UNIVERSITY OF CALIFORNIA

Los Angeles

Zooplankton Aggregations in California Coastal Zones

A dissertation submitted in partial satisfaction of the

Requirements for the degree Doctor of Philosophy

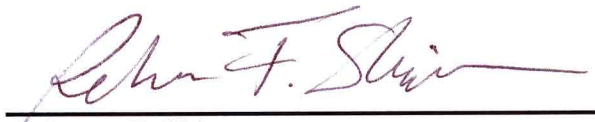
In Biology

by

Aaron Kimo Morris

2006

The dissertation of Aaron Kimo Morris is approved.



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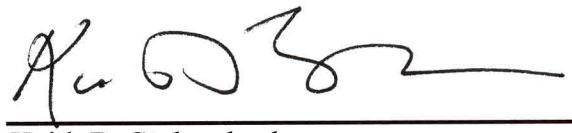

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DEDICATION

This dissertation is dedicated to my family –

April, Jadey Girl, Mom, Dad and Rachel.

This is also dedicated to Zoey, my iguana, for her unwavering loyalty.

Sit… good girl.

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During my entire graduate experience at UCLA, I also maintained a "real" job as a staff scientist at MBC Applied Environmental Sciences. Simultaneously accommodating my MBC and UCLA families was difficult. It would not have been possible were it not for Chuck Mitchell who initially introduced me to Bill Hamner and allowed me the flexibility to be a doctoral student and an MBC employee. I also thank the staff at MBC for their patience and their willingness to work around my ever-changing schedule.

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when she first saw moon jelly ephyrae pulsing under the microscope. Early on, she had a good idea where plankton came from since she also accompany me on educational cruises aboard the R/V Sea World UCLA where we would collect plankton in nets to show to high school and college students. Jade would look up at the video monitor and say, "Daddy, copepods!" In a sense, April and I have felt as though my graduate work was like having a second child. It did feel similar in some respects in that I certainly did have to heavily nurture the degree process, and on occasion I did have to be a disciplinarian – of course, that meant disciplining myself. Through the highs and lows, April has always been there to listen and to offer guidance. And during the busiest times, April's home cooking always helped. For example, here is the recipe for April's famous "dynamite casserole" – mix 1-cup each of bay scallop, shrimp, imo crab, mushroom, onion, zucchini in a bowl with sriracha Vietnamese hot sauce (just enough for taste). Stir fry until cooked through, then place the mix in a casserole dish. Layer Japanese kewpie mayonnaise on top and broil at 400ºF until brown. Remove from the oven and liberally apply sliced avocado and masago on top. Serve with steamed rice.

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PUBLICATIONS AND PRESENTATIONS

Morris, A.K., 2006, Macrozooplankton Assemblages in California Fronts, Coastal Environmental Quality Initiative, Paper 034. http://repositories.cdlib.org/ucmarine/ceqi/034

November 2004 – Western Society of Naturalists, Rhonert Park, California – "Caught On Video! Jellyfish Aggregations Along The Monterey Upwelling Shadow, Monterey. California"

August 2004 – Southern California Association of Marine Invertebrate Taxonomists, Los Angeles, California – "Oceanic Fronts: The Great Meeting Place"

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Morris, A.K., 1997, A Model of Trophic Evolutionary Pathways, MSc Thesis, Oregon State University, 147pp.

March 1996 – Tenth Annual Biology Graduate Student Symposium, Hatfield Marine Science Center, Newport, Oregon: "Parasites that modify host behavior".

February 1996 – 1995-96 Winter Graduate Seminar Series, Oregon State University: "A Classification of Trophic Strategies Based On Malthusian Parameters".

December 1996 – Ent. 591, Biology of the Acari, Oregon State University: "Evolution of Parasitism in the Acari".

Lafferty, K.D., and Morris, A.K., 1996, Altered Behavior of Parasitized Killifish Increases Susceptibility to Predation by Bird Final Hosts, Ecology 77(5): 1390-1397.

January 1995 – College of Creative Studies Biology Colloquium, University of California at Santa Barbara: "Parasites and Their Affect on Fish Behavior".

June 1994 – American Society of Ichthyologists and Herpetologists, University of Southern California and Natural History Museum of Los Angeles County: "Effects of the Trematode *Euhaplorchis californiensis* on the Behavior of the Estuarine Killifish *Fundulus parvipinnis* ".

ABSTRACT OF THE DISSERTATION

Zooplankton Aggregations in California Coastal Zones

by

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Professor William M. Hamner, Chair

The accumulation of zooplankton at fronts has been known to science for centuries, however zooplankton behavior is generally under-appreciated as a factor contributing to the observed aggregation. I observed distributional patterns of various zooplankton species near the Monterey Bay upwelling shadow front and in the nearshore zone of Santa Monica Bay, California, in an effort to estimate the extent to which behavior determines horizontal distributions near fronts.

Using high-definition digital video on a remotely operated vehicle, I quantified the distribution and swimming orientation of sea nettles near the Monterey front. Sea nettles were highly aggregated on the front, and were more abundant on the warmer northern side of the front compared to the colder southern side. Regardless of proximity,

sea nettle swimming orientation was generally directed towards the front, implying that the frontal aggregation was due in part to swimming behavior.

Zooplankton and water property data were gathered along three transects crossing the Monterey front. The distribution of fish and invertebrate eggs, which were passive tracers, revealed that the front was strongly convergent on two transects, but exhibited transverse shear flow along the third transect where eggs skewed away from the front. Despite differences in flow patterns along the transects, zooplankton aggregations always occurred along the front. Thus, at least at the transverse shear front, behavior must account for some of the distributional bias on the front.

A characterization of the nearshore zone off Dockweiler State Beach, Santa Monica Bay, was made using shipboard and in-water sampling of water properties and zooplankton net tows. A conspicuous difference in flow patterns was revealed between water shoreward of the 10-20m isobath, where water moved alongshore with a tidal periodicity and no net directional flow, and that offshore, where water traveled alongshore in one direction over time. The observed separation of inner and outer waters was corroborated by data on plankton species distributions. Most species were skewed in either the onshore or offshore direction, suggesting that species are generally confined to the water mass of their respective sources, and that there could be a reduction in onshore-offshore mixing between the 10-20m isobath.