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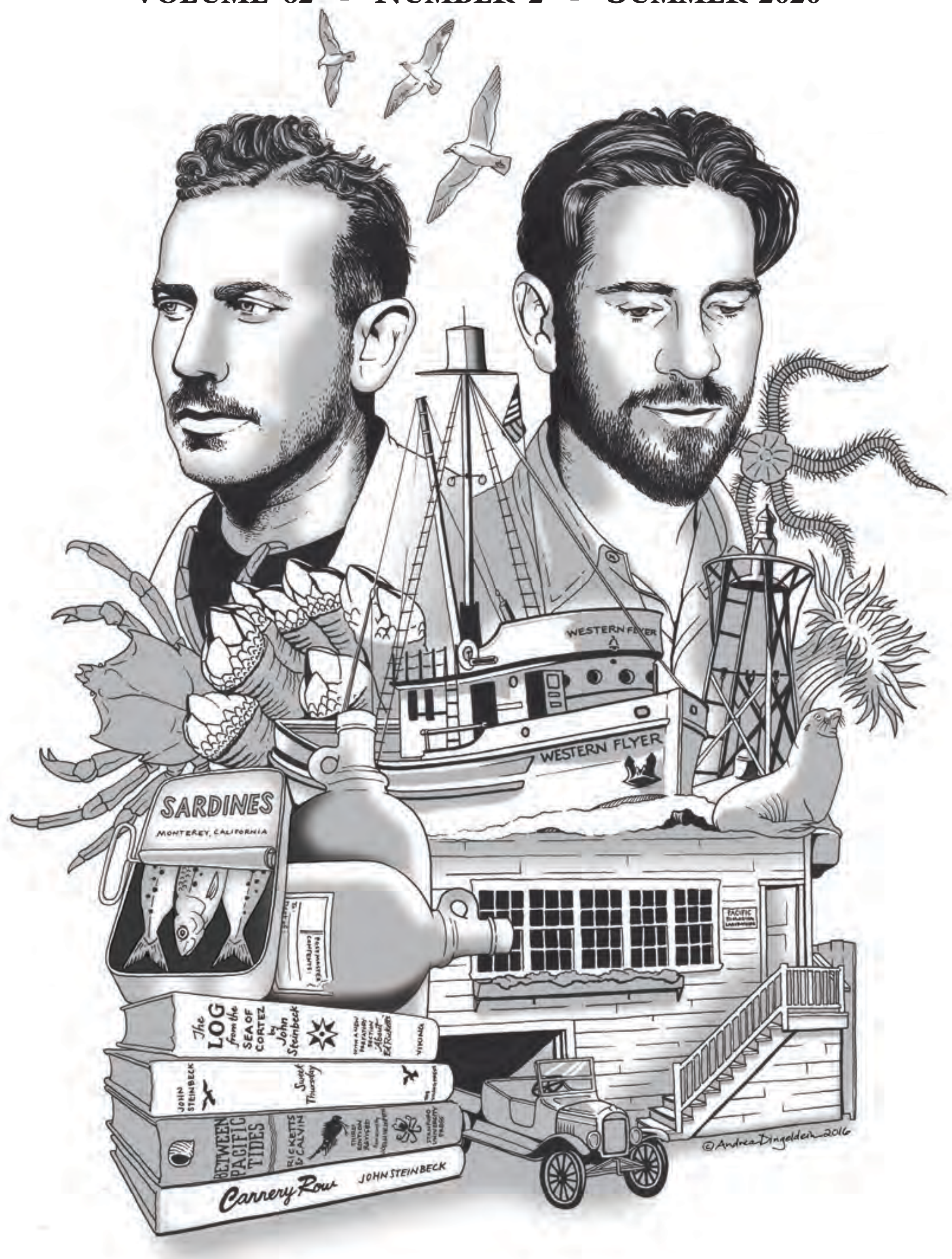

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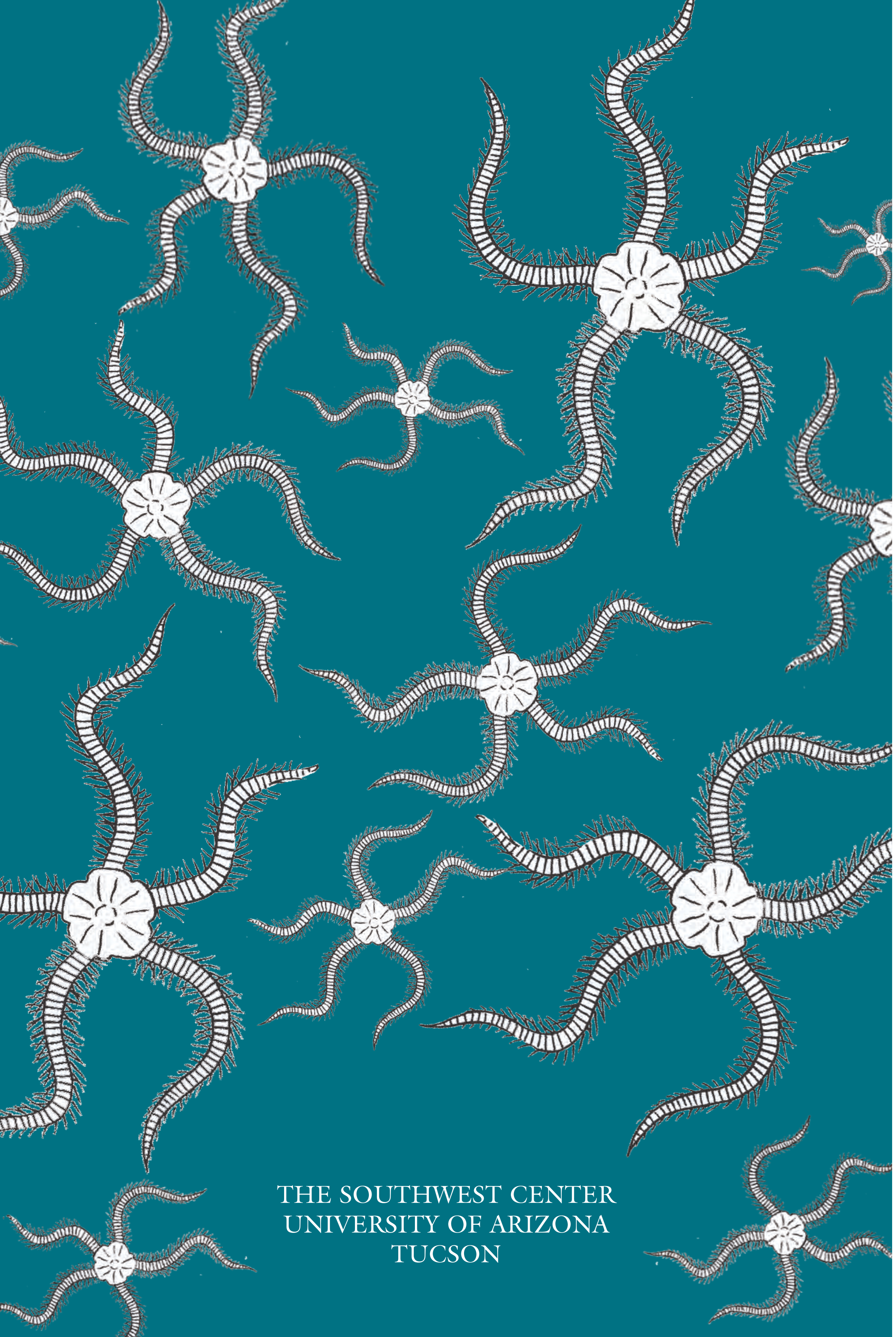

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Jeffrey M. Banister

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The 1940 Ricketts-Steinbeck Sea of Cortez Expedition: An 80-Year Retrospective

Guest Edited by Richard C. Brusca

Dedicated to the Western Flyer Foundation

Publishing the Southwest

Dedicated to the Western Flyer Foundation

It has been 80 years since John Steinbeck and Ed Ricketts sailed aboard the *Western Flyer* into the Sea of Cortez—a voyage that changed both of their lives and forever altered the arc of environmentalism and marine biology in North America. The contributors to this volume were inspired by their reflections on that voyage and those two remarkable individuals. A sublime attribute of the voyage and the book it spawned was the seamless blending of art, science, and philosophy. I thank Andrea Dingeldein for the use of her wonderful drawing, which captures the essence of the Ed Ricketts/John Steinbeck relationship and graces the cover of this special issue (see more of her work at www.thelocalnaturalist.com).

The expedition and the book, and so much that was later influenced by that amalgamation of ideas, also inspired creation of the Western Flyer Foundation, committed to restoring the purse seiner that Steinbeck and Ricketts chartered for their famous 1940 expedition. The boat is being fully restored and will soon be back in the water. This volume of *Journal of the Southwest* is dedicated to that foundation and its goal of cross-disciplinary learning that will be core to the educational mission of the restored *Western Flyer* (www.westernflyer.org). This compilation of essays offers another blend of art, philosophy, and science, influenced by the unique mélange that took place between two people and a boat 80 years ago.

My review of the Steinbeck-Ricketts 1940 expedition, with an annotated cruise log and species list, seemed long overdue. Hopefully it will provide grist for the mills of other scientists and writers in the years ahead.

Lindsey Haskin and I explore the influence of Steinbeck and others on Ricketts's thinking during his intellectual growth as a scientist. We walk readers through some of the steps in Ricketts's personal and professional life that helped shape the most influential, enduring, non-degreed marine biologist and invertebrate zoologist that America has ever seen.

Don Kohrs's essay on Ed Ricketts's life up to the 1940 Sea of Cortez expedition is illuminating and carefully researched. It includes his childhood years, the founding of Pacific Biological Laboratories, and the writing/publishing of *Between Pacific Tides*.

Kevin Bailey and Chris Chase explore the long and not-always illustrious history of the *Western Flyer*, the boat that wouldn't die. The *Flyer* had a life of her own, and she became an unexpected, deeply personal symbol of science, adventure, freedom, and camaraderie—eventually taking her place in American history. From sardine and salmon seiner, to bottom trawler, to Alaskan crab fisher, to private and government research vessel, the boat sank twice but is now being faithfully restored by the Western Flyer Foundation.

Katharine Rodger explores Ricketts's influence on Steinbeck's writing, giving the topic a new twist by examining the former's influence on *how* Steinbeck wrote. Rodger explores Ricketts's belief that only when one has mastered the form or craftsmanship of their art—be it poetry, prose, painting, music, or science—can the content or truth of that art be executed with purity. It would seem that both Steinbeck and Ricketts attained that aspiration in their unique creativity.

"Got Squid," a look at the long-term oceanography of the Sea of Cortez through the lens of Humboldt squid, a species not recorded by the Steinbeck-Ricketts expedition, is historical-ecological science at its best. W. F. Gilly and colleagues carefully analyze the history of Humboldt squid records and physical oceanography of the Gulf, coming to intriguing conclusions.

Susan Shillinglaw considers the meaning of Steinbeck and Ricketts's holistic approach and how that is reflected in their book, most pointedly in their admonition that we should look "from the tide pool to the stars and then back to the tide pool again." She examines the significance of "participation" in the intertidal region and the implication of breaking through, a concept vital to both men's thinking.

Richard McCourt and Josie Iselin provide a delightful look at the "other" Sea of Cortez expedition in 1940, that of the Allan Hancock Foundation and pioneering Pacific phycologist E. Yale Dawson. Dawson would go on to produce the algal equivalent of the Steinbeck-Ricketts invertebrate catalogue.

John Gregg's humble yet astute essay describes his deep belief that combining art and science, as did Steinbeck and Ricketts, is needed in modern society. Further, integrating disciplines is a critically needed approach for teaching youngsters how to be more well-rounded citizens and critical thinkers. He also describes how his nearly accidental discovery of the book *Sea of Cortez* helped shape his own life, eventually leading him to track down the *Western Flyer* and purchase it, almost directly off the seafloor.

Richard Astro's overview of the history of scholarly research on Steinbeck and Ricketts, beginning with the story of how he basically "founded the field," is a wonderful ride and perfect closing essay for this volume.

I most graciously thank the many anonymous peers who were kind enough to review the articles in this special issue of *JSW*. Naming you would compromise the review process, but you know who you are.

— R. C. Brusca, Tucson, Arizona
Summer 2020

The 1940 Ricketts-Steinbeck Sea of Cortez Expedition, with Annotated Lists of Species and Collection Sites

Richard C. Brusca

> The tide teaches us to live with mystery and complexity. It lives in the body of a mud shrimp, signaling when to swim and when to burrow. It lives in sandpipers, crabs, and whelks. It lives in the spirit of bores, in the prayers of monks. The tide is vibration, music, time.
>
> —Jonathan White, *Tides: The Science and Spirit of the Ocean*

Introduction

In March of 1940, modern marine ecology in the Sea of Cortez (Gulf of California) was born with the pioneering expedition of Edward (Ed) F. Ricketts and John Steinbeck aboard the *Western Flyer*, a sardine seiner out of Monterey, California. Although earlier biologists had visited the area, none had done so using an ecological, or "holistic," approach and none had done so with the intent of undertaking a broad faunal survey (Brusca 2018a). This was the first expedition to catalog the littoral/intertidal fauna of the Gulf of California. As Ricketts wrote in a letter to Steinbeck in 1941, "It seems gratifying to reflect on the fact that we, unsupported and unaided, seem to have taken more species, in greater number, and better preserved, than expeditions more pretentious and endowed" (Ricketts 1941). That assessment was probably accurate.

The science and philosophy of that voyage are eloquently chronicled in their 1941 book, *Sea of Cortez: A Leisurely Journal of Travel and Research.* Initially, they discussed exploring the region by car, but soon realized that the inaccessibility by land of most coastal sites on the Baja

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Journal of the Southwest 62, 2 (Summer 2020) : 218–334

California Peninsula demanded they charter a boat for the work. Thus, using funds from Steinbeck's successful early writing career, he and Ricketts chartered the *Western Flyer* for the 6-week expedition. The expedition's northernmost collecting sites were in the Midriff Islands, at Puerto Refugio on Isla Ángel de la Guarda, and at "Red Bluff Point" on Isla Tiburón. Thus, they barely "touched down" in the Northern Gulf and did not explore the biodiversity-rich coastlines of northeastern Baja California or northern Sonora. Their southernmost site on the Baja California Peninsula was Cabo San Lucas (at the tip of the peninsula), and on the mainland coast it was the Bahía Agiabampo coastal lagoon complex (on the Sonora-Sinaloa border). Although Isla Tiburón is part of the Comcaac/Seri Indian Territory, there is no evidence that Steinbeck or Ricketts had any actual encounters with the Comcaac People. The vast majority of Comcaac today reside on their communal property in the towns of Punta Chueca and El Desemboque, just north of Bahía Kino. But in the past they traded at least as far north as Puerto Peñasco and Bahía Adair, in the Upper Gulf (Mitchell et al. 2020).

Members of the expedition were Ed Ricketts, John Steinbeck, Carol Henning (Steinbeck's first of three wives), Anthony (Tony) Berry (captain), Sparky Enea (seaman and Captain Berry's brother-in-law), "Tiny" Colleto (seaman), and Hall (Tex) Travis (engineer). Steinbeck paid Captain Berry $2,500 for the 6-week charter (for the fascinating backstory on the *Western Flyer*, and the deal between Steinbeck and Berry, see Bailey 2015). The agreement was that Ricketts would reimburse Steinbeck one-half the charter price from royalties on their book once it was published, but there seems to be no evidence that ever happened. There is no doubt, however, that Ricketts saw the expedition as an opportunity to acquire specimens for sale through his Pacific Biological Laboratories, and he apparently made as much as $12,000 by doing so (Bailey 2015). However, none of this was mentioned in their 1941 book.

The landmark Ricketts-Steinbeck voyage to the Sea of Cortez, and the book it spawned, had a profound impact on the lives of the two men and on the American environmental consciousness (see Astro and Hayashi 1971; Astro 1973, 1995; Hedgpeth 1978a,b; Brusca 1993, 2018a; Beegel et al. 1997; Enea and Lynch 1991; Rodger 2002, 2006; Tamm 2004; Brusca 2004; Lannoo 2010; Bailey 2015; Hannibal 2016). In addition, it brought a new awareness of the Gulf of California (and Baja California) to both the public and the scientific worlds. The expedition and book have undoubtedly inspired hundreds of young biologists to devote their careers to marine biology and field biology. Their book (hereafter, *Sea of Cortez*) was also the first public call for conservation in the region.

The expedition made 24 discrete collections from 21 localities (20 within the Sea of Cortez itself), and captured an estimated 557 species of marine invertebrates, nearly 100 of which found their way to the Smithsonian Institution and are today available in the collections of the National Museum of Natural History. For more than 30 years, until my two editions of the "Gulf Handbook" were published (Brusca 1973, 1980a), the Ricketts-Steinbeck expedition report was the only place one could turn for a synoptic view of life in the Sea of Cortez. The "Phyletic Catalogue" in *Sea of Cortez* lists 484 species (and illustrates 83 of those); Brusca (1980a) lists 1,300 species (and illustrates 720). The only other large compilation of Sea of Cortez invertebrates, the Macrofauna Golfo Project, catalogs around 5,143 species of invertebrates and is available as an online searchable database (http://www.desertmuseum.org/center/seaofcortez/database.php). Table 1 gives the numbers of known invertebrate species in the Gulf based on a search of this database (1 July 2020; the tables appear in the appendix at the end of the text).

Sea of Cortez was a biology text, travelogue, adventure story, and philosophical inquiry. It was also testimony to a great friendship between two brilliant men. The book comprises six parts: Introduction, Narrative [the "Log"], Note on Preparing Specimens, an appendix titled Annotated Phyletic Catalogue ["Phyletic Catalogue"], a Glossary, and an Index. The 50 or so drawings of marine life were primarily by Alberté Spratt, an artist from Carmel (California), and the 15 color photographs were by Russell Cummings of Pacific Grove (California), as were most of the 73 black-and-white photographs (although a few were contributed by others). Toni Jackson edited the manuscript, constructed the Glossary, and transcribed the bulk of the difficult text, including both the Narrative and the Phyletic Catalogue.

Until now, there has never been an attempt to assemble a complete, site-by-site list of species from the expedition. This is done here, compiling data from the book, Ricketts's field notes from the trip (available in Rodger 2006), correspondence between Ricketts and specialists who made identifications for him (many of which arrived too late to be included in their book), specimens collected on the expedition that are now deposited at various institutions, and taxonomic/nomenclatural revisions since 1940.

The Marine Invertebrates of the Sea of Cortez Expedition

In the Introduction to *Sea of Cortez* (and in the Phyletic Catalogue, p. 304), Steinbeck and Ricketts wrote that they collected more than 550 different species, including "35 to 55" new undescribed/unnamed species. However, in the Phyletic Catalogue only 484 species are listed. Presumably the "missing 66 species" comprised unidentified specimens that Ricketts had sent to specialists for examination. In a letter from Ricketts to Steinbeck (22 August 1941), Ed wrote, "When complete data comes to hand, I think we shall have collected more than 600 species, of which 60 will have been undescribed at the time they were taken."

I estimate approximately 557 species were collected (Table 2), about 40 that were new to science and were named and described after *Sea of Cortez* was published (perhaps another dozen or so still remain undescribed). The highest numbers of species (per site; see Table 3) collected were 115 species at Punta Lobos on Isla Espíritu Santo (Collection No. 4, March 20), 95 at Puerto Escondido (Collections Nos. 11 and 12 [inner and outer bay], March 25–27), 99 at Bahía de los Ángeles (Collection No. 18; April 1), 92 at Puerto Refugio on the northern tip of Isla Ángel de la Guarda (Collection No. 19; April 2), and 91 at Bahía Concepción (Collection No. 14; March 28–29).

Today, the invertebrate diversity of the Sea of Cortez is fairly well documented. The Hendrickx et al. (2005) Macrofauna Golfo checklist enumerated 4,847 species, Brusca and Hendrickx (2010) stated over 4,900 named invertebrate species are known from the Gulf, and the Macrofauna Golfo online database lists 5,143 species (http://www.desertmuseum.org/center/seaofcortez/database.php; accessed 1 July 2020; see Table 1). Copepods and ostracods are not included in the Macrofauna Golfo database, raising the actual invertebrate count for the Gulf to over 5,200. New species continue to be described, the interstitial/meiofaunal biota and deep-sea faunas are still poorly known, and Brusca and Hendrickx (2010) and Brusca et al. (2005) estimated that only about 70% of the Gulf invertebrate species have so far been named and described.

There are a variety of sources for species identifications and names for the material from the Ricketts-Steinbeck expedition. Ricketts's unpublished field notes and the Narrative in *Sea of Cortez* provide preliminary names, but these are updated in the book's Phyletic Catalogue. I have updated those using Ricketts's correspondence with specialists, publications by taxonomists after the appearance of the book, and by more recent identifications of specimens housed in museums. The species names in Table 2 are my best estimate of the correct and currently accepted taxonomy and nomenclature. Many of the species in their Phyletic Catalogue were misspelled, and some of these errors have been perpetuated by others (corrected in Table 2). Ricketts was well aware that the book's Phyletic Catalogue had errors or names that needed updating, and he hoped to publish a "second edition" of the Catalogue (letter from Ricketts to Deichmann, 21 February 1942); however, by March 1942 those plans had been scuttled (letter from Ricketts to Deichmann, 9 March 1942; both letters available in Rodger 2002).

Steinbeck and Ricketts correctly judged the Sea of Cortez to be strongly dominated by what they called the "Panamic" fauna, today more commonly called the Tropical Eastern Pacific fauna (e.g., Brusca and Wallerstein 1979; Brusca 1980a; Brusca and Hendrickx 2010). They also recognized the southwestern coast of the Baja California Peninsula as being a region of overlap between the tropics to the south and temperate coastal waters to the north—described in detail in Brusca and Wallerstein (1979), Brusca (1980a), Whitmore et al. (2005), and Brusca et al. (2005). Recognized as early as the 1930s, Bahía Tortuga (aka Bahía San Bartolome, Bahía Tortolo), about 40 km south of Punta Eugenio, is the first place, moving southward along the outer Baja coast, where the number of tropical species appears to outnumber temperate species, while just outside the bay (e.g., Cabo Thurloe) temperate California's giant kelp, *Macrocystis*, makes its last stand (Fraser 1938; Brusca 1980a). Over 700 invertebrate species from the Sea of Cortez extend their range to southwestern Baja California, in the region between Cabo San Lucas and Bahía Tortuga.

Steinbeck and Ricketts provided a discussion of zoogeographic faunal relationships for the Sea of Cortez based on an analysis of the species they collected. They noted the strongest ties to tropical fauna of the East Pacific, and next strongest to warm temperate waters of Southern California. The least close ties were to the tropical west Pacific and the Caribbean Sea. Although they collected only about 10% of the known invertebrate species in the Gulf, their perceptions remain accurate. However, due to the state of invertebrate taxonomy in 1941, the extent of faunal relatedness to California shores, the west Pacific, and the Caribbean was exaggerated in their analysis. They noted, for example, that the Gulf's sponges and tunicates had the strongest ties to "north temperate zones" (*Sea of Cortez*, p. 308). This was a misperception likely based on the then-poor state of taxonomy for the Gulf species and on many similar-appearing (but actually different) species from California shores. Our understanding of these two taxa remains at a low state today, although the excellent work by José Luís Carballo and colleagues (at Universidad Nacional Autónoma de México's [UNAM's] Mazatlán marine lab) is rapidly increasing our understanding of the Gulf's sponge fauna.

The Ricketts-Steinbeck expedition collected only 14 species of sponges, yet there are 125 currently described from the Sea of Cortez (most having tropical affinities), 60 of which occur in the intertidal regions they were sampling. Similarly, they collected only 10 species of tunicates, whereas at least 43 species are so far known from the Gulf and certainly >100 species actually exist there. The tunicate fauna ("sea squirts") of the Tropical Eastern Pacific is extremely poorly known. The Gulf's sea anemone and gorgonian faunas were so poorly known in 1940 that Steinbeck and Ricketts did not even include them in their Phyletic Catalogue from the expedition.

Twenty-two of the 38 known species of littoral sea cucumbers (Holothuroidea) were collected by the expedition. However, some of the identifications (presumably all by E. Deichmann of the Smithsonian Institution) must be viewed with caution. Until very recently, there had been no taxonomists dedicated to studying the sea cucumber species of the Sea of Cortez. Prior to the publication of Francisco Solís-Marín et al.'s (2005, 2009) excellent work on Gulf Holothuroidea, a majority of species records from the Gulf are suspect. And, a number of the names used by Ricketts and Steinbeck have been changed since 1940 (see Table 2).

Similarly, only recently has the gorgonian fauna of the Tropical Eastern Pacific been clarified, through the systematic efforts of Odalisca Breedy and Héctor Guzmán (2002, 2005, 2007, 2011, 2015, 2016a,b,c). The Ricketts-Steinbeck expedition collected four species of Gorgonacea, but at least eight are now known to occur in the Gulf's intertidal zone.

Just under half of the known invertebrate species from the Sea of Cortez occur in the Gulf's intertidal zone—2,257 species. Thus, despite their rushed expedition, Steinbeck and Ricketts collected about 25% of the known littoral species—very impressive for just 6 weeks of fieldwork. The main taxa they missed were smaller forms (which are spread through all the phyla but are especially abundant among gastropods) and species whose uppermost occurrence is at or below the 0-tide level.

The expedition consciously avoided the "rarities," as Ricketts called them—the small or obscure forms. Instead, they concentrated on the most abundant species, ones they felt were most important in the food web and overall composition of the fauna. In a letter to Steinbeck, reflecting on their expedition but before the Sea of Cortez book had been released, Ed noted that "the commoner the animal the more attention we devoted to it, since it, more than the total of all rare forms, was important in the biological economy" (Ricketts to Steinbeck, 22 August 1941, available in Rodger 2002). The goal of the trip was clearly not to see how many species they could collect, or how many undescribed species they might find (though they found many). It was for something larger—to attain an overall sense of the fauna, its ecological and biogeographical relationships to other regions, a holistic view. Or, as Steinbeck (1951) put it, the "project had been to lay the basis for a new faunal geography."

Certain other taxa were also undersampled by Steinbeck and Ricketts. For example, they noted a paucity of hydroids in the Gulf, collecting only 7 species (64 species of Hydrozoa are currently known from the Gulf's littoral zone), and only 4 species of stony corals (at least 17 occur in the Gulf's littoral). They collected 7 species of flatworms (Platyhelminthes), but 17 have so far been described from the Gulf's intertidal region, this being only a small fraction of what is actually there (most are yet to be described). Surprisingly, they collected only a single ribbon worm (*Baseodiscus mexicanus*; phylum Nemertea), although 14 have been described from the Gulf's littoral, many of which are quite common. They collected only 14 of the 50 species of intertidal bryozoans known from the Gulf, 51 of the 377 species of intertidal polychaete worms (Annelida: Polychaeta), 12 of the 60 species of intertidal isopods (Crustacea: Isopoda), 10 of the 114 known intertidal amphipods (Crustacea: Amphipoda), and 10 of the 27 intertidal cirripedes (barnacles).

The expedition focused on larger organisms, mostly animals exceeding 2 cm in length. Thus, they took only 182 of the 927 known intertidal mollusc species, most of which are small. They also undersampled echinoids (sea urchins and their kin), taking only 15 of the 27 littoral species, missing such common urchin species as *Toxopneustes roseus* and *Lytechinus pictus* (presumably because these do not appear on the shore until around the 0-tide level, and much of their collecting was done at tidal levels higher than that). Overall, they collected 65 of the 120 known Gulf littoral echinoderm species.

Their collecting techniques were most successful with the large, colorful species groups. They collected 54 of the 163 littoral "true crabs" (Brachyura), although some of their identifications are suspect (e.g., they report only one species of *Callinectes*, but three very similar species occur in the Gulf). Similarly, they reported all records of sun stars as *Heliaster kubiniji*, although there are three similar-appearing *Heliaster* species in the Gulf.

The expedition brought back thousands of specimens, and Ricketts worked furiously to get them sorted, identified, and properly curated. He worked swiftly to package and send specimens to specialists around the country. Correspondence between Ricketts and these specialists reveals an amazing level of cooperation and respect for Ricketts by the zoological community at large. The list of cooperating taxonomists reads like a compendium of the top invertebrate zoologists working in North America at the time, three of whom (Ted Bullock, John Wells, and Joel Hedgpeth) lived long enough to make identifications for me in 1969–1970 when I was working on my own compendium of Gulf invertebrates.

Paul Bartsch. National Museum of Natural History (Smithsonian Institution), Washington, D.C. Scaphopod and bivalve molluscs.

R. S. Bassler. National Museum of Natural History (Smithsonian Institution), Washington, D.C. Bryozoa.

S. Stillman Berry. Chitons, cephalopods.

T. H. Bullock. Yale University. Hemichordata: Enteropneusta.

Austin H. Clark. National Museum of Natural History (Smithsonian Institution), Washington, D.C. Brittle stars (Ophiuroidea).

H. L. Clark. Museum of Comparative Zoology, Harvard University. Sea urchins.

Wesley R. Coe. Yale University. Nemerteans.

Ira E. Cornwall. Hopkins Marine Station, Stanford University. Barnacles.

Elisabeth Deichmann. Museum of Comparative Zoology, Harvard University. Holothurians (and possibly alcyonarians).

W. K. Fisher. Hopkins Marine Station, Stanford University. Sea stars, sipunculans, echiurans.

C. McLean Fraser. University of British Columbia. Hydroids.

Steve Glassell. Crustacea.

Olga Hartman. Allan Hancock Foundation, University of Southern California. Polychaetes.

Joel Hedgpeth, University of the Pacific (later, Oregon State University). Pycnogonids (sea spiders).

Dora Henry, University of Washington. Barnacles.

Libbie H. Hyman. American Museum of Natural History, New York. Flatworms.

M. W. de Laubenfels. Porifera. (Not recognized as a strong biologist, but for many years the only sponge specialist working in the eastern Pacific.)

Milton J. Lindner. U. S. Fish and Wildlife Service. Penaeid shrimps.

J. O. Maloney. National Museum of Natural History (Smithsonian Institution), Washington, D.C. Isopod Crustacea.

Harald Rehder. National Museum of Natural History (Smithsonian Institution), Washington, D.C. Bivalve molluscs.

Waldo L. Schmitt. National Museum of Natural History (Smithsonian Institution), Washington, D.C. Crustacea.

L. P. Schultz. National Museum of Natural History (Smithsonian Institution), Washington, D.C. Lancelets.

C. R. Shoemaker. National Museum of Natural History (Smithsonian Institution), Washington, D.C. Amphipods.

Willard G. Van Name. American Museum of Natural History, New York. Chordata: Tunicata.

John W. Wells. Ohio State University. Stony corals.

At least 4 species of invertebrates from the Sea of Cortez have been named in honor of John Steinbeck: *Phialoba steinbecki* (a sea anemone; now *Phymanthus steinbecki*), *Thalassema steinbecki* (an echiuran worm), *Eubranchus steinbecki* (a sea slug), and *Tellina* (*Marisca*) *steinbecki* (a clam). At least 10 species from the Sea of Cortez have been named in honor of Ed Ricketts: *Mysidium rickettsi* (a mysid), *Longiprostatum rickettsi* (a flatworm), *Isometridium rickettsi* (a sea anemone), *Palythoa rickettsi* (a zoanthid cnidarian), *Adesia rickettsi* (a sea slug), *Aclesia rickettsi* (a sea slug), *Tellina* (*Acorylus*) *rickettsi* (a clam), *Siphonides rickettsi* (a peanut worm; now *Apionsoma pectinatum*), *Macoma rickettsi* (a clam; now *Macoma indentata*), and *Polydora rickettsi* (a polychaete annelid).

Description of the Expedition

Reviewing comments in *Sea of Cortez* and Ricketts's field notes (in Rodger 2006) reveals the entire trip was made in haste—"chasing the tides" (a reality intertidal field biologists know all too well). At times, they even referred to it as a “makeshift expedition” (Steinbeck 1951). The expedition crew worked with such haste that they did not even take much time for photography, although they had both still and video cameras onboard (only one photo seems to have survived the trip). And, although some 8-mm movies were taken, the film was not properly cared for and eventually proved unusable. The *Flyer* had been booked for a 6-week charter, thus the expedition would have collected during two spring tide cycles, when the lowest low tides of the month occurred. However, it had just 24 actual collecting days inside the Gulf. Steinbeck and Ricketts wanted to cover as much ground as possible in that brief time period. (For example, *Sea of Cortez* mentions regretting not being able to go ashore at Mulegé, B.C., due to time constraints; they describe the town as appearing “gay against the mountains, red-roofed and white-walled. We wished we were going ashore there” [p. 195].) The *Flyer* put into only four official ports during the expedition: Cabo San Lucas, La Paz, Loreto, and Guaymas. But they appear to have spent time ashore, other than collecting, only in Loreto (2 days on a bighorn sheep/borrego cimarón hunt in the mountains west of Puerto Escondido, and a brief visit to the town of Loreto to see the Mission Nuestra Señora de Loreto) and Guaymas (3 days). Hedgpeth (1978b) wrote that Steinbeck “was tired and ready to go home and did not care much for Guaymas.” However, Ed’s notes from the trip make it clear that Steinbeck had such a rollicking good time in Guaymas that he suffered from a massive hangover that lasted several days, and that is more likely the reason he wanted to get out of town.

In the section of *Sea of Cortez* dealing with the Guaymas area and to the north, specifically Tiburón Island, there is an interesting discussion of the Seri People (today known by their native name, the Comcaac). However, I am aware of no evidence that Steinbeck or Ricketts actually met any Seris during the expedition. Hedgpeth (1978b) claimed “the Seri are doing well and have a thriving village about 15 miles north of new Bahía Kino.” But, in the 1970s (when Hedgpeth wrote), they were not doing well at all. Like many North American indigenous groups, they suffered from poverty and poor government support, and were caught between the two worlds of their ancestors and modern Mexico. Their primary source of peso revenue in the 1970s was their art—basket weaving and ironwood carving—and they mostly lived a sustainable subsistence from seafoods and land plants. Today, the once-profitable ironwood carving art market, which the Comcaac did by hand, has been ruined by Mexican ironwood carvers who use power machines to produce imitations of the elegant hand-carved Comcaac work.

The expedition collected almost nothing but shore animals. They paid very little attention to pelagic animals, fishes, whales, or subtidal fauna, although they often night-lighted from the *Flyer*. Interestingly, they did not write of giant (Humboldt) squid coming to their night-lights, something that is common today (see Gilly, this volume). Their collections were largely opportunistic, often rushed or at night, and not always during good low tide cycles. The selection of collecting sites was driven by the tides, by weather, and by the sailing wisdom of skipper Tony Berry, who had never even been inside the Gulf of California before. At many sites, they spent only an hour or so collecting. The collections were not empirically or quantitatively organized (e.g., no formal transects, quadrats, etc. were used), and their fieldwork varied greatly in effort from one site to another. For example, perhaps the most biologically diverse site in the Sea of Cortez is the coral reef at Bahía Pulmo, where Steinbeck and Ricketts reported about 85 invertebrate species. In contrast, Brusca and Thomson (1977) reported over 120 species from there, and this number has grown substantially since that early study (see Reyes-Bonilla and Álvarez-Filip 2008; García-Madrigal and Bastida-Zavala 1999 for brachyuran crabs; García-Madrigal 1999 for anomuran crabs). Further, the precise collecting locations from the Ricketts and Steinbeck expedition are largely unknown, and intertidal terrain (and thus, the littoral fauna) can vary dramatically across distances of only a few meters. For example, in 1940 the common Gulf sea star, *Heliaster kubiniji*, was abundant on rocky shores with barnacle-covered, medium to large boulders, but on the very same shore the terrain may switch within a meter to small, unstable stones that lack good barnacle development and there are no *Heliaster* to be found. For all these reasons, modern comparisons to their site species lists (e.g., Sagarin et al. 2008) should be viewed with caution.

The only sites Ricketts and Steinbeck had planned ahead of time to collect were Bahía Pulmo Reef, La Paz, and Bahía de los Ángeles. All others were to be opportunistic. Even at Puerto Refugio (on Isla Ángel de la Guarda) and Bahía de los Ángeles, two of the most biologically diverse localities in the entire Sea of Cortez, they did not collect all that many species (92 and 99 species, respectively). Steinbeck and Ricketts were sensitive to the approach they used, noting that "no general survey of the entire fauna has been attempted" (*Sea of Cortez*, p. 291). As noted above, they had one coordinated objective: "to make a survey of the common and obvious animals of a restricted area."

The expedition took place just before a highly contested presidential election in Mexico, in which PRI-affiliated president Lázaro Cárdenas hoped to hand the office to Manuel Ávila Camacho (who had been his right-hand man during the Mexican Revolution). The PRI had been rigging the elections since the revolution. After the election, it was reported that Camacho won the presidency with 94% of the popular vote! Not everyone in Mexico supported or backed the PRI's revolutionary legacy, and most regarded the party as highly corrupt. This political situation was creating unrest in the country and, combined with the Second World War (which had just begun in Europe), the circumstances gave Ricketts and Steinbeck further grist for thought and philosophizing about human nature and the human condition. Coincidentally, President Cárdenas visited La Paz in 1940, though he was not there when the *Western Flyer* and her crew visited (Figures 1–4).

Figure 1. 1940 postcard of La Paz. Photo No. 6569 from Archivo Histórico de B.C.S. Pablo L. Martínez, in La Paz, BCS.

Figure 2. The municipal pier was gone when the Western Flyer arrived in La Paz on March 21, 1940, and the Flyer anchored "250 yards westward" of where the pier used to be. This photograph, taken that same year, is of another, commercial pier in La Paz. Photo No. 3 from Archivo Histórico de B.C.S. Pablo L. Martínez, in La Paz, BCS.

Figure 3. Photograph of the La Paz malecón, 1940. Photo No. 6584 from Archivo Histórico de B.C.S. Pablo L. Martínez, in La Paz, BCS.

Figure 4. Photograph of President Lázaro Cárdenas and companions in front of the old Hotel Paraiso, La Paz, 1940. Cárdenas was president of Mexico from 1934 to 1940. Photo No. 8454 from Archivo Histórico de B.C.S. Pablo L. Martínez, in La Paz, BCS.

The daily log that follows is based on the published book, *Sea of Cortez*; the field notes of E. F. Ricketts (Hedgpeth 1978b; Ricketts Jr. and Rodger 2004; Rodger 2006); the ship's log of Captain Tony Berry (published in Hedgpeth 1978b); and letters between Ricketts and various taxonomic specialists he corresponded with after the expedition. Note that the transcript of Ed's log from the trip that appears in Hedgpeth 1978b is an abridged and shortened version; the verbatim version can be found in Rodger 2006. (The verbatim transcript is what Ricketts prepared after the trip and sent to Steinbeck to use in writing their book.) Hedgpeth also introduced some errors/*lapsus calami* into Ed's log. For example, March 19 got completely deleted from the Hedgpeth version, with data from March 18 through 20 jumbled up. As a result, information on Bahía/Cabo Pulmo is entirely missing from the Hedgpeth version. Curiously, however, Hedgpeth's site-dated map of the expedition track (pp. 154–155) is accurate.

The "Collection Numbers" appearing boldface in the text below do not occur in *Sea of Cortez*—they are my own bookkeeping convention. Table 4 gives a list of species collected per site. The specimens from the expedition have gotten disbursed and most are now located at the California Academy of Sciences, San Francisco (CAS; at least 92 species lots), and the Smithsonian Institution's National Museum of Natural History (USNM; at least 225 species lots), and a few are scattered at other institutions. Most of the CAS material was accessioned from its prior holding at Hopkins Marine Station, where it would appear that some specific collection locality and other important data were lost over the years.

It should be noted that there are some errors in the collection locality dates of the Ricketts-Steinbeck expedition provided in Sagarin et al. (2008). Cabo San Lucas was sampled on March 18 (not on March 17); Bahía San Carlos was sampled on two days, March 30 and 31 (not solely on March 30); San Francisquito was sampled only on March 31 (not on April 1); and Puerto San Carlos (Sonora) was sampled on April 4 (not on April 22).

After the Sea of Cortez voyage, the *Western Flyer*, through a succession of owners, went on to work as a fishing boat from California to Alaska. She worked as an ocean-perch trawler off the coast of Washington and British Columbia, a crabber in the Aleutian Islands, a salmon fishing boat in Puget Sound, and a tuna boat off the Pacific Coast of Baja California. She also conducted research surveys for the Bureau of Commercial Fisheries and the International Pacific Halibut Commission. For a complete history of the *Flyer*, see Kevin Bailey's (2015) excellent history of the boat. In the 1970s, one owner, Dan Luketa, changed the name of the boat to *Gemini* (after NASA's Project Gemini). Launched in 1937, the *Flyer* was one of at least four sardine seiners made by Western Boat Building Co. that worked in the Monterey sardine fleet at the time—the others being the *Western Sun*, the *Western Pride*, and the *Western Maid*. As a sardine boat in Monterey, the *Flyer* could carry a crew of ten.

Annotated Cruise Log

Numbers of species taken at each collecting location are based on identified and named species only (in the Phyletic Catalogue, and subsequent museum and Ricketts correspondence records). Other species might have been present and noted in the Narrative, but not identified (e.g., "large purple urchins"); these are indicated in the species lists below, but are not part of the numerical species counts. Latitude coordinates are from Ricketts's field notes.

March 11 (Monday). *Western Flyer* (hereafter, "*Flyer*") departs Monterey. The *Flyer*, built in 1937 as a purse seiner, was a 77-foot (25-foot-beam) trawler, with a 165-horsepower Atlas Imperial diesel engine. Her maximum speed was 10 knots (12 mph). On board were a 10-foot and 20-foot skiff.

Chapter 4 in *Sea of Cortez* describes the boat's departure from Monterey, and includes one of my favorite passages. "We sat on a crate of oranges and thought what good men most biologists are, the tenors of the scientific world—temperamental, moody, lecherous, loud-laughing, and healthy. Once in a while one comes on the other kind—what used in the university to be called a 'dry-ball'—but such men are not real biologists. They are the embalmers of the field, the picklers who see only the preserved form of life without any of its principle. Out of their own crusted minds they create a world wrinkled with formaldehyde. The true biologist deals with life, with teeming boisterous life, and learns something from it, learns that the first rule of life is living." And, "Your true biologist will sing you a song as loud and off-key as will a blacksmith, for he knows that morals are too often diagnostic of prostatitis and stomach ulcers.... At least he does not confuse a low hormone productivity with moral ethics."

March 13 (Wednesday). *Flyer* arrives in San Diego; takes on fuel, water, ice, and perishables. Here, Webster ("Toby") Street and Herb Klein disembark.

