carry out a major field program in coastal Israel to determine the environmental history of coastal marshes over the past 10,000 years. Unfortunately, team members were not able to join the actual field work because of travel restrictions; however, Israeli colleagues had samples collected and shipped to the Geological Collections lab. The result was a major success that has started to rewrite the history of the western arm of the Fertile Crescent, the band of arable land that runs from Egypt to present day Turkey. Post-doctoral researcher Gilad Stienberg led the publication of two papers from these studies, including the discovery of the oldest known tsunami event in the area, which wiped out coastal settlements nearly 10,800 years ago.

Other research supported by Friends of the Collections is a program of evaluating the buried carbon value of coastal salt marshes in San Diego. The team has been estimating the dollar value of blue carbon, the roots and leaves of marsh plants that are buried in salt marshes. Although the work is still preliminary, based on carbon prices proposed by the Biden Administration, marshes that exist or are planned for restoration in Mission Bay will be worth several million dollars by 2070.

Since visitors could not come to the Geological Collections during the COVID-19 shutdown, Collections Manager Alex Hangsterfer created a virtual lab tour with live question and answer sessions for nearly 200 students. Hangsterfer also recorded interviews with graduate students and staff so that the public could learn about team members' professional development and what led them to their current positions.

Donor support from Friends of the Collections has also been important in helping with curation of materials that was used in public outreach, including replica cores, fossils and rocks. These materials have all been very useful in an NSF-funded education project, called GEOPATHS, which is run through the Geological Collections. The GEOPATHS project takes student teachers to sea to give them research experiences they can carry into their classrooms. In addition, Collections Manager Hangsterfer used Friends of the Collections support to start interviewing GEOPATHS participants as a part of her ongoing career path interview project and will continue to do so into the 2022 year. She also ran a virtual curator's conference in June 2021 that was very well attended.

Dick Norris, Collection Curator
Alex Hangsterfer, Collection Manager

BEYSTER FAMILY LITTLE BLUE PENGUINS

SUPPORTED BY FRIENDS OF BIRCH AQUARIUM



Birch Aquarium has partnered with the Beyster Family and a number of other donors to bring a signature addition to the Seadragons, Seahorses and Penguins Gallery. The *Beyster Family Little Blue Penguins* is designed to bring guests close to Birch Aquarium's newest family members, the Little Blue Penguins.

Little Blue Penguins are the smallest species of penguin, less than 12 inches tall and just two or three pounds, and are known for their unique blue color and big personalities. Birch Aquarium will be the only aquarium in the Western United States to house these gregarious sea birds. This exhibit will allow visitors to engage in their world, share Birch Aquarium's ongoing scientific discovery, and inspire environmental stewardship for the benefit of Little Blue Penguins, seabirds and all life on

the planet. The development team continues to cultivate donors to name smaller spaces within the habitat as well as individual penguins.

"We are so very excited to be adding the *Beyster Family Little Blue Penguins* to Birch Aquarium at Scripps. The new facility will allow us to contribute to an international Species Survival Plan and create an interesting new guest experience," said Executive Director Harry Helling. "Little Blue Penguins will be wonderful ambassadors that can help us to engage our community more deeply and further our mission to connect understanding to protecting our ocean planet."

Construction for the *Beyster Family Little Blue Penguins* habitat began on September 27, 2021, with completion expected by summer 2022. The 2,900 square-foot exhibition will include rocky and sandy shore habitats and an 18,000-gallon

habitat where guests will watch the penguins socializing, interacting, and nest building. It also features a small amphitheater for guests to observe birds swimming and a discovery cave to closely observe Little Blue Penguins on land and inside a nesting box. Currently behind the scenes at Birch Aquarium are Little Blue Penguins from Dallas World Aquarium and will soon be joined by additional birds from Australian zoos.



▲ Little Blue Penguins swimming behind the scenes.

"Little Blue Penguins and other seabirds are sentinel species for our ocean's health and help us understand how we can be better stewards for our planet," said Jenn Nero Moffatt, senior director of Animal Care, Science and Conservation. "Penguins, by their unique nature, are adored by our community and in this way help to serve as great animal ambassadors. We hope that one look at their awkward waddling, their pint-sized bodies, torpedo swimming and social nature will leave our guests enchanted and wanting to learn how to aid in conservation efforts."

