How do organisms change genetically to adapt to environmental challenges? How does the genetic composition of populations, species, and communities change over time? Students use the RTC molecular lab, directed by Dr. Sarah Cohen, along with field and laboratory studies at the Romberg Tiburon Center, to answer questions using diverse organisms from sea stars and sea grasses to sea squirts and sea horses. The history of species, populations, and environmental change is recorded in the DNA variation that students can assess using modern molecular techniques including PCR, DNA sequencing, and DNA fragment sizing. Thanks to equipment grants from the National Science Foundation and the College of Science and Engineering, as well as donations from UC Davis, UCSF, Applied Biosystems, and private donors, students carrying out diverse studies using this joint use facility are answering ecological and evolutionary puzzles about local and distant organisms and environments. If you would like to know more, please see the website, http://rtc.sfsu.edu/in_cohen.htm.

Graduate student Verena Wang is using molecular techniques to investigate recently established populations of the invasive tunicate Botryllus schlosseri. Wang's research compares recently discovered Alaskan populations to long-established San Francisco Bay populations to see how invasions differ with time since establishment. She is using two molecular markers: a mitochondrial gene and a recently discovered highly variable nuclear gene that has never before been used for population genetics studies. Alaska is currently relatively uninvaséd, yet under significant threat. To preserve the remarkable biodiversity of this region, it is important to examine these new invaders, early in the process, to gain information that may be used to limit further invasion.

Graduate student Tricia Goulding is researching parasites to elucidate ecological interactions related to the health of marine organisms. She studies an acanthocephalan parasite, a “spiny-headed worm,” that infects the common filter-feeding mole crabs (Emerita spp.) found on sandy beaches. Mole crabs are a critical component of sandy beach food webs, and their parasites travel between them and vertebrate hosts including diverse seabirds and otters. Genetic techniques offer a way to determine if acanthocephalans from different crab populations have genetically diverged and actually represent different species. Goulding is studying whether multiple species of acanthocephalans co-occur among California mole crab populations, and whether different species infect geographically isolated species of mole crabs.

David Lake, a graduate student in the Cohen lab, is researching the population structure of flatworm parasites that have been introduced to the California coastline from the Atlantic Coast. The Parvatrema parasites use the Amethyst Gem clam as an intermediate host; this clam is native to the North American Atlantic, occurring from Nova Scotia to the Bahamas. The Amethyst Gem clam, with its broad thermal tolerance, has also become successful in San Francisco Bay and along the Pacific coast, and has displaced local populations of two species of native clams. Lake’s research examines whether this Atlantic clam brought parasites from its native range, and whether these parasites now inhabit native California clams. Invasive species threaten the stability of aquatic ecosystems, and knowing the number and extent of parasite invasions in these clams can serve as a model system for the introductions of other parasites brought by invasive species.

Xuman Tang’s Master’s thesis topic is “The identification of asexual and sexual reproduction patterns of eelgrass (Zostera marina) in the San Francisco Bay.” Eelgrass is a globally distributed marine angiosperm; it is a critical foundation species in many estuarine ecosystems, providing oxygen, food and habitat for many fish and invertebrates. Due to global climate change and disruptive human activities, eelgrass is threatened globally, including in the Bay area. Eelgrass reproduces both sexually (by flowering and germination) and asexually (by rhizome elongation). Tang is studying eelgrass reproductive patterns in San Francisco Bay using environmental mesocosms and fine scale genetic clone mapping. She collected seeds from three area sites, planted them in the greenhouse, and raised the plants for five months to find that blade growth and shoot reproduction rate do not differ between annual and perennial populations in the mesocosms. A fine scale clone map made by using DNA microsatellites with nine loci shows the importance of both sexual and asexual reproduction in a perennial eelgrass population, with high rates of sexual reproduction even in a perennial seagrass bed. Her work will help us understand how the surprising rates of genetic population differentiation among San Francisco Bay beds may occur.

Graduate student Ashley Smith is investigating how environmental parameters affect the reproductive biology of the six-rayed sea star along the rocky coastlines of Northern California. Ashley is measuring how hydrodynamics shape the reproductive output of the brooding sea-star. Specifically, she is using a wave dynamometer to measure local wave forces in both high- and low-energy habitats. Despite the crashing waves and rapid water currents in the rocky intertidal zone, brooding Leptasterias hold their young beneath their bodies. In this position, the majority of the stars’ tube feet are used to protect her brood. With just a small fraction of tube feet remaining attached to the substrate, and strong lateral forces from water movement, brooders have a great risk of brood loss. This data, coupled with active monitoring of both brood and embryo loss in varying hydrodynamic habitats, will give us a better understanding of the costs and benefits associated with this important reproductive strategy.

Richard Coleman, a graduating senior in Dr. Sarah Cohen’s lab, has been researching the ecological genetics of six-rayed sea stars in the genus Leptasterias. His research addresses pressing questions about how habitat diversity may promote species diversity in nearshore habitats. Although there have been numerous systematic studies on Leptasterias, few have focused on those living in Central California and thus their taxonomic status remains unresolved. Coleman has characterized, in detail, both genetic and morphological traits of 150 individuals from diverse microhabitats using PCR and sequencing to identify different species. Preliminary analysis suggests a novel clade, possibly at the species level, as well as intriguing differential distributions of genotypes between different habitat types, independent of geographic distance.

Mariana Padron, a graduate student from Venezuela working jointly with the Cohen lab at RTC and Dr. Healy Hamilton’s lab at the California Academy of Sciences, is examining geographic patterns of genetic connectivity in Caribbean and Atlantic seahorses. She is interested in the application of molecular genetics in prioritizing areas for conservation. Seahorses are economically valuable fish species that are listed as threatened. Previous studies have suggested that each one of the Caribbean seahorse species, Hippocampus erectus and H. reidi, may actually be a species complex, because of high levels of morphological variability and broad geographic distributions. She is using several types of molecular markers to help discriminate between closely related and cryptic species. This information will contribute to the management of exploited seahorse populations as required under the Convention on International Trade of Endangered Species (CITES).