March 14 (Thursday). *Flyer* departs San Diego (2:10 p.m.). Captain Berry begins keeping log of trip.

March 15 (Friday). Pass San Martín and Cedros Islands, and Punta Eugenia.

March 16 (Saturday). Pass Bahía Magdalena. **Collection No. 1 (p. 45 in *Sea of Cortez*)**: Outside Magdalena Bay, Tiny Colleto harpoons a hawksbill turtle (*Eretmochelys imbricata*), on which were barnacle bases, many hydroids, and two pelagic crabs (noted as *Planes minutus* in *Sea of Cortez*, but more likely to have been *Planes major*). The turtle's gut was filled with pelagic red crabs or langostinos (*Pleuroncodes planipes*). This material constitutes the first collection of the trip. Steinbeck saved the shell, which still exists.

True to his attachment to W. C. Allee's concept of "community," Ricketts's notes from the trip include this passage, "The completeness of the turtle—*Planes minutus*—hydroid—barnacle—*Pleuroncodes*.... association is very pleasing. There was the whole thing laid out before us." The Narrative also describes the plankton- and nekton-rich waters of this region, calling it "tuna water." Indeed it is, but over the past few decades overfishing for tuna off the west coast of the Baja California Peninsula has decimated their numbers. Overall, the east Pacific bluefin tuna population is now down to about 5% of its estimated original size. Despite this, the fishing continues (for both bluefin and yellowfin tuna, and skipjack), using drones and spotter planes to identify dolphin schools.

March 17 (Sunday). Arrive Cabo San Lucas cove, just after midnight (morning of March 18; after 4 days steaming from San Diego). In Captain Berry's log, it is noted that Cape Lazaro was seen at midnight, and the course changed for Cape San Lucas. (*Sea of Cortez* incorrectly states they passed Point Lazaro at 2 a.m. on March 18.) The captain's log notes that at 12:45 a.m. (on March 18), estimating they were getting close, Berry slowed the boat to a crawl. And then, all of a sudden, the shore was just ahead. Even with 14 fathoms on the sounding line, Berry wrote in his daily log, "boy, you could throw a rock on the shore." The *Western Flyer* was, at that point, floating over the famous "sand canyons" of Cabo San Lucas, where the slopes of the canyons are at the underwater angle of repose, so steep that the slightest disturbance initiates a "submerged sand-slide." Here, one can swim just a few meters offshore and find themselves over hundreds of meters of water.

March 18 (Monday). *Sea of Cortez* and Ricketts's field notes indicate there is little more to Cabo San Lucas than the cannery and a few fishermen's shacks. Since that time, Cabo San Lucas was targeted by Mexico's national tourism board (SECTUR) for significant development, and today it is a major tourist city. **Collection No. 2 (p. 58 in *Sea of Cortez*)**: Collection made on "cliffy rocks" south of the tuna cannery in cove; "fairly open to surf and ground swell from the south." Approx. 22°52' N latitude. One low tide collection, at approximately 0-tide level, made in haste. 53 species were collected. Cogent reflections in *Sea of Cortez* from this locality include: "The reports of biologists are the measure, not of the science, but of the men themselves." And, "A dull man seems to be a dull man no matter what his field, and of course it is the right of a dull scientist to protect himself with feathers and robes, emblems and degrees, as do other dull men who are potentates and grand imperial rulers of lodges of dull men." Truer words were never spoken. It was in a small cantina in the town of San Lucas that Ricketts and Steinbeck first heard of the legendary liquor Damiana. And it was at this first Gulf collecting site that they encountered Sally Lightfoot crabs (*Grapsus grapsus*) and wrote so eloquently of their antics.

March 19 (Tuesday). Bahía Pulmo Reef. Now Cabo Pulmo National Park. **Collection No. 3 (p. 76 in *Sea of Cortez*)**: Collections probably made from shore on innermost reef tract during one low tide only; "rocky and/or coral reef, with no loose boulders." Approx. 24°26' N latitude. Bahía Pulmo has long been said to be the only true coral reef in the Gulf (but see below), and it is one of the most species-rich sites in the Sea of Cortez. (In Bahía Pulmo, coral skeletal framework reefs sit atop basalt outcroppings; Brusca and Thomson 1977; Reyes-Bonilla and López-Pérez 2009.) Ricketts and Steinbeck describe the reef being "gradually exposed as the tide went down," which suggests they were on one of the near-shore reef tracts (the outer tracts remain submerged even at low tide). Collection was made in haste; only one (morning) low tide period was sampled. That the Pulmo Reef was hastily collected is evidenced by the fact that Steinbeck and Ricketts report only 85 invertebrate species. The most abundant mollusc on the reef today is *Conus princeps* (Vicencio Aguilar 1998), but this species was not reported by Steinbeck and Ricketts. The snapping shrimp reported in the Log from this location (as *Crangon malleator*) was described in 2013 as a new species, *Alpheus wonkimi*. The *Flyer* departed for Punta Pescadero (on the peninsula) at 3:30 p.m. (March 19), arriving at 6 p.m. to anchor for the night. It is worth noting that another coral reef (or "coral community" if one prefers) exists at Punta Bonanza, on the southeast coast of Isla Espíritu Santo. Here, a well-developed *Porites capitata* coral reef abuts the rocky shoreline, and in deeper waters of the bay patch reefs and large coral heads abound (*P. capitata*). This coral reef has not been mentioned in any publications that I am aware of although reef researchers in La Paz are likely aware of it.

March 20 (Wednesday). Left Punta Pescadero anchorage ~6 a.m. and steamed for Isla Espíritu Santo, Punta Lobos (SE tip of island). **Collection No. 4 (p. 91 in *Sea of Cortez*)**: Boulder "reef" S of Point Lobos ("small boulders on sand"), at base of cliff. Ricketts's notes list the latitude of this site as 24°29' N, which must be incorrect as this would be the latitude of Laguna la Salina in the middle of the east coast of the island and considerably north of Punta Lobos. (Punta Lobos is actually 24°28'18" N, 110°17'21" W.) They collected 115 species at Punta Lobos, making this the richest sampling site of the expedition. The collection included 6–7 new, undescribed species. Among the material from Punta Lobos in USNM collections are type specimens of one new species of sea anemone and 3 new species of sipunculans. The *Flyer* returned to Punta Coyote (= Pescadero Point) for the night due to strong winds around Point Lobos (which are common on the SE side of the island in April). The *Flyer* was to return to Isla Espíritu Santo by happenstance on April 12, where the last collection of the trip was made.

March 21 (Thursday). Bahía la Paz. **Collection No. 5 (p. 109 in *Sea of Cortez*):** "Rocky flat being drowned in sand," ½ to 1 mile NE of city of La Paz; many coral heads exposed above the sand. Ricketts and Steinbeck note that the "animals were mainly sand flat forms" and "completely protected from waves." Approx. 24°10' N latitude. The list of animals collected reflects both sandy and rocky substrates. 73 species were collected, and among those in the USNM collections are type specimens of 2 new anemone species.

With Jonathan White (author of *Tides: The Science and Spirit of the Ocean* and *Talking on the Water: Conversations about Nature and Creativity*), I revisited the Ricketts-Steinbeck La Paz site on 4 March 2020, 80 years after the *Flyer*'s visit (Figure 5). During our 1.5-hour examination of the site, at a -0.12-m low tide, we found only 15 of the 73 species collected by Ricketts and Steinbeck. Visually the site, which is now along the paved and lighted malecón roughly in the center of the city, looks pristine. Closer examination, however, reveals black anoxic sediment 2–4 cm beneath the surface, indicating nutrient over-enrichment, likely from the many storm drains emptying on the beach along the malecón. So far as we could discern, there were no living coral heads in the area, and the dead ones were all very small, 3–8 cm in diameter (*Pocillopora capitata*). Ricketts and Steinbeck also did not mention live corals at this site. Missing from the site (but collected by the Ricketts-Steinbeck expedition) were all of the larger invertebrates, e.g., large snails, echinoderms, octopuses, etc. Only two small, juvenile *Arbacia incisa* were found, submerged, at about the -0.5 tidal level. Predominant species were fire worms (*Eurythoe complanata*), sulfur cucumbers (*Holothuria lubrica*), and the ophiuroid *Ophiothrix spiculata*; the first two of which were under almost every rock. The rock-boring shrimp *Neaxius vivesi* was also common. Interestingly, Ricketts and Steinbeck did not record fire worms or sulfur cucumbers from this site. Their report of Sally Lightfoot crabs (*Grapsus grapsus*) from this site remains a mystery, as there is no appropriate habitat for this species in the area. They likely took *G. grapsus* at a rocky site a few kilometers away and combined it with their La Paz sample list. We also did not see the common Gulf fiddler crab *Uca crenulata*, even though the uppermost beach habitat, next to the malecón itself, appeared suitable for this species. The anoxic layer a few centimeters below the surface might now be excluding this once-common La Paz Bay species. No sea stars of any kind were seen. It is likely that the larger-bodied species are periodically harvested by locals for food and for the curio shop trade in La Paz. Also, echinoderms throughout the Gulf have not fully recovered from the devastating Gulf "echinoderm wasting disease" event that began in 1978 (Dungan et al. 1982).

Figure 5. Ricketts-Steinbeck collecting site No. 5, La Paz, page 109 in Sea of Cortez. Photo taken March 2020 by R. Brusca.

March 22 (Friday). Bahía la Paz, El Mogote. Good Friday; the crew went to church this morning in La Paz. Afternoon **Collection No. 6 (p. 119 in *Sea of Cortez*)**: "Sand and muddy sand at El Mogote, the peninsula NW of La Paz. Completely protected from waves." El Mogote is a huge, long sand spit that forms the outer shore of La Paz Bay; the bay side of the sand spit is lined with mangroves. Here 76 species were collected, and among those in the USNM collections are type specimens of a new anemone and a new echiuran. In that evening's notes, Ricketts and Steinbeck wrote, "Tiny returned to the *Flyer*, having collected some specimens of *Phthiruius pubis*, but since he made no notes in the field, he was unable or unwilling to designate the exact collecting station." Likely it was in La Paz's then-infamous El Ranchito district.

Of El Mogote, Ricketts and Steinbeck wrote (p. 120): "As the tide came up we moved upward in the intertidal toward the mangrove trees, and the foul smell of them reached us. They were in bloom, and the sharp sweet smell of their flowers, combined with the filthy odor of the mud around their roots, was sickening. We sat quietly and watched the moving life in the forests of the roots, and it seemed to us that there was stealthy murder everywhere. The roots gave off clicking sounds, and the odor was disgusting. We felt we were watching something horrible. No one likes the mangroves." Judging from the species list, they did not actually penetrate into the dense mangrove forest of El Mogote, where a very high species diversity exists. They likely just skirted the outer boundary of the vegetation. And yet, from these collections a new species of spoon worm (Echiura) was later described and named after Steinbeck by W. K. Fisher (*Thalassema steinbecki*).

March 21–22. La Paz, "misc. rocky shore collections," lumped as **Collection No. 7**: 21 species collected, and among those at the USNM are 2 that proved to be new species of zoanthid anemones later described by the Swedish biologist Oskar Carlgren.

March 23 (Saturday). The *Flyer* steamed this morning from La Paz to the SW shore of Isla San José and anchored in the large Bahía Amortajada (near the small islet of Islote Cayo; approx. 24°51'15" N, 110°35' W). Around 5 p.m., **Collection No. 8 (p. 127 in *Sea of Cortez*)**: "collecting on barren looking rocky reef or islet, probably Cayo Islet, ½ to ¾ mi. W of anchorage, cliffy rocks and great boulders. Exposed to Gulf waves." Ricketts gives the latitude of 24°53' N. Just 20 species were collected. Steinbeck and Ricketts described Islote Cayo (100 yards wide, a quarter mile long; see U.S. Hydrographic Office Publication No. 84, p. 130) as "burned" and being very low in diversity. Noted were "a few small *Heliaster*," *Grapsus grapsus*, "*Aletes*," sea cucumbers, and sea hares. This was one of their least productive collection sites. The *Flyer* remained anchored at Isla San José this night.

March 24 (Easter Sunday). Morning: Isla San José, Bahía Amortajada. **Collection No. 9 (p. 131 in *Sea of Cortez*)**: The Narrative describes collections made at the lagoon during morning tide (fiddler crabs and mudflat snails), but the Phyletic Catalogue reports only two species of rocky shore gastropods from this site. The lagoon (at the SW corner of Bahía Amortajada) is quite large, extending from ~110°35’ W to 110°32.7’ W, and there is no indication where exactly they collected, although they spent only 1 to 1.5 hours in the lagoon. It is unclear why so few species are reported from this Easter-morning collection; perhaps some specimens were lost (although there is no clear indication of this). Had Ricketts and Steinbeck walked a few meters inland from the littoral, they would have discovered considerable evidence of aboriginal inhabitation—abundant kitchen middens, grinding stones, ancient fire pits, etc.—and a beautiful desertscape of *Bursera*, cardón, and other large succulents. Francisco de Ortega might have been the first European to visit Bahía Amortajada, in 1633 (de Ortega 1970), reporting abundant freshwater springs, a discovery that was corroborated by the USS *Narragansett* in the 1870s (Belden 1880). It was likely this freshwater source that facilitated inhabitation by Native Americans from the Baja Peninsula. Ortega also reported “many Indians of the same language and character as those of the Port of La Paz.” In 1709, Father Juan María Salvatierra noted, “we have proof that the Indians of [Isla] San José slew the unlucky [pearl] divers who came in from a boat from Colima” (de Salvatierra 1971). Today, 7 of Mexico’s 56 extinct and endangered Native American laguages occur in Baja California (Fujita and Bonzon 2006; Vidal and Brusca 2020).

Afternoon: Around noon, the *Flyer* departed Isla San José and steamed to “Bahía San Marcial,” anchoring just S of Punta San Marcial (“Marcial Reef” of *Sea of Cortez*; “San Marti” of ship’s log; Bahía San Marte on modern maps). **Collection No. 10 (p. 152 in *Sea of Cortez*)** made just south of anchorage on a rocky reef extending about ¼ mile from shore. Approx. 25°30’30” N, 111°01’ W. Some of the afternoon collecting was also done on the boulder shore, “exposed to Gulf waves.” This site comprised a late-afternoon effort, and also an early-morning effort (4 a.m. the next morning, March 25): 62 species were collected, and among those in the USNM collections are type specimens of *Mysidium rickettsi*, described by Elizabeth Harrison and Tom Bowman in 1987. It was here that Steinbeck and Ricketts commented on the “great schools of tuna beating the water by the millions” (p. 154). The so-called Easter Sunday Sermon in the *Sea of Cortez* (Chapter 14, p. 131) was one of Ricketts’s three philosophical essays (“Essay on Non-teleological Thinking”), published largely verbatim.

March 25 (Monday). Brief (~1 hour), early-morning collection made again at San Marcial (**Collection No. 10, Cont.**). Steamed for Puerto Escondido.

Collection No. 11, Puerto Escondido Outer Bay and inlet channel (p. 156 in *Sea of Cortez*): 79 species collected. Steinbeck and Ricketts described Puerto Escondido, a large natural harbor about 25 km south of the city of Loreto, as "mostly completely protected, rocky pools and reefs, and mangrove swamp area. Some of the colleting here was done in the channel which leads into Puerto Escondido proper, where the tidal currents run strong, and some inside the completely protected cove, but mostly in a smaller cove outside, open only to the anchorage." The entrance to Puerto Escondido is 25°48'10" N, 111°18'30" W. In the species lists, I have tried to distinguish species collected in the outer bay (and the connecting channel) from those collected in the inner bay.

This afternoon, a local rancher (Leopoldo Perpuly) and his Loreto guests (a "customs man" named Manuel Madinabeitia C., a schoolteacher from Loreto named Gilberto Baldibia, and two "Indians") invited Steinbeck and Ricketts to go on a borrego (bighorn sheep) hunt in the mountains with them the following day (March 26). The group rode mules and horses into the mountains where they camped overnight, returning to the *Flyer* the next morning (March 27). No sheep were sighted, but a good time was had by all. In the mountains, they collected horsehair worms (Nematomorpha), possibly *Chorodes occidentalis* Montgomery (identification presumably by J. T. Lucker; USNM No. 159124). An entry in *Sea of Cortez* from late in the day March 26 (p. 168) notes that, for their Sea of Cortez expedition, they "took 2160 individuals of two species of beer"; they don't mention what the species were.

March 27 (Wednesday). **Collection No. 12, Puerto Escondido Inner Bay (p. 170 in *Sea of Cortez*)**, made before dawn: Rocky intertidal, sandy bay, 24 species collected. Steinbeck and Ricketts noted Puerto Escondido was one of the richest sites they visited (and it still is rich, despite the construction of a small marina that has taken place, in fits and starts, over the past 25 years or so). The combined outer and inner bay collections yielded 95 species, making this the second-richest collecting locality of the expedition. Ricketts's notes point out it was a good low tide, which no doubt facilitated their collecting success.

After the morning collection in Pueto Escondido, the *Flyer* steamed a short distance up the coast to Loreto, arriving ~11:30 a.m. While visiting Loreto late in the afternoon, they came upon "the destroyed mission," which was Mission Nuestra Señora de Loreto, the first mission built in the Californias (founded by Padre Juan María de Salvatierra in 1697, and completed in 1752). The Narrative makes no mention of Mission San Francisco Xavier, in the Sierra de la Giganta west of Loreto, which was founded in 1699 (the first mission in Baja to have glass windows, and with still-standing 300-year-old olive trees). Since 1996, the coast and islands around Loreto have been a national park, Parque Nacional Bahía de Loreto.

After leaving Loreto, the *Flyer* steamed to Isla Coronado, anchoring on the N end. This island is now part of Loreto Bay National Park. **Collection No. 13 (p. 176 in *Sea of Cortez*)**: 59 species collected, including type specimens of *Palythoa insignis* (a zoanthid anemone). Ricketts's field notes say they collected on the "NE shore of long westerly-extending point," which, today, is the island's main access beach for tourists from Loreto.

March 28 (Thursday). This morning the *Flyer* departed ~9 a.m. for Bahía Concepción, Punta San Rosalía, "about 15 miles S in Concepción Bay….along the western shore of Peninsula Concepción that forms the eastern boundary of the bay" (east shore of Bahía Concepción; approx. 26°40' N). Late-afternoon arrival and collection made (~5:30–7 p.m.). **Collection No. 14 (p. 185 in *Sea of Cortez*)**: Sandy beach. A total of 91 species was collected over two efforts (Thursday evening and Friday morning), including some from a "crab net" set at night in 4 fathoms; they also dragged a net along the bottom from the boat for a short distance.

Bahía Concepción is one of the best examples of a mini-extensional tectonic basin in the Gulf (and one of the largest fault-bounded bays in the Gulf). This huge and beautiful bay, 40 km (25 miles) in length and 270 km^2 (105 square miles) in area, formed along the eastern edge of the Baja California Peninsula as the Gulf was opening, and its long and narrow shape is the result of a half-graben created by northwest-southeast trending faults, the eastern one (Bahía Concepción Fault) lying on Peninsula Concepción. Around the bay are Oligocene to Miocene igneous rocks—andesites, basalts, tuffs, and breccias. There are also two areas on Peninsula Concepción where Cretaceous (75 mya) granodiorite outcrops. The shallow bay, mostly 25–30 m (80–100 feet) deep, was probably a non-marine basin during most of the Pleistocene, when sea levels were much lower (during glacial cycles).

March 29 (Friday). Morning: second collection in Bahía Concepción, near head of bay, on E side (approx. 26°35' N). Collections made by hand (wading in the water) and with net dragged from boat. **Collection No. 14, Cont. (p. 193 in *Sea of Cortez*)**. Departed Bahía Concepción in early afternoon for Caleta San Carlos/San Lucas Cove (south of Santa Rosalía), arriving around 5 p.m. En route, the *Flyer* passed Mulegé and Steinbeck and Ricketts note (p. 195) that they wished they had time to stop there.

The USNM houses at least 14 identified species from the Bahía Concepción collections of the *Western Flyer*. However, none of these are sand dollars, which Steinbeck and Ricketts collected in great abundance. These probably ended up being sold by Ricketts through his Pacific Biological Laboratories (PBL). Steinbeck and Ricketts were likely very impressed by the echinoderm fauna at this site, both the numbers of individuals and the presence of 7 species of echinoids.

Caleta San Carlos/San Lucas Cove (27°13' N, 112°13' W), late afternoon: **Collection No. 15 (p. 200 in *Sea of Cortez*)**. The cove comprises a protected saltwater lagoon formed by a sand bar. Sand flats of coastal lagoon explored on foot with shovel. Light hung off boat this night; small squid, nereid worms, crustaceans, and a "transparent ribbonfish" captured.

March 30 (Saturday). Morning collection, **Collection No. 15, Cont. (p. 200 in *Sea of Cortez*)**: Caleta San Carlos/San Carlos Cove. This was a ~3-hour collection (8:30–11:30 a.m.), and 59 species were taken. Steamed north midday for San Carlos Bay/Bahía San Carlos, passing Santa Rosalía en route. Arrived San Carlos Bay/Bahía San Carlos 6 p.m.

Afternoon collection, **Collection No. 16 (p. 203 in *Sea of Cortez*)**: San Carlos Bay/Bahía San Carlos. Collections made on rocky shore (and perhaps in back-beach lagoon). 27°52' N, 112°46' W. This afternoon collection was for only ~1 hour due to inaccessibility issues. After dark, night-light used from boat (captured squid, a larval mantis shrimp, nereid worms, crustaceans, and "transparent fish"). The majority of specimens were taken on the following day (March 31).

Note that the expedition collected at three "San Carlos" collection sites; these two in Baja California and the other being on the coast of Sonora and referred to by Steinbeck and Ricketts as "Port San Carlos" or "Puerto San Carlos" (although today the latter is commonly called Bahía San Carlos).

March 31 (Sunday). Morning collection in San Carlos Bay/Bahía San Carlos, Baja California Sur **(Collection No. 16, Cont., p. 205 in *Sea of Cortez*).** "Boulder shore; gravely foreshore." Poor tide this morning led to collections in upper-mid and high intertidal zones only, for ~1 hour. From these two San Carlos Bay/Bahía San Carlos collections, only 56 species were collected. It is not clear how they acquired a specimen of *Sicyonia penicillata*, which is an offshore penaeid shrimp; perhaps they found it dead and washed ashore. Here, *Sea of Cortez* notes that the three most common animals they have encountered in the Gulf are the sulfur cucumber (*Holothuria lubrica*), the brittle star *Ophiothrix spiculata*, and the sun star (*Heliaster kubiniji*). The first two are still the most common larger invertebrates in the Gulf's intertidal region. *Heliaster kubiniji*, however, was decimated in an echinoderm "wasting disease" that struck the Sea of Cortez in 1978, and has still not recovered from those losses. It has been suggested that a 1978 El Niño event spawned the epidemic that killed most *Heliaster* (and several other echinoderms) in the Gulf, although W. Gilley (pers. comm.) notes that 1978 was not a strong El Niño year. Although young *H. kubiniji* began to be common in the 1990s, by 2017 the species was scarce again. Adult *H. kubiniji* have been found only since the late 1990s, and they are restricted almost entirely to offshore islands and the Baja California Peninsula. Dungan et al. (1982) remains the only scientific report on the die-off event.

In the afternoon the *Flyer* steamed to Bahía de San Francisquito, arriving ~6 p.m. Evening **Collection No. 17 (p. 211 in *Sea of Cortez*)**. Approx. 28°25' N latitude. Rocky shore with sand patches. Strong winds and cold seawater led to an abbreviated collection effort. 30 species taken. From this collection came the commensal pearlfish, *Proctophilus winchellii*, which lives in the hindgut-anus of sea cucumbers (p. 215). It was this day's entry in *Sea of Cortez* (p. 217) that included the oft-quoted phrase, "It is advisable to look from the tide pool to the stars and then back to the tide pool again."

April 1 (Monday). The *Western Flyer* steamed this morning to Bahía de los Ángeles, arriving ~3:30 p.m. This area is now a biosphere reserve (Reserva de la Biosfera Bahía de los Ángeles y Canales de Ballenas y de Salsipuedes) that includes the Ballenas Channel and Guardian Angel Island. **Collection No. 18 (p. 219 in *Sea of Cortez*)**. Approx. 28°55' N latitude. A 1-hour collection (3:30–4:30 p.m.) from rocks in W side of bay yielded 88 species (including USNM type specimens of a new zoanthid species, *Palythoa ignota*, described by the Swedish biologist Oskar Carlgren in 1951). Granite boulders on sand. After that, the group took their skiff to the tidal flats at the north end of bay, where 8 species were collected (including specimens of a rare cerianthid, *Botruanthus benedeni,* now in the USNM collections). Altogether, 99 species were collected from the Bahía de los Ángeles area, making it one of the three richest collection sites of the expedition. Judging by material in the collections at USNM and CAS, other sites/samples were taken in and around the Bahía de los Ángeles area (though not specifically noted in *Sea of Cortez* or Ricketts's field notes), thus all of these collections are herein considered Collection No. 18. This is one of the few locations where *Sea of Cortez* notes algae (*Sargassum johnstonii* and *Padina durvillaei*).

From the *Flyer*, Steinbeck and Ricketts could see the spring on the hill above the settlement at Bahía de los Ángeles. This same spring still provides the water for the small village. Bahía de los Ángeles and the Canal de las Ballenas are home to the coldest seawater in the entire Gulf of California, due to year-round upwelling around Isla Ángel de la Guarda. Here, for reasons that have not been explored, many species of animals and algae reach greater sizes than anywhere else in the eastern Pacific—a phenomenon I have referred to as "cold-water gigantism."

April 2 (Tuesday). The *Flyer* steamed this morning to Puerto Refugio, at the north end of Isla Ángel de la Guarda, arriving ~2:45 p.m. Approx. 29°30' N latitude. **Collection No. 19 (p. 224 in *Sea of Cortez*)**; extensive collection made in Puerto Refugio during good low tide: 92 species collected. "Crab nets" set from boat took *Chloeia viridis,* and a hand net captured a nudibranch ("*Chioraera leonina*" = *Melibe leonina*).

April 3 (Wednesday). This morning, the *Flyer* steamed around the northern tip of Isla Ángel de la Guarda and across the Gulf to anchor off the SW corner of Isla Tiburón, at "Red Bluff Point" (presumably what is now called Punta Risco Colorado, as Ricketts gave the latitude as approx. 28°45' N). Evening **Collection No. 20 (p. 234 in *Sea of Cortez*)**. Collection made from 6:00 to 7:45 p.m.; 58 species taken, including type specimens for what Oskar Carlgren would, in 1951, describe as *Palythoa rickettsi* and *Bunodosoma californica* based on the specimens housed at the USNM. It was here that Steinbeck and Ricketts saw what was likely to have been Mexico's endangered fish-eating bat, *Myotis vivesi* (p. 226). Ricketts's field notes state this site was on the "SW corner of Tiburon

Island." However, the southwest "corner" of the island would likely have been Punta Willard, where a prominent lighthouse stands (which is not mentioned in his notes or in the Log). It seems more likely they collected on the southern point of the island, at Punta Risco Colorado (or possibly at Punta Monumento or Punta Ast Ah Keem).

April 4 (Thursday; incorrectly labeled April 22 in *Sea of Cortez*, p. 238). The *Flyer* steamed from Isla Tiburón toward Guaymas this morning. Arriving after dark (~6:30 p.m.), they anchored at Puerto (Bahía) San Carlos, Sonora (a few miles north of Guaymas Bay). This was the first stop on the "mainland" coast; due to night conditions, only a brief collection was made in "Puerto San Carlos" (today known as Bahía San Carlos/San Carlos Bay). 27°57' N, 111°35' W. **Collection No. 21 (p. 239 in *Sea of Cortez*).** 46 species collected, including type specimens of *Bunodactis mexicana* (since relegated to junior synonymy with *Anthopleura dowii*), *Aiptasiomorpha elongata*, and *Mysidium rickettsi*, all now in the USNM collections. Curiously, they do not mention the substantial mangrove forest that then existed at this site. Bahía San Carlos has been converted into a large boat marina since Steinbeck and Ricketts were there, although some of the mangrove lagoon remains healthy and intact (locally known as El Esterito). The Escuela de Ciencias Maritimas y Tecnología de Alimentos Guaymas that Hedgpeth (1978b) describes at the Miramar area of Guaymas has long been closed, and the resort-like development in the area is now concentrated in the area around the town of San Carlos (in the first bay north of Miramar).

April 5–8 (Friday–Monday). The *Flyer* steamed into Guaymas harbor late on the morning of April 5, and she departed Guaymas 4 p.m. on April 8 (Monday), anchoring just outside the harbor, at Isla Pajaros ("south of the Lobos light, and about 5 miles from Estero de la Luna"; approx. 27°53' N latitude), for the night. The 3-day/3-night stay in Guaymas included considerable debauchery (and hangovers).

According to Ricketts's transcribed notes from the expedition (Ricketts Jr. and Rodger 2004), the *Velero II* was docked in Guaymas when the *Flyer* arrived there on April 5. Ricketts ran into the "skipper" in town and had drinks and other exploits with him, leading to an invitation to lunch on the *Velero II*, which Ricketts and Tiny attended. Neither the book (*Sea of Cortez*) nor Ricketts's notes from the trip give the name of the "skipper." There is a bit of mystery here. Captain George Allan Hancock had replaced the *Velero II* (as the expeditionary ship of the

Allan Hancock Foundation, University of Southern California) with the *Velero III* in 1931. And, although the *Velero III* undertook an expedition to the Gulf in 1940, it spanned the period of January 17 to February 20 (Allan Hancock Foundation Collecting Stations 1030-40 to 1119-40; Fraser 1943a,b,c; Brusca 1980b), so it was not the same ship Ricketts visited in April 1940 in Guaymas. During the rest of 1940 the *Velero III* made only short trips in Southern California and northwestern Baja California. Captain Hancock skippered all of the ship's voyages. In 1941 the *Velero III* was acquired by the Maritime Commission and turned over to the U.S. Navy, to be converted to wartime use as the USS *Chalcedony*. After the war, the ship was purchased by the American Independent Oil Company and eventually converted into a luxury crusier for the sheik of Kuwait. I have been unable to determine the fate of the *Velero II* after Hancock replaced it with the *Velero III*.

Hancock, the founder of the University of Southern California's Allan Hancock Foundation, was a citizen scientist and seaman in Los Angeles with a long history of philanthropy. Among the ships he owned (and captained) were the *Cricket*, *Velero I, II, III*, and *IV*, and the *Oaxaca*. These plied the waters of west America from Alaska to Chile and, due to Hancock's interests in science, provided marine specimens to research institutions throughout California. Hancock had a special love for the Sea of Cortez. Among the many guests Captain Hancock entertained aboard the *Velero II* was Albert Einstein, just after he had received the Nobel Prize in physics. The *Velero III* was the first ship Hancock had built specifically for oceanographic research, and it played the decisive role in the establishment of the Allan Hancock Foundation at USC (Brusca 1980b). The expeditions and taxonomic publications of the once glorious but now defunct Allan Hancock Foundation stand above all others in documenting the biodiversity of the Gulf. Between 1942 and 1983, the Hancock Foundation publications on Pacific marine life produced an astonishing 22,469 pages of primarily invertebrate taxonomic text that stands as a watershed in marine biodiversity research. In *Sea of Cortez*, Steinbeck and Ricketts comment on the high price of publications of the Hancock Foundation, noting that they are "too expensive for the private worker to purchase, the price of Volume 2 alone being $17.50."

April 8 (Monday). The *Flyer* departed Guaymas harbor at 4 p.m., piloted out by Captain Corona, who also happened to own three shrimp boats. Corona gave Steinbeck and Ricketts "two giant shrimps" (both were the commercial blue shrimp, *Litopenaeus stylirostris*), a mounted crab, and two dried seahorses (*Hippocampus ingens*, now on Mexico's endangered species list). On leaving the harbor, Corona stopped at some of the shrimp boats he owned, prompting Ricketts to write in his field notes that the Mexican shrimp boats "merely show the big Japanese boats where the shrimps were located. Then they come over with their big fine equipment and clean out the beds." They anchored this night outside the harbor, opposite the Pajaro Island lighthouse. Ricketts wrote in his field notes, "we got to talking about telephones, of which there are several hundred in the states of Sonora, Sinaloa, and Nayarit."

April 9 (Tuesday). The *Flyer* pulls up anchor and heads south, spotting the Japanese shrimping fleet (11 trawlers, plus a large "factory ship," perhaps 10,000 tons; p. 248). Although no intertidal collecting was done while the *Flyer* was in Guaymas, Ricketts did bring back specimens of 2 penaeid shrimps (*Farfantepenaeus californiensis* and *Litopenaeus stylirostris*) and 2 specimens of flat lobster (*Evibacus princeps*), from the Japanese shrimp trawler they boarded (which had a mixed Japanese and Mexican crew). They also took various other invertebrates from the trawling fleet, but these are not discussed in *Sea of Cortez* and I have found no specimens in the USNM or CAS collections. However, in correspondence between Ricketts and S. Stillman Berry, it is apparent that they collected the squid *Lolliguncula panamensis* on board the trawler. In addition, the captain of the trawler they visited gave them a gift of two freshwater shrimp, which they concluded were *Macrobrachium jamaicense*.

After boarding the Japanese factory ship, the *Flyer* steamed on to an anchorage S of the Lobos lighthouse (~5 miles from Estero de la Luna). In his field notes, Ricketts wrote: "The Japanese very obviously will soon clean out the shrimp resources of Guaymas. In addition to which, they kill probably many hundreds of tons of fish per day, of which no human use is made and for which only the scavengers, such as sea gulls, can be thankful." And, "soon the Japanese will have cleaned out the fishing banks, a purely Mexican resource will be depleted, and the Mexicans will have nothing but the taxes they collected." And, "If the shrimp are going to be depleted anyway, and to hell with the future, the way California sardines are going, and the way much of United States timber has already gone, at least the depletion ought to be by Mexicans or for the immediate benefit of Mexico." In this ecological thinking, Ricketts was far ahead of his time. However, as it turns out, penaeid shrimps grow to maturity so fast, and are able to feed by scavenging on almost anything, that they are hard to "over-fish." However, the bottom trawls used to capture them destroy the seafloor and all life on it, and that is the principal problem with their use.

Note: Here the dates in *Sea of Cortez* get messed up; April 10 is missing. It is reconstructed here from the typed trip notes of Edward F. Ricketts ("Verbatim transcription of notes of Gulf of California Trip," provided by Ed Ricketts Jr. and Dr. Katharine A. Rodger, 2004).

April 10 (Wednesday). Went ashore in Estero de la Luna (about 40 miles S of Guaymas) in the early morning (6 a.m.), **Collection No. 22 (p. 253 in *Sea of Cortez*).** Approx. 27°18' N latitude. Only 34 species were collected, but including what would become type specimens of the sea anemone *Calamactis praelongus* and the crab barnacle *Chelonibia patula dentata* (now in the USNM). Ricketts felt this was a "surprisingly sterile" site. In the afternoon, the *Flyer* steamed south (noting passing the mouth of the Río Mayo) to outside the entrance to Estero Agiabampo, where they anchored 5 miles offshore.

April 11 (Thursday). This morning, the *Flyer* edged closer to shore, and the crew entered Estero Agiabampo by skiff. Approx. 26°20' N latitude. **Collection No. 23 (p. 261 in *Sea of Cortez*).** Collected from ~10:30 a.m. to ~12:30 p.m. Surprisingly, only 14 species were taken in 2 hours' time. Here, they found a population of the temperate north Pacific eelgrass *Zostera marina* (identified by E. Yale Dawson). Dawson noted that this was the southernmost record for this flowering plant on the Pacific Coast. Today, in the Gulf, it occurs only in the Canal de Infiernillo (Baja California) and from Kino Bay (Sonora) south sporadically to Altata in Sinaloa. *Zostera marina* is unique in the Gulf because it is an annual; it is a perennial in the rest of its range. Its seeds were an important food resource for the Seri/Comcaac People. Eelgrass in the Gulf is an important food for wintering black brandt and green sea turtles.

The *Flyer* steamed all night for Baja with the intent of heading toward Isla San José. However, with Tiny and Sparky at the wheel they went off course, and by Friday morning they were at Isla Espíritu Santo!

April 12 (Friday). Waking up at Isla Espíritu Santo ~10 a.m., Steinbeck and Ricketts took the opportunity to collect at Bahía San Gabriel (NW side of island). Approx. 24°26' N, 110°21' W latitude. **Collection No. 24 (p. 266 in *Sea of Cortez*):** 78 species collected in ~2 hours, 14 of which are in USNM collections, including type specimens of 2 new sea anemones and 2 new zoanthids. Ricketts's field notes mention: "There is a fine big patch of coral almost emerging in the center of the bay. Mangrove islands and swamps on some of the boulder patches." After spending only a few hours in the beautiful San Gabriel Bay, the *Flyer* steamed on for Cape San Lucas.

Jonathan White and I revisited the Ricketts-Steinbeck Bahía San Gabriel (Isla Espíritu Santo) site on 5 March 2020. During our 2-hour examination of the site, at a -0.25-m low tide, we found 24 of the 78 species collected by Ricketts and Steinbeck. *Palythoa* sp., *Porites californica*, *Holothuria lubrica*, *Ophiocoma* spp., *Cataleptodius occidentalis*, and *Ligia* were all abundant. A single *Isostichopus fuscus* was found, but it was dying of wasting disease. Notably absent from the site were the very common swimming crab *Callinectes bellicosus*, Sally Lightfoot crabs (*Grapsus grapsus*), *Eriphia squamata*, *Ophioderma* spp., *Aplysia californica*, and cerianthid anemones. Species found by Brusca-White, but not by Ricketts-Steinbeck, at this site included *Holothuria impatiens*, *Porites californica*, and *Astrangia* sp. Although Ricketts and Steinbeck noted a "fine big patch of coral" in the center of the bay, we saw only isolated, though sizable, coral heads. However, the south shore of the bay, in front of the mangrove-lined 19th-century pearl oyster lagoon, has a large growth of *Porites californica* (erect, lobate form) of considerable extent (about 50 m in length along the shoreline). The sand beach of this bay is composed almost entirely of degraded coral.

Isla Espíritu Santo is well known for its richness of marine life, and it also gets ~25,000 visitors annually. In 2003, contributions from the Nature Conservancy, World Wildlife Fund (Switzerland), FUNDEA (Fundación Mexicana para la Educación Ambiental), and the Walton Foundation provided funds to purchase the island and donate it to CONANP (Mexico's National Park Service). The David and Lucille Packard Foundation donated over a million dollars for a trust to be used for protection of the island. Conflicts with ejido landowners ensued, but the island seems to be well protected today. It is part of the Islas del Golfo de California Área de Protección de Flora y Fauna and also the UNESCO Islas del Golfo de California Biosphere Reserve (declared in 1995). And in 2007, the island was declared a national park (Parque Nacional Archipélago Espíritu Santo). Curiously, Steinbeck and Ricketts do not mention the old pearl oyster lagoon in the bay, even though they collected along the edge of the mangroves that surround this structure. Sagarin et al. (2008) also do not mention the pearl oyster operation. The pearl oyster cultivation system in Bahía San Gabriel was built by Don Gastón Vivés in the late 1800s. There is also ample evidence of prehispanic people (Pericú sites) on the island. Radiocarbon dates from 40 sites on the island show occupation from about 9,000 BC to the 15th century AD. At one site, shells with ages of 36,550 to 47,500 years have been found, but Tom Bowen (pers. comm. 2016) suspects these were already ancient when Native Americans collected them.

April 13 (Saturday). The *Flyer* departs for the Pacific, passing the light on Cabo Falso at 3 a.m.

April 17 (Wednesday). The *Flyer* arrives in San Diego, after a stormy 4 days at sea.

April 18 (Thursday). John and Carol Steinbeck, Ricketts, and the *Flyer*'s crew enjoyed a day in San Diego. Steinbeck's Hollywood-actor friend Max Wagner and his girlfriend, Alberta, and Tiny's girlfriend from Monterey, showed up for the celebration.

April 19 (Friday). John and Carol stay on the *Flyer* to steam to Monterey. Ricketts drives to Los Angeles with Alberta and Max. They arrived at Max's studio ~6 p.m., socialized with folks, and then went to the "RKO lot ~9 p.m." This night, Ricketts and Max and Alberta "made the rounds" of the Hollywood nightclubs. In his field notes, Ricketts says, "Jack [*sic*] Wagner is a good man." Ricketts spent the night at Alberta's sister's home, in Compton (central Los Angeles).

April 20 (Saturday). Ricketts, Max, and Alberta knocked around Long Beach and San Pedro, and searched for some fishing boats from Monterey that they thought might be there (*Sea Giant*, *New Roma*). Ricketts spent this night again at Alberta's sister's home. The *Western Flyer* arrived in Monterey this day.

April 21 (Sunday). Ricketts visited the beach (Long Beach) this day, and then took the overnight train for Monterey ~5:30 p.m. Had dinner in Santa Barbara en route.

April 22 (Monday). Ricketts arrived in Monterey early this morning. His field notes end on this day. In them, he reveals his sentimental nature (and his love of women and desire for a successful intimate relationship) with these comments:

I had kept up good spirits throughout but feel depressed and lonely now. Part probably hangover, part let-down from the last few days, which were fairly happy, but most probably due to seeing how when people come back from a trip, everyone has some one person who sidetracks everything else just for him…. I have been companions with terribly nice people like Jan [Alberta's sister?] and Alberta—and had a fine time—but their depths were for someone else, and they had little or nothing to give me.... I suppose the answer is that it's nice to be loved best and only; and who hasn't that, lacks an important part of life.

Appendix: Tables 1–4

Table 1. Named/Described Species of Invertebrates Known from the Sea of Cortez (as of 1 July 2020)

Phylum	Total Number Known from Gulf*	Occurring in the Intertidal Zone	Endemic to the Gulf (% of group)
Annelida (Polychaeta)	774	377	101 (13%)
Annelida (Echiura)	4	2	1 (25%)
Annelida (Sipuncula)	13	10	0
Arthropoda (all)	1,134 Crustacea = 1,107	544 Crustacea = 526	134 (12%) Crustacea = 134 (12%)
Brachiopoda	5	2	4 (80%)
Bryozoa	170	50	10 (5.9%)
Chaetognatha	20	11	0
Chordata	43	9	3 (7%)
Cnidaria	279	111	47 (16.9%)
Ctenophora	4	0	2 (50%, both possibly undescribed species)
Echinodermata	276	120	18 (6.5%)
Hemichordata	3	3	0
Mollusca	2,251	927	471 (21%)
Nemertea	17	14	2 (11.8%)
Platyhelminthes	22	17	9 (40.9%)
Porifera	125	60	27 (21.6%)
Xenacoelomorpha	3	0	2 (67%)
TOTALS	5,143**	2,257 (44%)	831 (16.2%)

*1,040 species occur in the Upper Gulf of California and Colorado River Delta Biosphere Reserve (Reserva de la Biosfera del Alto Golfo de California y Delta del Río Colorado); this number is 20.5% of all Gulf species.
**Note: The 1940 Steinbeck-Ricketts expedition collected ~557 species.