Without a doubt, the opening of the *Beyster Family Little Blue Penguins* exhibit will gain widespread attention throughout the region and will highlight Birch Aquarium's global work on Species Survival Plans (SSPs) through the Association of Zoos and Aquariums (AZA) thanks to support from Friends of Birch Aquarium.

BIRCH AQUARIUM EDUCATION

SUPPORTED BY FRIENDS OF BIRCH AQUARIUM

In 2020-21, the Birch Aquarium Education team served 13,643 students through virtual school programs, virtual afterschool/PrimeTime, virtual camps and onsite camps in June. Fifty-seven percent of those students received full or partial scholarships to attend programming.

In recognition of the K-12 loss of learning caused by the pandemic, Birch Aquarium continued to pivot to deliver engaging educational content to the community in the comfort and safety of their homes through an array of recorded videos and live-streamed events. With the help of generous philanthropic support, the aquarium classrooms were converted to virtual studios with the K-5 Virtual 2020 Summer Camp as a pilot of virtual, interactive experiences. After surveying teachers, the aquarium's education team had a better understanding of the challenges and uncertainties that teachers and students were facing. Not only were technical difficulties now an expected part of life, but many teachers were already finding it difficult to convert the Next Generation Science Standards (NGSS)-based curriculum to a distance-learning environment. With this feedback, the education staff worked diligently to convert the Discovery Lab programs for grades pre-K-12 to a virtual format and developed two new virtual programs: Ask a Naturalist and Animal Encounters.

Out of School Time Programming

Virtual programming was also created for students outside of school time. Building upon the success of the summer 2020 virtual camps, the education staff created a seasonal virtual after school multi-series for grades K-8. During these six-session series offered in the fall, winter and spring, two ocean educators taught virtually to build upon childrens' curiosity, allowing them to join other learners as they explored ocean science in interactive and fun ways. Topics ranged from discovering ocean habitats and creatures to designing ocean engineering solutions. Additionally, virtual winter camps for grades K-2 and 3-5 were held during the two weeks of winter break, providing an opportunity for children to stay engaged with activities featuring wintry worlds and polar expeditions.

Partnering with San Diego Unified School District's PrimeTime Program

San Diego Unified School District's PrimeTime program typically provides before- and after-school programming to students at school sites. Due to the pandemic, and in accordance with state, county and San Diego Unified orders, Birch Aquarium was able to offer 81 virtual after-

school programs to serve more than 1,000 students thanks to donor support. Of the current schools taking part in Birch Aquarium-PrimeTime programming, all were designated as Title 1 and 73 percent of participating students qualified for free or reduced lunch programs. The team looks forward to continuing to collaborate with PrimeTime to provide enrichment opportunities to their students in a safe and experiential manner during this school year.

Return to In-Person Programming

After over a year of focusing on programming in a virtual format, Birch Aquarium was able to make a safe return to in-person programming with summer camps. Over 10 weeks, in-person camps allowed children ages 5 to 10 to explore underwater worlds and meet ocean creatures in fun and safe week-long camps. Campers played games, created fun crafts, engaged in science activities, and got up close with our aquarium animals. For the first time ever, extended day options were also available, allowing parents to customize their day to meet their needs.

Supporting the 2021-22 Academic Year

Looking at the 2021-22 academic year, Birch Aquarium anticipates the need for further flexibility in meeting K-12 education needs. The continuation of virtual programs will be needed as schools and families face an ever-changing situation, but the education team also plans to conduct outreach and on-site programs as the year progresses. Birch Aquarium's education team continues to listen and respond to the needs of teachers and school administrators and works closely with San Diego Unified and others to deliver engaging science programs with best practices, meeting students and teachers where they are.



▲ In-person programming returns with summer campers on-site.

Continue the nontradition.

Thank you for supporting Scripps Institution of Oceanography and Birch Aquarium at Scripps. Your contributions are part of the Campaign for UC San Diego – our comprehensive fundraising effort concluding June 30, 2022. Together with our philanthropic partners, we will continue our nontraditional path towards revolutionary ideas, unexpected answers, lifesaving discoveries and planet-changing impact.

For more information about how you can support your passion at Scripps Oceanography and Birch Aquarium and continue the nontradition, please contact:

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