Table 2. Annotated List of Species Collected by the Steinbeck-Ricketts Sea of Cortez Expedition (Higher-Level Taxonomy Following Brusca et al. 2016)

TOTAL = ~557 species

Abbreviations Used

Sea of Cortez = the book, *Sea of Cortez: A Leisurely Journal of Travel and Research*
Narrative = Narrative (or "Log") section of the book *Sea of Cortez*
Phyletic Catalogue = Annotated Phyletic Catalogue (Appendix) of the book *Sea of Cortez*
Gulf = Gulf of California/Sea of Cortez
USNM = Smithsonian Institution's National Museum of Natural History

Phylum Porifera (sponges): 16 species

Class Calcarea (3 species)

Leucetta losangelensis (the most common calcareous sponge in the Gulf, and one of the most common sponges in the Eastern Pacific)
Leuconia heathi (a questionable identification of this California species)
Leucosolenia coriacea

Class Demospongiae (13 species)

Aaptos vannamei (a questionable identification of a "black sponge")
Chondrosia reniformis
Cliona californiana (as *C. celata*, and as *C. californiana*)
Geodia mesotriaena (the most commonly encountered sponge of the expedition)
Geodia sp.
Haliclona ecbasis (this species has apparently been reported from the Gulf by no one else)
Hircinia variabilis (questionable identification)
Hymeniacidon sp. (there are 3 species in this genus known from the Gulf: *H. sinapium*, *H. adreissiformis,* and *H. rubiginosa*; the last is known from Puerto Refugio and likely the species Steinbeck and Ricketts found there)
Spirastrella sp. (reported as "a white encrusting sponge"; probably *S. coccinea*, a common Gulf species)
Stelletta clarella (reported as *Steletta estrella*)

Tedania ignis (rossibly *T. nigrescens*)
Tedania "ignis"
Tethya aurantia

Phylum Cnidaria/Coelenterata (sea anemones, corals, hydroids, etc.): 49 species

Subphylum Hydrozoa (6 species)

Aglaophenia diegensis (one of the most common hydroids in the northeastern Pacific)
Aglaophenia longicarpa
Obelia dichotoma (found on the shell of a sea turtle off Point Abreojos, west Baja, as well as intertidally)
Obelia plicata
Plumularia setacea (a wide-ranging hydroid species, Galapagos Islands to British Columbia)
Sertularia versluysi

Subphylum Anthozoa (43 species)

ANEMONES (28 species)

Aiptasiomorpha elongata
Alicia beebei
Andvakia insignis (a burrowing anemone; as *Pachycerianthus insignis*, a junior synonym)
Anthopleura dowii (specimens taken from Puerto San Carlos, Sonora, were described by Carlgren in 1951 as a new species, *Bunodactis mexicana*; however, Daly [2004] showed Carlgren's specimens to have been *Anthopleura dowii*, thus making *B. mexicana* a junior synonym of *A. dowii*; Daly further reckoned that Brusca's (1973, 1980a) records of *Bunodactis mexicana* were actually an undescribed species, which he named *Isoaulactini hespervolita* Daly, 2004)
Anthothoe panamensis
Botruanthus benedeni (burrowing anemone)
Bunodosoma californica
Calamactis praelongus (holotype)
Calliactis polypus (this anemone has been reported worldwide; in the Eastern Pacific, so far as is known, it is found only on the shells of gastropods inhabited by the hermit crab *Dardanus sinistripes*)
Cerianthus sp. (5 cerianthid-like burrowing anemones are currently known from the Sea of Cortez: *Andvakia insignis, Cerianthus vas, Isarachnanthus panamensis, Pachycerianthus aestuari, Botruanthus benedini*)

Epiactis irregularis (holotype)
Epizoanthus californicus (syntypes)
Epizoanthus gabrieli (holotype)
Harenactis sp. (burrowing anemone, family Haloclavidae; this genus has only 2 described species—*H. argentina* and *H. attenuata*—the latter being a Southern California species that is today not known from the Gulf)
Palythoa complanata (holotype; type locality; noted in the Narrative as "In superficial appearance it was identical with…*Zoanthus pulchellus*" of the Caribbean)
Palythoa ignota (syntypes)
Palythoa insignis (syntypes)
Palythoa pazi (syntypes)
Palythoa praelonga (syntypes)
Palythoa rickettsi (holotype and paratypes)
Phialoba steinbecki (syntypes)
Phyllactis bradleyi
Phyllactis concinnata
Phymactis clematis
Telmatactis panamensis
Zoanthus danae
Zoanthus depressus (holotype)
Zoanthus dowi

GORGONIANS (4 species)
Pacificgorgonia adamsi (as *Gorgonia adamsi*; "lacy sea fans")
Leptogorgia alba (as *Lophogorgia alba*, a junior synonym; white gorgonian from the Japanese shrimp trawler)
Leptogorgia rigida
Muricea austera

SEA PENS & SEA WHIPS (3 species)
Pennatula sp. (a sea pen; although not mentioned in the Phyletic Catalogue, Ricketts's field notes and correspondence with E. Deichmann note "*Pennatula* sp., La Paz, under cement wharf"; there are a few reports of *Pennatula phosphorea* from the Pacific, but these might be incorrect identifications as this appears to be an Atlantic species)
Ptilosarcus undulatus (= *Leioptilus undulata*)
Stylatula elongata

CORALS (8 species)
Astrangia pedersenii (solitary coral and one of 11 *Astrangia* species in the Gulf; considered a junior synonym of *A. haimei* by Squires 1959)

Pocillopora capitata (Reyes [1992] considers *P. robusta* and *P. porosa* to be junior synonyms of *P. capitata*; many species of *Pocillopora* have been reported from the Gulf, but their taxonomy and nomenclature are still not well resolved)
Pocillopora capitata capitata (probably a misidentification of *Pocillopora meandrina*)
Pocillopora meandrina
Porites californica (sometimes reported as *P. porosa*, a junior synonym; Steinbeck and Ricketts correctly noted this was the commonest coral on Gulf shores, occurring as dome-shaped encrusting heads 8 inches in diameter)
Porites cf. *nodulosa* (in the Gulf, *P. nodulosa* has been considered to be restricted to the Cabo Pulmo-Cabo San Lucas corridor; Reyes [1991] considered it a synonym of *P. panamensis*)
Porites cf. *porosa* (= *P. panamensis* of most, but not all modern workers; this species is protected by Mexican federal law)
Porites sp. (as "probably *P. porosa*")

Phylum Ctenophora (comb jellies): 1 species

Pleurobranchus areolatus (almost certain a misidentification of *Pleurobranchus digueti*)

Phylum Platyhelminthes, Class Turbellaria (free-living flatworms): 5 species

Latocestus sp. (presumably an undescribed species)
"*Planocera*-like forms"
Stylochoplana plehni (= *Leptoplana californica*)
Stylochus sp. (possibly *S. atentaculatus* described by Hyman in 1953)
Stylochus (?) sp. (possibly *Stylochoplana panamensis*)

Phylum Nemertea (ribbonworms): 1 species

Baseodiscus mexicanus (the largest and most distinctive nemertean in the Gulf, and apparently the only species collected by the expedition)

Phylum Bryozoa/Ectoprocta (moss animals): 14 species

Antillesoma antillarum (as *Physcosoma antillarium*, a junior synonym; a cosmopolitan bryozoan species)
Bugula neretina (one of the most widespread bryozoans in the Gulf; also ranging from central California to Panama)

Cellepora sp. (3 species in this bryozoan genus are known from the Gulf: *C. brunnea, C. minuta, C. quadrispinosa*)
Crisia sp. (this was likely *C. operculata* Robertson, 1910)
Flustra (?) sp. (the genus *Flustra* has been split, and there are now a half-dozen species in other genera that this could have been)
Lagenipora erecta (no species in this genus are known to occur in the Gulf today; many *Lagenipora* have been transferred to other genera in recent years)
Lichenopora sp. (misspelled in Log as "*Lichenspora*," p. 342; there are 3 species of *Lichenopora* in the Gulf: *L. buskiana, L. intricata, L. novaezelandiae*)
Membranipora tuberculata (a common bryozoan ranging from California to Peru)
Membranipora sp. (4 species of *Membranipora* are known from the Gulf today: *M. tuberculata, M. tenuis, M. savarti, M. arborescens*)
Porella sp. (2 species of *Porella* are known from the Gulf: *P. rogickae, P. porifera*; if the identification was by R. S. Bassler, it is likely the correct genus identification)
Scrupocellaria diegensis (there seems to be no subsequent record of this California species from the Gulf; 4 other species in this genus are known from the Gulf, and the expedition's specimen was likely one of these: *S. bertholetti, S. mexicana, S. scruposa, S. varians*)
Scrupocellaria sp. (4 species in this genus are known from the Gulf: *S. bertholetti, S. mexicana, S. scruposa, S. varians*)
Stylopoma spongites (a tropical West Atlantic species; presence in Gulf needs confirmation)
Thalamoporella californica (a well-known California bryozoan ranging south to Colombia and the Galapagos Islands)

Phylum Sipuncula (peanut worms are now widely regarded as highly modified annelids): 10 species

Antillesoma antillarum (as *Physcosoma antillarium Themiste hennahi*; = *Dendrostoma lissum*, a junior synonym) (holotype)
Apionsoma (Edmondsius) pectinatum (described by Fisher as *Siphonides rickettsi*, a junior synonym) (holotype)
Apionsoma misakianum (as *Golfingia hespera and Phascolosoma hesperum*, junior synonyms)
Phascolosoma agassizii (as *Physcosoma agassizii*, a junior synonym)
Phascolosoma dentigrerum
Phascolosoma elachum (holotype)

Phascolosoma hesperum (commensal in *Cerianthus* tubes)
Phascolosoma sp. (the "small *P. agassizii*")
Phascolosoma sp., cf. *P. gouldii* (Ricketts speculated this was an undescribed species, but it may have been one of the other 3 species of *Phascolosoma* now known from the Gulf: *P. nigrescens, P. perlucens*, or *P. agassizii*, or even some other genus)
Sipunculus nudus

Phylum Echiura (spoon worms are now regarded as highly modified annelids): 2 species

Ochetostoma edax (types; endemic to the Sea of Cortez)
Thalassema steinbecki (holotype)

Phylum Annelida, Polychaeta (free-living segmented worms): 53 species

Acromegalomma circumspectum (identification made by Gómez and Tovar-Hernández 2008; possibly the same specimens reported by Steinbeck and Ricketts as *Megalomma mushaensis*, below)
Acromegalomma mushaensis (as *Megalomma mushaensis*; a nearly circumtropical sabellid polychaete)
Acromegalomma quadrioculatum (as *Megalomma quadrioculatum,* but possibly a misidentification of *Acromegalomma circumspectum*)
Amblyosyllis sp. (= *Pterosyllis* according to Steinbeck and Ricketts; there are about 4 dozen species of syllid polychaetes known from the Gulf, only one of which is in this genus, *A. granosa*)
Anaitides madeirensis
Armandia sp. (2 species of polychaetes in this genus are known from the Gulf: *A. brevis* and *A. intermedia*)
Bhawania riveti (described as "a *Phyllodoce*-like form"; this species has apparently not been reported since the expedition, but another species, *B. goodei*, has been reported from the Gulf)
Ceratonereis tentaculata
Chloeia viridis (the 3-stripe fire worm; a stinging polychaete and fairly common tropical East Pacific species)
Cirriformia spirabranchus (a well-known, tube-building cirratulid polychaete)
Dasybranchus caducus (a Caribbean species thought to also occur in the Gulf)

Dorvillea cerasina (as *Stauronereis cerasina*; one of 6 *Dorvillea* species known from the Gulf)
Eudistoma sp. (Steinbeck and Ricketts speculated that this might be an undescribed species; 2 *Eudistoma* species are currently known from the Gulf, *E. mexicanum* and *E. psammion*)
Eulalia myriacyclum (long, green, sand flat polychaete)
Eunice afra (a single specimen of this Gulf endemic polychaete was taken on the expedition)
Eunice antennata (a wide-ranging polychaete occurring from Southern California to Ecuador)
Eunice aphroditois
Eunice filamentosa (a Gulf endemic)
Eunice schemacephala (this is a tropical West Atlantic species and may have been a misidentification; there are 2 dozen species of *Eunice* known from the Gulf today)
Eunice sp. (there are about 2 dozen species of *Eunice* known from the Gulf today)
Eupomatus sp. (there are 3 species of *Eupomatus* known from the Gulf today: *E. brachyacantha, E. recurvispina, E. uncinatus*)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Eusigalion lewisii (a polychaete of uncertain identification; nothing with this name is known today from the Sea of Cortez)
Glycera dibranchiata (a well-known polychaete ranging from San Francisco Bay to the Gulf)
Halosydna glabra (a scale worm described the year before the expedition)
Idanthyrsus pennatus (a circumtropical terebellid polychaete)
Iphione ovata (a tropical scale worm)
Lepidonotus hupferi
Maldanidae (bamboo worms; about a dozen species of maldanids occur in the Gulf)
Marphysa aenea
Neanthes sp. (taken by night-lighting; 5 species of *Neanthes* are known from the Gulf: *N. caudate, N. cortezi, N. micromma, N. pelagica, N. succinea*)
Notopygos ornata (Gulf "small fire worm")
Odontosyllis sp. (there are 4 species of *Odontosyllis* known from the Gulf: *O. heterodonta, O. phosphorea, O. polycera, O. undecimdonta*)
Oenone fulgida (as *Aglaurides fulgida*; a Tropical East Pacific polychaete)
Ophiodromus pugettensis (as *Podarke pugettensis*; Steinbeck and Ricketts found it only in the ambulacral groove of *Oreaster*

occidentalis, but it is known to be a symbiont in several Gulf sea stars)
Owenia fusiformis (a circumtropical polychaete species)
Palola siciliensis (a nearly circumtropical polychaete species)
Perineris sp., epitokous stage (taken by night-lighting; there are no known polychaetes of this genus known in the Gulf today; given that the specimens were epitokes, the identification could easily have been incorrect)
Pista elongata (a Tropical East Pacific terebellid polychaete)
Platynereis agassizi, epitokous ("heteronereids" taken by night-lighting; likely a misidentification of one of the 3 species of *Platynereis* known from the Gulf today: *P. bicanaliculata, P. dumerilii, P. polyscalma*)
Platynereis polyscalma ("epitokous or heteronereids forms" taken by night-lighting; a well-known nereid polychaete ranging from the Central Gulf to Ecuador)
Polydora sp. (perhaps *P. citron* or *P. websteri*, both described by Olga Hartman in the mid-1940s)
Polyodontes oculea (scale worm, in a *Cerianthus*-like tube)
Protula tubularia (a poorly known serpulid polychaete)
Salmacina tribranchiata (as *S. dysteri*, see Bastida-Zavala et al. [2016]; tube worms with rusty red gills)
Scolelepis sp. (an unidentified spionid polychaete)
Spirobranchus incrassatus (spiral-gilled, calcareous tube worm)
"*Spirorbis* tubes" (about 15 species of Spirorbidae are known from the Gulf today)
Stylarioides capulata (this Southern California species has apparently not been reported from the Gulf since the Steinbeck-Ricketts expedition)
Stylarioides papillata (possibly *Pherusa papillata*, a Southern Gulf flabelligerid polychaete)
Thelepus setosus (a circumtropical terebellid polychaete)
Thormora johnstoni (a widely distributed East Pacific scale worm)
Travasia gigas (a well-known California-Gulf polychaete)

Phylum Echinodermata (sea stars, urchins, sea cucumbers, etc.): 64 species

Class Asteroidea (15 species)
Acanthaster ellisii (the Eastern Pacific crown-of-thorns)
Astrometis sertulifera
Astropecten armatus (a very common sand sea star in the Gulf, but collected only once on the expedition)
Echinaster tenuispina (= *Othilia tenuispina*)

Heliaster kubiniji (the Gulf sun star; second most ubiquitous animal on the expedition; suffering from a "wasting disease" beginning in 1978, from which it never fully recovered, this sea star is rare in the Gulf today)
Heliaster sp.
Henricia sp. (5 species in this genus are known from the Gulf today: *H. aspera, H. asthenactis, H. clarki, H. gracilis, H. polyacantha*)
Leiaster teres
Linckia columbiae
Luidia phragma (a very common subtidal species taken by the expedition only at Bahía Concepción, from 7 fathoms, in "crab nets")
Mithrodia bradleyi
Nidorellia armata
Pentaceraster cumingi (as *Oreaster occidentalis,* a junior synonym)
Pharia pyramidalis
Phataria unifascialis

Class Ophiuroidea (12 species)
Amphipholis elevata (a rarely collected, littoral-to-73-m-deep, long-armed sand bottom brittle star)
Ophiactis savignyi (a common Tropical East Pacific 6-armed brittle star)
Ophiactis simplex (the small, 5- or 6-armed brittle star)
Ophiocnida hispida (an East Pacific tropical, bristly, long-armed brittle star)
Ophiocoma aethiops
Ophiocoma alexandri
Ophioderma panamense
Ophioderma teres
Ophionereis annulata
Ophiophragmus marginatus (a sand-burrowing, long-armed brittle star; had not been reported since Lütken's original description from Nicaragua, a century earlier)
Ophiothrix rudis
Ophiothrix spiculata

Class Echinoidea (15 species)
Agassizia scrobiculata (a heart urchin)
Arbacia incisa (the common, sharp-spined purple urchin; *Arbacia stellata* by some workers—the name is in dispute)
Astropyga pulvinata (taken only at Bahía Concepción, with a crab net baited with fish guts)

Centrostephanus coronatus
Clypeaster rotundus
Diadema mexicanum (= *Centrechinus mexicanus*; curiously, the expedition collected this very common, toxic-spined species only twice, at Punta Lobos and at Marcial Point)
Echinometra vanbrunti
Encope grandis
Encope micropora (= *E. californica*, a junior synonym)
Eucidaris thouarsii
Lovenia cordiformis (a heart urchin)
Mellita longifissa
Meoma grandis (a heart urchin)
Metalia nobilis (as *M. spatagus*; a small and uncommon heart urchin ranging from the Upper Gulf to Panama)
Tripneustes gratilla (as *Tripneustes depressus*; a trans-Pacific species)

Class Holothuroidea (22 species)
Afrocucumis ovulum (as *Euthyonidiuim ovulum*; an uncommon species known only from the Central and Southern Gulf, south to Peru)
Chiridota aponocrita (a small synaptid cucumber)
Chiridota sp. (not in Phyletic Catalogue, but identified by E. Deichmann; there are only 2 valid species of *Chiridota* known from the Gulf today, *C. aponocrita* and *C. rigida*)
Epitomapta tobogae (as *Leptosynapta* sp.)
Euapta godeffroyi (a large, conspicuous, synaptid cucumber; surprisingly taken at only 2 localities)
Holothuria arenicola (a circumtropical species common in the Gulf)
Holothuria difficilis (a circumtropical species)
Holothuria impatiens (a circumtropical species; the second most common sea cucumber of the expedition)
Holothuria inhabilis (a flat, sand-encrusted, trans-Pacific species; found only once)
Holothuria kefersteini
Holothuria languens
Holothuria lubrica (= *Slenkothuria lubrica*; the sulfur cucumber; the most common sea cucumber taken during the expedition, and the most common littoral cucumber in the Sea of Cortez today). Ricketts's field notes state, "one fact increasingly emerges; the green and black cucumber (*C. lubrica*) is the most ubiquitous Gulf of California shore animal, and *Heliaster* runs it a close second." One specimen of

Holothuria lubrica from the expedition had a commensal pearl fish living in it, *Encheliophiops hancocki* Reid.
Holothuria paraprinceps
Holothuria rigida (a circumtropical cucumber)
Isostichopus fuscus
Neocucumis veleronis (as *Euthyonidium veleronis*; found only once)
Neothyone gibbosa
Paracaudina chilensis Müller, 1850 (a smooth, white, burrowing cucumber resembling a sipunculan; found only once). The taxonomic nature of this "cosmopolitan" species is unclear and the Gulf specimens could be an undescribed species. Not included in the Solís-Marín et al. (2009) monograph of Gulf holothurians.
Pentamera chierchia (found only once)
Pseudocnus californicus (as *Cucumaria californica*; found only once)
Stichopus jusus (not in Phyletic Catalogue, but identified by E. Deichmann; the nature of this species name is unclear)
Thyone parafusus (taken only at this locality)

Phylum Arthropoda, subphylum Crustacea (crabs and their kin): 152 species

Class Copepoda (1 species)

Gastrodelphys dalesi (a symbiont with the sabellid polychaete *Acromegalomma circumspectum*; discovered by Gómez and Tovar-Hernández 2008)

Class Thecostraca, Subclass Cirripedia (barnacles and their kin) (11 species)

Balanus fissus
Balanus improvisus
Balanus inexpectatus (as *Balanus amphitrite inexpectatus*)
Balanus trigonus
Chelonibia patula dentata (type specimen) (incorrectly stated in Phyletic Catalogue as being from "Agiabampo Bay"; actually from the cheliped of the swimming crab, *Callinectes bellicosus*, from Estero de la Luna, Sonora; identified by Dora Henry as a new subspecies and described by her)
Chthamalus anisopoma
Megabalanus californicus (as *Balanus tintinabulum californicus*)
Megabalanus peninsularis (as *Balanus tintinabulum peninsularis*)
Paraconcavus mexicanus (as *Balanus concavus*)

Tetraclita rubescens (as *Tetraclita squamosa*)
Tetraclita stalactifera (as *Tetraclita squamosa stalactifera*)

Class Malacostraca, Subclass Hoplocarida (mantis shrimps) (3 species)

Neogonodactylus stanschi (as *Gonodactylus stanschi*)
Neogonodactylus zacae (as *Gonodactylus oerstedii*, which is actually a West Atlantic species; the specimens were re-examined by Ray Manning in 1972 and described as the new species *Gonodactylus zacae*, later moved to *Neogonodactylus*)
Pseudosquilla lessonii (larvae taken by night-lighting; questionable identification)

Class Malacostraca, Subclass Eumalacostraca (crabs, shrimps, amphipods, isopods, etc.) (137 species)

BRACHIURANS ("true" crabs) (55 species)

Ala cornuta (as *Anaptychus cornutus*, a junior synonym)
Callinectes bellicosus (the pugnacious blue swimming crab; Steinbeck and Ricketts noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case)
Cataleptodius occidentalis (as *Leptodius occidentalis*, a junior synonym; one of the most common and abundant small crabs in the Gulf)
Daira americana
Dissodactylus nitidus (one of several species of small pea crabs, Pinnotheridae, commensal on sand dollars in the Tropical East Pacific)
Dissodactylus xantusi (one of several species of small pea crabs, Pinnotheridae, commensal on sand dollars in the Tropical East Pacific)
Domecia hispida (as *Eriphides hispida*, a junior synonym of this circumtropical coral-inhabiting crab)
Epialtus minimus
Epixanthus tenuidactylus (as *Ozius tenuidactylos*, a junior synonym)
Eriphia squamata ("old lumpy claws"; a very common, small, pugnacious xanthid crab ranging from the Upper Gulf to Peru)
Eucinetops lucasi
Eucinetops panamensis
Eurypanopeus planissimus

Geograpsus stormi (as *Geograpsus lividus*, a junior synonym; circumtropical)

Geotice americanus (Steinbeck and Ricketts initially misidentified this species as *Hemigrapsus oregonensis*; S. Glassell presumably made the correction)

Glyptoxanthus meandricus (a spectacularly sculptured xanthid crab, once common but now becoming scarce)

Goniopsis pulchra

Gonopanope areolata (as *Micropanope areolata*, a junior synonym)

Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)

Hepatus kossmanni (a gift to Ricketts from Captain Corona of Guaymas, who operated a fleet of shrimp trawlers; formerly a common species in shrimp net bycatch, now rare due to decades of bottom trawling)

Heteractaea lunata (an uncommon xanthid crab in the Gulf)

Hypoconcha panamensis (collected in "crab net on bottom at night, 7 fathoms"; this crab normally carries a clam shell over its carapace)

Litopenaeus stylirostris (as *Penaeus stylirostris*; found dead on sand flats; probably washed up from a local shrimp boat)

Microphrys platysoma

Mithraculus denticulatus (as *Mithrax areolatus*, a junior synonym)

Moreiradromia sarraburei (as *Dromidia larraburei*, a junior synonym; pelagic larvae collected by night-lighting)

Ocypode occidentalis

Ozius tenuidactylus

Pachygrapsus crassipes (one of the most common invertebrates of the temperate NW Pacific coast, but probably always rare in the Gulf; a temperate disjunct species ranging from the Pacific Northwest to Magdalena Bay [SW Baja], reappearing in the Northern and Central Gulf). The last reliable records in the Gulf seem to be from the late 1960s, and it might be that sea surface temps are now too warm for this species to survive in the Sea of Cortez. Also reported from Japan and Korea. Randall's original type locality of Hawaii was almost certainly an error.

Pachygrapsus socius (as *Pachygrapsus transversus*, an Atlantic species)

Panopeus bermudensis (in 1941, this species was thought to be distributed in the Caribbean and Tropical East Pacific; however, the "panopeid" crabs are a taxonomic mess and the actual identity of the expedition's Sea of Cortez species is

unclear; there are ~2 dozen described panopeid crabs usually recognized from the Gulf, but this is not one of them)
Parapinnixa nitida (a small pea crab, Pinnotheridae, that might be endemic to the Gulf; collected by night-lighting)
Percnon gibbesi
Pilumnoides sp. (juvenile; there is only one species in this genus reported from the Sea of Cortez today, *P. rotundus*, described in 1940 and rare in the Gulf)
Pilumnus gonzalensis
Pilumnus pygmaeus
Pilumnus townsendi
Pinnixa transversalis (a common Tropical East Pacific pea crab, Pinnotheridae; collected from a "sandy-tubed worm on a sand flat" at Bahía de los Ángeles)
Pinnotheres sp. (an unidentified Pinnotheridae)
Pitho picteti
Pitho sexdentata
Platypodiella rotundata (as *Platypodia rotundata*)
Podochela latimanus
Polyonyx quadriungulatus (typically commensal in the tubes of chaetopterid polychaetes, but found "free living" at El Mogote)
Portunus xantusii affinis (as *Portunus pichilinquei*, a junior synonym of this subspecies)
Portunus xantusii minimus (as *Portunus minumus*, a species that has been sunk into *P. xantusii*; captured by night-lighting)
Sesarma sulcatum
Stenorhynchus debilis (the common Gulf arrow crab)
Teleophrys cristulipes
Thoe sulcataTrapezia bidentata (as *Trapezia cymodoce ferruginea*, a junior synonym)
Trapezia digitalis
Trapezia sp. (perhaps *T. digitalis*)
Uca crenulata (Steinbeck and Ricketts felt this was the only species of *Uca* they collected on the expedition; however, that is unlikely; the taxonomy of this genus is desperately in need of revision and some species are difficult to differentiate)
Xanthodius cooksoni (as *Leptodius cooksoni*, a junior synonym)
Xanthodius sternberghii (as *Xanthodius hebes*, a junior synonym)

ANOMURANS (porcelain crabs, hermit crabs, ghost shrimps, lobsters, etc.) (35 species)
Albunea lucasii (sand crab; noted as *Emerita* sp. in *Sea of Cortez*)
Calcinus californiensis
Callianassa sp. cf. *C. uncinata* and *C. rochei*

Clibanarius digueti (the blue-spotted hermit crab; perhaps the most common hermit in the Gulf)
Clibanarius panamensis
Dardanus sinistripes
Emerita rathbunae (a sand crab)
Megalobrachium sinuimanus (as *Pisonella sinuimanus*)
Megalobrachium tuberculipes (as *Pisonella tuberculipes*; an uncommon Tropical East Pacific porcelain crab)
Neaxius vivesi (as *Axius vivesi*; a common species throughout the Gulf, but the expedition took it only at one site)
Pachycheles biocellatus (formerly *Petrolisthes biocellatus*)
Pachycheles panamensis (formerly *Pachycheles sonorensis*)
Pachycheles setimanus (formerly *Petrolisthes setimanus*)
Pachycheles sp. (6 species of *Pachycheles* are known from the Gulf today)
Paguristes digueti (a subtidal, tropical hermit crab "taken in crab nets set at night in 7 fathoms" in Bahía Concepción)
Pagurus albus
Pagurus benedicti
Pagurus lepidus
Panulirus inflatus
Panulirus interruptus
Petrochirus californiensis (the passive "gentle giant"; the largest hermit crab in the Gulf)
Petrolisthes armatus (one of the most common porcelain crabs in the Gulf; likely this species was at every rocky shore they visited, even though they reported it only twice)
Petrolisthes edwardsii
Petrolisthes gracilis (one of the most common porcelain crabs in the Gulf; likely this species was at every rocky shore they visited, even though they reported it only 4 times)
Petrolisthes hians (as *Pisosoma flagraciliata*, a junior synonym)
Petrolisthes hirtipes (a very common porcelain crab in the Gulf)
Petrolisthes hirtispinosus (a common porcelain crab in the Gulf)
Petrolisthes lewisi (as *Pisosoma lewisi*)
Petrolisthes nigrunguiculatus (a common porcelain crab in the Gulf)
Petrolisthes sp.
Pleuroncodes planipes (the pelagic red lobsterette)
Porcellana cancrisocialis (typically found on the shells of the hermit crabs *Petrochirus californiensis* and *Dardanus sinistripes*)
Porcellana paguriconviva
Upogebia thistlei (a ghost shrimp)

Upogebia sp. (there are 8 species of mud/ghost shrimp in this genus in the Gulf, but they are difficult to distinguish and often confused with species of other Gulf thalassinidean shrimps, such as *Pomatogebia*, *Neotrypaea*, *Naushonia*, *Callianidea*, and *Biffarius*)

ISOPODS (13 species)

Cirolana nielbrucei (as *Cirolana harfordi; C. harfordi* is a temperate isopod species that is rare in the Gulf; the Steinbeck-Ricketts specimens [from USNM] were described as *Cirolana neilbrucei* by Brusca, Wetzer, and France in 1995)

"*Dynamella*" sp. (presumably a misspelling of *Dynamenella*, an isopod genus known from California shores, and not from the Sea of Cortez; however, it is more likely the specimens were *Dynoides*, *Paracerceis*, or *Paradella*)

Eurydice caudata (a wide-ranging isopod known from central California to Ecuador; the expedition took these specimens by night-lighting)

Excorallana tricornis (misspelled as *Exocorallana*; there are 5 species of *Excorallana* in the Gulf, 3 that were named and described only recently, so the accuracy of this identification is questionable; further, J. O. Maloney was not known to be the best crustacean taxonomist working at the time)

Exosphaeroma yucatanum (almost certainly a misidentification of some other sphaeromatid isopod; *E. yucatanum* is a West Atlantic species)

Ligia exotica (as *Ligyda exotica*)

Ligia occidentalis

Ligia sp. (probably *Ligia occidentalis*)

Mesanthura sp. (almost certainly the very common *M. occidentalis*)

Paracerceis gilliana (from Isla San Marcos; almost certainly a mistaken identification as *P. gilliana* is a Californian species; 3 species in this genus occur in the Gulf: *P. richardsoni*, *P. sculpta*, *P. spinulosa*)

Paracerceis sp. (3 species in this genus occur in the Gulf: *P. richardsoni*, *P. sculpta*, *P. spinulosa*)

Paranthura longitelson (as *Paranthura* sp. in Phyletic Catalogue; collected by night-lighting)

Rocinela signata (reported as *Rocinella aries*, a misspelling of the junior synonym)

Ampithoe plumulosa (broadly distributed in the east Pacific: Canada to Ecuador)
Ampithoe ramondi (a circumtropical species)
Ampithoe sp.
Aruga dissimilis (a Southern California species)
Aruga sp. (only one species in this genus is known from the Gulf today, *A. holmesi*)
Bemlos macromanus (a Tropical East Pacific amphipod, ranging from the Gulf to the Galapagos)
Caprella aequilibra (a caprellid amphipod, in an "*Obelia* colony")
Elasmopus pocillimanus (a cosmopolitan amphipod; not reported otherwise in the Gulf)
Elasmopus sp. (possibly the same species as *E. pocillimanus*)
Ericthkonius brasiliensis (in an "*Obelia* colony")
Hyale hawaiensis (probably an incorrect identification; likely one of the amphipod species named by J. L. Barnard in 1979—e.g., *H. californica, H. guasave, H. yaqui, H. zuaque*)
Parajassa sp. (in an "*Obelia* colony")
Pontharpinia sp.
Pontogeneia sp. (in an "*Obelia* colony")

EUPHAUSIDS (1 species)
Nyctiphanes simplex (a widespread Eastern Pacific euphausid/krill; one of the primary food items of baleen whales in the Gulf)

MYSIDS (3 species)
Archeomysis cf. *maculata*
Mysidium rickettsi (as *Mysidopsis* sp.; not described until 1987, when Harrison and Bowman came across the specimen in the USNM collections where the type material is housed today)
Siriella pacifica

CUMACEANS (1 species)
Cumella sp. (taken only once, at Bahía Concepción)

SHRIMPS (15 species)
Alpheus lottini (as *Crangon ventrosus*, a tropical trans-Pacific snapping shrimp)
Alpheus wonkimi (as *Crangon [=Alpheus] malleator*, a snapping shrimp)
Crangon sp. No. 1 (likely an unknown species of caridean shrimp, but not a *Crangon*; many shrimps identified as *Crangon* by Steinbeck and Ricketts proved to be alphaeid shrimps)

Crangon sp. No. 2 (likely an unknown species of caridean shrimp, but not a *Crangon*; many shrimps identified as *Crangon* by Steinbeck and Ricketts proved to be alphaeid shrimps)
Crangon sp. No. 3 (likely an unknown species of caridean shrimp, but not a *Crangon*; many shrimps identified as *Crangon* by Steinbeck and Ricketts proved to be alphaeid shrimps)
Farfantepenaeus californiensis
Macrobrachium jamaicense (an amphi-American freshwater shrimp; source of specimen unknown)
Palaemon ritteri
Pontonia pinnae (a symbiont in the hatchet clam, *Pinna rugosa*)
Sicyonia penicillata (an offshore, deeper-water penaeid shrimp)
Synalpheus digueti
Synalpheus sanjosei
Synalpheus sanlucasi
Synalpheus townsendi
Synalpheus sp.

Phylum Mollusca (clams, snails, cephalopods, etc.): 176 species

<u>Class Polyplacophora (15 species)</u>
Acanthochitona exquisita
Acanthochitona sp.
Americhiton arragonites (as *Acanthochitona arragonites* in Phyletic Catalogue)
Callistochiton elenensis (as *Callistochiton infortunatus*, a junior synonym)
Callistochiton sp. (3 species of *Callistochiton* are known from the Gulf today: *C. colimensis, C. elenensis, C. palmulatus*)
Chaetopleura limaciformis
Chaetopleura aff. *lurida* (the “small, hairy chiton” of the Log; Central Gulf to Colombia)
Chiton virgulatus
Ischnochiton tridentatus
Lepidozona clathrata (as *Ischnochiton clathratus*, a junior synonym, in Phyletic Catalogue)
“Minute *Mopalia*-like form”
Nuttallina sp. cf. *allantophora* (*N. allantophora* is now a junior synonym of *Liolophura japonica*, a far-west Pacific species; it is probable that the expedition’s specimen was *Nuttallina crossota* Berry, 1956, the only species in this genus known from the Gulf today)
Stenoplax limaciformis (as *Ischnochiton limaciformis* in Phyletic Catalogue)

Stenoplax sonorana (as *Ischnochiton conspicuus*, a misspelling of the junior synonym, in Phyletic Catalogue)
Stenoplax sp. (7 species of *Stenoplax* are known from the Gulf today)

Class Scaphopoda (2 species)

Graptacme semipolitum (as *Dentalium semipolitum*, a junior synonym; the "striated" tusk shell from El Mogote)
Laevidentalium splendidum (as *Dentalium semipolitum*, a junior synonym; the "smooth" tusk shell from El Mogote)

Class Bivalvia (43 species)
Anadara multicostata (as *Arca multicostata*, a junior synonym)
Anadara tuberculosa (as *Arca tuberculosa*, a junior synonym)
Anomalocardia subrugosa
Anomia peruviana (known in Mexico as *papas fritas*, or the Peruvian jingle, this is the only species in the genus that occurs in the Gulf; cited as a "rock oyster" in the Narrative. Surprisingly, this is the only record of this very common species from the expedition. The Seri people make necklaces from these beautiful and delicate shells)
Arca mutabilis (as *Navicula mutabilis*, a junior synonym)
Arca pacifica (as *Navicula pacifica*, a junior synonym)
Arcopsis solida (as *Fossularca solida*, a junior synonym; the common "garbanzo clam" of the Gulf)
Atrina tuberculosa (the less common of two pen shells called *callo de hacha*, the other being *Pinna rugosa*)
Barbatia reeveana (the hairy ribbed mussel; one of the commoner Gulf arc shells)
Brachidontes semilaevis (as *Brachidontes multiformis*, a junior synonym)
Carditamera affinis (as *Carditamera affinis californica*; Steinbeck and Ricketts considered this "the commonest bivalve in the Gulf"; also common in shell middens in the Northern Gulf)
Chama echinata (as *Chama squamuligera*; Coan and Valentich-Scott [2012] consider *C. squamuligera* to be a white morph of *C. echinata*)
?*Chama frondosa* (as *Chama mexicana* Carpenter; noted as a species of *Spondylus* in the Narrative)
Chione californiensis (as *Chione succincta*, a junior synonym; one of the most common bivalves in the Gulf)
Chione sp.
Diplodonta subquadrata (as *Taras subquadrata*, a junior synonym)

Divalinga eburnea (as *Divaricella eburnea*, a junior synonym; Steinbeck and Ricketts described their specimen as "pearly-white" and ranging from Cape San Lucas to Panama; but this species has pale brown stripes and ranges throughout the Gulf to Peru and the Galapagos Islands; perhaps their specimen was an old, worn shell, or this is a misidentification)
Dosinia dunkeri
Felaniella cornea (as *Felaniella sericata*, a junior synonym)
Fugleria illota (the "triangular *Arca*" of the Log)
Glovibenus fordii (as *Anomalocaridia subrugosa*, a junior synonym)
Gregariella coarctata (misidentified as *Botulina opifex*, a West Atlantic species)
Isognomon janus (as *I. anomioides*, a junior synonym; a thin rock oyster)
Isognomon recognitus (as *I. chemnitziana* d'Orbigny, a junior synonym)
Leukoma grata (as *Protothaca grata*, a junior synonym)
Lithophaga aristata
Lithophaga plumula ("or similar"—a boring clam)
Macoma indentata (initially identified by H. Rehder as an undescribed species he intended to name *M. rickettsi*)
Megapitaria aurantiaca (as *Macrocallista aurantiaca*, a junior synonym; one of two species known as "chocolata clam," or "almeja chocolata," in Mexico)
Megapitaria squalida (as *Macrocallista squalida*, a junior synonym; one of two species called "chocolata clam," or "almeja chocolata," in the Gulf)
Modiolus capax (as *Volsella capax*, the bearded mussel; *Volsella* is a junior synonym of *Modiolus*)
Ostrea sp. (there are 7 true oysters [Ostreidae] in the Gulf, the most "*Chama*-like" being *Ostrea conchaphila*)
"*Paphia*-like form" (probably a misidentification; there are no *Paphia* known to occur in the Gulf)
Periglypta multicostata (the "*Chione*-like form, 90 mm" in the Narrative)
Pinctada mazatlanica (the Panamic pearl oyster; surprisingly, this species was collected at only one site)
Pinna rugosa (the principal commercial Gulf hacha)
?*Ptera sterna* (as *Pinctada fimbriata* Dunker 1852; a likely misidentification; the "clam-like hacha" of the Narrative)
Saccostrea palmula (as *Ostrea cumingiana* Dunker 1846, and *O. mexicana*, both junior synonyms of *S. palmula*; a fairly common edible oyster found throughout the Gulf, and also common in Northern Gulf aboriginal shell middens)

Semele corrugata (the "unribbed *Paphia*-like form" in the Narrative; this species is not known to occur north of South America, and this is likely a misidentification of one of the other 21 species of *Semele* that do occur in the Gulf)
Spondylus princeps (reported as "*Spondlyus* [*sic*] sp. probably *limbatus* Sowerby"; *S. limbatus* is a junior synonym of *S. princeps*, the most common spiny oyster in the Gulf; surprisingly, this common species was collected only once in the Gulf)
Tagelus affinis
Tivela planulata
Trachycardium procerum

<u>Class Gastropoda (111 species)</u>

SHELLED GASTROPODS (90 species)

Acanthais triangularis (as *Thais triangularis*, a junior synonym)
Acanthina lugubris
Bulla gouldiana (reported from Puerto Escondido as the "undetermined bubble shell"; there are 3 species of bubble shells known from the Gulf today)
Callopoma fluctuosum (possibly a junior synonym of *Tegula brunnea* or *Chlorostoma brunneum fluctuosum*)
Cerithideopsis californica (as *Cerithidea mazatlanica*, a junior synonym; I disagree with the synonymy of *C. mazatlanica* and *C. californica*, as the two seem easy to distinguish from one another)
Cerithium maculosum (it is a mystery why the only tidal flat site at which Steinbeck and Ricketts collected this species was Puerto San Carlos, Sonora; this snail is very abundant on tidal flats throughout the Gulf, and they should have also collected it in the La Paz area, at Puerto Escondido's inner bay, in Bahía Concepción, in San Carlos Bay, Baja, on the tidal flats at Bahía de los Ángeles, and at Esteros Agiabampo and de la Luna)
Chicoreus erythrostomus (= *Phyllonotus bicolor, = Hexaplex erythrostomus*; pink murex; shells only, on beach at Bahía Concepción). Hedgpeth's (1978b) comment in a footnote that these large murexes "may be taken by the bushel in [shrimp] trawl hauls as far north as Puerto Peñasco" is telling. This was the case for many years, but by the 1990s they had been so decimated by trawlers, divers, and shore collectors that they were beginning to be scarce, and today they are rare on the coast of Sonora.

Columbella fuscata
Conus brunneus
Conus nux
Conus princeps
Coralliophila californica
Coralliophila costata
Coralliophila monodonta (as *Galeropsis madreporarum*, a junior synonym; Steinbeck and Ricketts were uncertain of this identification of the Puerto Lobos specimens)
Costoanachis coronata (as *Anachis coronata*)
Crassispira (*Monilispira*) *monilifera* (as *Monilispira monilifera*)
Crepidula incurva
Crepidula onyx (a slipper shell)
Crepidula striolata (as *Crepidula squama*, a junior synonym)
Crucibulum scutellatum (as *Crucibulum imbricatum*, a junior synonym)
Crucibulum spinosum
Diodora alta (misspelled in Phyletic Catalogue as “*Diadora*”)
Diodora inaequalis (misspelled as “*inequalis*” in Phyletic Catalogue)
Echinolittorina aspera (as *Littorina philippi*, a junior synonym)
Echinolittorina modesta (as *Nodilittorina modesta*)
Enaeta cumingii
Engina ferruginosa Reeve (the identity of this species is unclear, but it is likely what we now call *Morula nodulosa* or *Morula ferruginosa*)
Eualetes centiquadra, “or another vermetid snail”
Fissurella rugosa
Fusinus dupetitthouarsi (this is an offshore species that is frequently captured, and killed, by shrimp trawlers)
Heliacus bicanaliculatus (as *Heliacus radiatus*, a junior synonym)
Hexaplex brassica (as *Phyllonotus brassica*, a junior synonym; the cabbage murex)
Hexaplex princeps (as *Phyllonotus princeps*, a junior synonym)
Hipponix antiquatus
Liocerithium judithae (as *Cerithium sculptum*, a junior synonym; the “mid-tide minute spired snail” of the Narrative; one of the most common small snails in the Gulf)
Lottia atrata (as *Acmaea atrata*, a junior synonym)
Lottia dalliana (as *Acmaea daliana*, a junior synonym)
Lottia discors (as *Acmaea discors*, a junior synonym)
“*Lottia gigantea*” (almost certainly a misidentification; this is a western Baja/California temperate species)
Lottia mesoleuca (as *Acmaea mesoleuca*, a junior synonym)
Lottia pediculus (as *Acmaea pediculus*, a junior synonym)

Lottia strigatella (as *Acmaea strigatella*, a junior synonym)
Mancinella tuberculata (as *Thais tuberculata* and *Neorapana tuberculata*)
Melampus olivaceous (an intertidal pulmonate)
Melongena patula
Migtra tristis (as *Strigatella dolorosa*, a junior synonym)
Mitrella densilineata (as *Nitidella densilineata*, a junior synonym)
Mitrella guttata (as *Nitidella guttata*, a junior synonym; this species, one of the most common small snails in the Gulf, is considered a synonym of *Mitrella/Columbella ocellata* by some workers, but the latter is a trans-Atlantic species)
Mitrella santabarbarensis (as *Anachis reevei*, a junior synonym)
Murex rectirostris (likely a misidentification of *Murex elenensis* of *M. recurvirostris*)
Muricopsis armatus (as *Muricopsis squamulata*, a junior synonym)
Naria albuginnosa (= *Cypraea albuginosa*)
Nassarius iodes (as *Nassarius ioaedes*)
Nassarius luteostomus
Nassarius tiarula (as *Nassarius tegula*, a junior synonym)
Natica chemnitzii (the "variegated *Polinices*-like form" of the Log)
Neverita reclusiana (as *Polinices reclusianus*, a junior synonym of *Polinices reclusiana*, misspelled in the Log)
Nodilittorina modesta
Oliva venulata
Olivella dama (as *Oliva dama*)
Ovulidae (there are 7 ovulid species known from the Gulf today)
Parametaria epamella (as *Parametaria coniformis*, a junior synonym; originally described as *Columbella epamella*)
Phyllonotus erythrostomus (as *Phyllonotus bicolor*, a junior synonym; the pink-mouth murex; Steinbeck and Ricketts found this to be the most common large snail of their expedition—indeed, it was once the most common littoral and shallow subtidal large snail throughout the Gulf, but no longer, due to intense over-collecting; large specimens are now exceedingly rare intertidally)
Pleuroploca princeps (as *Fasciolaria princeps*, a junior synonym)
Plicopurpura patula (as *Purpura patula*, a junior synonym, as is *Purpura pansa*; one of the purple dye snails)
Polinices bifasciatus (moon snail)
Polinices uber (moon snail)
Pseudozonaria annettae (= *Cypraea annettae*, = *Zonaria annettae*, = *C. sowerbyi*, = *C. ferruginosa*)

Purpura sp. (the genus *Purpura* has been split into several genera, including *Plicopurpura* and *Pteropurpura*; at least 6 species in these 2 genera occur in the Gulf today)
Simnialena inflexa (as *Simnia variabilis*, a junior synonym; Ovulidae)
Siphonaria aequilorata (misspelled as "*aequilirata*"; an intertidal pulmonate; this is the "sand flat limpet" of the Narrative)
Siphonaria maura (as *Simnia variabilis*; a limpet-like intertidal pulmonate)
Stramonita haemastoma (as *Thais biserialis*, a junior synonym)
Strombina maculosa
Strombus galeatus
Strombus gracilior (presumably the "stalk-eyed conchs" of the Log)
Strombus spp. (taken with a crab net, baited with fish guts)
Tectura fascicularis (as *Acmaea fascicularis*, a junior synonym)
Tegula impressa
Tegula mariana
Tegula rugosa (today, this is probably the most common species of *Tegula* in the Gulf)
Tegula sp.
Terebra variegata
Thais planospiral (known locally as *ojo de Judas*)
Thylacodes squamigerus (as *Aletes squamigerus*, a junior synonym; also = *Aletes squamigerus*—the scaled worm snail; this species is not reported from the Gulf today, so the identity of these specimens is unclear)
Turbo fluctuosus (as *Callopoma fluctuosum*, a junior synonym; probably the most common mid-size gastropod in the Gulf)
"Undetermined bubble shell"
Vasula speciosa (as *Thais centiquadrata*, a junior synonym; this species has had a tortuous nomenclatural history—other synonyms include *Thais speciosa, Purpura speciosa, Purpura centriquadra, Manciella speciosa,* and *Purpura triserialis*)
Vermetus contortus (a worm snail strongly resembling a serpulid polychaete)
Vermicularia pellucida eburnea (as *Vermicularia eburnea*; the species was sunk into *V. pellucida*, which has several subspecies)

SLUGS (21 species)
Aclesia rickettsi (as "*Notarchus* (*Aclesia*) sp." in Phyletic Catalogue; apparently this sea slug has not been reported since MacFarland's original description in 1966)

Aegires sp. (the "small, elongate, dotted" slug of the Log; only one species in this genus is known from the Gulf today, *A. albopunctatus*)
Aplysia californica (sometimes as *"Tethys* sp. probably *californica"*)
Berthella sp. (as *Berthella plumula* in Phyletic Catalogue, which is an Atlantic species; there are 3 described species in this genus known from the Gulf)
Berthellina ilisima (as *Berthellina engeli*; the apricot slug)
Diodora alta (misspelled in Phyletic Catalogue as "*Diadora*")
Diodora inaequalis (misspelled as "*inequalis*" in Phyletic Catalogue)
Dolabella auricularia (as "*Dolabella* sp. probably *californica*" in Phyletic Catalogue, a junior synonym)
Doris umbrella
Elysia diomedea (= *Tridachiella diomedea*, the famous Gulf "Mexican/Spanish dancer" nudibranch; Steinbeck and Ricketts note it was "possibly the most common nudibranch" they encountered; it is still very common, except where tide-pool tourists have taken them in excess)
"Giant sea hares" (= *Aplysia californica*?)
Haminoea virescens (as *Haminoea strongi*, a junior synonym, in Phyletic Catalogue)
Hoffmannola lesliei (as *Onchidium lesliei* in Phyletic Catalogue)
"Large seal-brown nudibranch"
Melibe leonina (as *Chioraera leonina*, a junior synonym; the "pelagic nudibranch also found in Puget Sound"; the existence of this species in the Gulf is still uncertain)
Onchidella binneyi
Pleurobranchidae (unidentified slug)
Pleurobranchus digueti (the "red tectibranch" of the Log)
"Small white *Cadlina*-like dorid"
Stylocheilus striatus (as *Stylocheilus longicauda*)
Unidentified dorid nudibranch

Class Cephalopoda (5 species)

Doryteuthis opalescens (as *Loligo opalescens*, a junior synonym; taken from a Japanese shrimp trawler just south of Guaymas; identified by S. Stillman Berry but likely a misidentification because *D. opalescens*, the California market squid, is a temperate species that doesn't do well in warm waters, although it ranges south as far as the central west coast of Baja California)

Larval male Loliginidae (taken by night-lighting; identified by S. Stillman Berry)
Lolliguncula panamensis (the Panama brief squid; taken from a Japanese shrimp trawler just south of Guaymas; identified by S. Stillman Berry)
Octopus bimaculatus
Octopus sp. (not *O. bimaculatus*; there are 9 species of *Octopus* in the Gulf)

Phylum Hemichordata, Class Enteropneusta (acorn worms): 2 species

Balanoglossus sp.
Ptychodera flava

Phylum Chordata, Subphylum Urochordata/Tunicata (sea squirts): 11 species

Aplidium californicum (= *Amaroucium californicum*; a wide-ranging East Pacific compound tunicate)
Ascidia sp. (a solitary tunicate; noted in the Narrative as "large sea-squirt the color of water"; there are 3 species of *Ascidia* known from the Gulf today—*A. sydneiensis, A. interrupta*, and *A. ceratodes*—it is likely their specimen was one of these, and possibly *A. interrupta* which fits their description and is the most common of the three)
Botrylloides diegensis
Clavelina sp. (Steinbeck and Ricketts speculated this was an undescribed species; there is only one species of *Clavelina* known from the Gulf today, *C. fasciculata*)
Cystodytes dellechiajei
Didemnum carnulentum (a compound tunicate)
Didemnum vanderhorsti (a compound tunicate)
Eudistoma sp. (Steinbeck and Ricketts speculated that this might be an undescribed species; 2 *Eudistoma* species are currently known from the Gulf, *E. mexicanum* and *E. psammion*)
Polyclinum sp. (2 species of *Polyclinum* are known from the Gulf today, *P. laxum* and *P. vasculosum*; however, the tunicate fauna of the Gulf has never been carefully studied)
Pyura sp. (the "red sea squirt" of the Log; likely *P. lignosa*, a common simple tunicate ranging from the Central Gulf to at least Costa Rica)
Trididemnum opacum (a compound tunicate)

Phylum Chordata, Subphylum Cephalochordata (lancelets): 1

Branchiostoma californiense (the common Gulf lancelet)

Table 3. Numbers of Invertebrate Species Taken at Each Collecting Station by the 1940 Steinbeck-Ricketts Sea of Cortez Expedition

Collection No. 1 (March 16). Offshore (outside) Magdalena Bay (southwest Baja California Peninsula). 3 species.
Collection No. 2 (March 18). Cabo San Lucas. 53 species.
Collection No. 3 (March 19). Pulmo Reef. 85 species.
Collection No. 4 (March 20). Isla Espíritu Santo, Punta Lobos. 115 species.
Collection No. 5 (March 21). La Paz, sand flats with rocks and dead coral. 73 species.
Collection No. 6 (March 22). La Paz, El Mogote (tidal flats with mangroves). 76 species.
Collection No. 7 (March 21–22). La Paz, Bahía La Paz, Misc. rocky shore colleting. 21 species.
Collection No. 8 (March 23). Isla San José, Islote Cayo. 20 species.
Collection No. 9 (March 24; Easter Sunday). Isla San Jose, Bahía Amortajada. 2 species.
Collection No. 10 (March 24, Easter Sunday; morning of March 25). Punta/Bahía San Marcial. 63 species.
Collection No. 11 (March 25). Puerto Escondido, outer bay. 79 species.
Collection No. 12 (March 27). Puerto Escondido, inner bay. 24 species.
Total species count for Puerto Escondido = 95 species.
Collection No. 13 (March 27). Isla Coronado, Loreto area. 61 species.
Collection No. 14 (March 28–29). Bahía Concepción. 91 species.
Collection No. 15 (March 30). San Lucas Cove. 60 species.
Collection No. 16 March 30–31). Bahía San Carlos, Baja California. 58 species.
Collection No. 17 (March 31). Bahía de San Francisquito. 30 species.
Collection No. 18 (April 1). Bahía de Los Ángeles. 88 species rocky shores, 8 species tidal flats, 3 species Ballenas Canal = 99 species.
Collection No. 19 (April 2). Isla Ángel de la Guarda, Puerto Refugio. 92 species.
Collection No. 20 (April 3). Isla Tiburón, Red Bluff Point/Punta Colorado. 58 species.
Collection No. 21 (April 4). Sonora, Guaymas area, Puerto San Carlos. 47 species.
Collection No. 22 (April 10). Sonora, Estero de la Luna (S of Guaymas). 34 species.
Collection No. 23 (April 11). Sonora, Estero Agiabampo. 14 species.
Collection No. 24 (April 12). Isla Espíritu Santo, Bahía San Gabriel. 78 species.

Table 4. Annotated List of Invertebrate Species, by Station, Collected by the 1940 Steinbeck-Ricketts Sea of Cortez Expedition

These species records are from several sources. First, from the Narrative and Annotated Phyletic Catalogue of *The Sea of Cortez: A Leisurely Journal of Travel and Research*. This is updated using information in Ricketts's post-expedition correspondence with taxonomic specialists, and then further updated with museum collections records from the Smithsonian Institution's National Museum of Natural History (USNM, denoted with *) and San Francisco's California Academy of Sciences (CAS, denoted with **). Finally, all of the species names are updated based on the post-1940 taxonomic literature (e.g., the Macrofauna Golfo database: http://www.desertmuseum.org/center/seaofcortez/database.php). See previous site descriptions for details on localities.

Many of the identifications given in *Sea of Cortez* are incorrect or questionable, and a great many of the expedition's species have undergone name changes since 1940, either through taxonomic revisions or simple nomenclatural changes. In fact, about 30% of the names in the Phyletic Catalogue have been updated or are questionable, and these are noted in the following lists. The invertebrate fauna of the Sea of Cortez is still relatively poorly known, and many groups have still not benefited from any specialist concentrating in the region (e.g., cnidarians, brachiopods, nematodes, hemichordates, tunicates). The smaller phyla are essentially unknown for the region—Xenacoelomorpha, Gastrotricha, Entoprocta, Gnathostomulida, Micrognathozoa, Rotifera, Phoronida, Kinorhyncha. Steinbeck and Ricketts (hereafter, S&R) often used names of temperate California species they were familiar with, when, in fact, the Gulf specimens in question were similar-appearing, but different, tropical species. However, S&R were keenly aware that they were working in a faunal region (which they called the Panamic Region, but today is usually referred to as the Tropical Eastern Pacific Biogeographic Region) vastly different from the one they knew best, the Temperate Northeast Pacific. They noted that a biologist from Monterey (California) entering the Sea of Cortez at Cabo/Cape San Lucas "would find himself in a territory wholly unfamiliar zoologically" (*Sea of Cortez*, p. 297). They even noted the phenomenon of "look-alike ecological equivalents" (described in some detail in Brusca 1980a), stating, "Unfamiliar animals would be found inhabiting familiar ecological niches." And further, "*Pisaster* would be replaced by the many-rayed *Heliaster* which clings equally tightly; *Strongylocentrotus* spp. by *Echinometra vanbrunti*" (*Sea of Cortez*, p. 298). In some cases, S&R did not distinguish between closely related species (probably because they were unaware of them). For example, during the expedition, they assumed that all *Heliaster* were *H. kubiniji*, whereas some specimens they saw, especially in the Cabo San Lucas/La Paz region, could have been *H. microbrachius*, and they seemed to assume that all (or most) of the swimming crabs were *Callinectes bellicosus* although there are several other similar species.

As noted in *Sea of Cortez* (p. 306), for many of the animal groups S&R collected, little information existed in 1940 for the Sea of Cortez or Tropical Eastern Pacific in general, such as sponges (Porifera), sea anemones, alcyonarians, flatworms (Platyhelminthes), sipunculans, echiurans, and sea squirts (Urochordata). In fact, they had so little information to go on for the anemones and alcyonarians that they did not even include them in the Phyletic Catalogue, although they did collect specimens in these phyla that were worked on by specialists later in time and these are included in the following lists.

I estimate ~557 species were collected by the expedition, about 40 of which were new to science and have since been named and described (perhaps another dozen or so still remain undescribed).

<u>Abbreviations Used</u>

Sea of Cortez = the book, *Sea of Cortez: A Leisurely Journal of Travel and Research*
Narrative = Narrative (or "Log") section of the book *Sea of Cortez*
Phyletic Catalogue = Annotated Phyletic Catalogue (Appendix) of the book *Sea of Cortez*
S&R = Steinbeck and Ricketts
Gulf = Gulf of California/Sea of Cortez
BC = Baja California
BCS = Baja California Sur

ANNOTATED COLLECTION LISTS

The species lists below, for each collecting station, follow the same taxonomic order of phyla as that in the Phyletic Catalogue in *Sea of Cortez*. In all of Ricketts's writings, he consistently ordered the animal phyla such that Echinodermata was placed near Mollusca, rather than with the other deuterostome phyla (Hemichordata and Chordata). The concept of the Deuterostomia, while first proposed over 100 years ago, did not become firmly codified in the minds of American biologists until the work of Libbie Hyman and others in the 1950s. Thus, the sequence of phyla in the Phyletic Catalogue and the following lists is:

Porifera
Cnidaria/Coelenterata
Platyhelminthes/Turbellaria
Nemertea
Bryozoa/Ectoprocta
Sipuncula
Echiura
Annelida/Polychaeta
Echinodermata
Arthropoda
Mollusca
Hemichordata/Enteropneusta
Chordata/Urochordata/Tunicata
Chordata/Cephalochordata

March 16: Outside Magdalena Bay, SW coast of Baja California Peninsula. **Collection No. 1 (p. 45 in the Narrative)**

Note: The Narrative section of the *Sea of Cortez* states this collection was from the vicinity of Bahía Magdalena, but the Phyletic Catalogue, p. 474, states "S of Punta Abreojos," (misspelled as "Abrojos"). Punta Abreojos is near Laguna San Ignacio, far north of Bahía Magdalena.

Hawksbill turtle *Eretmochelys imbricata* harpooned, with symbiotic hydroids (*Obelia dichotoma*) and pelagic crabs (*"Planes minutus"*). *Planes minutus* is an Atlantic and Indian Ocean species; it is likely the crab they found was *Planes major* (a well-known facultative symbiont of sea turtles, especially loggerhead turtles). Turtle's gut filled with the pelagic red crab *Pleuroncodes planipes*. *Pleuroncodes planipes* were also found in schools offshore.

March 18: Cabo/Cape San Lucas, BCS. **Collection No. 2 (p. 58 in the Narrative)**

Leucetta losangelensis (the most common calcareous sponge in the Gulf, and one of the most common sponges in the region)
Sertularia versluysi (a transisthmian hydroid species)
Leptogorgia rigida ("purple pendant gorgonian" of the Narrative)

**Zoanthus depressus* (holotype; type locality)
***Pleurobranchus areolatus* (almost certainly a misidentification of *Pleurobranchus digueti*)
"*Planocera*-like forms" (flatworms)
Crisia sp. (this was likely *C. operculata* Robertson, 1910)
**Apionsoma misakianum* (as *Phascolosma hesperum*, a junior synonym; = *Golfingia hespera*)
Polydora sp. (attached to the tube of *Spirobranchus*; likely either *P. citron* or *P. websteri*, both described by Olga Hartman in the mid-1940s)
Eupomatus sp. (minute serpulids attached to tube of *Spirobranchus*; 3 species of *Eupomatus* are known from the Gulf today: *E. brachyacantha, E. recurvispina, E. uncinatus*)
Spirobranchus incrassatus (a large worm with anastomosing calcareous tubes; spiral gills banded red, white, and black)
Heliaster kubiniji (the most common of the Gulf sun stars)
Pentaceraster cumingi (as *Oreaster occidentalis,* a junior synonym; a widespread Tropical East Pacific species)
**Ophiocoma alexandri*
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
***Echinometra vanbrunti*
Holothuria lubrica (= *Slenkothuria lubrica*; the sulfur cucumber; the most common sea cucumber taken during the expedition, and the most common cucumber in the Gulf littoral today)
Tetraclita stalactifera (as *Tetraclita squamosa stalactifera*)
Chthamalus anisopoma
Megabalanus californicus (as *Balanus tintinabulum californicus*)
***Megabalanus peninsularis* (as *Balanus tintinabulum peninsularis*)
Balanus trigonus
Petrolisthes hians (as *Pisosoma flagraciliata*, a junior synonym)
***Petrolisthes edwardsii*
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Pachygrapsus socius (as *Pachygrapsus transversus* in Phyletic Catalogue, an Atlantic species)
***Percnon gibbesi*
Thoe sulcata
Pilumnoides sp. (juvenile; there is only one species in this genus reported from the Gulf today, *P. rotundus*, described in 1940 and rare in the Gulf)
Isognomon janus (as *I. anomioides*, a junior synonym; very common, thin rock oyster on rocky shores in the Gulf)
Saccostrea palmula (as *Ostrea cumingiana* Dunker 1846, and *O. mexicana*, both junior synonyms of *S. palmula*; this is a fairly common edible oyster found throughout the Gulf, and also common in Northern Gulf shell middens)
Chama echinata
Siphonaria aequilorata (misspelled as "*aequilirata*"; an intertidal pulmonate; this is the "sand flat limpet" of the Narrative)
**Siphonaria maura* (as *Simnia variabilis*; an intertidal limpet)

**Conus nux*
**Echinolittorina modesta* (as *Nodilittorina modesta*)
**Simnialena inflexa* (Ovulidae)
Mitrella santabarbarensis (as *Anachis reevei*, a junior synonym)
Columbella fuscata
Mitrella densilineata (as *Nitidella densilineata*, a junior synonym)
Mitrella guttata (as *Nitidella guttata*, a junior synonym; this species, one of the most common small snails in the Gulf, is considered a synonym of *Mitrella/Columbella ocellata* by some workers, although the latter is a trans-Atlantic species)
Coralliophila californica
Plicopurpura patula (as *Purpura patula*, a junior synonym, as is *Purpura pansa*; one of the purple dye snails)
Stramonita haemastoma (as *Thais biserialis*, a junior synonym)
Vasula speciosa (as *Thais centiquadrata*, a junior synonym; this species has had a tortuous nomenclatural history—other synonyms include *Thais speciosa, Purpura speciosa, Purpura centriquadra, Manciella speciosa,* and *Purpura triserialis*)
Echinolittorina modesta (as *Littornia conspersa*, a junior synonym)
Lottia atrata (as *Acmaea atrata*; with the barnacle *Chthamalus anisopoma* attached)
Lottia discors (as *Acmaea discors*)
Tectura fascicularis (as *Acmaea fascicularis*)
Pleurobranchus digueti (the "red tectibranch" of the Narrative)
Didemnum carnulentum
Trididemnum opacum
Also mentioned in the Narrative: 5 types of sponges, brachiopods, no chitons

March 19: Cabo Pulmo/Bahía Pulmo Reef, BCS. **Collection No. 3 (p. 76 in the Narrative)**

Chondrosia reniformis
Muricea austera ("large fleshy gorgonian" in the Narrative)
Pacifigorgia adamsi (as *Gorgonia adamsi*; "lacy sea fans")
***Leptogorgia rigida*
Astrangia pedersenii (a solitary coral and one of 11 *Astrangia* species in the Gulf; considered a junior synonym of *A. haimei* by Squires 1959)
Porites cf. *porosa* (on sand bottom adjacent to reef) (= *P. panamensis* of most, but not all modern workers; this species is protected by Mexican federal law)
Pocillopora capitata (a major reef-building coral in Pulmo Bay). Reyes (1992) considers *P. robusta* and *P. porosa* to be junior synonyms of *P. capitata*. Many species of *Pocillopora* have been reported from the Gulf, but their taxonomy and nomenclature are still not well resolved.
Pocillopora capitata capitata (probably a misidentification of *Pocillopora meandrina*)
**Pocillopora meandrina*
Stylochus sp. or spp. (undescribed flatworm/Platyhelminthes; this might have been *S. atentaculatus* described by Hyman in 1953)

Membranipora tuberculata (a common bryozoan ranging from California to Peru)
Halosydna glabra (a scale worm described the year before the expedition)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site S&R visited)
Anaitides madeirensis (an elongate phyllodocid polychaete)
Ophiodromus pugettensis (as *Podarke pugettensis*; S&R found it only in the ambulacral groove of *Oreaster occidentalis*, but it is known to be a symbiont in several Gulf sea stars)
Odontosyllis sp. (there are 4 species of *Odontosyllis* known from the Gulf: *O. heterodonta, O. phosphorea, O. polycera, O. undecimdonta*; the last was described and named by Olga Hartman in 1964, who identified the S&R polychaetes)
Eunice aphroditois
Eunice antennata (a wide-ranging polychaete occurring from Southern California to Ecuador; the "*Lumbrinereis*-like form" in the Narrative)
Idanthyrsus pennatus (a circumtropical terebellid polychaete)
Heliaster kubiniji
Phataria unifascialis
Pharia pyramidata
Nidorellia armata (a very common shallow-water sea star in the Gulf, but collected by S&R only at Pulmo Reef and Puerto Escondido)
Mithrodia bradleyi
Pentaceraster cumingi (as *Oreaster occidentalis,* a junior synonym; a widespread Tropical East Pacific species)
Ophiothrix spiculata
Ophiothrix rudis (an uncommon brittle star ranging from the Southern Gulf to southern Mexico; most often reported from corals but both species of *Ophiothrix* in the Gulf live commensally with other organisms)
**Ophiactis simplex* (the small, 5- or 6-armed brittle star)
**Ophiocoma alexandri*
Eucidaris thouarsii (the commonest sea urchin in the Gulf; collected "at practically every suitable collecting place")
Echinometra vanbrunti
Arbacia incisa (these are the urchins S&R noted at Pulmo Reef, "penetrated all but the heaviest part of the soles of our rubber boots")
Afrocucumis ovulum (as *Euthyonidiuim ovulum*; an uncommon species known only from the Central and Southern Gulf, south to Peru; taken only at this location)
Megabalanus peninsularis (as *Balanus tintinabulum peninsularis*)
**Alpheus wonkimi* (as *Crangon* [= *Alpheus*] *malleator*, a snapping shrimp)
**Alpheus lottini* (as *Crangon ventrosus*, a tropical trans-Pacific snapping shrimp)
Trapezia spp. (red coral crabs)
Mithrax denticulatus (= *M. areolatus*; spider crab)
**Exosphaeroma yucatanum* (almost certainly a misidentification of some other sphaeromatid isopod; *E. yucatanum* is a west Atlantic species)
Tetraclita stalactifera (as *Tetraclita squamosa stalactifera*)
***Alpheus lottini*
***Synalpheus sanlucasi*

Synalpheus sanjosei
Synalpheus digueti
Synalpheus sp.
Calcinus californiensis (one of the most attractive hermit crabs in the Gulf)
Pachycheles biocellatus (formerly *Petrolisthes biocellatus*; living in coral interstices)
Pachycheles panamensis (formerly *Pachycheles sonorensis*)
Pachycheles setimanus (formerly *Petrolisthes setimanus*; living in coral interstices)
Pachycheles sp. (6 species of *Pachycheles* are known from the Gulf today)
Petrolisthes hians (as *Pisosoma flagraciliata*, a junior synonym)
Thoe sulcata
****Mithraculus denticulatus*** (as *Mithrax areolatus*, a junior synonym; common)
Platypodiella rotundata (as *Platypodia rotundata*)
Daira americana
Pilumnus pygmaeus (an uncommon hairy crab of the Southern Gulf)
Eriphia squamata (“old lumpy claws”; a very common, small, pugnacious xanthid crab ranging from the Upper Gulf to Peru)
Domecia hispida (as *Eriphides hispida*, a junior synonym of this circumtropical coral-inhabiting crab)
Trapezia bidentata (as *Trapezia cymodoce ferruginea*, a junior synonym; the “cherry-colored coral crab” in the Narrative)
Trapezia digitalis (common among the coral heads)
***Trapezia* sp. (perhaps *T. digitalis*)
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Pachygrapsus socius (as *Pachygrapsus transversus*, an Atlantic species)
Isognomon janus (as *I. anomioides*, a junior synonym; very common, thin rock oyster on rocky shores in the Gulf)
Ostrea sp. (reported as a “*Chama*-like form”; there are 7 true oysters [Ostreidae] in the Gulf, the most “*Chama*-like” being *Ostrea conchaphila*)
Gregariella coarctata (misidentified as *Botulina opifex*, a west Atlantic species; a fairly common boring clam in the Gulf)
Brachidontes semilaevis (as *Brachidontes multiformis*, a junior synonym; a very common small mytilid mussel in the Gulf)
Lithophaga aristata
Chama echinata (attached by the left valve to rocks; this is the “oyster-like form [*Spondylus*?]” from the Narrative)
Siphonaria maura (as *Siphonarea pica*, a junior synonym; the “stellate *Acmaea*” of the Narrative)
Coralliophila monodonta (as *Galeropsis madreporarum*, a junior synonym)
Vermetus contortus (a worm snail strongly resembling a serpulid polychaete)
Hexaplex princeps (as *Phyllonotus princeps*, a junior synonym)
Thais planospiral (known locally as “ojo de Judas”)
*Ovulidae
**Simnialena inflexa* (as *Simnia variabilis*, a junior synonym; Ovulidae)
Naria albuginnosa (= *Cypraea albuginosa*)
Vermicularia pellucida eburnea (as *Vermicularia eburnea*; the species was sunk into *V. pellucida*, which has several subspecies)

Crepidula striolata (as *Crepidula squama*, a junior synonym)
Lottia atrata (as *Acmaea atrata*, a junior synonym)
Lottia discors (as *Acmaea discors*, a junior synonym)
Tectura fascicularis (as *Acmaea fascicularis*, a junior synonym)
Diodora alta (misspelled in Phyletic Catalogue as “*Diadora*”)
Fissurella rugosa
Aplidium californicum (=*Amaroucium californicum*; wide-ranging East Pacific compound tunicate; the tunicates of the Gulf of California have not yet been carefully studied)
Also mentioned in narrative: “probably *Phyllonotus regius*” (presumably *Chicoreus erythrostomus*), sipunculans, anemones, octopus

March 20: Isla Espíritu Santo, Punta Lobos (S end of island). **Collection No. 4 (p. 91 in the Narrative)**

Aaptos vannamei (questionable identification of a black sponge)
Geodia mesotriaena (the most commonly encountered sponge of the expedition)
Haliclona ecbasis (this species has apparently been reported from the Gulf by no one else)
Leucetta losangelensis (the most common calcareous sponge in the Gulf, and one of the most common sponges in the Tropical East Pacific)
**Porites californica* “massive form” (as *P. porosa*, a junior synonym; S&R correctly noted this was the commonest coral on Gulf shores, occurring as dome-shaped encrusting heads 8 inches in diameter)
**Phyllactis concinnata* (anemone)
**Telmatactis panamensis* (anemone)
Stylochus sp. or spp. (undescribed flatworm/Platyhelminthes; this might have been *S. atentaculatus* described by Hyman in 1953)
Baseodiscus mexicanus (the largest and most distinctive nemertean in the Gulf, and apparently the only species S&R collected)
**Themiste hennahi* (as *Dendrostoma lissum*, sipunculan) (holotype; type locality)
**Phascolosoma elachum* (sipunculan) (holotype; type locality)
Phascolosoma agassizii (as *Physcosoma agassizii*, a junior synonym)
Phascolosoma sp., cf. *P. gouldii* (S&R speculated this was an undescribed species, but it may have been one of the other two species of *Phascolosoma* now known from the Gulf: *P. nigrescens, P. perlucens*, or even some other genus)
**Siphonides rickettsi* (sipunculan) (holotype; type locality)
Ochetostoma edax (type specimen of a new spoon worm)
Antillesoma antillarum (as *Physcosoma antillarium*, a junior synonym; a cosmopolitan species)
Iphione ovata (a tropical scale worm)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Eunice afra (a single specimen of this Gulf endemic polychaete was taken)
Eunice aphroditois
Eunice schemacephala (this is a tropical West Atlantic species and possibly was a misidentification; there are 2 dozen species of *Eunice* known from the Gulf today)

Oenone fulgida (as *Aglaurides fulgida*; a Tropical East Pacific polychaete)
Eualetes centiquadra, or another vermetid snail
Chaetopleura limaciformis
Heliaster kubiniji
****Astrometis sertulifera**
***Echinaster tenuispina*
Phataria unifascialis
Pharia pyramidata
Mithrodia bradleyi
Pentaceraster cumingi (as *Oreaster occidentalis,* a junior synonym; a widespread Tropical East Pacific species)
Ophiocoma aethiops
Ophiocoma alexandri
**Ophiothrix spiculata*
Ophionereis annulata
Ophioderma teres
Ophioderma panamense (for some reason this is the only locality at which the expedition collected this very common littoral species, which occurs throughout the Gulf)
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
Echinometra vanbrunti
Arbacia incisa
Diadema mexicanum (= *Centrechinus mexicanus*; curiously, S&R collected this common, toxic-spined species only twice, at Punta Lobos and at Marcial Point)
Tripneustes gratilla (= *Tripneustes depressus*; a trans-Pacific species; collected only at this locality)
Holothuria arenicola (a circumtropical species common in the Gulf)
Holothuria difficilis (a circumtropical species, taken only at this locality)
Holothuria impatiens (a circumtropical species; S&R describe this as the second most common sea cucumber from their expedition)
Holothuria kefersteini
Holothuria lubrica (= *Slenkothuria lubrica*; the sulfur cucumber; the most common sea cucumber taken during the expedition, and the most widespread and abundant sea cucumber in the Gulf today). Ricketts's field notes from this station read, "present by the millions." One specimen had a commensal pearl fish living in it, *Encheliophiops hancocki* Reid.
Holothuria languens (two color varieties taken at Punta Lobos—"one was yellowish; the other mottled")
Chiridota aponocrita (a small synaptid cucumber, taken only at this locality)
Isostichopus fuscus (not in Phyletic Catalogue, but identified by E. Deichmann)
**Neogonodactylus zacae* (as *Gonodactylus oerstedii*, which is actually a West Atlantic species; the specimens were re-examined by Ray Manning in 1972 and described as the new species *Gonodactylus zacae*, later moved to *Neogonodactylus*)
**Neogonodactylus stanschi* (as *Gonodactylus stanschi*)

Tetraclita stalactifera (as *Tetraclita squamosa stalactifera*)
Chthamalus anisopoma
Pontonia pinnae (a symbiont in the hatchet clam, *Pinna*)
Crangon sp. No. 1 (likely an unknown species of caridean shrimp, but not a *Crangon*; many shrimps identified as *Crangon* by S&R proved to be alphaeid shrimps)
Crangon sp. No. 2 (likely an unknown species of caridean shrimp, but not a *Crangon*; many shrimps identified as *Crangon* by S&R proved to be alphaeid shrimps)
Crangon sp. No. 3 (likely an unknown species of caridean shrimp, but not a *Crangon*; many shrimps identified as *Crangon* by S&R proved to be alphaeid shrimps)
Synalpheus sanlucasi
Calcinus californiensis (one of the most distinctive and attractive hermit crabs in the Gulf)
Pleuroncodes planipes ("carapaces found washed ashore in hordes")
Petrolithes hirtispinosus (a common porcelain crab in the Gulf)
Petrolisthes nigrunguiculatus (a common porcelain crab in the Gulf)
Megalobrachium sinuimanus (as *Pisonella sinuimanus*)
Petrolisthes lewisi (as *Pisosoma lewisi*)
***Xanthodius cooksoni*
Thoe sulcata
Mithraculus denticulatus (as *Mithrax areolatus*, a junior synonym; common)
Microphrys platysoma
Platypodiella rotundata (as *Platypodia rotundata*)
Xanthodius cooksoni (as *Leptodius cooksoni*, a junior synonym)
Epixanthus tenuidactylus (as *Ozius tenuidactylos*, a junior synonym)
***Eriphia squamata* ("old lumpy claws"; a very common, small, pugnacious xanthid crab ranging from the Upper Gulf to Peru)
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Arcopsis solida (as *Fossularca solida*, a junior synonym; the common "garbanzo clam" of the Gulf)
Arca mutabilis (as *Navicula mutabilis*, a junior synonym; the "minute *Zirfaea*-like form" of the Narrative)
Pinna rugosa (the principal commercial Gulf hacha)
Isognomon janus (as *I. anomioides*, a junior synonym; very common, thin rock oyster on rocky shores in the Gulf)
Carditamera affinis (as *Carditamera affinis californica*; S&R considered this "the commonest bivalve in the Gulf"; common in Northern Gulf aboriginal shell middens, where they appear to have been fashioned into pendants)
Chama echinata (as *Chama squamuligera*; Coan and Valentich-Scott [2012] consider *C. squamuligera* to be a white morph of *C. echinata*)
Chaetopleura aff. *lurida* (the "small, hairy chiton" of the Narrative; *C. lurida* ranges from the Central Gulf to Colombia)
Stenoplax limaciformis (as *Ischnochiton limaciformis* in Phyletic Catalogue)
Conus brunneus
**Conus nux*

**Conus princeps*
**Nodilittorina modesta* (gastropod)
Crassispira (*Monilispira*) *monilifera* (as *Monilispira monilifera*)
Mitra tirstis
Mitrella guttata (as *Nitidella guttata*, a junior synonym; this species, one of the most common small snails in the Gulf, is considered a synonym of *Mitrella/Columbella ocellata* by some workers, but the latter is a trans-Atlantic species)
Coralliophila costata
?*Quoyula madreporarum* (as *Galeropsis madreporarum*, a junior synonym; S&R were uncertain of this identification of the Puerto Lobos specimens)
Hexaplex princeps (as *Phyllonotus princeps*, a junior synonym)
Vasula speciosa (as *Thais centiquadrata*, a junior synonym; this species has had a tortuous nomenclatural history—other synonyms include *Thais speciosa, Purpura speciosa, Purpura centriquadra, Manciella speciosa,* and *Purpura triserialis*)
Acanthais triangularis (as *Thais triangularis*, a junior synonym; also *Mancinella triangularis*)
Naria albuginnosa (= *Cypraea albuginosa*)
Pseudozonaria annettae (= *Cypraea annettae, = Zonaria annettae, = C. sowerbyi*, = *C. ferruginosa*)
**Liocerithium judithae* (as *Cerithium sculptum*, a junior synonym; the "mid-tide minute spired snail" of the Narrative; one of the most common small snails in the Gulf)
Echinolittorina modesta (as *Littornia conspersa*, a junior synonym)
Crucibulum scutellatum (as *Crucibulum imbricatum*, a junior synonym)
Diodora inaequalis (misspelled as "*inequalis*" in Phyletic Catalogue)
Aclesia rickettsi (as "*Notarchus* (*Aclesia*) sp." in Phyletic Catalogue; apparently this sea slug has not been reported since MacFarland's original description in 1966)
Pleurobranchus digueti (the "red tectibranch" of the Narrative)
** *Berthellina ilisima* (as *Berthellina engeli*; the apricot slug)
** *Stylocheilus striatus* (as *Stylocheilus longicauda*)
** *Elysia diomedea* (= *Tridachiella diomedea*; the famous Gulf "Mexican/Spanish dancer" nudibranch; S&R note it was "possibly the most common nudibranch" they encountered; it is still very common, except where tide-pool tourists have taken them in excess)
***Doris umbrella*
**Aclesia rickettsi* (aplysiid sea slug) (lectotype)
Pleurobranchidae (unidentified slug)
"Small white *Cadlina*-like dorid"
"Large seal-brown nudibranch"
Balanoglossus sp. (acorn worm)
Ptychodera flava (acorn worm)
***Aplidium californicum* (= *Amaroucium californicum*; a wide-ranging east Pacific compound tunicate; the tunicates of the Gulf of California have not yet been carefully studied)

Eudistoma sp. (S&R speculated that this might be an undescribed species; two *Eudistoma* species are currently known from the Gulf, *E. mexicanum* and *E. psammion*)
Pyura sp. (the "red sea squirt" of the Narrative; likely *P. lignosa*, a common simple tunicate ranging from the Central Gulf to at least Costa Rica)
Also mentioned in the Narrative: octopus, bryozoans

March 21: La Paz (sand flats with rocks and dead coral, east of town), BCS.
Collection No. 5 (p. 109 in the Narrative)

Geodia mesotriaena (the most commonly encountered sponge of the expedition)
Hircinia variabilis (a questionable identification)
**Epiactis irregularis* (holotype; type locality)
**Phialoba steinbecki* (syntype; anemone)
**Phyllactis concinnata*
**Telmatactis panamensis* (anemone)
Plumularia setacea (this hydroid ranges from the Galapagos Islands to British Columbia)
Porites californica, "massive form" (as *P. porosa*, a junior synonym; S&R correctly noted this was commonest coral on Gulf shores, occurring as dome-shaped encrusting heads 8 inches in diameter)
***Ptilosarcus undulatus* (= *Leioptilus undulatus*)
Pennatula sp. (a sea pen;although not mentioned in the Phyletic Catalogue, Ricketts's field notes and correspondence with E. Deichmann note "*Pennatula* sp. La Paz, under cement wharf"; there are a few reports of *Pennatula phosphorea* from the Pacific, but these might be incorrect identifications as that appears to be an Atlantic species)
Stylopoma spongites (a tropical west Atlantic species; presence in Gulf needs confirmation)
Antillesoma antillarum (as *Physcosoma antillarium*, a junior synonym; a cosmopolitan bryozoan species)
Bhawania riveti (described as "a *Phyllodoce*-like form"; this species has apparently not been reported since the S&R expedition, but another species, *B. goodei*, has been reported from the Gulf)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Notopygos ornata ("small Gulf fire worm")
Stylarioides papillata (possibly *Pherusa papillata*, a Southern Gulf flabelligerid polychaete)
Heliaster sp.
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
Ophiocoma aethiops
Ophiocoma alexandri
Ophionereis annulata
Ophioderma teres
Holothuria impatiens (a circumtropical species; S&R describe this as the second most common sea cucumber from their expedition)

Holothuria kefersteini
Neocucumis veleronis (as *Euthyonidium veleronis*; taken only at this location)
Neothyone gibbosa
Stichopus jusus (not in Phyletic Catalogue, but identified by E. Deichmann; the nature of this species name is unclear)
Ampithoe ramondi (a circumtropical amphipod found in a cluster of hydroids)
Neaxius vivesi (as *Axius vivesi*; a common species throughout the Gulf, but the expedition took it only at this one site)
Calcinus californiensis (one of the most attractive hermit crabs in the Gulf)
Thoe sulcata
Mithraculus denticulatus (as *Mithrax areolatus*, a junior synonym; common)
Barbatia reeveana (the hairy ribbed mussel; one of the commoner Gulf arc shells)
Engina ferruginosa Reeve (the identity of this species is unclear, but it is likely what we now call *Morula nodulosa* or *Morula ferruginosa*)
Columbella fuscata
Heliaster kubiniji
Phataria unifascialis
Phara pyramidalis
Eucidaris thouarsii
Lithophaga plumula ("or similar"—a boring clam)
Eurythoe complanata
Pleuroncodes planipes ("carapaces found washed ashore in hordes")
Microphrys platysoma
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case)
Pilumnus townsendi
Heteractaea lunata (an uncommon xanthid crab in the Gulf; S&R found this species only once, in coral heads at this site)
**Ampithoe ramondi*
**Neogonodactylus zacae* (as *Gonodactylus oerstedii*, which is actually a West Atlantic species; the specimens were re-examined by Ray Manning in 1972 and described as the new species *Gonodactylus zacae*, later moved to *Neogonodactylus*)
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Uca crenulata (S&R felt this was the only species of *Uca* they collected on the expedition; however, the taxonomy of this genus is desperately in need of revision and some species are difficult to differentiate)
Atrina tuberculosa (the less common of two pen shells called *callo de hacha*, the other being *Pinna rugosa*)
Carditamera affinis (as *Carditamera affinis californica*; S&R considered this "the commonest bivalve in the Gulf"; common in shell middens in the Northern Gulf, where they appear to have been fashioned into pendants)
Trachycardium procerum
Dosinia dunkeri
Muricopsis armatus (as *Muricopsis squamulata*, a junior synonym)

Phyllonotus erythrostomus (as *Phyllonotus bicolor*, a junior synonym; the pink-mouth murex; S&R found this to be the most common large snail of their expedition—indeed, it was once the most common littoral and shallow subtidal large snail throughout the Gulf, but no longer, due to intense over-collecting; large specimens are now exceedingly rare intertidally)
Hexaplex brassica (as *Phyllonotus brassica*, a junior synonym; the cabbage murex)
Mancinella tuberculata (as *Thais tuberculata*, a junior synonym)
Pseudozonaria annettae (= *Cypraea annettae,* = *Zonaria annettae,* = *C. sowerbyi*, = *C. ferruginosa*)
Thylacodes squamigerus (as *Aletes squamigerus*, a junior synonym; also = *Aletes squamigerus*, the scaled worm snail; this species is not reported from the Gulf today, so the identity of these specimens is unclear)
Crepidula onyx (slipper shell)
Polinices uber
Turbo fluctuosus (as *Callopoma fluctuosum*, a junior synonym; the most common mid-size gastropod in the Gulf)
Tegula mariana
***Elysia diomedea*
***Aclesia rickettsi* (paratype; as "*Notarchus* (*Aclesia*) sp." in Phyletic Catalogue; apparently this sea slug has not been reported since MacFarland's original description in 1966)
Tridachiella diomedea (the famous Gulf "Mexican/Spanish dancer" nudibranch; S&R note it was "possibly the most common nudibranch" they encountered; it is still very common, except where tide-pool tourists have taken them in excess)
Octopus bimaculatus
Aplidium californicum (= *Amaroucium californicum*; a wide-ranging East Pacific compound tunicate; the tunicates of the Gulf of California have not yet been carefully studied)
Didemnum carnulentum
Cystodytes dellechiajei
Clavelina sp. (S&R speculated this was an undescribed species; there is only one species of *Clavelina* known from the Gulf today, *C. fasciculata*)
Also mentioned in the Narrative: orange nudibranchs (probably *Berthellina ilisima*), mud-living mussels, pink ghost shrimps

March 22: El Mogote (mud flats, adjacent to mangroves), BCS. **Collection No. 6 in the Narrative**

**Phyllactis bradleyi*
**Andvakia insignis* (burrowing anemone; as *Pachycerianthus insignis*, a junior synonym) (holotype; presumably the "*Cerianthus*" mentioned in the Narrative)
Stylatula elongata (presumably the "littoral pennatulids like *Pennatula aculeata*" of the Narrative; note that *P. aculeata* is an Atlantic species)
Baseodiscus mexicanus (the largest and most distinctive nemertean in the Gulf)
Sipunculus nudus

Thalassema steinbecki (holotype)
Glycera dibranchiata (a well-known polychaete ranging from San Francisco Bay to the Gulf)
Marphysa aenea (found at the base of mangroves; a well-known Tropical East Pacific species)
Dasybranchus caducus (a Caribbean species thought to also occur in the Gulf)
Pista elongata (a Tropical East Pacific terebellid polychaete)
Eurythoe complanata
Polychaeta, Maldanidae (about a dozen species of maldanids occur in the Gulf)
Owenia fusiformis (a circumtropical polychaete)
Ophiothrix spiculata
Ophiactis savignyi (a common Tropical East Pacific 6-armed brittle star)
Amphipholis elevata (a rarely collected, littoral-to-73-m-deep, long-armed sand bottom brittle star)
Agassizia scrobiculata (heart urchin)
Holothuria impatiens (a circumtropical species; S&R describe this as the second most common sea cucumber from their expedition)
Holothuria languens (described as "chunkier" than the specimens taken at Punta Lobos)
Holothuria kefersteini (?)
Holothura rigida (a circumtropical species)
Holothuria paraprinceps
Thyone parafusus (taken only at this locality; the "small black cucumbers" of the Narrative?)
Paracaudina chilensis (a smooth, white, burrowing cucumber resembling a sipunculan; taken only at this locality)
Ampithoe plumulosa (amphipod; broadly distributed in the east Pacific: Canada to Ecuador)
Paracerceis sp. (3 species in this genus occur in the Gulf: *P. richardsoni*, *P. sculpta*, *P. spinulosa*)
Balanus inexpectatus (as *Balanus Amphitrite inexpectatus*)
Balanus fissus
Litopenaeus stylirostris (as *Penaeus stylirostris*; found dead on the sand flats; probably washed up from a local shrimp boat)
**Farfantepenaeus californiensis*
Synalpheus sanjosei
Clibanarius panamensis
Petrochirus californiensis (the largest hermit crab in the Gulf, aka "the gentle giant")
Pagurus lepidus
Petrolisthes armatus (one of the most common porcelain crabs in the Gulf; this species was at just about every rocky shore they visited, even though they collected it only twice)
Polyonyx quadriungulatus (typically commensal in the tubes of chaetopterid polychaetes, but found "free living" at El Mogote)
Podochela latimanus
Thoe sulcata

Pitho picteti
Mithraculus denticulatus (as *Mithrax areolatus*, a junior synonym; common)
Teleophrys cristulipes
Microphrys platysoma
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]
Daira americana
Cataleptodius occidentalis (as *Leptodius occidentalis*, a junior synonym; one of the most common and abundant small crabs in the Gulf)
Panopeus bermudensis (in 1941, this species was thought to be distributed in the Caribbean and Tropical East Pacific; however, the "panopeid" crabs are a taxonomic mess and the actual identity of the S&R Sea of Cortez species is unclear; there are ~2 dozen described panopeid crabs usually recognized from the Gulf, but this is not one of them)
Pilumnus townsendi
Geograpsus stormi (as *Geograpsus lividus*, a junior synonym; a circumtropical species)
Graptacme semipolitum (as *Dentalium semipolitum*, a junior synonym; the "striated" tusk shell from El Mogote)
Laevidentalium splendidum (as *Dentalium semipolitum*, a junior synonym; the "smooth" tusk shell from El Mogote)
Anadara multicostata (as *Arca multicostata*, a junior synonym)
Anadara tuberculosa (as *Arca tuberculosa*, a junior synonym)
Modiolus capax (as *Volsella capax*, the bearded mussel; *Volsella* is a junior synonym of *Modiolus*)
Carditamera affinis (as *Carditamera affinis californica*; S&R considered this "the commonest bivalve in the Gulf"; common in shell middens in the Northern Gulf, where they appear to have been fashioned into pendants)
Divalinga eburnea (as *Divaricella eburnea*, a junior synonym; S&R described their specimen as "pearly-white" and ranging from Cape San Lucas to Panama; but this species has pale brown stripes and ranges throughout the Gulf to Peru and the Galapagos Islands; perhaps their specimen was an old, worn shell, or this is a misidentification)
Chione californiensis (as *Chione succincta*, a junior synonym; one of the most common bivalves in the Gulf)
Dosinia dunkeri
Megapitaria squalida (as *Macrocallista squalida*, a junior synonym; one of two species called "chocolata clam," or "almeja chocolata," in the Gulf)
Oliva venulata
Pseudozonaria annettae (= *Cypraea annettae,* = *Zonaria annettae,* = *C. sowerbyi*, = *C. ferruginosa*)
Strombus gracilior
Natica chemnitzii (the "variegated *Polinices*-like form" of the Narrative)
Polinices bifasciatus (moon snail)
Polinices uber

Aplysia californica (as *"Tethys* sp. probably *californica")*
Tridachiella diomedea (the famous Gulf "Mexican/Spanish dancer" nudibranch; S&R note it was "possibly the most common nudibranch" they encountered; it is still very common, except where tide-pool tourists have taken them in excess)
***Aplysia californica*
***Berthellina engeli*
***Elysia diomedea* (opisthobranch)
Bulla gouldiana
Balanoglossus sp. (acorn worm)
Polyclinum sp. (2 species of *Polyclinum* are known from the Gulf today, *P. laxum* and *P. vasculosum*; however, the tunicate fauna of the Gulf has never been carefully studied)
Botrylloides diegensis
Also mentioned in the Narrative: 2 species of tusk shells, keyhole limpets, fiddler crabs, *Nidorellia armata*?, *Linckia*?, white sea whip, flatworms (several species), burrowing shrimp ("*Upogebia*"?), octopus

<u>March 21–22: Misc. rocky shore collections, Bahía La Paz. **Collection No. 7 in the Narrative**</u>

Cliona californiana (as *C. celata*)
**Unidentified sponge
**Porites californica*
**Epizoanthus californicus* (syntype)
**Palythoa pazi* (syntype)
***Stylocheilus striatus* (as *Stylocheilus longicauda*)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Heliaster kubiniji
***Phataria unifascialis*
Pharia pyramidata
Pentaceraster cumingi (*Oreaster occidentalis,* a junior synonym; a widespread Tropical East Pacific species)
**Ophiocoma aethiops*
**Ophiocoma alexandri*
**Ophioderma teres*
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
***Neocucumis veleronis*
Balanus inexpectatus (as *Balanus amphitrite inexpectatus*)
Cataleptodius occidentalis (as *Leptodius occidentalis*, a junior synonym; one of the most common and abundant small crabs in the Gulf)
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Modiolus capax (as *Volsella capax*, the bearded mussel; *Volsella* is a junior synonym of *Modiolus*; this is the "*Mytilus*-like form" of the Narrative)
***Elysia diomedea*

<u>March 23: Islote Cayo, SW tip of Isla San José, ~1.5 miles from Bahía Amortajada. **Collection No. 8 (p. 127 in the Narrative)**</u>

Leucetta losangelensis (the most common calcareous sponge in the Gulf, and one of the most common sponges in the Tropical East Pacific)
Leucosolenia coriacea
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
"*Spirorbis* tubes" (about 15 species of Spirorbidae are known from the Gulf today)
Heliaster sp. (presumably *H. kubiniji*)
Phataria unifascialis
Pharia pyramidata
Eucidaris thouarsii (the commonest urchin in the Gulf; collected "at practically every suitable collecting place")
Tetraclita stalactifera (as *Tetraclita squamosa stalactifera*)
Elasmopus pocillimanus (a cosmopolitan amphipod; not reported otherwise from the Gulf)
Hyale hawaiensis (probably an incorrect identification; likely one of the amphipod species named by J. L. Barnard in 1979—e.g., *H. californica, H. guasave, H. yaqui, H. zuaque*)
*"*Dynamella*" sp. (probably a misspelling of *Dynamenella*, an isopod genus known from California shores, but not from the Sea of Cortez; however, it is more likely the specimens were *Dynoides*, *Paracerceis*, or *Paradella*)
Petrolisthes nigrunguiculatus (a common porcelain crab in the Gulf)
Xanthodius sternberghii (as *Xanthodius hebes*, a junior synonym)
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations and in abundance here)
Brachidontes semilaevis (as *Brachidontes multiformis*, a junior synonym; a very common small mytilid mussel in the Gulf)
Coralliophila costata
**Liocerithium judithae* (as *Cerithium sculptum*, a junior synonym; one of the most common small snails in the Gulf)
"*Lottia gigantea*" (almost certainly a misidentification; this is a western Baja/California temperate species)
Also noted in the Narrative: many anemones, some cucumbers, one small sipunculan, tube snails ("*Aletes*, or a similar genus"; any of a dozen possible Vermetidae species), "sea rabbits" (probably *Aplysia* sp.)

<u>March 24 (morning): Easter Sunday, Isla San José, Bahía Amortajada. **Collection No. 9 (p. 131 in the Narrative)**</u>

Echinolittorina aspera (as *Littorina philippi*, a junior synonym)
Diodora inaequalis (misspelled as "*inequalis*" in Phyletic Catalogue)
Note: These two species are rocky shore gastropods; however, Ricketts's "Verbatim Transcription" states they collected fiddler crabs and estuarine snails in the lagoon at Bahía Amortajada, although I have not come across those specimens in any published lists or museum collections

March 24: afternoon of Easter Sunday; March 25: morning, Marcial "Reef," Bahía San Marcial, just S of Punta Marcial. **Collection No. 10 (p. 152 in the Narrative)**

Geodia mesotriaena (the most commonly encountered sponge of the expedition)
Aglaophenia diegensis (one of the most common hydroids in the northeastern Pacific)
Astrangia pedersenii (a solitary coral and one of 11 *Astrangia* species in the Gulf; considered a junior synonym of *A. haimei* by Squires 1959)
**Porites californica* "massive form" (as *P. porosa*, a junior synonym; S&R correctly noted this was the commonest coral on Gulf shores, occurring as dome-shaped encrusting heads 8 inches in diameter)
Stylochus (?) sp. (this might have been *Stylochoplana panamensis*)
Bugula neretina (one of the most widespread bryozoans in the Gulf; also ranging from central California to Panama)
Lagenipora erecta (no species in this genus are known to occur in the Gulf; many *Lagenipora* have been transferred to other genera in recent years)
Lichenopora sp. (misspelled in the Narrative as "*Lichenspora*," p. 342; there are three species of *Lichenopora* in the Gulf: *L. buskiana, L. intricata, L. novaezelandiae*)
Scrupocellaria sp.
Iphione ovata (a tropical scale worm)
Thormora johnstoni (a widely distributed East Pacific scale worm)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Odontosyllis sp. (there are 4 species of *Odontosyllis* known from the Gulf: *O. heterodonta, O. phosphorea, O. polycera, O. undecimdonta*; the last was described and named by Olga Hartman in 1964, who identified the S&R polychaetes)
Thelepus setosus (a circumtropical terebellid polychaete)
Heliaster kubiniji
Phataria unifascialis
Pharia pyramidata
**Mithrodia bradleyi*
Astrometis sertulifera
Echinaster tenuispina (= *Othelia tenuispina*; noted to be more common the farther north they traveled; once very common, now less so due to uncontrolled beach tourism)
**Ophiocoma alexandri*
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
Echinometra vanbrunti
Centrostephanus coronatus
Diadema mexicanum (= *Centrechinus mexicanus*; curiously, S&R collected this common, toxic-spined species only twice, at Punta Lobos and at Marcial Point)
Isostichopus fuscus (as *Stichopus fuscus*; it is surprising that this very common Gulf sea cucumber was found only at two localities by the expedition)

Chthamalus anisopoma

Eurydice caudata (a wide-ranging isopod known from central California to Ecuador; S&R took these specimens by night-lighting)

**Nyctiphanes simplex* (a widespread eastern Pacific euphausid/krill; one of the primary food items of baleen whales in the Gulf)

**Archeomysis* cf. *maculata* (a mysid, taken along with the euphausid *N. simplex*)

**Mysidium rickettsi* (as *Mysidopsis* sp., a mysid taken by night-lighting; not described until 1987, when Harrison and Bowman came across the specimen in the USNM collections) (holotype and allotype; type locality)

**Eurydice caudata*

**Elasmopus pocillimanus*

**Hyale hawaiensis* (probably an incorrect identification; likely one of the amphipod species named by J. L. Barnard in 1979—e.g., *H. californica, H. guasave, H. yaqui, H. zuaque*)

Crangon sp. No. 1 (likely an unknown species of caridean shrimp, but not a *Crangon*)

**Panulirus inflatus* (a recently molted specimen of the tropical, blue spiny lobster; it is odd that only a single specimen of this common lobster was taken by the expedition)

Clibanarius digueti (the blue-spotted hermit crab; perhaps the most common hermit in the Gulf)

Petrolithes hirtipes (a very common porcelain crab in the Gulf)

Pitho sexdentata

Ala cornuta (as *Anaptychus cornutus*, a junior synonym)

Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]

Xanthodius sternberghii (as *Xanthodius hebes*, a junior synonym)

Uca crenulata (S&R felt this was the only species of *Uca* they collected on the expedition; however, the taxonomy of this genus is desperately in need of revision and some species are difficult to differentiate)

Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)

Chiton virgulatus

Acanthochitona sp.

Arca mutabilis (as *Navicula mutabilis*, a junior synonym; the "minute *Zirfaea*-like form" of the Narrative)

Chama echinata (as *Chama squamuligera*; Coan and Valentich-Scott [2012] consider *C. squamuligera* to be a white morph of *C. echinata*)

Cerithideopsis californica (as *Cerithidea mazatlanica*, a junior synonym; Brusca disagrees with the synonymy of *C. mazatlanica* and *C. californica*, and the two seem easy to distinguish from one another)

Melampus olivaceous (an intertidal pulmonate)

Mitrella guttata (as *Nitidella guttata*, a junior synonym; this species, one of the most common small snails in the Gulf, is considered a synonym of *Mitrella/Columbella ocellata* by some workers, but the latter is a trans-Atlantic species)

*Liocerithium judithae (as *Cerithium sculptum*, a junior synonym; one of the most common small snails in the Gulf)
**Conus princeps*
Thylacodes squamigerus (as *Aletes squamigerus*, a junior synonym; also = *Aletes squamigerus*, the scaled worm snail; this species is not reported from the Gulf today, so the identity of these specimens is unclear)
Tegula impressa
Tegula sp.
Acanthochitona exquisita
Chiton virgulatus (S&R note this is the commonest chiton in the Gulf; it remains so today)
Ischnochiton tridentatus
Eudistoma sp. (S&R speculated that this might be an undescribed species; 2 *Eudistoma* species are currently known from the Gulf, *E. mexicanum* and *E. psammion*)
Also mentioned in the Narrative: sea fans, sipunculans, snapping shrimps, cerianthids

<u>March 25: Puerto Escondido, BC outer bay.</u> **<u>Collection No. 11 (p. 156 in the Narrative)</u>**

Aaptos vannamei (questionable identification of a black sponge)
Cliona californiana (as *C. celata*)
Aglaophenia longicarpa
**Anthopleura dowii* (anemone)
**Palythoa complanata* (holotype; type locality) (noted in the Narrative as "In superficial appearance it was identical with…*Zoanthus pulchellus*" of the Caribbean)
**Zoanthus danae*
Astrangia pedersenii (a solitary coral and one of 11 *Astrangia* species in the Gulf; considered a junior synonym of *A. haimei* by Squires 1959)
Latocestus sp. (undescribed species of flatworm/Platyhelminthes)
Membranipora sp. (4 species of *Membranipora* are known from the Gulf today: *M. tuberculata, M. tenuis, M. savarti, M. arborescens*)
Phascolosoma sp. ("small *P. agassizii*")
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Odontosyllis sp., pelagic epitokous stage (there are 4 species of Odontosyllis known from the Gulf: *O. heterodonta, O. phosphorea, O. polycera, O. undecimdonta*; the last was described and named by Olga Hartman in 1964, who identified the S&R polychaetes)
Oenone fulgida (as *Aglaurides fulgida*; a Tropical East Pacific polychaete)
Ceratonereis tentaculata
Heliaster kubiniji
Pharia pyramidata
Mithrodia bradleyi (15 inches in diameter)

Pentaceraster cumingi (*Oreaster occidentalis,* a junior synonym; a widespread Tropical East Pacific species)
Nidorellia armata (a common littoral sea star in the Gulf, but collected by S&R only at Pulmo Reef and Puerto Escondido)
**Leiaster teres* (sea star)
**Phataria unifascialis*
**Acanthaster ellisii* (Eastern Pacific crown-of-thorns)
**Ophiothrix spiculata*
**Ophioderma teres*
Eucidaris thouarsii (one of the commonest urchins in the Gulf; collected "at practically every suitable collecting place")
Holothuria arenicola (a circumtropical species common in the Gulf)
Holothuria impatiens (a circumtropical species; S&R describe this as the second most common sea cucumber from their expedition)
Holothuria lubrica (= *Slenkothuria lubrica*; the sulfur cucumber; the most common sea cucumber taken during the expedition)
Holothura rigida (a circumtropical species)
Neothyone gibbosa
Isostichopus fuscus (not in Phyletic Catalogue, but identified by E. Deichmann; now a rare, Mexican endangered species due to over-exploitation in the 1980s and 1990s)
Euapta godeffroyi (a large, conspicuous synaptid cucumber; surprisingly taken at only 2 localities)
Chiridota sp. (not in Phyletic Catalogue, but identified by E. Deichmann; there are only two valid species of *Chiridota* known from the Gulf today, *C. aponocrita* and *C. rigida*)
Ligia exotica (as *Ligyda exotica*)
**Ligia occidentalis*
Tetraclita stalactifera (as *Tetraclita squamosa stalactifera*)
Clibanarius digueti (the blue-spotted hermit crab; perhaps the most common hermit in the Gulf)
Petrolisthes nigrunguiculatus (a common porcelain crab in the Gulf)
Megalobrachium sinuimanus (as *Pisonella sinuimanus*)
Podochela latimanus
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]
Platypodiella rotundata (as *Platypodia rotundata*)
Xanthodius cooksoni (as *Leptodius cooksoni*, a junior synonym)
Panopeus bermudensis (in 1941, this species was thought to be distributed in the Caribbean and Tropical East Pacific; however, the "panopeid" crabs are a taxonomic mess and the actual identity of the S&R Sea of Cortez species is unclear; there are ~2 dozen described panopeid crabs usually recognized form the Gulf, but this is not one of them)
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Chiton virgulatus (S&R noted this is the commonest chiton in the Gulf; it remains so today)

Lepidozona clathrata (as *Ischnochiton clathratus*, a junior synonym)
Ischnochiton tridentatus
Acanthochitona sp.
Barbatia reeveana (the hairy ribbed mussel; one of the commoner Gulf arc shells)
Arcopsis solida (as *Fossularca solida*, a junior synonym; the common "garbanzo clam" of the Gulf)
Pinna rugosa (the principal commercial Gulf hacha)
Isognomon janus (as *I. anomioides*, a junior synonym; very common, thin rock oyster on rocky shores in the Gulf)
Isognomon recognitus (as *I. chemnitziana* d'Orbigny, a junior synonym)
?*Ptera sterna* (as *Pinctada fimbriata* Dunker 1852; a likely misidentification; the "clam-like hacha" of the Narrative)
Pinctada mazatlanica (the Panamic pearl oyster; surprisingly, this is the only locality this common, but largely subtidal species was collected)
Spondylus princeps (reported as "*Spondlyus* [*sic*] sp. probably *limbatus* Sowerby"; *S. limbatus* is a junior synonym of *S. princeps*, the most common spiny oyster in the Gulf; surprisingly, this common species was collected only once in the Gulf)
Anomia peruviana (known in Mexico as *papas fritas*, or the Peruvian jingle, this is the only species in the genus that occurs in the Gulf; cited as a "rock oyster" in the Narrative; surprisingly, this is the only record of this very common species from the expedition; the Seri People make necklaces from these beautiful and delicate shells)
Modiolus capax (as *Volsella capax*, the bearded mussel; *Volsella* is a junior synonym of *Modiolus*)
Semele corrugata (the "unribbed *Paphia*-like form" in the Narrative; this species is not known to occur north of South America, thus this is likely a misidentification of one of the other 21 species of *Semele* that do occur in the Gulf)
Pleuroploca princeps (as *Fasciolaria princeps*, a junior synonym)
Engina ferruginosa Reeve (the identity of this species is unclear, but it is likely what we now call *Morula nodulosa* or *Morula ferruginosa*)
Mitrella guttata (as *Nitidella guttata*, a junior synonym; this species, one of the most common small snails in the Gulf, is considered a synonym of *Mitrella/Columbella ocellata* by some workers, but the latter is a trans-Atlantic species)
Coralliophila costata
Phyllonotus erythrostomus (as *Phyllonotus bicolor*, a junior synonym; the pink-mouth murex; S&R found this to be the most common large snail of their expedition—indeed, it was once the most common littoral and shallow subtidal large snail throughout the Gulf, but no longer, due to intense over-collecting; large specimens are now exceedingly rare intertidally)
Mancinella tuberculata (as *Thais tuberculata*, a junior synonym)
Pseudozonaria annettae (= *Cypraea annettae,* = *Zonaria annettae,* = *C. sowerbyi*, = *C. ferruginosa*)
Strombus galeatus

Crepidula onyx (slipper shell)
Crucibulum scutellatum (as *Crucibulum imbricatum*, a junior synonym)
Crucibulum spinosum
Tegula mariana
Diodora inaequalis (misspelled as "*inequalis*" in Phyletic Catalogue)
** *Dolabella auricularia* (as "*Dolabella* sp. probably *californica*" in Phyletic Catalogue, a junior synonym)
Acanthochitona exquisita
***Berthellina engeli*
***Cystodytes dellechiajei* (ascidian)
Pyura sp. (the "red sea squirt" of the Narrative; likely *P. lignosa*, a common simple tunicate ranging from the Central Gulf to at least Costa Rica)
Ascidia sp. (noted in the Narrative as "large sea-squirt the color of water"; S&R speculated that this might be an undescribed species; there are 3 species of *Ascidia* known from the Gulf today—*A. sydneiensis, A. interrupta*, and *A. ceratodes*—it is likely their specimen was one of these, and possibly *A. interrupta* which fits their description and is the most common of the three)

March 27: Puerto Escondido, BC inner bay. **Collection No. 12 (p. 170 in the Narrative)**

Tethya aurantia
Aaptos vannamei (questionable identification of a black sponge)
**Alicia beebei* (anemone)
**Phialoba steinbecki* (anemone)
**Phymactis clematis* (anemone)
**Telmatactis panamensis* (anemone)
**Phyllactis concinnata* (anemone)
**Aiptasiomorpha elongata* (anemone)
?*Cerianthus* sp. (5 cerianthid-like burrowing anemones are currently known from the Sea of Cortez: *Andvakia insignis, Cerianthus vas, Isarachnanthus panamensis, Pachycerianthus aestuari, Botruanthus benedini*)
Porites sp. (as "probably *P. porosa*")
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Heliaster kubiniji
Leiaster teres (an uncommon, large, purple-blue sea star ranging from the Gulf to Panama and the Galapagos Islands)
Isostichopus fuscus (as *Stichopus fuscus*; it is surprising that this very common Gulf sea cucumber was found at only 2 localities by the expedition)
Euapta godeffroyi (a large, conspicuous synaptid cucumber; surprisingly taken at only 2 localities during the expedition)
**Ophiactis savignyi*
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]

Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Carditamera affinis (as *Carditamera affinis californica*; S&R considered this "the commonest bivalve in the Gulf"; common in shell middens in the Northern Gulf, where they appear to have been fashioned into pendants)
Megapitaria aurantiaca (as *Macrocallista aurantiaca*, a junior synonym; one of two species known as "chocolata clam," or "almeja chocolata," in Mexico)
Periglypta multicostata (the "*Chione*-like form, 90 mm" in the Narrative)
Leukoma grata (as *Protothaca grata*, a junior synonym)
"Giant sea hares" (= *Aplysia californica*?)
"Undetermined bubble shell"

<u>March 27: Loreto area, Isla Coronado.</u> <u>**Collection No. 13 in the Narrative**</u>

Aaptos vannamei (questionable identification of a black sponge)
Tethya aurantia
Geodia sp.
Cliona californiana (?)
**Phialoba steinbecki* (anemone)
**Telmatactis panamensis* (anemone)
**Palythoa insignis* (syntype)
**Zoanthus dowi*
**Astrangia pedersenii* (a solitary coral and one of 11 *Astrangia* species in the Gulf; considered a junior synonym of *A. haimei* by Squires 1959)
**Porites* cf. *nodulosa* (in the Gulf, *P. nodulosa* has been considered to be restricted to the Cabo Pulmo-Cabo San Lucas corridor; Reyes [1992] considered it a synonym of *P. panamensis*)
Cellepora sp. (3 species in this bryozoan genus are known from the Gulf: *C. brunnea, C. minuta, C. quadrispinosa*)
Phascolosoma sp. ("small *P. agassizii*"; as *Physcosoma agassizii*, a junior synonym)
Ochetostoma edax (type specimen of a spoon worm new to science)
Iphione ovata (a tropical scale worm)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Anaitides madeirensis (an elongate phyllodocid polychaete)
Dorvillea cerasina (as *Stauronereis cerasina*)
Eunice antennata (a wide-ranging polychaete occurring from Southern California to Ecuador; the "*Lumbrinereis*-like form in the Narrative)
Cirriformia spirabranchus (a well-known, tube-building cirratulid polychaete)
Acromegalomma mushaensis (as *Megalomma mushaensis*; a nearly circumtropical sabellid polychaete; very common)
Acromegalomma circumspectum (identification made by Gómez and Tovar-Hernández 2008; possibly the same specimens reported by S&R as *Megalomma mushaensis*, above)
Heliaster kubiniji
Phataria unifascialis

Mithrodia bradleyi
**Ophiocoma aethiops*
**Ophiocoma alexandri*
Ophiactis savignyi (a common Tropical East Pacific 6-armed brittle star)
Ophiactis simplex (the small, 5- or 6-armed brittle star)
Ophioderma teres
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
Holothuria lubrica (= *Slenkothuria lubrica*; the sulfur cucumber; the most common sea cucumber taken during the expedition)
Holothuria arenicola (not in Phyletic Catalogue, but identified by E. Deichmann; a circumtropical species common in the Gulf)
**Ampithoe* sp.
**Ampithoe plumulosa* (a broadly distributed, East Pacific amphipod)
**Aruga dissimilis* (a Southern California species of amphipod)
**Bemlos macromanus* (a Tropical East Pacific amphipod, ranging from the Gulf to the Galapagos)
Petrolithes hirtispinosus (a common porcelain crab in the Gulf)
Megalobrachium tuberculipes (as *Pisonella tubeerculipes*; an uncommon Tropical East Pacific porcelain crab)
Epialtus minimus
Pitho sexdentata
Mithraculus denticulatus (as *Mithrax areolatus*, a junior synonym; common)
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]
Gonopanope areolata (as *Micropanope areolata*, a junior synonym)
Pilumnus gonzalensis
Pilumnus townsendi
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Gastrodelphys dalesi (a copepod symbiont with the sabellid polychaete *Acromegalomma circumspectum*; discovered by Gómez and Tovar-Hernández 2008)
Arcopsis solida (as *Fossularca solida*, a junior synonym; the common "garbanzo clam" of the Gulf)
Isognomon janus (as *I. anomioides*, a junior synonym; very common, thin rock oyster on rocky shores in the Gulf)
Acanthochitona exquisita
Acanthochitona sp.
Mancinella tuberculata (as *Thais tuberculata*, a junior synonym)
Pseudozonaria annettae (= *Cypraea annettae,* = *Zonaria annettae,* = *C. sowerbyi*, = *C. ferruginosa*)
Heliacus bicanaliculatus (as *Heliacus radiatus*, a junior synonym)
Diodora inaequalis (misspelled as "*inequalis*" in Phyletic Catalogue)
Fissurella rugosa
**Heliacus areola bicanaliculatus* (architectonid gastropod)

**Unidentified dorid nudibranch
Didemnum carnulentum (this tunicate was mistaken for a white sponge in the Narrative)
Cystodytes dellechiajei
Pyura sp. (the "red sea squirt" of the Narrative; likely *P. lignosa*, a common simple tunicate ranging from the Central Gulf to at least Costa Rica)

March 28–29: Bahía Concepción, E shore of bay. **Collection No. 14 (pp. 185, 193 in the Narrative)**

Tedania "ignis"
Geodia mesotriaena (the most commonly encountered sponge of the expedition)
Haliclona ecbasis (this species has apparently been reported from the Gulf by no one else)
Tedania ignis (possibly *T. nigrescens*)
Cerianthus sp. (5 cerianthid-like burrowing anemones are currently known from the Sea of Cortez: *Andvakia insignis, Cerianthus vas, Isarachnanthus panamensis, Pachycerianthus aestuari, Botruanthus benedini*)
**Calliactis polypus* (this anemone has been reported worldwide; in the eastern Pacific, so far as is known, it is found only on the shells of gastropods inhabited by the hermit crab *Dardanus sinistripes*)
Porites californica "massive form" (as *P. porosa*, a junior synonym; S&R correctly noted this was the commonest coral on Gulf shores, occurring as dome-shaped encrusting heads 8 inches in diameter)
**Porites* cf. *nodulosa* (in the Gulf, *P. nodulosa* has been considered to be restricted to the Cabo Pulmo-Cabo San Lucas corridor; Reyes [1992] considered it a synonym of *P. panamensis*)
**Zoanthus danae*
Halosydna glabra (a scale worm described just the year before the expedition)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Ceratonereis tentaculata (epitokous/heteronereids stage taken by night-lighting)
Platynereis polyscalma ("epitokous or heteronereids forms" taken by night-lighting; a well-known nereid polychaete ranging from the Central Gulf to Ecuador)
Eunice sp. (there are about 2 dozen species of *Eunice* known from the Gulf today)
Chicoreus erythrostomus (= *Phyllonotus bicolor*, = *Hexaplex erythrostomus*; pink murex; shells only, on beach)
Strombus galeatus
Strombus spp. (taken with a crab net, baited with fish guts)
Heliaster kubiniji
Phataria unifascialis
**Luidia phragma* (a very common subtidal species taken by S&R only at this location, 7 fathoms, in crab nets)
**Ophiocnida hispida* (a Tropical East Pacific, bristly, long-armed brittle star)
**Ophioderma teres*

**Ophionereis annulata*
**Ophiothrix spiculata*
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
***Astropyga pulvinata* (taken with a crab net, baited with fish guts; "A net left down five minutes was brought up with at least 20 urchins in it, and all attacking the bait"; S&R collected this urchin only once, assuming it is strictly subtidal, which it is not)
Encope micropora (= *E. californica)* (common)
Encope grandis (common)
Encope californica
Clypeaster rotundus (noted as rare)
Meoma grandis (heart urchin; abundant 2 to 3 feet below water surface at low tide)
Holothuria inhabilis (a flat, sand-encrusted, trans-Pacific species; only record from expedition)
**Cumella* sp. (Cumacea)
Ampithoe plumulosa (a broadly distributed, East Pacific amphipod)
Pontharpinia sp. (amphipod taken by night-lighting)
Pontonia pinnae (living inside hachas, presumably *Pinna rugosa*)
Eurydice caudata (a wide-ranging isopod known from central California to Ecuador; S&R took these specimens by night-lighting)
Excorallana tricornis (misspelled as *Exocorallana*; there are 5 species of *Excorallana* in the Gulf, 3 that were named and described only recently, so the accuracy of this identification is questionable; further, J. O. Maloney was not known to be the best crustacean taxonomist working at the time)
Mesanthura sp. (almost certainly the very common *M. occidentalis*)
Megabalanus californicus (as *Balanus tintinabulum californicus*)
Balanus improvisus
Balanus trigonus
*,***Pontonia pinnae* (a symbiont in the hatchet clam, *Pinna*)
Synalpheus sanjosei
Synalpheus digueti
Synalpheus townsendi
**Eurydice caudata*
**Excorallana tricornis occidentalis*
**Ampithoe plumulosa*
**Pontharpinia* sp. (gammarid amphipod)
Clibanarius digueti (the blue-spotted hermit crab; perhaps the most common hermit in the Gulf)
Petrochirus californiensis (the largest hermit crab in the Gulf, aka "the gentle giant")
Paguristes digueti (a subtidal, tropical hermit crab "taken in crab nets set at night in 7 fathoms")
Petrolisthes armatus (one of the most common porcelain crabs in the Gulf; likely this species was at every rocky shore they visited, even though they collected it only twice)
Porcellana paguriconviva

Hypoconcha panamensis (collected in “crab net on bottom at night, 7 fathoms”; this crab normally carries a clam shell over its carapace)
Eucinetops lucasi
Epialtus minimus (“associated with hatchet clam,” *Pinna rugosa*)
Ala cornuta (as *Anaptychus cornutus*, a junior synonym; “associated with the hatchet clam,” *Pinna rugosa*)
Microphrys platysoma
Portunus xantusii affinis (as *Portunus pichilinquei*, a junior synonym of this subspecies; taken at night with a “crab net at 7 fathoms”)
**Callinectes bellicosus* (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, “found at practically every suitable station,” and this is still the case) [presence assumed]
Pilumnus townsendi
Dissodactylus nitidus (one of several species of small pea crabs, Pinnotheridae, commensal on sand dollars in the Tropical East Pacific)
Dissodactylus xantusi (one of several species of small pea crabs, Pinnotheridae, commensal on sand dollars in the Tropical East Pacific)
Pinnotheres sp. (“94 pea-crabs” taken by night-lighting at anchorage; should read, “94 specimens of unidentified Pinnotheridae”)
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Sesarma sulcatum
Uca crenulata (S&R felt this was the only species of *Uca* they collected on the expedition; however, the taxonomy of this genus is desperately in need of revision and some species are difficult to differentiate)
Anadara multicostata (as *Arca multicostata*, a junior synonym)
Barbatia reeveana (the hairy ribbed mussel; one of the commoner Gulf arc shells)
Arca pacifica (as *Navicula pacifica*, a junior synonym; the “common large irregular elongate form” in the Narrative)
?*Atrina tuberculosa* (the less common of two pen shells called *callo de hacha*, the other being *Pinna rugosa*; the uncertainty is because S&R did not differentiate the 2 species on the expedition)
Pinna rugosa (the principal commercial Gulf hacha)
Isognomon janus (as *I. anomioides*, a junior synonym; very common, thin rock oyster on rocky shores in the Gulf)
?*Chama frondosa* (as *Chama mexicana* Carpenter; noted as a species of *Spondylus* in the Narrative)
Oliva venulata
Enaeta cumingii
Pleuroploca princeps (as *Fasciolaria princeps*, a junior synonym)
Phyllonotus erythrostomus (as *Phyllonotus bicolor*, a junior synonym; the pink-mouth murex; S&R found this to be the most common large snail of their expedition—indeed, it was once the most common littoral and shallow subtidal large snail throughout the Gulf, but no longer, due to intense over-collecting; large specimens are now exceedingly rare intertidally)
Strombus galeatus
**Liocerithium judithae* (as *Cerithium sculptum*, a junior synonym; one of the most common small snails in the Gulf)

Crepidula onyx (slipper shell)
Crucibulum scutellatum (as *Crucibulum imbricatum*, a junior synonym)
Ischnochiton tridentatus
Aplidium californicum (= *Amaroucium californicum*; a wide-ranging East Pacific compound tunicate; the tunicates of the Gulf of California have not yet been carefully studied)
Didemnum carnulentum
*******Didemnum vanderhorsti*
Eudistoma sp. (S&R speculated that this might be an undescribed species; 2 *Eudistoma* species are currently known from the Gulf, *E. mexicanum* and *E. psammion*)
Ascidia sp. (noted in the Narrative as "large sea-squirt the color of water"; S&R speculated that this might be an undescribed species; there are 3 species of *Ascidia* known from the Gulf today—*A. sydneiensis, A. interrupta*, and *A. ceratodes*—it is likely their specimen was one of these, and possibly *A. interrupta* which fits their description and is the most common of the three)
Also mentioned in the Narrative: "Masked rock-clams," solitary corals (on a "masked rock clam")

<u>March 30 (morning): Isla San Marcos, San Lucas Cove (south of Santa Rosalía). **Collection No. 15 (p. 200 in the Narrative);** steamed for San Carlos Bay in afternoon</u>

?*Cerianthus* sp. ("very plentiful" at this location; 5 cerianthid-like burrowing anemones are currently known from the Sea of Cortez: *Andvakia insignis, Cerianthus vas, Isarachnanthus panamensis, Pachycerianthus aestuari, Botruanthus benedini*)
**Botruanthus benedeni* (burrowing anemone)
**Apionsoma misakianum* (as *Golfingia hespera and Phascolosoma hesperum*, junior synonyms)
Membranipora tuberculata (a common bryozoan ranging from California to Peru)
Eusigalion lewisii (a polychaete of uncertain identification; nothing with this name is known today from the Sea of Cortez)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the Expedition visited)
Amblyosyllis sp. (=*Pterosyllis* according to S&R; there are about 4 dozen species of syllid polychaetes known from the Gulf, only one of which is in this genus, *A. granosa*)
Neanthes sp. (taken night-lighting; 5 species of *Neanthes* are known from the Gulf: *N. caudate, N. cortezi, N. micromma, N. pelagica, N. succinea*)
Perineris sp., epitokous stage (taken by night-lighting; there are no known polychaetes of this genus known in the Gulf today; given that the specimens were epitokes, the identification could easily have been incorrect)
Platynereis agassizi, epitokous ("heteronereids") (taken by night-lighting; likely a misidentification of one of the 3 species of *Platynereis* known from the Gulf today: *P. bicanaliculata, P. dumerilii, P. polyscalma*)

Glycera dibranchiata (a well-known polychaete ranging from San Francisco Bay to the Gulf)
Scolelepis sp. (an unidentified spionid polychaete)
Armandia sp. (2 species of polychaetes in this genus are known from the Gulf: *A. brevis, A. intermedia*)
Travasia gigas (a well-known California-Gulf polychaete)
Chione spp.
Carditamera affinis
Octopus bimacultus
Larval male Loliginidae (squid) (taken by night-lighting; identified by S. Stillman Berry)
Heliaster kubiniji
Phataria unifascialis
Astrometis sertulifera
Ophiothrix spiculata
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
Holothuria lubrica
**Ampithoe plumulosa* (a broadly distributed, east Pacific amphipod)
**Pontharpinia* sp. (amphipod taken by night-lighting)
Eurydice caudata (a wide-ranging isopod known from central California to Ecuador; S&R took these specimens night-lighting)
Ligia occidentalis
**Paranthura* sp.
**Paracerceis gilliana* (almost certainly a mistaken identification, as *P. gilliana* is a Californian species; 3 species in this genus occur in the Gulf: *P. richardsoni*, *P. sculpta*, *P. spinulosa*)
**Albunea lucasii* (sand crab; noted as *Emerita* sp. in *Sea of Cortez*)
***Pagurus albus*
Clibanarius digueti (the blue-spotted hermit crab; perhaps the most common hermit in the Gulf)
Dardanus sinistripes
Paguristes digueti (a subtidal, tropical hermit crab)
Pagurus benedicti
Moreiradromia sarraburei (as *Dromidia larraburei*, a junior synonym; pelagic larvae collected by night-lighting)
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [Presence assumed]
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Uca crenulata (S&R felt this was the only species of *Uca* they collected on the expedition; however, the taxonomy of this genus is desperately in need of revision and some species are difficult to differentiate)
Felaniella cornea (as *Felaniella sericata*, a junior synonym)
Chione californiensis (as *Chione succincta*, a junior synonym; one of the most common bivalves in the Gulf)

Megapitaria squalida (as *Macrocallista squalida*, a junior synonym; one of two species called "chocolata clam," or "almeja chocolata," in the Gulf)
Tagelus affinis (a single specimen; this is the only station this subtidal species was collected)
?*Tivela planulata* (the "Pismo-like clams" of the Narrative)
Olivella dama (as *Oliva dama*)
Fusinus dupetitthouarsi (this is an offshore species that is frequently capture, and killed, by shrimp trawlers; the "large snail….from San Lucas Cove sand flats" of the Narrative)
Nassarius iodes (as *Nassarius ioaedes*)
Nassarius tiarula (as *Nassarius tegula*, a junior synonym)
Strombina maculosa
Murex rectirostris (likely a misidentification of *Murex elenensis* of *M. recurvirostris*)
Mancinella tuberculata (as *Thais tuberculata*, a junior synonym)
Strombus gracilior
Natica chemnitzii
Turbo fluctuosus (as *Callopoma fluctuosum*, a junior synonym; the most common mid-size gastropod in the Gulf)
Balanoglossus sp. (acorn worm)
Branchiostoma californiense (the common Gulf lancelet; referred to as "*Amphioxus*" by Ricketts)

<u>March 30 (afternoon) and March 31 (morning): Bahía San Carlos/San Carlos Bay/ San Carlos Cove, BC.</u> <u>**Collection No. 16 (pp. 203–205 in the Narrative)**</u>

Note: This site is called "Punta Trinidad" in Sagarin et al. (2008). Also note, this is not the same locality as "Bahía San Carlos, Sonora," which is referred to as "Puerto San Carlos" by S&R (see Collection No. 21). Collections made 6–7:30 p.m. on March 30 and 10 a.m.–12 p.m. on March 31.

Blue sponges
Large yellow sponge (*Cliona californiana*?)
White sponge (*Steletta coccinea*?)
Astrangia pedersenii (a solitary coral and one of 11 *Astrangia* species in the Gulf; considered a junior synonym of *A. haimei* by Squires 1959)
Phascolosoma sp. ("small *P. agassizii*"; as *Physcosoma agassizii*, a junior synonym)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Heliaster kubiniji
Astrometis sertulifera
Linckia columbiae
**Ophioderma teres*
Ophionereis annulata
Holothuria lubrica

Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
Long-spined purple urchin (probably *Arbacia stellata* [formerly *A. incisa*] or *Echinometra vanbrunti*)
Agassizia scrobiculata (heart urchin)
Tetraclita stalactifera (as *Tetraclita squamosa stalactifera*)
**Ligia occidentalis*
Ligia exotica (as *Ligyda exotica*)
**Eurydice caudata* (a wide-ranging isopod known from central California to Ecuador; S&R took these specimens by night-lighting)
**Sicyonia penicillata* (an offshore, deeper-water penaeid shrimp)
**Siriella pacifica* (mysid)
**Elasmopus* sp. (amphipod)
**Pontharpinia* sp. (amphipod; possibly 2 different species)
**Pseudosquilla lessonii* (larvae taken by night-lighting)
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Eucinetops panamensis
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]
Glyptoxanthus meandricus (a spectacularly sculptured xanthid crab, once common but now becoming scarce)
***Cataleptodius occidentalis* (as *Leptodius occidentalis*, a junior synonym; one of the most common and abundant small crabs in the Gulf)
Xanthodius cooksoni (as *Leptodius cooksoni*, a junior synonym)
Pilumnus gonzalensis
Eriphia squamata ("old lumpy claws"; a very common, small, pugnacious xanthid crab ranging from the Upper Gulf to Peru)
Calcinus californiensis (one of the most attractive hermit crabs in the Gulf)
Petrolisthes gracilis (one of the most common porcelain crabs in the Gulf; likely this species was at every rocky shore they visited, even though they collected it only 4 times)
Petrolithes hirtipes (a very common porcelain crab in the Gulf)
Petrolisthes nigrunguiculatus (a common porcelain crab in the Gulf)
Petrolisthes sp.
Acanthochitona sp.
Acanthochitona exquisita (abundant at this site)
Chiton virgulatus (S&R noted this is the commonest chiton in the Gulf; it remains so today)
Ischnochiton tridentatus
Stenoplax sonorana (as *Ischnochiton conspicuus*, a misspelling of the junior synonym in Phyletic Catalogue)
Arcopsis solida (as *Fossularca solida*, a junior synonym; the common "garbanzo clam" of S&R)
Isognomon recognitus (as *I. chemnitziana* d'Orbigny, a junior synonym)
Brachidontes semilaevis (as *Brachidontes multiformis*, a junior synonym; a very common small mytilid mussel in the Gulf)

Carditamera affinis (as *Carditamera affinis californica*; S&R considered this "the commonest bivalve in the Gulf"; common in shell middens in the Northern Gulf, where they appear to have been fashioned into pendants)
Tivela planulata? ("Pismo clams" of the Narrative)
Oliva venulata
Mitrella guttata (as *Nitidella guttata*, a junior synonym; this species, one of the most common small snails in the Gulf, is considered a synonym of *Mitrella*/*Columbella ocellata* by some workers, but the latter is a trans-Atlantic species)
Acanthina lugubris
Tegula rugosa (today, this is probably the most common species of *Tegula* in the Gulf)
****Crepidula striolata*** (as *Crepidula squama*, a junior synonym)
***Hoffmannola lesliei* (as *Onchidium lesliei*)
***Haminoea virescens* (as *Haminoea strongi*, a junior synonym)
"Undetermined bubble shell"
Octopus bimaculatus
Also mentioned in the Narrative: anemones, flatworms, nemertean, sipunculan, limpets, tunicates, orange nudibranchs (probably *Berthellina ilisima*), giant terebellid worms, tunicates

<u>March 31 (evening): Bahía de San Francisquito, BC. **Collection No. 17 (p. 211 in the Narrative)**</u>

Note: Ricketts's log notes that the morning tide on March 31 was very poor ("about 2.5 ft or 3 ft below the uppermost line of barnacles").

Leucetta losangelensis (the most common calcareous sponge in the Gulf, and one of the most common sponges in the Tropical East Pacific)
Scrupocellaria diegensis (there seems to be no subsequent record of this California species from the Gulf; 4 other species in this genus are known from the Gulf, and the S&R specimen was likely one of these: *S. bertholetti, S. mexicana, S. scruposa, S. varians*)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Salmacina tribranchiata (as *S. dysteri*; tube worms with rusty red gills; S&R noted this worm "resembles *Filograna*")
Astrometis sertulifera
Heliaster kubiniji
Phataria unifascialis
Ophioderma teres
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
**Chthamalus anisopoma*
**Tetraclita stalactifera* (as *Tetraclita squamosa stalactifera*, and as *Tetraclita squamosa stalactifera*, f. *confinis*)
**Rocinela signata* (reported as *Rocinella aries*, a misspelling of the junior synonym)

**Panulirus interruptus* (the Mexican spiny lobster, with the odd range of San Luis Obispo, California, to Cabo San Lucas, including the Central and Southern Gulf; the expedition found only dried carapaces on the shore here and in several other bays)
Clibanarius digueti (the blue-spotted hermit crab; perhaps the most common hermit in the Gulf)
Petrolisthes nigrunguiculatus (a common porcelain crab in the Gulf)
Emerita rathbunae (burrowed in beach sand)
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Pachygrapsus crassipes (one of the most common invertebrates of the temperate NW Pacific coast, but probably always rare in the Gulf; a temperate disjunct species ranging from the Pacific Northwest to Magdalena Bay [SW Baja], reappearing in the Northern and Central Gulf). The last reliable records in the Gulf seem to be from the late 1960s, and it might be that sea surface temps are now too warm for this species to survive in the Sea of Cortez. Also reported from Japan and Korea. Randall's original type locality of Hawaii was almost certainly an error.
Geograpsus stormi (as *G. lividus*)
Ischnochiton tridentatus
Acanthina lugubris
Lottia dalliana (as *Acmaea daliana*, a junior synonym)
Tegula sp.
Purpura sp. (the genus *Purpura* has been split into several genera, including *Plicopurpura* and *Pteropurpura*; at least 6 species in these 2 genera occur in the Gulf today)
Didemnum carnulentum (this tunicate was mistaken for a white sponge in the Narrative)
Cystodytes dellechiajei
Also mentioned in the Narrative: anemones, bristle chitons, the usual holothurians (presumably *Holothuria lubrica*)

<u>April 1: Bahía de Los Ángeles, BC.</u> <u>**Collection No. 18 (p. 219 in the Narrative)**</u>

<u>From intertidal rocks on W side of bay</u>
Geodia sp.
Cliona californiana (as *C. celata*)
Stelletta clarella (as *Steletta estrella*)
Tethya aurantia
**Anthopleura dowii* (anemone)
**Anthothoe panamensis*
**Bunodosoma californica*
**Palythoa ignota* (syntype)
Latocestus sp. (undescribed species of flatworm/Platyhelminthes)
***Baseodiscus mexicanus* (the largest and most distinctive nemertean in the Gulf)

Bugula neretina (one of the most widespread bryozoans in the Gulf; ranging from central California to Panama)
Scrupocellaria sp. (4 species in this genus are known from the Gulf: *S. bertholetti, S. mexicana, S. scruposa, S. varians*)
Thalamoporella californica (a well-known California bryozoan ranging south all the way to Colombia and the Galapagos Islands)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Thelepus setosus (a circumtropical terebellid polychaete)
Salmacina tribranchiata (as *S. dysteri*; tube worms with rusty red gills; S&R noted this worm "resembles *Filograna*")
***Heliaster kubiniji*
Phataria unifascialis
Linckia columbiae
Mithrodia bradleyi
Echinaster tenuispina (= *Othelia tenuispina*; noted to be more common the farther north they traveled; once very common, now less so due to uncontrolled beach tourism)
***Astropecten armatus* (a very common sand sea star in the Gulf, but collected by S&R only at this single location)
Ophionereis annulata
Ophioderma teres
Ophiocoma aethiops
Ophiactis savignyi (a common Tropical East Pacific 6-armed brittle star)
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
Arbacia incisa
Encope californica
Encope grandis
Holothuria lubrica (= *Slenkothuria lubrica*; the sulfur cucumber; the most common sea cucumber taken during the expedition and the most common littoral cucumber in the Sea of Cortez today)
Pseudocnus californicus (as *Cucumaria californica*; found only at this location)
***Neothyone gibbosa*
***Pentamera chierchia* (found only at this locality)
Epitomapta tobogae (as *Leptosynapta* sp.; taken only at this locality, and possibly also Puerto Refugio, Isla Ángel de la Guarda)
Ligia occidentalis (as *Ligyda occidentalis*; although collected only from this single site, this isopod is common on virtually all rocky shores in the Gulf north of Bahía La Paz, though difficult to capture)
Tetraclita stalactifera (as *Tetraclita squamosa stalactifera*)
Chthamalus anisopoma
Clibanarius digueti (the blue-spotted hermit crab; perhaps the most common hermit in the Gulf)
Petrolisthes gracilis (one of the most common porcelain crabs in the Gulf; likely this species was at every rocky shore they visited, even though they collected it only 4 times)

Petrolisthes hirtipes (a very common porcelain crab in the Gulf)
Platypodiella rotundata (as *Platypodia rotundata*)
Eurypanopeus planissimus
Pilumnus gonzalensis
Eriphia squamata (“old lumpy claws”; a very common, small, pugnacious xanthid crab ranging from the Upper Gulf to Peru)
Pinnixa transversalis (a common Tropical East Pacific pea crab, Pinnotheridae; collected from a “sandy-tubed worm on a sand flat”)
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Geotice americanus (S&R initially misidentified this species as *Hemigrapsus oregonensis*; S. Glassell presumably made the correction)
**Panulirus interruptus*
Acanthochitona exquisita (abundant at this site)
Chaetopleura aff. *lurida* (the “small, hairy chiton” of the Narrative; *C. lurida* ranges from the Central Gulf to Colombia)
Chiton virgulatus (S&R note this is the commonest chiton in the Gulf; it remains so today)
Lepidozona clathrata (as *Ischnochiton clathratus*, a junior synonym)
A “minute *Mopalia*-like form”
Arcopsis solida (as *Fossularca solida*, a junior synonym; the common “garbanzo clam” of the Gulf)
Fugleria illota (the “triangular *Arca*” of the Narrative)
Isognomon janus (as *I. anomioides*, a junior synonym; very common, thin rock oyster on rocky shores in the Gulf)
Saccostrea palmula (as *O. mexicana*, a junior synonym; this is a fairly common edible oyster found throughout the Gulf, and it is also common in Northern Gulf shell middens; this was the “rock oysters” reported from Bahía de los Ángeles in the Narrative)
Carditamera affinis (as *Carditamera affinis californica*; S&R considered this “the commonest bivalve in the Gulf”; common in shell middens in the Northern Gulf, where they appear to have been fashioned into pendants)
Chione californiensis (as *Chione succincta*, a junior synonym; one of the most common bivalves in the Gulf)
Megapitaria squalida (as *Macrocallista squalida*, a junior synonym; one of two species called “chocolata clam,” or “almeja chocolata,” in the Gulf)
Leukoma grata (as *Protothaca grata*, a junior synonym)
Macoma indentata (initially identified by H. Rehder as an undescribed species he intended to name *M. rickettsi*)
“*Paphia*-like form” (probably a misidentification; there are no *Paphia* known to occur in the Gulf)
Terebra variegata
Migtra tristis (as *Strigatella dolorosa*, a junior synonym)
Nassarius tiarula (as *Nassarius tegula*, a junior synonym)
Costoanachis coronata (as *Anachis coronata*)
Mitrella guttata (as *Nitidella guttata*, a junior synonym; this species, one of the most common small snails in the Gulf, is considered a synonym of *Mitrella/Columbella ocellata* by some workers, but the latter is a trans-Atlantic species)

Acanthina lugubris
Mancinella tuberculata (as *Thais tuberculata*, a junior synonym)
**Liocerithium judithae* (as *Cerithium sculptum*, a junior synonym; the "small turret-snails" of the Narrative; one of the most common small snails in the Gulf)
Crepidula onyx (slipper shell)
Crucibulum spinosum
Neverita reclusiana (as *Polinices reclusianus*, a junior synonym of *Polinices reclusiana*, misspelled in the Narrative)
Lottia dalliana (as *Acmaea daliana*, a junior synonym)
Tegula impressa
Pleurobranchidae (unidentified slug)
Hoffmannola lesliei (as *Onchidium lesliei* in Phyletic Catalogue; this species is very similar to *Onchidella binneyi*, and this identification needs verification)
***Berthellina engeli*
***Onchidella binneyi*
Octopus bimaculatus
Octopus sp. (not *O. bimaculatus*; there are 9 species of *Octopus* in the Gulf)
Balanoglossus sp. (acorn worm)
Aplidium californicum (= *Amaroucium californicum*, a wide-ranging east Pacific compound tunicate; the tunicates of the Gulf of California have not yet been carefully studied)
Didemnum carnulentum
Eudistoma sp. (S&R speculated that this might be an undescribed species; 2 *Eudistoma* species are currently known from the Gulf, *E. mexicanum* and *E. psammion*)
Branchiostoma californiense (the common Gulf lancelet)

<u>From tidal flats on N side of bay</u>
**Botruanthus benedeni* (cerianthid anemone)
Anthothoe carcinophila? (the "long turreted snails carrying commensal anemones on their shells" of the Narrative)
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]
Felaniella cornea (as *Felaniella sericata*, a junior synonym)
Chione sp.
Tivela sp.
Octopus sp. (not *O. bimaculatus*)
Crepidula onyx (slipper shell; the "sand flats limpets" of the Narrative)
Branchiostoma californiense (the common Gulf lancelet)
Also mentioned in the Narrative: oysters (attached to rocks in mud), highly ornamented limpets (attached to rocks in mud), small snails (attached to rocks in mud), chitons, tube worms with pea crabs (Pinnotheridae) commensal in the tubes

<u>From "Ballenas Canal" (on collection labels)</u>
**Ophiactis savignyi*
**Ophiocoma aethiops*
**Ophionereis annulata*

<u>April 2: Isla Ángel de la Guarda, Puerto Refugio.</u> <u>**Collection No. 19 (p. 224 in the Narrative)**</u>

Aaptos vannamei (questionable identification of a black sponge)
Hymeniacidon sp. (there are 3 species in this genus known from the Gulf: *H. sinapium*, *H. adreissiformis,* and *H. rubiginosa*; the last is known from Puerto Refugio and likely the species S&R reported)
Leucetta losangelensis (the most common calcareous sponge in the Gulf, and one of the most common sponges in the Tropical East Pacific)
Leuconia heathi (questionable identification; this is a California species)
Aglaophenia diegensis (one of the most common hydroids in the northeastern Pacific)
**Porites californica* (as *P. porosa*, a junior synonym; S&R correctly noted this was the commonest coral on Gulf shores, occurring as dome-shaped encrusting heads 8 inches in diameter)
**Phyllactis concinnata* (ruffled anemone)
**Telmatactis panamensis* (anemone)
Flustra (?) sp. (the genus *Flustra* has been broken apart, and there are now a half-dozen species in other genera that this could have been)
Phascolosoma sp. ("small *P. agassizii*"; as *Physcosoma agassizii*, a junior synonym)
Sipunculus nudus
**Ochetostoma edax* (type specimen of a new echiuran described by W. K. Fisher in 1946; Ricketts's field notes called this "a green *Echiurus*")
Chloeia viridis (the 3-stripe fire worm; a stinging polychaete and fairly common Tropical East Pacific species)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Notopygos ornata ("small Gulf fire worm")
Eulalia myriacyclum (long, green, sand flat polychaete)
Eunice filamentosa (a Gulf endemic)
Palola siciliensis (regarded as a nearly circumtropical polychaete)
Protula tubularia (a poorly known serpulid polychaete)
Stylarioides capulata (this Southern California species has apparently not been reported from the Gulf since the S&R report)
Eurythoe complanata
Chloeia viridis (the "short fat stinging worm")
Heliaster kubiniji
Astrometis sertulifera
Phataria unifascialis
Linckia columbiae

Mithrodia bradleyi
Henricia sp. (5 species in this genus are known from the Gulf today: *H. aspera, H. asthenactis, H. clarki, H. gracilis, H. polyacantha*)
Echinaster tenuispina (= *Othelia tenuispina*; noted to be more common the farther north they traveled; once very common, now less so due to uncontrolled beach tourism)
**Ophiocoma alexandri*
**Ophioderma teres*
**Ophionereis annulata*
**Ophiothrix spiculata*
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
Arbacia incisa
Centrostephanus coronatus
Metalia nobilis (= *M. spatagus*; a small and uncommon heart urchin ranging from the Upper Gulf to Panama, taken only at this locality)
Holothuria arenicola (a circumtropical species common in the Gulf)
Holothuria impatiens (a circumtropical species; S&R describe this as the second most common sea cucumber from their expedition)
Holothuria lubrica (= *Slenkothuria lubrica*; the sulfur cucumber; the most common sea cucumber taken during the expedition and the most common cucumber in the Sea of Cortez littoral today)
Chthamalus anisopoma
Ligia sp.
**Aruga* sp. (amphipod; only one species in this genus is known from the Gulf today, *A. holmesi*)
Pachygrapsus crassipes (one of the most common invertebrates of the temperate NW Pacific Coast, but probably always rare in the Gulf; a temperate disjunct species ranging from the Pacific Northwest to Magdalena Bay [SW Baja], reappearing in the Northern and Central Gulf) The last reliable records in the Gulf seem to be from the late 1960s, and it might be that sea surface temps are now too warm for this species to survive in the Sea of Cortez. Also reported from Japan and Korea. Randall's original type locality of Hawaii was almost certainly an error.
Moreiradromia sarraburei (as *Dromidia larraburei*, a junior synonym; small specimens in tide pools)
Eucinetops lucasi
Microphrys platysoma
Portunus xantusii affinis (as *Portunus pichilinquei*, a junior synonym of this subspecies; taken by night-lighting)
Cataleptodius occidentalis (as *Leptodius occidentalis*, a junior synonym; one of the most common and abundant small crabs in the Gulf)
Eurypanopeus planissimus
Pilumnus gonzalensis
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Palaemon ritteri

Petrolithes hirtipes (a very common porcelain crab in the Gulf)
Acanthochitona exquisita (abundant at this site)
Acanthochitona sp.
Chiton virgulatus (S&R note this is the commonest chiton in the Gulf; it remains so today)
Lepidozona clathrata (as *Ischnochiton clathratus*, a junior synonym, in Phyletic Catalogue)
Ischnochiton tridentatus
Nuttallina sp. cf. *allantophora* (*N. allantophora* is now a junior synonym of *Liolophura japonica*, a far-west Pacific species; it is probable that the expedition's specimen was *Nuttallina crossota* Berry, 1956, the only species in this genus known from the Gulf today)
Chaetopleura limaciformis
Stenoplax sp. (7 species of *Stenoplax* are known from the Gulf today)
Arcopsis solida (as *Fossularca solida*, a junior synonym; the common "garbanzo clam" of the Gulf)
Fugleria illota (the "triangular *Arca*" of S&R)
Isognomon janus (as *I. anomioides*, a junior synonym; very common, thin rock oyster on rocky shores in the Gulf)
Brachidontes semilaevis (as *Brachidontes multiformis*, a junior synonym; a very common small mytilid mussel in the Gulf)
Carditamera affinis (as *Carditamera affinis californica*; S&R considered this "the commonest bivalve in the Gulf"; common in shell middens in the Northern Gulf, where they appear to have been fashioned into pendants)
Lottia atrata (as *Acmaea atrata*, a junior synonym)
Lottia dalliana (as *Acmaea daliana*, a junior synonym)
Lottia mesoleuca (as *Acmaea mesoleuca*, a junior synonym)
Engina ferruginosa Reeve (the identity of this species is unclear, but it is likely what we now call *Morula nodulosa* or *Morula ferruginosa*)
Columbella fuscata
Acanthina lugubris
**Liocerithium judithae* (as *Cerithium sculptum*, a junior synonym; one of the most common small snails in the Gulf)
Turbo fluctuosus (as *Callopoma fluctuosum*, a junior synonym; the most common mid-size gastropod in the Gulf)
Tegula impressa
Diodora inaequalis (misspelled as "*inequalis*" in Phyletic Catalogue)
Fissurella rugosa
Aplysia californica (as "*Tethys* sp. probably *californica*")
Berthella sp. (as *Berthella plumula* in Phyletic Catalogue, which is an Atlantic species; there are 3 described species in this genus known from the Gulf)
Aegires sp. (the "small, elongate, dotted" slug of the Narrative; only one species in this genus is known from the Gulf today, *A. albopunctatus*)
Pleurobranchidae (unidentified slug)
Melibe leonina (as *Chioraera leonina*, a junior synonym; the "pelagic nudibranch also found in Puget Sound"; the existence of this species in the Gulf is still uncertain)

***Hoffmannola lesliei* (as *Onchidium lesliei*; this species is very similar to *Onchidella binneyi*, and this identification needs verification; Ricketts's field notes referred to this as a "tectibranch," noting how abundant they were; today, *O. binneyi* is very abundant at this site)
***Haminoea virescens* (as *Haminoea strongi*, a junior synonym)
Octopus bimaculatus
Aplidium californicum (= *Amaroucium californicum*, a wide-ranging East Pacific compound tunicate; the tunicates of the Gulf of California have not yet been carefully studied)
Didemnum carnulentum
Eudistoma sp. (S&R speculated that this might be an undescribed species; 2 *Eudistoma* species are currently known from the Gulf, *E. mexicanum* and *E. psammion*)
Ascidia sp. (noted in the Narrative as "large sea-squirt the color of water"; S&R speculated that this might be an undescribed species; there are 3 species of *Ascidia* known from the Gulf today—*A. sydneiensis, A. interrupta*, and *A. ceratodes*—it is likely their specimen was one of these, and possibly *A. interrupta* which fits their description and is the most common of the three)
Also mentioned in the Narrative: mussels (*Mytilus*-like), hermit crabs, a "*Leptosynapta*-like form" (possibly *Epitomapta tobogae*)

April 3: Isla Tiburón, Red Bluff Point/Punta Risco Colorado (south end of island). **Collection No. 20 (p. 234 in the Narrative)**

Spirastrella sp. (reported as "a white encrusting sponge"; probably *S. coccinea*, a common Gulf species)
Aglaophenia diegensis (one of the most common hydroids in the northeastern Pacific)
Astrangia pedersenii (a solitary coral and one of 11 *Astrangia* species in the Gulf; considered a junior synonym of *A. haimei* by Squires 1959)
**Porites californica* (as *P. porosa*, a junior synonym; S&R correctly noted this was the commonest coral on Gulf shores, occurring as dome-shaped encrusting heads 8 inches in diameter)
**Bunodosoma californica* (syntype)
**Telmatactis panamensis* (anemone)
**Palythoa rickettsi* (holotype and paratype; type locality)
Stylochoplana plehni (= *Leptoplana californica*; a flatworm/Platyhelminthes)
Porella sp. (2 species of *Porella* are known from the Gulf: *P. rogickae, P. porifera*; if the identification was by R. S. Bassler, it is likely the correct genus identification)
Eurythoe complanata (the ubiquitous fire worm; found at every rocky shore site the expedition visited)
Heliaster kubiniji
Phataria unifascialis
*,***Linckia columbiae*
**Pharia pyramidata*

Ophiothrix spiculata
Ophiocoma aethiops
Ophiactis simplex (the small, 5- or 6-armed brittle star)
Eucidaris thouarsii (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
Centrostephanus coronatus
Holothuria impatiens? or *Holothuria arenicola*? (not in Phyletic Catalogue, but in a letter from E. Deichmann; however, Ricketts's collecting notes say this specimen was "probably the common knobby form," which would imply it might have been either one of these species; both are circumtropical species common in the Gulf)
Tetraclita rubescens (as *Tetraclita squamosa*)
Grapsus grapsus (Sally Lightfoot crab; few)
Pachygrapsus crassipes (one of the most common invertebrates of the temperate NW Pacific coast, but probably always rare in the Gulf; a temperate disjunct species ranging from the Pacific Northwest to Magdalena Bay [SW Baja], reappearing in the Northern and Central Gulf) The last reliable records in the Gulf seem to be from the late 1960s, and it might be that sea surface temps are now too warm for this species to survive in the Sea of Cortez. Also reported from Japan and Korea. Randall's original type locality of Hawaii was almost certainly an error.)
Stenorhynchus debilis (the common Gulf arrow crab)
Cirolana nielbrucei (as *Cirolana harfordi; C. harfordi* is a temperate isopod species that is rare in the Gulf; the S&R specimens [from USNM] were described as *Cirolana neilbrucei* by Brusca, Wetzer, and France in 1995)
Paranthura longitelson (as *Paranthura* sp. in Phyletic Catalogue; collected by night-lighting)
***Palaemon ritteri*
Clibanarius digueti (the blue-spotted hermit crab; perhaps the most common hermit in the Gulf)
Megalobrachium tuberculipes (as *Pisonella tuberculipes*; an uncommon Tropical East Pacific porcelain crab)
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]
Eurypanopeus planissimus
Pilumnus gonzalensis
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Chiton virgulatus (S&R noted this is the commonest chiton in the Gulf; it remains so today)
Ischnochiton tridentatus
Stenoplax limaciformis (as *Ischnochiton limaciformis* in Phyletic Catalogue)
Callistochiton sp. (3 species of *Callistochiton* are known from the Gulf today: *C. colimensis, C. elenensis, C. palmulatus*)
Arcopsis solida (as *Fossularca solida*, a junior synonym; the common "garbanzo clam" of the Gulf)

Fugleria illota (the "triangular *Arca*" of S&R)
Isognomon janus (as *I. anomioides*, a junior synonym; very common, thin rock oyster on rocky shores in the Gulf)
Diplodonta subquadrata (as *Taras subquadrata*, a junior synonym)
Stramonita haemastoma (as *Thais biserialis*, a junior synonym)
Vasula speciosa (as *Thais centiquadrata*, a junior synonym; this species has had a tortuous nomenclatural history—other synonyms include *Thais speciosa, Purpura speciosa, Purpura centriquadra, Manciella speciosa,* and *Purpura triserialis*)
Lottia atrata (as *Acmaea atrata*, a junior synonym)
Lottia pediculus (as *Acmaea pediculus*, a junior synonym)
Turbo fluctuosus (as *Callopoma fluctuosum*, a junior synonym; the most common mid-size gastropod in the Gulf)
Tegula mariana
Diodora alta (misspelled in Phyletic Catalogue as "*Diadora*")
Diodora inaequalis (misspelled as "*inequalis*" in Phyletic Catalogue)
***Elysia diomedea*
Tridachiella diomedea (the famous Gulf "Mexican/Spanish dancer" nudibranch; S&R note it was "possibly the most common nudibranch" they encountered; it is still very common, except where tide-pool tourists have taken them in excess)
Turbo fluctuosus (= *Callopoma fluctuosum*)
Callopoma fluctuosum (possibly a junior synonym of *Tegula brunnea* or *Chlorostoma brunneum fluctuosum*?)
Aplidium californicum (= *Amaroucium californicum*; a wide-ranging East Pacific compound tunicate; the tunicates of the Gulf of California have not yet been carefully studied)
Eudistoma sp. (S&R speculated that this might be an undescribed species; 2 *Eudistoma* species are currently known from the Gulf, *E. mexicanum* and *E. psammion*)
Also noted in the Narrative: barnacles

April 4 (mislabeled as April 22 in the Narrative): Guaymas area, Puerto/Port San Carlos, Sonora (N of Guaymas). **Collection No. 21 (p. 239 in the Narrative)**

Cliona californiana (as *C. celata*)
Aglaophenia diegensis (one of the most common hydroids in the northeastern Pacific)
**Aiptasiomorpha elongata* (holotype)
**Anthopleura dowii* (Specimens taken from Puerto San Carlos, Sonora, were described by Carlgren in 1951 as a new species, *Bunodactis mexicana*. However, Daly [2004] showed Carlgren's specimens to have been *Anthopleura dowii*, thus making *B. mexicana* a junior synonym of *A. dowii*. Daly further reckoned that Brusca's [1973, 1980a] records of *Bunodactis mexicana* were actually an undescribed species, which he named *Isoaulactini hespervolita* [Daly 2004])
**Telmatactis panamensis*

Latocestus sp. (undescribed species of flatworm/Platyhelminthes)
**Phascolosoma dentigrerum*
Eurydice caudata (a wide-ranging isopod known from central California to Ecuador; S&R took these specimens by night-lighting)
Heliaster kubiniji
Phataria unifascialis
Ophioderma teres
Holothuria lubrica (= *Slenkothuria lubrica*; the sulfur cucumber; the most common sea cucumber taken during the expedition and the most common littoral cucumber in the Sea of Cortez today)
**Chthamalus anisopoma*
**Mysidium rickettsi* (paratype)
Sicyonia penicillata (as *Eusicyonia penicillata*; a penaeid shrimp taken while night-lighting)
Clibanarius digueti (the blue-spotted hermit crab; perhaps the most common hermit in the Gulf)
Dardanus sinistripes (or more likely from a Japanese shrimp trawler at Guaymas; possible labeling confusion)
Petrolisthes gracilis (one of the most common porcelain crabs in the Gulf; likely this species was at every rocky shore they visited, even though they collected it only 4 times)
Portunus xantusii minimus (as *Portunus minumus*, a species that has been sunk into *P. xantusii*; captured by night-lighting)
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]
Cataleptodius occidentalis (as *Leptodius occidentalis*, a junior synonym; one of the most common and abundant small crabs in the Gulf)
Parapinnixa nitida (a small pea crab, Pinnotheridae, that might be endemic to the Gulf; collected by night-lighting)
Geotice americanus (S&R initially misidentified this species as *Hemigrapsus oregonensis*; S. Glassell presumably made the correction)
Callistochiton elenensis (as *Callistochiton infortunatus*, a junior synonym, in Phyletic Catalogue)
Arcopsis solida (as *Fossularca solida*, a junior synonym; the common "garbanzo clam" of the Gulf)
Fugleria illota (the "triangular *Arca*" of S&R)
Isognomon janus (as *I. anomioides*, a junior synonym; very common, thin rock oyster on rocky shores in the Gulf)
Carditamera affinis (as *Carditamera affinis californica*; S&R considered this "the commonest bivalve in the Gulf"; common in shell middens in the Northern Gulf, where they appear to have been fashioned into pendants)
Leukoma grata (as *Protothaca grata*, a junior synonym; taken at the Pajaro Island anchorage, just outside Guaymas)
**Conus princeps*
Fusinus dupetitthouarsi (this is an offshore species that is frequently captured, and killed, by shrimp trawlers)

Engina ferruginosa Reeve (the identity of this species is unclear, but it is likely what we now call *Morula nodulosa* or *Morula ferruginosa*)
Acanthina lugubris
Muricopsis armatus (as *Muricopsis squamulata*, a junior synonym)
Phyllonotus erythrostomus (as *Phyllonotus bicolor*, a junior synonym; the pink-mouth murex; S&R found this to be the most common large snail of their expedition; although they list it from only a few locales it was likely present at all rocky shore sites they visited—indeed, it was once the most common littoral and shallow subtidal large snail throughout the Gulf, but no longer, due to intense over-collecting; large specimens are now exceedingly rare intertidally)
Stramonita haemastoma (as *Thais biserialis*, a junior synonym)
Vasula speciosa (as *Thais centiquadrata*, a junior synonym; this species has had a tortuous nomenclatural history—other synonyms include *Thais speciosa, Purpura speciosa, Purpura centriquadra, Manciella speciosa,* and *Purpura triserialis*)
Mancinella tuberculata (as *Thais tuberculata*, a junior synonym)
Cerithium maculosum (it is a mystery why this is the only tidal flat site S&R collected this species, which is very abundant on tidal flats throughout the Gulf; they should have also collected it in the La Paz area, at Puerto Escondido's inner bay, in Bahía Concepción, in San Carlos Bay, on the tidal flats at Bahía de los Ángeles, and at Esteros Agiabampo and de la Luna)
**Liocerithium judithae* (as *Cerithium sculptum*, a junior synonym; one of the most common small snails in the Gulf)
Crepidula incurva
Lottia mesoleuca (as *Acmaea mesoleuca*, a junior synonym)
Tegula rugosa (encrusted with *Chthamalus anisopoma*; today, this is probably the most common species of *Tegula* in the Gulf)
Diodora inaequalis (misspelled as "*inequalis*" in Phyletic Catalogue)
***Berthellina engeli*
Pleurobranchidae (unidentified slug)

<u>From Japanese shrimp trawlers (April 9)</u>
Leptogorgia alba (as *Lophogorgia alba*, a junior synonym; white gorgonian; from the Japanese shrimp trawler)
Hepatus kossmanni (a gift to Ricketts from Captain Corona of Guaymas, who operated a fleet of shrimp trawlers; formerly a common species in shrimp net bycatch, now rare due to decades of bottom trawling)
**Macrobrachium jamaicense* (an amphi-American freshwater shrimp; source of specimen unknown)
Lolliguncula panamensis (Panama brief squid; taken from a Japanese shrimp trawler just south of Guaymas; identified by S. Stillman Berry)
Doryteuthis opalescens (as *Loligo opalescens*, a junior synonym; taken from a Japanese shrimp trawler just south of Guaymas; identified by S. Stillman Berry but likely a misidentification because *D. opalescens*, the California market squid, is a temperate Californian species that doesn't do well in warm waters, although it ranges south as far as the central west coast of Baja California)

April 10: Estero de la Luna (~40 miles S of Guaymas). **Collection No. 22 (p. 253 in the Narrative)**

Obelia dichotoma (also found on the shell of a sea turtle off Point Abreojos)
Obelia plicata
Harenactis sp. (burrowing anemone, family Haloclavidae; this genus has only 2 described species—*H. argentina* and *H. attenuata*, the latter being a Southern California species that is today not known from the Gulf)
Cerianthus sp. (5 cerianthid-like burrowing anemones are currently known from the Sea of Cortez: *Andvakia insignis, Cerianthus vas, Isarachnanthus panamensis, Pachycerianthus aestuari, Botruanthus benedini*)
**Calamactis praelongus* (holotype; type locality)
**Botruanthus benedeni* (burrowing cerianthid anemone)
**Ophiophragmus marginatus* (a sand-burrowing, long-armed brittle star; had not been reported since Lütken's original description, from Nicaragua, a century earlier)
Mellita longifissa (this is the only locality the expedition collected this small sand dollar, which ranges from the Upper Gulf to Ecuador)
Agassizia scrobiculata (heart urchin)
Paraconcavus mexicanus (as *Balanus concavus*)
Megabalanus californicus (as *Balanus tintinabulum californicus*)
**Balanus inexpectatus* (as *Balanus amphitrite inexpectatus*)
**Balanus trigonus* (attached to the blue swimming crab, *Callinectes bellicosus*)
**Chelonibia patula dentata* (type specimen) (incorrectly stated in Phyletic Catalogue as being from "Agiabampo Bay"; actually from the cheliped of the swimming crab, *Callinectes bellicosus*, from Estero de la Luna, Sonora; identified by Dora Henry as a new subspecies and described by her)
Pontogeneia sp. (amphipod, in an "*Obelia* colony")
Caprella aequilibra (caprellid amphipod, in an "*Obelia* colony")
Ericthkonius brasiliensis (amphipod, in an "*Obelia* colony")
Parajassa sp. (amphipod, in an "*Obelia* colony")
Clibanarius panamensis
Dardanus sinistripes
Pagurus albus
Callianassa sp. cf. *C. uncinata* and *C. rochei*
Porcellana cancrisocialis (typically found on the shells of the hermit crabs *Petrochirus californiensis* and *Dardanus sinistripes*)
**Callinectes bellicosus* (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]
Felaniella cornea (as *Felaniella sericata*, a junior synonym; a Tropical Eastern Pacific clam)
Anomalocardia subrugosa
Glovibenus fordii (as *Anomalocaridia subrugosa*, a junior synonym)
**Melongena patula*
Nassarius iodes (as *Nassarius ioaedes*)
Nassarius luteostomus

Nassarius tiarula (as *Nassarius tegula*, a junior synonym)
Parametaria epamella (as *Parametaria coniformis*, a junior synonym; originally described as *Columbella epamella*)
Natica chemnitzii
Balanoglossus sp. (acorn worm)
Also mentioned in the Narrative: gorgonians with hydroids growing on them

April 11: Estero Agiabampo. **Collection No. 23 (p. 261 in Narrative)**

Bugula neretina (one of the most widespread bryozoans in the Gulf; also ranging from central California to Panama)
Polyodontes oculea (scale worm, in *Cerianthus*-like tube)
Lepidonotus hupferi
"*Spirorbis* tubes" (about 15 species of Spirorbidae are known from the Gulf today)
Balanus inexpectatus (as *Balanus Amphitrite inexpectatus*)
Clibanarius panamensis
Petrochirus californiensis (the largest hermit crab in the Gulf, aka "the gentle giant"—presumably the "big hermit crabs in conch shells" in the Narrative)
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]
Ocypode occidentalis (ghost crab; this being the only place this very common sandy beach crab was collected suggests S&R focused almost strictly on rocky shores and mudflats)
Chione californiensis (as *Chione succincta*, a junior synonym; one of the most common bivalves in the Gulf)
Dosinia dunkeri
Megapitaria squalida (as *Macrocallista squalida*, a junior synonym; one of two species called "chocolata clam," or "almeja chocolata," in the Gulf)
Strombus gracilior (presumably the "stalk-eyed conchs" of Narrative)

April 12: Isla Espíritu Santo, Bahía San Gabriel. **Collection No. 24 (p. 266 in Narrative)**

Geodia mesotriaena (the most commonly encountered sponge of the expedition)
Leucetta losangelensis (the most common calcareous sponge in the Gulf, and one of the most common sponges in the region)
**Aiptasiomorpha elongata* (anemone)
**Andvakia insignis* (anemone) (syntypes)
**Epizoanthus gabrieli* (holotype; type locality)
**Palythoa praelonga* (syntypes)
**Zoanthus danae*
Cerianthus (tube only; 5 cerianthid-like burrowing anemones are currently known from the Sea of Cortez: *Andvakia insignis, Cerianthus vas, Isarachnanthus panamensis, Pachycerianthus aestuari, Botruanthus benedini*)
Lepidonotus hupferi (a tropical scale worm)

Acromegalomma mushaensis (as *Megalomma mushaensis*; a nearly circumtropical sabellid polychaete; very common)
Acromegalomma circumspectum (identification made by Gómez and Tovar-Hernández 2008; possibly the same specimens reported by S&R as *Megalomma mushaensis*, above)
** *Acromegalomma quadrioculatum* (as *Megalomma quadrioculatum*)
Heliaster kubiniji
Phataria unifascialis
**Ophiocoma aethiops*
**Ophiocoma alexandri*
**Ophioderma panamense*
**Ophioderma teres*
**Ophionereis annulata*
**Ophiactis savignyi* (a common Tropical East Pacific 6-armed brittle star)
***Eucidaris thouarsii* (one of the most common urchins in the Gulf; collected "at practically every suitable collecting place")
***Arbacia incisa* (*Arbacia stellata* by some workers; the name is in dispute)
Lovenia cordiformis (heart urchin; taken only at this locality)
Holothuria lubrica (= *Slenkothuria lubrica*; the sulfur cucumber; the most common sea cucumber taken during the expedition and the most common littoral cucumber in the Sea of Cortez today)
Euapta godeffroyi (a large, conspicuous synaptid cucumber; surprisingly taken at only 2 localities)
**Chthamalus anisopoma*
Ligia sp.
**Bemlos macromanus* (amphipod)
Goniopsis pulchra (in mangroves)
Xanthodius sternberghii (as *Xanthodius hebes*, a junior synonym)
Pitho sexdentata
Microphrys platysoma
***Ozius tenuidactylus* (brachyuran crab)
Callinectes bellicosus (the pugnacious blue swimming crab; S&R noted this was the most common crab in the Gulf, "found at practically every suitable station," and this is still the case) [presence assumed]
Cataleptodius occidentalis (as *Leptodius occidentalis*, a junior synonym; one of the most common and abundant small crabs in the Gulf)
Epixanthus tenuidactylus (as *Ozius tenuidactylos*, a junior synonym)
***Eucinetops lucassi* (majid crab)
Eriphia squamata ("old lumpy claws"; a very common, small, pugnacious xanthid crab ranging from the Upper Gulf to Peru)
Grapsus grapsus (Sally Lightfoot crab; taken at all rocky shore stations)
Geograpsus stormi (as *Geograpsus lividus*, a junior synonym; a circumtropical species)
Pachygrapsus socius (as *Pachygrapsus transversus*, an Atlantic species)
**Upogebia thistlei*

Upogebia sp. (there are 8 species of mud/ghost shrimp in this genus in the Gulf, but they are difficult to distinguish and often confused with species of other Gulf thalassinidean shrimps, such as *Pomatogebia*, *Neotrypaea*, *Naushonia*, *Callianidea*, and *Biffarius*)
Pontonia pinnae (a symbiont in the hatchet clam, *Pinna*)
Megalobrachium sinuimanus (as *Pisonella sinuimanus*)
Crangon sp. No. 1 (likely an unknown species of caridean shrimp, but not a *Crangon*)
Crangon sp. No. 2 (likely an unknown species of caridean shrimp, but not a *Crangon*)
Clibanarius digueti (the blue-spotted hermit crab; perhaps the most common hermit in the Gulf)
Petrolisthes gracilis (one of the most common porcelain crabs in the Gulf; likely this species was at every rocky shore they visited, even though they collected it only 4 times)
Gastrodelphys dalesi (a copepod symbiont with the sabellid polychaete *Acromegalomma circumspectum*; discovered by Gómez and Tovar-Hernández 2008)
Acanthochitona exquisita
Americhiton arragonites (as *Acanthochitona arragonites*; a single specimen taken)
Arcopsis solida (as *Fossularca solida*, a junior synonym; the common "garbanzo clam" of the Gulf)
Arca mutabilis (as *Navicula mutabilis*, a junior synonym; the "minute *Zirfaea*-like form" of the Narrative)
Isognomon janus (as *I. anomioides*, a junior synonym; very common, thin rock oyster on rocky shores in the Gulf but found attached to mangrove roots here)
Saccostrea palmula (as *O. mexicana*, a junior synonym; this is a fairly common edible oyster found throughout the Gulf, and it is also common in Northern Gulf shell middens)
Brachidontes semilaevis (as *Brachidontes multiformis*, a junior synonym; a very common small mytilid mussel in the Gulf)
Carditamera affinis (as *Carditamera affinis californica*; S&R considered this "the commonest bivalve in the Gulf"; common in shell middens in the Northern Gulf, where they appear to have been fashioned into pendants)
Chama echinata (as *Chama squamuligera*; Coan and Valentich-Scott [2012] consider *C. squamuligera* to be a white morph of *C. echinata*)
Chione californiensis (as *Chione succincta*, a junior synonym; one of the most common bivalves in the Gulf)
Chione sp.
Siphonaria aequilorata (misspelled as "*aequilirata*"; an intertidal pulmonate; this is the "sand flat limpet" of the Narrative)
Oliva venulata
Mitrella guttata (as *Nitidella guttata*, a junior synonym; this species, one of the most common small snails in the Gulf, is considered a synonym of *Mitrella/Columbella ocellata* by some workers, but the latter is a trans-Atlantic species)

Vasula speciosa (as *Thais centiquadrata*, a junior synonym; this species has had a tortuous nomenclatural history—other synonyms include *Thais speciosa, Purpura speciosa, Purpura centriquadra, Manciella speciosa,* and *Purpura triserialis*)
Hipponix antiquatus
Crucibulum spinosum
Lottia strigatella (as *Acmaea strigatella*, a junior synonym)
**Conus brunneus*
***Berthellina engeli*
***Aplysia californica*
** *Melibe leonina* (as *Chioraera leonina*, a junior synonym; the "pelagic nudibranch also found in Puget Sound"; the existence of this species in the Gulf is still uncertain)
***Dolabella auricularia* (as "*Dolabella* sp. probably *californica*" in Phyletic Catalogue; a junior synonym)
Diodora inaequalis (misspelled as "*inequalis*" in Phyletic Catalogue)
Polyclinum sp. (2 species of *Polyclinum* are known from the Gulf today, *P. laxum* and *P. vasculosum*; however, the tunicate fauna of the Gulf has never been carefully studied)
Cystodytes dellechiajei
Also mentioned in the Narrative: a fine patch of coral in the middle of the bay, hacha, porcelain crabs

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The Making of a Marine Biologist: Ed Ricketts

Richard C. Brusca and T. Lindsey Haskin

Edward F. Ricketts (1897–1948) transformed marine biology on the west coast of North America. And, remarkably, he propelled the emergence of important new perspectives on coastal biology and ecology without ever publishing a professional academic research paper. He played an important role in the emergence of marine ecology as a scientific discipline and a career option for young biologists. Environmentalism, as we know it today, did not exist in the 1930s and 1940s, and the field of ecology itself was still a fairly obscure scientific discipline (Hedgpeth 1978a; Lannoo 2010). Ricketts was engaging with both ecology (the science) and environmentalism (the personal philosophy) at a pivotal point in time. He was a pioneer who explored ecology's many facets and implications in remarkable ways. His life was a web of interconnectedness and it reflected his view that everyone and everything is inextricably linked to everything else.

Ricketts's impact stems largely from his two landmark books, *Between Pacific Tides* and *Sea of Cortez: A Leisurely Journal of Travel and Research*, but he and his ideas powerfully influenced many others—including Nobel laureate John Steinbeck and renowned mythologist Joseph Campbell—and his ideas continue to influence scientists, writers, artists, and musicians today. Ed loved teaching, and his ideas and writing continue to teach us, even 72 years after his death. His legacy is inextricably intertwined with that of celebrated author John Steinbeck, with whom he forged a deep friendship and intellectual collaboration grounded in shared ideas about science, art, nature, and humanity that were groundbreaking for their time. An understanding of the intellectual and professional development of either of these great men cannot be achieved without reflecting on their close friendship.

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Early Years

Ricketts was fascinated by natural history from an early age (Rodger 2002, 2015; Kohrs, this volume). Katharine Rodger (2002) notes that he was, "from birth, a child of intelligence and rare charm.... He began speaking very young and began using whole but simple sentences before he was a year old." His family lived in Mitchell, South Dakota, during his formative years and he spent much of his time outdoors exploring nature (Rodger 2006). In a letter to D. M. Clay, Ricketts once said, "At the age of six, I was ruined for any ordinary activities when an uncle....gave me some natural history curios and an old zoology textbook. There I saw for the first time those magical and incorrect words, 'coral insects' " (Ricketts, undated, in Rodger 2002).

Ricketts's college education proceeded in fits and starts. He did not consider formal (school) learning a necessity and never graduated from a university. Learning seems to have been his university goal, not degree-getting. Even so, he placed high value on knowledge and learning in general, and passionately drove himself in that direction.

His university studies began at Illinois State Normal School in 1915, where he took three courses in zoology before dropping out to "explore the country" and try his hand at various jobs in Texas and New Mexico. According to Joel Hedgpeth (1978b), he left school to "escape" an affair with an older, married woman. In September 1917, the army drafted Ed and he clerked in the Medical Corps at Camp Grant, Illinois. The World War I armistice prompted his March 1919 discharge and he enrolled at the University of Chicago. Like all new college students, Ricketts spent the next two years satisfying academic prerequisites. Then, he dropped out again to "take a walk." He passed November and December of 1920 strolling from Indianapolis, Indiana, to Savannah, Georgia—a distance of nearly 800 miles—to escape from what John McCosker (1995) claimed was another dalliance with an older, married woman (Hedgpeth 1978a; Rodger 2002). Four years later, Ricketts published an account of that trip in the June 1925 issue of *Travel* magazine ("Vagabonding through Dixie," Ricketts 1925).

Ricketts returned to the University of Chicago in 1921, taking courses in biology and psychology (Hedgpeth 1995). In the fall of 1922 he took a course from pioneering animal ecologist Warder Clyde Allee, who imbued Ed with a view of animal communities that deeply influenced the way he looked at tide pools and life in general. In a letter that Allee wrote to Joel Hedgpeth in 1950, he remembered Ricketts as "a member of a small group of 'Ishmaelites' who tended sometimes to be disturbing, but were always stimulating" (Hedgpeth 1978a). In addition to Allee, the ideas of two other pioneering sociobiologists, Alfred E. Emerson and William Emerson Ritter, also greatly influenced Ricketts's views.

W. C. Allee (1885–1955) was a visionary biologist who saw animal "societies" as windows providing insight into human society, an idea that forever influenced Ricketts's thinking and writing (e.g., Allee 1923a,b, 1931, 1938). Allee also analyzed how physical factors control the distribution of littoral marine species, concluding that predictable communities of animal species are tied to specific aspects of their physical habitat (Allee 1923a,b). In addition to laying foundational ideas in ecology, Allee helped launch the discipline known today as sociobiology—which explores how biology influences social behavior among animals. His groundbreaking 1938 book, *The Social Life of Animals*, explored revolutionary ideas about animal aggregations and cooperation, group organization and behavior, caste and social hierarchy among animals, and their implications for understanding human behavior. Key among them was the radical idea that cooperation is an innate drive propelling animal behavior, perhaps more powerfully than the drive to compete. Allee suggested that different kinds of organisms lived together in associations that gave survival value to all, and in ways that could, theoretically, be understood and thus predicted (Allee 1931). Hannibal (2016) astutely recognized that Allee, a practicing Quaker, "sought to integrate ethics and science and argued that animals benefit from living in cooperation." She further recognized that Allee "expressly looked for biological grounds upon which to argue the benefits and naturalness of cooperative human societies, posing the idea in counterbalance to the every-organism-for-itself way of looking at Darwin's definition of natural selection."

Allee studied social behavior of animals in both aquatic and terrestrial environments. He and his colleague, Alfred Emerson (1896–1976), were central figures in what became known as the "Chicago school" of ecology. Emerson developed a model of biological evolution in which the social group constitutes a "superorganism" that is the primary unit of natural selection. Much of Emerson's extensive research involved the study of termite physiology, morphology, and behavior.

William Ritter (1856–1944) is perhaps best known for founding Scripps Institution of Oceanography in La Jolla, California. However, before that, while on the faculty at the University of California at Berkeley, he introduced a school of thought called "organicism." The term had been used before, but Ritter was the first to posit a theory applying it to biology. In 1919, he published what he considered his magnum opus, a 400-page treatise titled *The Unity of the Organism; or, the Organismal Conception of Life*, which postulates how all life is organized around interrelationships among things, living in a complex web.

Allee, Emerson, and Ritter fostered the idea that groups of co-occurring organisms constitute something more than simply the sum of the individuals (Allee et al. 1949). Just as a human is more than simply the sum of its millions of cells (due to specialization and cooperation among those cells), aggregations and colonies of individuals function in ways that are unique from each individual. In Allee's views, even co-occurring groups of differing species constitute a unique "community" of life that has qualities greater than, and not recognizable, in each individual species alone. Ritter worked on colonial tunicates (phylum Chordata, subphylum Urochordata) that showed specialization of individuals that helped the entire colony survive (Ritter 1919). Like Emerson, Ritter speculated beyond these colonial organisms to suggest that aggregations such as ant and termite colonies also function as single organisms, or "superorganisms." And he felt that the principles governing these "lower forms" could be extended to human society (Ritter 1915, 1919; Ritter and Bailey 1928).

In 1923, Ed Ricketts and his former college roommate, Albert Galigher, cooked up an idea to open a biological supply business on the Pacific Coast. They moved from Chicago to the Monterey Peninsula (California) and established Pacific Biological Laboratories (PBL) at 165 Fountain Avenue in Pacific Grove. Ricketts's wife, Nan, and their 3-month-old son, Ed Jr. (born 23 August 1923), followed a few months later. The first location of PBL was short-lived, and eventually the lab moved to 740 Ocean View Avenue, on the waterfront in Monterey—the location that John Steinbeck made famous in his novel *Cannery Row*. Later, when the street was renamed Cannery Row, the number was changed to 800.

At the time, Hopkins Marine Station (founded in 1892 at Lovers Point in Pacific Grove, and relocated to its present location at Point Cabrillo in 1917) was an intellectual magnet on the Monterey Peninsula with a single building that still stands today as the Agassiz Building.

As soon as he arrived, Ricketts immediately began combing the tide pools of the Monterey Peninsula, collecting biological specimens that

Pacific Biological Laboratories ("Western Biological Laboratories" in Steinbeck's *Cannery Row*) began selling to schools and labs throughout the country. In 1929, Ricketts designed and had printed an expansive, upgraded version of the PBL Catalogue that was a prototype for what was to become the "phyletic catalogue" of his groundbreaking book, *Between Pacific Tides*. Although only three phyla—sponges, cnidarians, and ctenophores—were included in this catalogue, it was the first of a planned series that was supplanted by the book itself, as further editions of the lab catalogue never materialized.

Ed Ricketts, 1936. Photograph by Ralph Buchsbaum, courtesy Vicki Pearse.

No guides existed to familiarize Ricketts with Pacific tide-pool life. Instead, he had to pore through original and often obscure scientific literature to identify the creatures he collected. He also built a lengthy list of specialist correspondents around the country with whom he consulted (see Brusca, this volume). Ricketts's ecological views took shape on collecting trips that carried him from Puget Sound, Canada, to Baja California, Mexico. Ed, Nan, and their three children visited Puget Sound many times, renting cottages in Hoodsport, Washington, a picturesque coastal town hugging the placid waters of Hood Canal, where their hosts and regular seasonal visitors came to know them well.

As Ricketts scoured Pacific Coast tide pools, an emerging sense of animal community organization, influenced strongly by Allee's, Emerson's, and Ritter's views of ecology, took form. Ed's keen observational skills led him to conclude that seashore life of the Pacific Northwest could be segregated into broad biogeographic assemblages. He quickly learned that fauna of the Pacific Coast of North America splits into two fundamental groups. North of Point Conception (California) a cold-temperate fauna dominates, and to the south a warm-temperate one. Within each of these, exposed outer coastlines and protected inner waterways and bays also host distinct faunas. In particular, the outer coast of Vancouver Island, the Queen Charlottes, and the far northwest shores have a markedly different fauna than that inhabiting the calmer and more protected waters of the Inside Passage and Puget Sound.

Ed Ricketts, in a tide pool near Port Townsend, Washington.

During the 1930s and early 1940s, Ricketts built a large circle of friends—the "Lab Group." Ed's broad interests and interdisciplinary thinking were reflected in this rare assemblage of intellectuals and artists, who gathered regularly to share stories, ideas, and adult libations. Some of the people who drifted into and out of the group and influenced Ricketts's thinking included mythologist Joseph Campbell (e.g., *The Hero with a Thousand Faces*, *The Power of Myth*), modernist novelist and painter Henry Miller (e.g., *Tropic of Cancer*, *Tropic of Capricorn*, *Black Spring*), and avant-garde composer John Cage (e.g., *Sonatas and Interludes*). Other friends included Ritchie and Tal Lovejoy; Jack and Sasha Calvin; attorney Webster "Toby" Street; Francis Whitaker (a Monterey artist-blacksmith); Bruce Ariss (a Monterey artist and designer who accompanied Ricketts on collecting excursions to Mexico and who, later in life, was set director for the *I Love Lucy* show); Lincoln Steffens (news journalist and writer); and artist Jim (and wife Peggy) Fitzgerald. Fred Strong appeared on the scene during these years, eventually marrying Ed's sister Frances in 1932. It was, again, Hannibal's (2016) take on those years of the Lab Group that might best capture the essence of things: "Pacific Grove in the 1930s was something like East Hampton in the 1970s. The vibe was festive, with a higher purpose, and among the parties and the fun, lasting contributions were being created by foundational artists."

Professional biologists also visited Ed at the Lab, including Waldo Schmitt from the Smithsonian Institution, Libbie Hyman from the American Museum of Natural History, and Torsten Gislén of the University of Lund, Sweden. The Gislén family spent 2 years in the U.S., most of their time in the Monterey area where they rented a house in Pacific Grove near the Ricketts's home. This broad cross-section of intellectuals, artists, and unemployed devotees of life played a profound role in shaping Ricketts's thinking, especially his holistic view of life. They helped him see the value of interconnections and cross-disciplinary thinking—ultimately the core strength of the yet-to-fully-emerge discipline of ecology. However, none of these friendships were as deep or consequential as the one he formed with John Steinbeck in the formative days of their respective careers. And, appropriately, ecology played a fundamental role in their friendship.

Steinbeck and Ricketts met in 1930, when Steinbeck was 28 years old and Ricketts 33. This was just 2 years after Steinbeck met his wife-to-be, Carol Henning, at Lake Tahoe and finished his first novel, *Cup of Gold*

(1929; a historical novel about the 17th-century pirate Henry Morgan, inspired by Steinbeck's first sea voyage from California to New York, via the Panama Canal) (DeMott 1995; Shillinglaw 2006). As soon as Steinbeck and Ricketts met, they struck up a friendship and discovered that they shared fascinations with marine biology, literature, philosophy, art, music, and alcohol. Some might add "women" to their list of shared interests, but it seems to us that Ricketts, far more than Steinbeck, appreciated the fairer sex, viewed them as equals, and valued spending quality time with them. Although, by today's standards, Ricketts's ongoing extramarital affairs, especially with much younger women, might be viewed as risqué.

As Hedgpeth (1978b) noted, "frequent love is possible [but] it requires a vitality of mind, which Ed certainly had." And, "sexual intercourse was a lovely and holy thing to Ed, an expression of body and spirit, that 'divinely superfluous beauty' for which almost any price was not too great." Ricketts's broad, interdisciplinary interests, including sexuality (both his own, and that of the tide-pool creatures he studied), were as much a part of his life and his thinking as was zoology. This was the milieu in which Ricketts easily convinced Steinbeck—who was already familiar with the subject—that ecology was one of the most important emerging disciplines in human cultural growth.

The two spent countless hours discussing the nuances of ecological concepts and their implications for understanding human behavior. Ideas they explored emerged in both of their writings. Steinbeck accompanied Ricketts on collecting excursions. They both saw tide pools as living examples of cooperation among life forms and real-life laboratories for exploring the "holistic view" of life they'd learned about from the writings of Allee, Ritter, and Emerson.

Hedgpeth (1971) notes a "scrap of paper" on which Ricketts had written, "I have been especially interested in John Steinbeck's notions because they developed widely the holistic concepts being felt specifically in modern biology." This suggests that Steinbeck was thinking about the ideas promulgated by Allee, Emerson, and Ritter before he ever met Ricketts. Allee visited Hopkins in mid-March 1923, just before the summer session began, and it is likely he spread his emerging ideas about groups of organisms acting as "superorganisms" around the lab. Steinbeck was enrolled at Stanford at the time and took a zoology course at Hopkins that summer, taught by Charles Vincent Taylor, who probably presented Allee's ideas in his lectures (Astro 1973, 1976, 1995; Hedgpeth 1978a;

Benson 1984). It has also been suggested that Ritter was a visiting professor at Hopkins that fateful summer, but the Hopkins Marine Station Visitor Logbook for 1923 does not record Ritter as having visited that year. (Of course, it's possible, though unlikely, that he visited but did not sign the logbook.) That same summer, Daniel Trembly MacDougal (first director of Tucson's Desert Botanical Laboratory, then of the Carnegie Institution of Washington, D.C.) also visited the lab. MacDougal had earlier published the first modern description of the Colorado River delta and uppermost Gulf of California (MacDougal 1906).

Recognizing Animal Communities and *Between Pacific Tides*

Ed Ricketts was by nature a generalist who synthesized ideas, combining "all his experience, observation, and reading into an integrated whole, a total picture" (Hedgpeth 1978a). What Ricketts discovered in the tide pools he studied coalesced into a schematic diagram of littoral ecology that he premiered in one of the most pivotal books ever written about marine biology—*Between Pacific Tides* (Ricketts and Calvin 1939). Building on Allee's intertidal research in Massachusetts, Ricketts catalogued how environmental conditions predict the presence/absence of species and particular communities on Pacific shores, and how these species form cooperative associations. Ricketts also embraced new ecological ideas, such as competitive exclusion, and wrote with an understanding of food webs that was on the forefront of science at the time.

Ricketts collaborated on *Between Pacific Tides* with his friend Jack Calvin, who helped Ed on many collecting trips, provided photographs for *Between Pacific Tides*, and edited the manuscript. Calvin was a scholar in his own right—a writer, environmentalist, photographer, illustrator, and eventually a printer. He held a master's degree in English literature from Stanford (where he and Steinbeck first met), and he wrote several books and a column for the Carmel *Pinecone* (titled "The Boojum"). Calvin, with his wife, Sasha Kashevaroff, and her mother, came to California from Juneau (Alaska) in the late 1920s. Before moving to Carmel, Calvin taught high school in Mountain View (California). Jack built a cottage for Sasha and himself in Carmel in 1929, but in 1931 the couple returned to Alaska, this time moving to Sitka where Jack founded that state's oldest conservation group, the Sitka Conservation Society, which still survives. Among other activities today, it encourages citizen scientists to help monitor human impacts in the Tongass National Forest (Hannibal 2016). According to Calvin (Rodger 2015), it was he who suggested that Ricketts write about the local marine life.

In 1932, Calvin and his wife sailed their 33-foot motorboat, *Grampus*, to Tacoma (Washington), where Ricketts and the budding writer Joseph Campbell joined them. Campbell, still a "starving artist," had moved to Pacific Grove (near Monterey) a few months earlier and lived next door to Ed and Nan on 4th Street, in a house known locally as "Canary Cottage" where he traded work for rent. The foursome sailed on the *Grampus* from Tacoma to Sitka via the Inside Passage, on a collecting trip for Ricketts and for a chance to accumulate more data for his planned book on the Pacific Northwest. The *Grampus* charter was "funded" by a commercial contract (with Pacific Biological Laboratories) to collect specimens, especially the commerically important small hydromedusa *Gonionemus vertens*. At Sitka, Sasha's sister Xenia Kashevaroff (who was, at one point, Ricketts's lover) joined the voyage for the final leg of the 1,100-mile sea journey to Juneau.

Immediately after the *Grampus* expedition, Ed prepared a typescript from his notes (titled "Notes and observations, mostly ecological, resulting from northern Pacific collecting trips chiefly in southeastern Alaska, with special reference to wave shock as a factor in littoral ecology," aka the "Wave Shock Essay"), about a fourth of which is reproduced in Hedgpeth (1978a) and all of which is reproduced in Straley (2015). Although never formally published, the Wave Shock Essay was read and edited by at least three other scientists: Walter K. Fisher, George E. MacGinitie, and Waldo Schmitt. As noted by Miner et al. (2015), his experiences during the *Grampus* expedition firmly cemented recognition of three distinct kinds of coastal habitats in Ricketts's mind, as he would codify in *Between Pacific Tides*: open coasts, protected outer coasts, and bays and estuaries.

Ricketts worked to polish the final version of the manuscript for *Between Pacific Tides* during the *Grampus* expedition, and while the group was in Sitka, Joseph Campbell read it and offered his editorial suggestions. In Juneau, the group visited Sasha Calvin's family, including her father, Andrew Petrovich Kashevaroff, the Russian Orthodox priest at the town's St. Nicholas Church. On 26 August 1932, Ricketts and Campbell boarded the *Princess Louise* and departed for Seattle; it would be the last trip they took together (Mondor 2015).

Ricketts explored the biological significance of tides more than any scientist preceding him (and most after him). In the early 1930s, he got caught up in a hypothesis by G. H. Darwin, son of Charles Darwin. The younger Darwin postulated that, as time has passed since the formation of the Earth, day length has gradually gotten longer, due partly to the drag of the tides on the planet's rotation. He even put a number on it, declaring that day length has increased by about 1 minute every 6 million years. In addition, he estimated that the lunar month was becoming longer as the moon's distance from the Earth increased. As a result of these two factors, G. H. Darwin reasoned, tides have gradually decreased since the Earth's oceans first formed. Thus, tides of the past would have been greater, and long ago, much greater. The stronger tides would have had a greater influence on Earth's life forms, on land and in the sea. Reasoning forward from this idea, Ricketts concluded that Cambrian tides might have been a dominant environmental factor for littoral animals that indelibly imprinted adaptive traits that survive in their genes to the present day. In this regard, Ricketts wrote (in an unpublished 1934 manuscript):

> Consider especially [the tide's] influence on gonads turgid with eggs or sperm, already almost bursting and awaiting only some "last straw." Note also the dehiscence of ova thru the body wall of the polychaete worms of ancient lineage, dating back almost unchanged to the Cambrian.... There is tied up to the most primitive and powerful social (collective) instinct, a rhythm "memory" which affects everything, and which in the past was probably far more potent than it is now.

Of critical importance was Ed's thoughtful approach to understanding the influence of tides on seashore life. Although he did not "discover" the phenomenon of intertidal zonation, which dates back at least to Pruvot's work in 1897, the year Ed was born, Ricketts was the first person to systematize and index the concept for a broad region (the Pacific Coast of North America) and to cast it in a contemporary ecological context.

Many of Ricketts's ideas were liberally borrowed and published upon by academic scientists, such as Maxwell S. Doty, Thomas Alan Stephenson, and Eugene Kozloff. However, none of these academic scientists gave Ricketts his due credit for codifying, in great detail, the concept of intertidal zonation. Prior to *Between Pacific Tides*, books on seashore life in North America were organized taxonomically, phylum by phylum, species by species. One of the first, and most well known, of these was *Seashore Animals of the Pacific Coast*, by Johnson and Snook. (1927). Well after *Between Pacific Tides* made its debut, more such books continued to be organized taxonomically, e.g., MacGinitie and MacGinitie (1949, 1968), Brusca (1973, 1980), Brusca and Brusca (1978), Morris et al. (1980), Carlton (2007). Eugene Kozloff's two editions on seashore life in the northeast Pacific (1973, 1983) came the closest to Ricketts's approach, organized as chapters treating docks and pilings, rocky shores of Puget Sound, rocky shores of the open coast, sandy beaches, and bays and marshes. However, within each of these broad habitat categories, animals were still mostly described in a linear and taxonomic fashion.

In his 1983 volume, Kozloff clearly attempted to treat the seashore in a fashion that captured both Ricketts's schema and the traditional taxonomic approach. The closest thing we have today to Ricketts's dream of an "outer shores" guide is Chapter 5 in that book, which examines the outer shores from Vancouver Island to Northern California. Surprisingly, Kozloff never mentions Ricketts's ideas, or *Between Pacific Tides*, failing to even include that landmark book in his compiled list of references—a grievous and almost certainly purposeful oversight.

Flattely and Walton (1922) toyed with the idea of presenting seashore life from an ecological point of view. As they suggested in the preface to their book: "Hitherto, the authors of works dealing with the sea-shore have confined themselves almost entirely to describing and classifying the different forms of life occurring between tidemarks. The main idea underlying the present work, on the other hand, is to treat the plants and animals inhabiting the sea-shore from the ecological standpoint." But they failed to achieve that goal, and their treatise on British shores ended up being a dry, basic marine ecology text.

The British naturalist and marine biologist T. A. Stephenson visited Pacific Grove to study the intertidal zonation near Hopkins Marine Station and had at least one lengthy conversation with Ed Ricketts about littoral ecology (Hedgpeth 1978a). Ed, in his usual generous way, subsequently wrote Steinbeck that he considered Stephenson one of the world's greatest zoologists, and probably the greatest ecologist (Hedgpeth 1978a). However, Stephenson's monumental monograph (*Life Between Tidemarks on Rocky Shores*), published posthumously and with a title unsettlingly similar to Ed's own *Between Pacific Tides*, does not even mention Ed or his work (Stephenson and Stephenson 1972). Like Kozloff's lack of acknowledgment for the work of Ed Ricketts, Stephenson seems to have snubbed Ed because he was not a member of the PhD/ academic "card-carrying club." But Stephenson's work is not synthetic, or barely so at best, and it is trite in its descriptive approach, contributing little to the fledgling field of ecology.

In contrast, far more important was Sven Ekman's book, *Tiergeographie des Meeres* (1935), the English (and updated) translation of which appeared in 1953. Ed Ricketts (and RCB, as a young marine biology student) found Ekman's synthesis of profound importance—"a magnificent thing," Ed called it (and he must have read the original German version). Even today, no marine ecologist should fail to read Ekman's treatise, if only to ponder that such a beautifully synthetic work could have been written in the 1930s.

Ed Ricketts was not infrequently criticized by his scientific colleagues for using anthropomorphic language to describe animals and animal communities. But one might ask, is not "desire" a perfectly useful word to describe individuals of a species that are feeling the innate urge to mate? When the waters warm, or the currents change just so, or the moon is full, does not their body physiology give them the same urges we humans have when conditions trigger our own desires to mate? Though largely disregarded by his contemporaries of the time, Ricketts's *Between Pacific Tides* has outlasted and outsold all of these other publications. Since its original release by Stanford University Press in 1939, this celebrated text has gone through five additional editions (1948, 1952, 1962, 1968, 1985). It is the all-time best-selling book published by Stanford University Press.

As the field of ecology gradually emerged, it began to give scientific underpinning to what is now called environmentalism. This view of the natural world collided with the anthropocentric view that long dominated science and philosophy and was at the foundation of America's emergence as an economic and industrial power. The waves of European immigrants that came to the New World, drawn by the promise of opportunities, claimed a divinely granted right to exploit what was viewed as a limitless supply of natural resources, declaring it was their "Manifest Destiny" to do so. The adherents to this outlook assumed that the land and the natural resources were put there specifically for European Christians to use as they saw fit and they claimed a moral obligation to remove any obstacles, including indigenous people, that stood in their way. However, within a century, the limits of nature's bounty became evident and scientists who studied the intricacies of natural systems began to challenge the notion that natural resources were inexhaustible. Ever since, a debate has raged in America that pits science against a host of traditional social, economic, political, and religious philosophies. As Ricketts waded through Pacific Coast tide pools, he immersed himself in this emerging debate.

Ricketts, along with his best friend John Steinbeck, explored this emerging argument's intricacies and nuances through a collaborative, multidisciplinary prism whose spectrum ranged from biology and quantum physics to classical music and poetry. They saw animal ecology as a particularly revealing window into human sociology (Davis 2004), despite the fact that the nascent field was struggling to find acceptance. A letter from Joseph Grinnell to Aldo Leopold in 1939 described the field's precarious status: "Some of our potent professors do not grant the worthiness, or even the existence, of a field [called] ecology" (Meine 1988). And Leopold himself, in *A Sand County Almanac* (1949), said, "Ecology is an infant just learning to talk. Its working days lie in the future."

The Great Depression brought Manifest Destiny and other philosophies underpinning American expansion into question, stimulating widespread philosophical exploration. Ricketts's lab was hit hard, as businesses across the country failed. John Steinbeck had a much better time of it financially, due to the success of his books.

In the late 1930s Steinbeck produced three novels that established him as one of the twentieth century's leading authors and strongest advocates of social justice. *In Dubious Battle* (1936), *Of Mice and Men* (1937), and *The Grapes of Wrath* (1939) were emotionally charged and politically controversial stories set in Depression-ridden California. All three explored the importance of individual responsibility as a key aspect of social strength—a theme Steinbeck went on to explore for the rest of his life (Beegel et al. 1997). *The Grapes of Wrath*, in particular, ignited a storm of controversy. Despite the fact that the literary world hailed it as a grand achievement with some calling Steinbeck "America's greatest living writer," California's powerful and conservative agricultural community, including the influential Associated Farmers Organization, reacted violently. They condemned Steinbeck for his harsh (though realistic) portrayal of agribusiness farms and the terrible ways in which migrant farmers were treated. At the same time Eleanor Roosevelt was publicly praising his work, they branded Steinbeck an unpatriotic communist. Steinbeck even received death threats and was accused of being a "drug fiend." Conservatives burned copies of his book across the nation, and the conservative backlash led the FBI and J. Edgar Hoover to begin investigating him. This public reaction struck Steinbeck deeply and in the spring of 1939, on the brink of despair, he declared an end to his career as a novelist. He returned to the lab on Cannery Row to work with his best friend and make a "new start."

Sea of Cortez

Ed Ricketts provided Steinbeck a path for the conflicted writer to remove himself physically and emotionally from the turmoil haunting him after publication of *The Grapes of Wrath.* Ricketts had traveled and collected along the northwest coast of the Baja California Peninsula, where the warm-temperate fauna was essentially the same as in Southern California. But he had long desired to travel to the Sea of Cortez, or Gulf of California, which is home to a tropical-subtropical fauna that he knew would be very different from anything else he had ever experienced. So he suggested to Steinbeck that they start planning an extended trip there. Steinbeck jumped at the idea, and their plans soon reached beyond the Gulf of California to include a series of additional ambitious projects.

First, they would travel to the Sea of Cortez to study its intertidal life and write a handbook. They also planned a handbook to the marine life of San Francisco Bay. Ricketts's notes on the planned San Francisco Bay book suggest it would be, first and foremost, a field guide for the lay audience and beginning biology classes in the Bay Area. It would not have a lengthy bibliography, or treat the natural history of each species in great depth, instead referencing *Between Pacific Tides* and Johnson and Snook's *Seashore Animals of the Pacific Coast* (1927) for additional information. However, Ricketts's 20-page proposal (Ricketts, unpublished) also notes that the book will contain "frequent considerations of an ecological and sociological nature," and "the physical architecture of the book" would "derive through the method of sociology"; a study of the "principle of co-operation, in demonstrating survival value of the primitive tendency toward aggregation by animals subjected to unfavorable conditions, may throw light on some of the problems of social organization." His proposal also argued that the book's approach would be convenient and interesting for "the nostalgic layman who respects *Novalis dictum*, 'Philosophy is properly homesickness, the wish to be everywhere at home.' "

After completing their guidebook to San Francisco Bay, they would prepare a study of the open coast of the Pacific Northwest, which Ed referred to as the "outer shores." This would be a companion volume to *Between Pacific Tides* and the book they planned to write based on the Sea of Cortez. The entire northeast Pacific Coast would thus be "catalogued." A planned fourth book would be a grand synthesis of Pacific coastal ecology.

By any measure, 1940 was a watershed year. World War II had "officially" commenced the year before, when Britain and France declared war on Germany, which had already conquered much of Eastern Europe. In one year, Germany overran Norway, Denmark, Holland, Belgium, and Luxembourg. Italy and Japan allied with Hitler and the Axis was born. By mid-1940, Germany's forces had marched into Paris and its bombers began pounding England. In 1940, Franklin D. Roosevelt was reelected president of the United States for a third term, Ernest Hemingway published *For Whom the Bell Tolls*, Carl Sandberg received the Pulitzer Prize for *Abraham Lincoln: The War Years*, Charlie Chaplin's classic film *The Great Dictator* premiered, and Walt Disney's *Fantasia* was released. In 1940 John Steinbeck was awarded the Pulitzer Prize for *The Grapes of Wrath* and Hollywood quickly turned it into a movie. In 1940, the then territory of Baja California Sur had a population of 51,471. It was also the year that the legendary Hotel Perla de la Paz opened, and the first air service to La Paz began.

For the Monterey sardine fishing industry 1940 was a banner year. Sardines were so plentiful in Monterey Bay in those days that the fleet of mostly Sicilian-owned purse seiners home-ported in Monterey Harbor simply fished locally, motoring out of the harbor before sunset to make their first set just after dark. By morning their fish holds bulged with sardines that they delivered to the canneries surrounding Ed's lab on Cannery Row. The sardine fishing season ended each March, and in 1940 the fishermen's association threw a big party. Boats were decorated and the revelry continued for an entire weekend. As soon as the party ended, one boat in the fleet embarked on an extraordinary trip.

The *Western Flyer*, a 77-foot wooden purse seiner under the command of her owner and captain, Tony Berry, motored past the harbor breakwater, rounded Point Pinos, the southern boundary of Monterey Bay, and turned into the open Pacific. Onboard were the captain and his crew of three deckhands along with five passengers. Two would disembark in San Diego, Webster Street and Herb Klein. The other three continued south along the Baja California Peninsula, en route to the Sea of Cortez:

Ed Ricketts, John Steinbeck (who chartered the vessel for the voyage), and Steinbeck's wife, Carol. The *Western Flyer*'s fish hold was no longer configured to transport freshly caught sardines. Instead, it was stocked with the means to scientifically collect, preserve, and study marine life. For the next 6 weeks, the *Western Flyer* was no longer a fishing boat, she was a research vessel and she steered a course for the Sea of Cortez.

Western Flyer, on an early sea trial, fully rigged (1937). Photograph probably by Martin Petrich Jr. (per Clare Petrich). Courtesy of the Petrich Family Collections.

The three friends spent each day examining the rocky shores, sandy beaches, mangrove swamps, and other varied habitats in the intertidal region of the Gulf of California. Each evening, Ricketts preserved the specimens he deemed worth keeping and made journal entries detailing the day's collecting activities and the habitat conditions encountered before joining the others aboard for beer and conversations that stretched late into the night. The tale of the voyage scribed by Steinbeck and Ricketts makes up the first half of their book and illustrates how the two friends delved deep into the philosophical underpinnings of ecology and sociology, applying what they observed in the tide pools and while interacting with people they met on the journey. Some events sparked alarm about what the future might hold for the rich biodiversity they encountered and the prosperity of the people they met in Mexico. Of particular concern was the indiscriminate and wasteful harvesting of marine resources.

They spent a day aboard a Japanese shrimp trawler at work and learned that the net is weighted with a lead line that scrapes the seafloor clean as the vessel steams forward. Everything in its path is dislodged from the seabed and captured in the huge net that is brought aboard and dumped on the deck. Deckhands then pick through the mounds of marine life to separate out the shrimp, which make up but a tiny fraction of the total catch. The remaining fish and other sea creatures caught in the trawl are simply pushed over the side as waste and left to die. Steinbeck and Ricketts decried the tremendous destruction they witnessed. Their calls for ending the practice preceded by decades the coining of the term "bycatch" by which biologists and conservationists now refer to the millions of tons of sea life that are killed and discarded in this manner each year.

Despite the carnage, Steinbeck and Ricketts didn't blame or condemn the men on the vessel. Instead, they accepted the reality of what they saw and explained it in terms that linked back to concepts they learned from Allee, Ritter, and Emerson, in particular the holistic-superorganism view, which they applied when they wrote of the men working on the destructive Japanese shrimp boats:

> They were good men, but they were caught in a large destructive machine, good men doing a bad thing.

And of those facilitating the work they wrote:

> The Mexican official and the Japanese captain were both good men,

> but by their association in a project directed honestly or dishonestly by forces behind and above them, they were committing a true crime against nature and against the immediate welfare of Mexico and the eventual welfare of the whole human species.

Instead of blaming the individuals, Steinbeck and Ricketts concluded that, like the U.S. Navy artillery gunners they met preparing for war in San Diego on a refueling stop before entering Mexican waters, they didn't fully understand the scale of the destruction that the "organism" of which they were a part was capable. Steinbeck and Ricketts speculated that if the navy men could see the death and devastation their guns caused in the places where their shells landed, or if the crewmen aboard the shrimp trawler could see the destruction they caused to the seafloor and understand its implications for future generations of people who would depend upon the sea for food and incomes, neither would likely continue doing what they did. But these individuals remained focused on performing their own specific functions without concern for the devastation wrought by the larger societal "machine" of which they were a small part. Rather than concern themselves with its impact, they simply focused their attention on doing what was demanded of them.

The successes of the Japanese shrimp fleet got the attention of the Mexican government. Also, the war began to substantially reduce the number of foreign fishing boats in Mexican waters, especially Japanese fleets. In 1944, for the first time ever, Mexican fisheries took a larger catch from the country than did foreigners. And, by 1948, a major political push in Mexico City began to expand the national fisheries and exclude foreigners.

Sea of Cortez: A Leisurely Journal of Travel and Research is a very different book from *Between Pacific Tides*. In fact, it is really two books. The 277-page Narrative is literary prose written as a "daily log" of the trip that reflects philosophically on natural history and sociology. The 306-page Phyletic Catalogue is a detailed list of the species taken on the expedition, along with bibliographic and natural history information on each. Thus the book does not follow the habitat-community approach of *Between Pacific Tides,* which was the result of years of intensive study and a massive accumulation of observational data. In contrast, *Sea of Cortez* was the result of a brief 24 days of observation in the Gulf, at just 21 locations, and could not possibly have had the biological depth of *Between Pacific Tides.*

At its core, the Narrative is Steinbeck and Ricketts's attempt to motivate readers to broaden their perspectives on their links to nature and humanity as a whole. It is also the clearest and most overt exploration of their ideas about life in which they demonstrate how ecological concepts shine a new and exciting light on our personal links to the totality of existence—what they termed the "ALL." Steinbeck and Ricketts encourage readers to be curious and look beyond their personal horizons to consider how their actions influence not just their immediate neighbors and surroundings, but also those unseen beneath the waves, over the next hill, and on the other side of the planet. They did so by "looking from the tide pool to the stars and back again," and by applying scientific and philosophical ecological concepts to what they saw and experienced on their expedition while reveling in and celebrating their fascination with the interconnections and interdependencies linking it all together.

Hints of everything they learned about ecology and biology from their college days to the moment they boarded the *Western Flyer* can be found on the book's pages. From Allee to Ritter to *Between Pacific Tides* and *The Grapes of Wrath* and everything in between, it is all there. Perhaps more than any other book, *Sea of Cortez* inspired countless young people to abandon more lucrative career paths and become marine biologists and conservationists, especially along the Pacific Coast, from Mexico to Alaska. According to many, it did so not simply by illustrating the real-life significance of biology and ecology, but also by convincing young readers that science can be a lot more fun than they had ever imagined.

The *Western Flyer* returned to Monterey from the Sea of Cortez in late April 1940, but several months passed before Steinbeck and Ricketts began writing their book about the voyage. A few weeks after returning, Steinbeck and his wife, Carol, flew to Mexico City with Herb and Rosa Kline to begin filming a movie based on another of his stories, *The Forgotten Village* (1941). Ricketts soon followed, driving Steinbeck's car down to them, arriving in Mexico City in early June 1940. Being in Mexico City gave Ricketts a vitally important opportunity to work in the library of Mexico's National University (Universidad Nacional Autónoma de México) and research subjects for the second part of the book—the Phyletic Catalogue. Over the course of his visits to Mexico, Ed developed a great fondness for Mexican culture and people. He found their acceptance of "what is" fit comfortably into his non-teleological framework of thinking. He also found Steinbeck's screenplay (*The Forgotten Village*) at odds with this view, resulting in a temporary falling out between the two. Ricketts left Mexico City in late June, traveling by train via Guadalajara, Tepic, Mazatlán, Guaymas, and Tucson before returning to Monterey.

Back in Monterey, Ricketts immersed himself in preparing the second, more scientific part of *Sea of Cortez*—the Phyletic Catalogue—employing the same methodology he had used to prepare *Between Pacific Tides.* A hired photographer prepared black-and-white and color plates of specimens collected on the trip. Ricketts also reached out to his international network of correspondent taxonomists for help verifying the identities of the creatures they had collected. He also consulted experts at Stanford University's Hopkins Marine Station in Monterey. Walter K. Fisher (1878–1953) had been director of Hopkins Marine Station since Ricketts established Pacific Biological Laboratories. Fisher was an expert on starfish, spoon worms (Echiura), and peanut worms (Sipuncula) whom Ed consulted over the years, even though Fisher harshly criticized and antagonized Ricketts.

Fisher scorned Ed's writing style, labeling it convoluted and overly philosophical. Less than enthusiastic opinions of *Between Pacific Tides* from Fisher (and another well-known California marine biologist, George MacGinitie), as well as Stanford University Press's concern that a sufficient market did not exist, had delayed acceptance of the book. Many historians suspect that Fisher was the inspiration, if not the direct target, for the tirade against crusty-minded "dry-ball" professors in the *Sea of Cortez.* According to Hedgpeth (1978b), Fisher thought the book "a bunch of rubbish except for the solid material of the appendix." Despite their difficult relationship, Fisher played a key role in identifying specimens from the Steinbeck-Ricketts Sea of Cortez expedition. And, of course, Fisher often got rare and important specimens from Ricketts for his own research. Two of the undescribed spoon worms collected on the Sea of Cortez expedition were later named and described by Fisher (*Ochetostoma edax* and *Thalassema steinbecki*). It is noteworthy that, although Fisher honored John Steinbeck with a species name, he failed to do so for Ed Ricketts.

Steinbeck returned to Monterey from Mexico and began work on his part of *Sea of Cortez* in January 1941. Working from Ricketts's journal and collecting notes, as well as *Western Flyer* captain Tony Berry's ship log, Steinbeck crafted the Narrative portion of the book. Steinbeck did not keep a formal notebook on the trip. Much if not most of the ideas for the book appear in Ricketts's original notes from the expedition. Once Ricketts compiled the scientific portion of the book, he worked with Steinbeck to prepare instructions for the book's layout that were sent, along with the manuscript, to Steinbeck's publisher in New York, Viking Press.

Sea of Cortez was released on December 5, 1941, a Friday. Events two days later doomed the book to relative obscurity. The December 7 Japanese attack on Pearl Harbor pushed nature, science, and travel out of the public consciousness. America entered the second global war in half a century. Steinbeck and Ricketts were swept up in the war effort too.

After the Sea of Cortez

Ricketts was drafted into the army in October 1942 and worked as a lab technician in the venereal disease section of the induction center at the Presidio of Monterey. There, he allegedly became infamous for a mixed drink he invented, which Steinbeck claimed was known as "Ricketts's Folly" (Steinbeck claimed it was a blend of grain alcohol, codeine, and grenadine; a colorful exaggeration, we suspect). Ricketts's son, Ed Jr., was drafted the year his father was discharged, in 1943, and ended up being stationed in New Guinea.

In 1942, Steinbeck released a book titled *The Moon Is Down* that was inspired by radio reports of the Norwegian resistance fighting against the invading Nazis that he had heard aboard the *Western Flyer*. He also divorced his wife Carol and married Gwyn Conger with whom he moved to New York City. He then spent the majority of 1943 in Europe reporting on the war effort for the *New York Herald Tribune*.

Upon discharge from the military, due to lack of business at Pacific Biological Laboratories, Ricketts went to work for California Packing Corporation as a chemist (where he worked at least through 1947). In the 1930s, Ricketts began compiling data on sardine catches and oceanographic conditions, recording population fluctuations, and contributing occasional commentaries to the yearly sardine supplements published in the *Monterey Peninsula Herald*. Throughout the 1940s, he studied and chronicled the disappearance of the sardines in Monterey Bay, applying a "holistic" view to identify over-harvesting, combined with oceanographic cycles, as the cause of the decline. However, none of his work on sardines was ever published in the professional literature. In 1945, Steinbeck published his novel *Cannery Row*, which made Ricketts a local celebrity and gained him national fame.

In the 1947 annual Sardine Edition of the *Herald* (March 7), Ricketts documented, in more detail than anyone else had ever done, the central California sardine situation. He countered the popular notion in the fishing community that the drop in sardine numbers was due to a "change in the currents." Ricketts presented a step-by-step description of the factors that influence sardine production, beginning with upwellings, how they work, and that they are tied to sea surface temperatures, which fluctuated from one year to the next (using sea temperature data from Hopkins Marine Station). He described the link between upwellings and nutrient supplies to the phytoplankton community, and the link between phytoplankton standing crops and zooplankton production, which sardines rely on for food and their ability to produce offspring. He then described how excessive fishing pressure during years of depressed upwelling (and thus, reduced zooplankton populations) suppressed sardine recruitment for subsequent years. Today, this food web approach, combined with an understanding of basic oceanography, seems almost elementary. But in the 1940s, it was on the cutting edge of science and was a measure of Ed Ricketts's broad, interdisciplinary way of thinking.

In Ed's article for the 1948 Sardine Edition of the *Herald* (April 2), he countered two new ideas floating around in the fishing community—that the reduction in catch was due either to the dumping of munitions in the bay by the military or to atomic bomb tests. Using data from government records, he showed that the most recent banner year for sardine catch was in 1936, and since then there had been a gradual decline due to over-harvesting combined with fluctuations in oceanographic conditions.

In a letter to Torsten Gislén (27 December 1938), Ricketts foreshadowed what was to come.

> The canneries are going strong—they will extract every single sardine out of the ocean if legislation doesn't restrain them, already the signs of depletion are serious. Funny how Americans can't learn the lesson that the north European countries have known for a century.

Eight years later, in a letter to his friend Ritchie Lovejoy (22 October 1946), Ricketts summarized pretty much everything that was known about the sardines off central California. He was the first scientist to provide a credible explanation of California's teetering sardine situation in the 1940s. The conservation warnings of Ricketts and others went unheeded, the catch collapsed, and by the late 1940s the Monterey sardine industry was all but dead.

In 1942, Ricketts returned to Hoodsport to begin collecting and gathering new data for his planned book, *The Outer Shores*, a term he used for the rugged, wave-exposed coastlines of the Pacific Northwest (e.g., Vancouver Island, Haida Gwaii [the Queen Charlotte Islands], the islands of northeast Alaska). He made the trip accompanied by his new girlfriend. Early in the spring of 1940, just before departing for the Sea of Cortez, Ed had met Toni Jackson (Toni Seixas Solomons Jackson), divorced with a 6-year-old daughter. Not long after returning from the expedition, Toni and her daughter, Kay, moved into the lab. Toni's father was Theodore Solomons, the explorer who had worked out and defined the John Muir Trail. Although Ed and Toni eventually "married," it was presumably not legal because Ed and Nan had never divorced. Ricketts was very fond of Kay, but in 1945 the child was diagnosed with a brain tumor, from which she died a few years later (on 5 October 1947).

In October 1944, Steinbeck and Gwyn (and their new baby boy, Thom) moved back to the Monterey Peninsula, purchasing a house known as the "de Soto adobe," not far from Ed's lab. It was during this time that the two men seriously developed their plan for their new book, *The Outer Shores.* Their close friendship proved to be enduring, although for Steinbeck the people of Monterey were not as he remembered them from their earlier, halcyon days together there.

Ricketts spent the summers of 1945 and 1946 on Vancouver Island, and in summer 1946 went on to the Queen Charlotte Islands (now known as Haida Gwaii) and Prince Rupert (British Columbia) doing fieldwork for the planned book. In Haida Gwaii, Ed, accompanied by Toni, landed (by steamship) at New Masset, on Graham Island (the largest in the archipelago), a village of just a hundred or so houses and a few hundred people (the population today not much higher, around 800 people). In the 1940s, the outer shores of British Columbia were still in a pioneering stage, and travel was mostly by boat. Even in the mid-1950s, when RCB's family began their many annual summer treks to Campbell River (on the inner coast of Vancouver Island), most of that island beyond Victoria remained primitive and lacked paved roads.

Ed Jr. accompanied them on the 1946 trip to Vancouver and the Queen Charlottes. It was on the 1945 and 1946 trips, working in the Inland Passage, that Ed finally concluded that his book on northwestern shores would have to be limited to the outermost coasts of Vancouver Island and the Queen Charlottes; the fauna of the Inland Passage shores, being so distinct, would require a separate book. Of course, there was no internet then, and tide tables were difficult to come by, especially for remote areas. But Ed and Ed Jr. measured and graphed the tides manually. Ed Jr. carefully calculated tidal flow patterns that allowed his father to plot animal and algal distributions in the intertidal zone. One of the fundamental phenomena Ed discovered was that, on the outer shores, the beach region between +6-foot and +8-foot tides is uncovered by every low tide, and covered by every high tide—that is, animals and algae in this zone are uncovered and covered twice daily. Thirty years later, RCB extended this idea, speaking to its universality using the Sea of Cortez as a new model. For that region, his "Zone 2, the *Tetraclita-Nerita* Zone," was characterized by the presence of *Tetraclita rubescens* (= *T. squamosa*), *Nerita scabricosta*, *Mexacanthina* (=*Acanthina*) *angelica*, *Lottia atrata*, *Tegula rugosa*, and several other animals (Brusca 1973, 1980).

Ricketts was a liberal-minded, intellectual existentialist who didn't hesitate to explore the philosophical implications of biology and their application to human existence. In his notes from the 1945 trip to the west coast of Vancouver Island (sent to Steinbeck for "rendering"), Ed explored the nature of the emerging science of ecology, noting:

> I got to thinking about the ecological method, the value of building, or trying to build, whole pictures. No one can controvert it. An ecologist has to consider the parts each in its place and as related to, rather than as subsidiary to the whole. It would undoubtedly be good if political leaders, if there are such, would get to know that method. If they could realize no man is an island to himself, any more than the animals are that make up the community, that make up a region, that make up a coastline, he'd be careful to look at more than his own narrow segment.

Kay's death in 1947 proved too much for Toni and Ed's relationship to bear, and they separated. Toni left Monterey and moved to Southern California. There, she met and began living with another marine biologist, Ben Volcani (they married and moved to Palestine in 1948). Later that year, Ed met and began dating Alice Campbell, a 25-year-old philosophy and music major at the University of California, Berkeley. Ricketts and Steinbeck began planning another trip to the Queen Charlottes, this time to include Alice. Ed and Alice married on 2 January 1948, but, again, most historians conclude it was not a legal marriage because Ed and Nan's divorce was never finalized.

In February 1948, Steinbeck visited Ricketts in Monterey to finalize plans for the upcoming Queen Charlotte Islands expedition and the book they hoped it would spawn. They decided to embark in late May. After Steinbeck returned to New York, Ed mailed him all his notes from his previous work for *The Outer Shores.* He included a note that read, "Well, Jnny [sic] boy, this is it, this is 30, the trips of 1945 and 46 are over, it's your book now, and God bless you."

On May 8, 1948, a few days after returning the proofs he'd reviewed for the second edition of *Between Pacific Tides,* Ed hopped into his 1936 Buick to make a quick run to the store. As he drove across the railroad tracks on Drake Street (off Cannery Row) in Monterey, the Buick stalled on the tracks just as the southbound express came through a blind crossing. Unable to stop, the locomotive smashed into Ed's car. He was rushed to the hospital where he lingered a few days before passing away. Steinbeck bolted from New York to be at his side but arrived too late to bid his best friend farewell.

Three years after Ed Ricketts died, Steinbeck's editor convinced him to republish just the Narrative portion of their 1941 book under the title *The Log from the Sea of Cortez* (1951). This new edition begins with a heartfelt homage written by Steinbeck about his dearest friend. Among the touching passages describing this extraordinary individual, Steinbeck refers to the expedition he planned to make with Ricketts to the outer shores, writing,

> At the time of Ed's death our plans were completed, tickets bought, containers and collecting equipment ready for a long collecting trip to the Queen Charlotte Islands, which reach so deep into the Pacific Ocean. There was one deep bay with a long and narrow opening where we thought we might observe some changes in animal forms due to a specialized life and a long period of isolation. Ed was to have started within a month and I was to have joined him there. Maybe someone else will study that little island sea. The light has gone out of it for me.

For unclear reasons the 1951 *Log* did not include Ed's name on the byline—a serious and sad omission, especially given that Ed's treatise on non-teleological thinking was in the book, and the fact that so many academic writers had failed to acknowledge Ed's contributions to their own publications. Steinbeck must surely have been aware of these academic slights during Ed's career. It has been speculated that Steinbeck pushed to keep Ed's name on the book but the publisher refused (perhaps thinking it would dilute Steinbeck's name).

Long after Ricketts's death, the Pacific Northwest field notes and journals he sent to Steinbeck were edited by Joel Hedgpeth and published in a little two-volume set titled *The Outer Shores* (1978). Ed's notes reveal how consistently forward-thinking he was in terms of ecology. In them, Ricketts describes observations leading him to believe that the lower limit of animals in the intertidal zone has "nothing to do with a need for the tidal rhythm" but instead "is due to the workings of a biological.... factor," whereas the upper limit "is probably a function of increasing tidal exposure." This is now viewed as a fundamental generalization of littoral ecology. The roles of competition and predation as mechanisms structuring communities and regulating littoral distributions, and the overarching roles of certain dominant species ("keystone species"), were codified in the classic research papers of Joseph Connell and Robert Paine in the 1960s, and thereafter by a long lineage of their students. But Ricketts explored and discussed these same concepts 25 years before Connell's and Paine's work was published. The profound role of wave energy/shock on beach communities led him to accurately conclude that "the fauna of the surf-swept rocks outside Sitka resembles that of the similarly exposed California coast nearly 2000 miles distant, more than it does that of similar type of bottom protected from surf only three miles away."

Ed's notes were filled with philosophical meanderings, commonly those that invoke his holistic views of ecology. For example, he frequently referred to a biological community as a "society of species," and he defined ecology as "that science which deals with the framework of relations between an animal or a society of animals and its environment.... this is the method of sociology" (Ricketts, unpublished). Particularly good insight into the mind of Ed Ricketts can be found in this comment (Ricketts, unpublished):

> Even the two chief philosophies of human society are paralleled on the shore: those dedicated to the principle that the individual serves the state, chiefly as a unit or cog in that supra-personal social organization that is the colony; and those based on the democratic principle that the state serves the all-important individual. The latter are exemplified by the octopus and by other actively predacious animals which, by their individual skill through intelligence and sensory ability, function as free entities; the former by the sponges, corals, barnacles, compound tunicates, etc., which very definitely function as a group in competitive food getting, in colonizing every

> available square inch of suitable area, and in reproducing, and in which the colonial individual is almost entirely lost sight of before the coherent unity of the community.

Throughout the 1930s and into the 1940s, Ed worked on three philosophical essays. None of them were ever formally published, not even with John Steinbeck's and Paul de Kruif's (*Microbe Hunters*, 1926) efforts and support. However, one of them ("Essay on Non-teleological Thinking") did make it verbatim into *Sea of Cortez* (the "Easter Sunday Sermon" in Chapter 14). The other two essays were *The Philosophy of Breaking Through* and *The Spiritual Morphology of Poetry*. The latter was a short treatise arguing how poetry can be a vehicle for individual transcendence. Ed had all three of these philosophical narratives widely reviewed by his friends, and Steinbeck and Campbell gave him feedback on several versions of them. These essays have also been widely critiqued by modern writers, such as Richard Astro, Joel Hedgpeth, Katharine Rodger, and others. The pieces no doubt influenced some of Steinbeck's novels. As Jackson Benson (1984) observed, one of Steinbeck's most famous novels, *Of Mice and Men*, seems to have been written from a purely non-teleological point of view—no cause and effect, no heroes or villains; it is simply "what is."

Reflections

Ricketts was a pioneer of community ecology on the Pacific Coast of America. In his 1945 "Outer Shores Transcript," sent to Steinbeck for review, he stated succinctly that, "Ecology is the science of relationships" (Rodger 2006). Being a generalist (and a synthesizer) distinguished him from other scientists, especially biologists, who increasingly moved toward specialization, or reductionism, which steered the field of biology away from communities, to species, cells, and eventually DNA. While biologists built taller and taller intellectual silos for their work, Ricketts tore down walls that increasingly blocked a much grander and awe-inspiring vista of the totality of existence and the inextricable links joining all of its components. His driving passion was systems, not species. As Lannoo (2010) put it, "Both men [Steinbeck and Ricketts] had grave suspicions about an emphasis on reductionism at the expense of holistic understanding."

Ed Ricketts was one of those rare individuals who, by his very nature, was both a mystic and a scientist. Hedgpeth (1978b) remarked that one of Ed's favorite bits of advice was, "When you are caught by the tide, don't fight it, drift with it and see where it takes you"—pure Zen, indeed. Of course, Zen can be that enlightenment attained through meditation, self-contemplation, or intuition (rather than through faith and devotion), and Ed often expressed this view. His observations of Tony Berry at the helm of the *Western Flyer* evoked in him a Zen-like sense of boats, sailing, and the sea:

> One thing doesn't shift as you approach [the horizon on a boat] because there's no real approaching: the compass-point 170°; the abstract, Schiller's and Goethe's "Ideal"….to be worked out in terms of reality. Someone said of the tide pool area: "the world under a rock." So it could be said of navigation: "The world within the horizon."

Had he lived another decade, he would likely have embraced Alan Watts's groundbreaking book *The Way of Zen*. Many of the ideas Ed expressed are also echoed in the writings of Hermann Hesse (1877–1962), although he seems not to have read much, or any, of Hesse's work. Hedgpeth always felt Ricketts had more in common with Hesse than with Steinbeck (Hesse was one of Hedgpeth's favorite writers). Hannibal (2016) probably had it right, when she said, "The story of Ed Ricketts is a case study of the hero's journey eventually articulated by Joseph Campbell. Whatever else he did or didn't do, Ricketts followed his bliss."

Ed Ricketts is also a cultural hero in the field of marine biology. More than anything else, it was the writings of Ed Ricketts (and stories told about him by Joel Hedgpeth and John Steinbeck) that influenced RCB's own earliest inclinations toward marine biology, invertebrate zoology, and the Sea of Cortez. After all, Ed seemed to have lived just as he wished, with enough to eat and drink, great books and music to enjoy, good friends to spend time with, traveling up and down the coast tide-pooling, and unabashedly enjoying intimate relationships with his lady friends. Who wouldn't want a life like that, and if becoming a marine biologist was all that was needed, it seems like a no-brainer.

Not much has been written about Joel Hedgpeth's relationship with Ed Ricketts. Joel Hedgpeth and RCB had many discussions about Ricketts and Steinbeck from 1959 through the early 1990s. Joel first met Ed when they began corresponding in 1935, about the sea spiders (Pycnogonida) to be included in *Between Pacific Tides*, although they did not meet face-to-face until 1938 or perhaps 1939. After that, Joel visited Monterey and Ed several times a year. Joel knew Steinbeck too, but he knew Ed far better. Joel was never part of the inner circle of friends, the Lab Group—probably in part because he chose to remain an aloof academic figure himself. We view Hedgpeth as a biologist's version of Gore Vidal—critical, cynical, caustic, a skeptic of the human condition, and bordering slightly on misanthropic. Joel's view of the world was proffered forth by Jerome Tichenor (pseudonym for Hedgpeth) in *Poems in Contempt of Progress* (1974). Tichenor's poem "Miltonesque" could have been written by Ricketts. And certainly Ed would have approved of Tichenor's "The Oyster" (first published in the *Maryland Tidewater News* around 1950):

> Consider the case of the oyster,
> Which passes its time in the moisture:
> Of sex alternate,
> It chooses not to mate,
> But lives in a self-contained cloister.

Two of Joel's edited books eventually became marine biologists' "bibles"—his 1957/1963 two-volume *Treatise on Marine Ecology and Paleoecology*, and his 1952–1985 revisions of *Between Pacific Tides*. In the early years, Joel and Gary J. Brusca (RCB's brother) worked together at the University of the Pacific's (UOP) marine laboratory (Pacific Marine Station) in Dillon Beach, California (at the mouth of Tomales Bay), where RCB spent his summers. Joel became director of the Dillon Beach lab when he took a professorship in zoology at UOP in 1957 (in 1963 he left UOP for an ill-fated position at Oregon State University). Later, Joel and RCB taught a 5-week summer course together, in Mexico, for the University of Arizona, titled "Marine Ecology of the Sea of Cortez." In the evenings, after his third gin and tonic, Joel would be inclined to wax philosophical on Ed Ricketts and *Between Pacific Tides*, or to pull out his Irish harp to entertain whoever was around with his plucking and his bawdy Celtic ditties, stirring memories of Steinbeck and Ricketts's famous line from *Sea of Cortez*, "Your true biologist will sing you a song as loud and off-key as will a blacksmith." One of the things Joel confirmed was the fact that a healthy sex drive was a significant motivator (and occasional liability) for Ricketts. Indeed, he had a pattern of taking long out-of-town trips after affairs with women had ended. As Steinbeck and

Ricketts proclaimed in *Sea of Cortez*, "At least [a true biologist] does not confuse a low hormone productivity with moral ethics."

Joel's curious behavior was probably partly due to what he viewed as a "disfigurement" of his face, resulting from a childhood accident when he was playing with a blasting cap and it exploded. He also lost some fingers in that event. However, it was likely also that Joel was simply socially uncomfortable and so put on airs, an aloof persona of detached intellectualism to cover his awkwardness. In any event, he certainly marched to his own drummer. He left the University of Texas without completing his PhD, due to what he called "an internecine dispute" (Schram and Newman 2007). He returned to UC Berkeley, where he'd taken his master's degree under S. F. Light (of "Light's Manual" fame), and completed his PhD there.

It was Waldo Schmitt, at the National Museum of Natural History, who first formally introduced Hedgpeth and Ricketts (Hedgpeth 1996). Although Joel's graduate work had been on crustaceans, he soon moved on to pycnogonids (sea spiders), and Ed needed help with that obscure group of marine arachnids. Schram and Newman (2007) suggest that Steinbeck's *Sweet Thursday* (1954) character, "Old Jingleballicks," might have been modeled after Joel Hedgpeth. However, that would have been Steinbeck's personal decision. As Hedgpeth (1996) noted, Ed called many people he disliked or considered incompetent "Jingleballicks." It seems more likely that Steinbeck's character was an amalgam of several people (one can only speculate who those might have been). Joel came to greatly value his friendship with Ed (Hedgpeth 1976). Hedgpeth eventually adopted the *nom de plume* of Jerome Tichenor. Under this name, he wrote scathing letters to newspaper editors and published his poetry (e.g., *Poems in Contempt of Progress*). He also claimed Professor Tichenor was president (and sole member) of the "Society for the Prevention of Progress." Had Ed lived longer, he likely would have been elected the second member of the society.

At least two oral histories of Hedgpeth have been compiled. In Robert Calvert's interview with Joel (done in 1976, in New Orleans), Hedgpeth expressed that he, and others, including Joseph Campbell, felt that Steinbeck didn't really "understand what Ed Ricketts was all about." In Ann Lage's interview with Joel (conducted in 1992), Hedgpeth notes that Ricketts recognized the phenomenon of "competitive exclusion" before most American scientists even knew what the phrase meant (Hedgpeth 1996). Ricketts had read the abstract of an obscure 1932 paper by Argentinian biologist Angel Cabrera, and realized it was what he was seeing in California tide pools.

Although the Ecological Society of America was founded in 1920, the field remained largely marginalized for another 20 years. Growing from the seeds planted by Allee, Ritter, Emerson, Ricketts, Leopold, and others, ecology was finally popularized in the 1960s with the newly emerging environmental movement. Another marine biologist, Rachel Carson, gave ecology and environmentalism/conservation a large boost with her popular books, *The Sea Around Us* (1951) and *Silent Spring* (1962). By the mid-1970s, colleges and universities had begun to retool their biology curricula to put ecology front and center, combining the traditional zoology and botany departments into new "ecology and evolutionary biology" departments. The field has gone through several popular movements, some of which tended to lose sight of its roots in natural history (e.g., mathematical and theoretical ecology). Today, it seems to be reaching maturity, or at least a stasis of some kind. And since the turn of the 21st century, with the dramatic rise of molecular biology and no end in sight as new techniques continue to come online, the field of ecology has become less popular. However, trends suggest that ecologists may soon come to embrace molecular methods to perhaps revitalize their field once again, as has begun to happen in so many other subdisciplines of biology. Hopefully, such a trend will not again lose sight of the wellspring of ecology—natural history observation. One cannot help but wonder what Ricketts would have to say about a "molecular transect" in the sea, in which tiny water samples are analyzed to reveal the hundreds of species living in the area based on nothing but tiny fragments of DNA floating with the currents.

Perhaps Ed Ricketts will inspire a new generation of biologists to explore the broader implications of their work by emulating his ability to explore links between ecology, philosophy, and human society. As he wrote in a proposal for a book on littoral ecology:

> The great problems facing mankind today are social problems. From the lowest to the highest forms in the series, all animals are at some time in their lives immersed in some society; the social medium is the condition necessary to conservation and renewal of life….social facts are subject to laws and these are the same everywhere that such facts appear, so that they constitute a considerable and uniform domain in nature, a homogeneous whole thoroughly integrated in all its parts. Light may well be shed on the social problems of

Homo sapiens by a consideration of the social adaptations achieved on the humbler group levels.

There is no doubt that the fields of ecology and environmentalism that Ed Ricketts helped spawn will be part of Western consciousness for a very long time to come.

Acknowledgments

First off, we wish to thank Katie Rodger and Eric Tamm for publishing their outstanding, foundational books on Ed Ricketts; they are wonderful gifts to us all. We also thank Kevin Bailey for his extraordinary research on the *Western Flyer*, and Richard Astro for starting it all. This essay was read and improved by Mary Ellen Hannibal, Katie Rodger, John Pearse, and Don Kohrs. ✤

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Ed Ricketts: From Pacific Tides to the Sea of Cortez

Donald G. Kohrs

Edward Flanders Robb Ricketts

Ed Ricketts was born to Charles Abbott Ricketts and Alice Beverly Flanders Ricketts in Chicago, Illinois, in 1897. Their daughter, Frances, was next born to the family in 1899, followed by a son, Thayer, in 1902. Besides one year spent living in Marshall, North Dakota, the Ricketts children were raised in Chicago, where the family were members of the Episcopal Church (Rodger 2002).

Ed Ricketts's interest in biology was first sparked at age 6 when an uncle gave him several curiosities of natural history and an old zoology textbook. He was a bright child whose early interests included natural history, poetry, art, and philosophy—interests that remained with him throughout his adult life (Rodger 2006).

In 1904, Ricketts was enrolled in Martin A. Ryerson Public School; 10 years later he graduated from the West Side's John Marshall High School. Ricketts next attended Illinois State Normal School for a short while (1915–1916), taking three courses in zoology, but dropped out to "explore the country," working at various jobs in Texas and New Mexico. In September 1917, he was drafted into World War I as a clerk in the Medical Corps at Camp Grant in Illinois. He was discharged in March 1919, after the armistice (Hedgpeth 1978).

In the summer of 1919, Ricketts enrolled in the University of Chicago. During spring of 1920, he joined two graduate students, James Nelson Gowanloch and Albert Edward Galigher, in renting an apartment on Chicago's South Side. Ricketts's association with these two Chicago

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roommates would soon lead to his moving to California and becoming the proprietor of Pacific Biological Laboratories.

In January 1920, Gowanloch traveled with his advisor, Dr. Frank R. Lillie, to Pacific Grove, California, and spent 3 months conducting research at Stanford University's Hopkins Marine Station. Gowanloch expressed his enjoyment of this trip in a book he sent to the station's director years later: "To Dr. Walter K. Fisher, With kindest regards, and recalling a happy visit at Pacific Grove, 1920. James Nelson Gowanloch" (Gowanloch 1933). Upon his return to Chicago, Gowanloch likely shared stories of his visit to Pacific Grove with his roommates, Galigher and Ricketts.

In the fall of 1920, Ricketts did not attend classes, but instead took a "walking trip" through the South that traversed Indiana, Kentucky, North Carolina, and Georgia, a ramble similar to that of John Muir's *A Thousand-Mile Walk to the Gulf* (Hedgpeth 1978; Rodger 2002). He published an account of his excursion in the June 1925 issue of *Travel* magazine ("Vagabonding through Dixie," Ricketts 1925). In 1921, Ricketts returned to the University of Chicago where he continued to enroll in classes in biology.

In July 1922, Ricketts's college roommate Albert Galigher married Doris June Kingsley. Six weeks after the Galighers' wedding, Ed Ricketts married Anna "Nan" Barbara Maker. Doris and Nan had long been close friends. Doris had encouraged Nan to move from Pittsburgh, Pennsylvania, to Chicago, Illinois, and introduced Nan to Ed Ricketts (Rodger 2002).

Soon after Ed and Nan's wedding, Albert Galigher set off on a sometimes-dirt Lincoln Highway with his wife and mother bound for Pacific Grove (Groesbeck 2014). By late summer of 1922, the Galighers had settled into the small coastal community. In April 1923, Albert and Doris Galigher's son David was born.

In the fall of 1922, Ricketts enrolled in his final academic course, a senior-level class titled Animal Ecology, taught by Warder Clyde Allee (Rodger 2006). After finishing the fall quarter, Ricketts left the University of Chicago without completing a degree.

Ed Ricketts delayed his move to California until after the birth of their first child, who was born in August 1923. Soon thereafter, Ricketts left Chicago for the opportunity to be a junior partner with Galigher in Pacific Biological Laboratories. Nan and their 3-month-old son Ed Jr. followed a few months later, arriving in Pacific Grove in November 1923.

Ed and Nan lived in a succession of houses on the Monterey Peninsula, beginning with the Galigher house in Pacific Grove. In 1924 they moved into a place on Cedar Street in the same neighborhood. In November of that year, their second child, a daughter, Nancy Jane Ricketts, was born. By the time their third child, Cornelia, was born in April 1928, they were living on 4th Street in Pacific Grove—a "Spanish-style house" that Nan remembered fondly. From 1932 to 1934, they lived at 3rd and Junipero in Carmel, and it was here that John and Carol Steinbeck became frequent visitors. In 1934, the family moved to 9th and Junipero. It was in this house that Nan began making furniture, a hobby that grew to the point that she did it for a living after her separation from Ed. Around the time of Ed and Nan's final separation they lived at 9th and Dolores, where there was a studio apartment that Nan rented out to help make ends meet.

Pacific Biological Laboratories

First located in a one-story board and batten building at the corner of Fountain Avenue and High Street in Pacific Grove, Pacific Biological Laboratories (PBL) supplied prepared microscope slides and biological specimens to schools and academic research institutions.

The collaborative partnership of Galigher and Ricketts lasted just a few years, ending in 1925. Nan Ricketts remembered the transfer of Galigher's share of Pacific Biological Laboratories to her husband in her memoir: "After about two years there had to be a change at the Lab; there was a need for more financing. So Ed started writing to different biology houses and other sources to find someone to invest. University Apparatus in Berkeley responded. I believe that Ed and Albert both were in favor of the company. Then there came the split of partnership between Ed and Albert. Each had the opportunity to buy out the other, on certain conditions. It happened that Ed was the one who was able to raise the money, and Albert and Doris went to Berkeley" (Ricketts 1984).

In the early months of 1928, the building that housed Pacific Biological Laboratories was sold and scheduled for demolition. Several months later, Ricketts purchased a double lot with an existing house on Ocean View Avenue in New Monterey as the next location for his biological supply business.

During the first half of the 1930s, the business flourished as biological supply orders were shipped to clients around the world. In 1936 several unfortunate events occurred that devastated the prospering Pacific Biological Laboratories.

First, in January 1936, Ricketts's father, who for many years had helped with the business, passed away. Then on November 25, 1936, a fire broke out in the Del Mar Cannery next to Pacific Biological Laboratories. The blaze, which resulted from an overloaded electrical circuit, lasted 3 hours and destroyed the lab. Ricketts lost almost everything he owned, which included his scientific and personal library, years of accumulated research notes, lab equipment, business records, clothes, and treasured family heirlooms. Beyond the loss of his material possessions, the means by which Ricketts supported himself and his family, the biological supply business, was in ruins.

The following year, Ricketts built a new lab on the same Ocean View Avenue property. By 1938, Pacific Biological Laboratories was again shipping specimens, but the business never recovered to its previous level of financial success.

For 20 years Pacific Biological Laboratories served as the gathering spot for the many artists, scientists, and writers whom Ricketts befriended. Beyond a pleasant gathering place, Pacific Biological Laboratories served as his residence, business, and scientific laboratory. At this location Ricketts toiled at the scientific writing of *Between Pacific Tides*, *Sea of Cortez*, and *The Outer Shores*.

Between Pacific Tides

The life of Ed Ricketts has received considerable attention. Much of this has been the consequence of his having been the inspiration for the character "Doc" in John Steinbeck's novels *Cannery Row* and *Sweet Thursday*. Their close friendship has led scholars to direct much effort toward understanding the influence Ricketts had on John Steinbeck. Less attention has been given to appreciating Ricketts's career as a scientist and lead author of the book *Between Pacific Tides*.

Between Pacific Tides, by Edward F. Ricketts and Jack Calvin, stands as an American classic in the literature of marine biology. First published in 1939, the book presents Ricketts's detailed observations gathered during 10 years of his exploring and collecting marine specimens along the Pacific Coast (Ricketts and Calvin 1939). Now in its fifth edition, *Between Pacific Tides* has sold more than 100,000 copies and remains one of the best-selling titles published by Stanford University Press.

Scholars have accounted the book's popularity to the authors' revolutionary approach of organizing intertidal life according to habitat, rather than the traditional taxonomic organization. This ecological structuring of the book allowed the animals to be grouped according to where they occur—on rocky shores, sandy beaches, sand flats, mud flats, or wharf pilings.

A second feature contributing to its success is the book's approach to intertidal life, beginning at the upper tide level and advancing seaward, just as a person exploring the shore would walk. Within this arrangement, the authors provided information about individual species' life history, physiology, community relations, and the influences of fluctuating tide level and wave shock.

A third feature that accounts for the book's popularity is the authors' nontechnical writing style, which presents the information in a manner useful to both scientist and layperson. Besides their use of a clear writing style, Ricketts and Calvin went a step further to reach the lay reader by presenting dry scientific details as an engrossing blend of facts colored with snippets of wry humor.

Beyond engaging readers as to the curiosities of marine invertebrates common to Pacific shores, the book itself has stirred interest. Scholars have often wondered how Ricketts and Calvin gathered the scientific findings presented in their book. A survey of the coastal habitats surrounding Monterey Bay alone could not have provided a sufficient understanding of the ecology of the Pacific Coast for the writing of *Between Pacific Tides.* Nor could the 10-week collecting trip from Tacoma, Washington, to Juneau, Alaska, via a 33-foot boat (*Grampus*) serve as an adequate scientific survey of the coast. As for the identification of invertebrates collected along the coast, little has been written about Ricketts's communication with taxonomic experts and their contribution to the science presented in the book.

Ed Ricketts's first interactions with scientists, whose areas of expertise were marine invertebrates, began while a student at the University of Chicago. His exchanges with the scientific community broadened when Ricketts became the sole proprietor of Pacific Biological Laboratories and a frequent visitor to Stanford University's Hopkins Marine Station.

Hopkins Marine Station

Much has been written of Warder Clyde Allee and the effect his Animal Ecology course at the University of Chicago had on Ricketts, including influencing the organizational structure of *Between Pacific Tides* (Lannoo 2010).

Less attention has focused on other marine biologists and zoological experts who were Ricketts's friends, collaborators, and acquaintances. Ed Ricketts has often been portrayed as an outsider to the academic world. Scholars have suggested that the scientific community had excluded Ricketts because he had not graduated with a degree from an academic institution. Numerous letters of correspondence from Ricketts to professional scientists, and their courteous replies, suggest otherwise. These communications serve as a testimony to the fact that Ricketts was well respected among academic scientists and other professional zoologists, who responded to and supported his requests for the identification of species and for scientific literature pertaining to his research.

Upon his arrival to the Monterey Peninsula in the fall of 1923, Ricketts found himself awash in the unfamiliar marine creatures found along the shores, including many animals yet to be taxonomically described and given scientific names. Much to Ricketts's good fortune, Stanford University had established a marine biological laboratory, Hopkins Marine Station, in Pacific Grove.

The Hopkins Marine Station of Ed Ricketts's day was a vibrant and exciting place, as the Stanford faculty and students, and a stream of visiting oceanographers, fisheries scientists, and invertebrate zoologists, expanded the potential of the education and research facility.

A primary supporter of Ricketts's efforts to identify species was the then director of Hopkins Marine Station, Walter K. Fisher, who was familiar with the marine invertebrates found along the Pacific Coast. In addition to W. K. Fisher's assistance, Ricketts's effort to become familiar with the littoral invertebrates was supported by both Stanford faculty (e.g., Rolf Bolin, Harold Heath, Frank Mace MacFarland, Arthur Russell Moore, Tage Skogsberg) and graduate students (e.g., Max Walker de Laubenfels, George and Nettie MacGinitie, Lucina Stanford) (Kohrs 2015).

Among the many scientists who visited the seaside laboratory were a number who helped to identify invertebrate species for Ricketts. Several of these scientists became leaders in their fields, including Henry B. Bigelow, founder and first director of Woods Hole Oceanographic Institution; T. Wayland Vaughan, director of the Scripps Institution of Oceanography; Naohide Yatsu, third director of Misaki Marine Biological Station, University of Tokyo; Torsten Gislén, professor of zoology at Lund University, Sweden; Charles Henry O'Donoghue, University of Manitoba, Winnipeg; and Deogracias D. Villadolid, director of the Bureau of Fisheries, Philippines (Kohrs 2015).

Other scientists visiting Hopkins Marine Station and helping to identify invertebrate species for Ricketts held curator positions at several of America's leading natural history museums. These visiting invertebrate specialists included Waldo L. Schmitt and Ira E. Cornwall of the U.S. National Museum of Natural History (Smithsonian Institution), Elisabeth Deichmann and Herbert Lyman Clark of Harvard's Museum of Comparative Zoology, and Libbie H. Hyman and Willard G. Van Name of New York's American Museum of Natural History. Several of these curators—Deichmann, Clark, and Hyman—returned to Pacific Grove many times over the years, continuing their scientific studies of Pacific Coast invertebrates (Kohrs 2015).

Throughout his 25 years as a collector, Ricketts provided an untold number of marine invertebrate specimens to these and other taxonomic experts. In return for the specimens, Ricketts received taxonomic identifications of the species that aided him in organizing the marine invertebrates in his book *Between Pacific Tides.* Beyond receiving species identifications, Ricketts requested and received the scientific papers, which he referred to as "separates," authored by these specialists.

Ricketts mentions this collaborative exchange of specimens for separates in a document he compiled listing the contents of the Pacific Biological Laboratories destroyed in the fire of 1936. Within the document, titled "Contents of PBL destroyed Nov. 1936," Ricketts described this exchange of material: "Some of the bound volumes consisted of scientific treatises which were sent to me upon request from the Smithsonian Institution–US National Museum at no charge, presumably because of the pleasant relations between PBL and USNM whereby we sent them literally thousands of specimens at no charge" (Ricketts 1936).

The collection of scientific separates Ricketts gathered for his library rivaled that of any academic scientist or professional invertebrate zoologist of his time. Ricketts's use of this extensive scientific library, specific to the invertebrate zoology and marine ecology of the Pacific shores, allowed him to describe the latest scientific findings about the animals in *Between Pacific Tides.*

Beyond his painstaking efforts to identify species and gather the literature for the book, research for *Between Pacific Tides* involved years of Ricketts conducting surveys of the intertidal zone—from Boca de la Playa, Mexico, to Sitka, Alaska—as he formulated his thoughts on the ecological basis for the distribution of littoral invertebrates along the shores of the Pacific Coast.

Collecting Trips Along the Pacific Coast

When he arrived in California, in 1923, Ricketts began collecting marine invertebrates from the shores of the Monterey Peninsula. In her memoir, Nan Ricketts describes several excursions that included the family. Her remembrance of their frequent visits to the shore during the time the Ricketts and Galigher families shared a house, and an automobile, reads: "We had only one car, and when there were collecting trips to be made, we made it a picnic day too. We packed food if we had to go far. If not then we just packed food for the babies and put the babies in a wash basket in the back of the 'Big Mitchell,' our car. It was an oldie but was very good to us, taking us on many beautiful trips and adventures" (Ricketts 1984).

Several years later Ricketts replaced the Big Mitchell with the purchase of a Packard sedan and extended his collecting trips farther afield. For 10 years, Ed and Nan Ricketts conducted annual collecting trips, traveling by automobile, to the shores of Southern California and Baja California (Mexico) in the winter months, and the shores of northern Washington State and British Columbia during the summers.

On several trips south, their friends George and Nettie MacGinitie joined the couple on the excursions (Ricketts 1930a,b). On another trip south, Torsten Gislén and his wife accompanied Ed, Nan, and their 2-year-old daughter Cornelia. The excursion with the Gisléns was described by Nan Ricketts in her memoir: "There were some wonderful collecting areas around Laguna Beach, La Jolla and Newport Beach. On one occasion we had with us a Swedish family from Lund University, the Gisléns.... When we crossed the Mexican border, the guards took Dr. Gislén to the office because he was from Sweden. Ed went with him to help since Ed was well known by the guards as the funny Californian who carries a lot of empty jars in his car and fills them up with animals" (Ricketts 1984).

In 1934 and 1935, Ed and Nan took the children on 3-month summer vacations north of Puget Sound (Ricketts 1934; Ricketts 1935a,b). During these trips, the couple worked the low tides, collecting specimens for Pacific Biological Laboratories.

After his separation from Nan, in spring 1936, Ed took a collecting trip with John Steinbeck, and Bruce Ariss and his wife, Jean, to the beaches of Southern California (La Jolla Beach, Corona del Mar) and Mexico (Ensenada, San Antonio del Mar, Boca de la Playa) (Ariss 1988).

During the summer of 1937, Ricketts traveled twice in the Packard to the shores north of Puget Sound, accompanied by his son, Ed Jr., on both trips, and his daughter Nancy on the second trip (Ricketts 1937a,b; Ricketts 1938).

In an article he wrote for the *Monterey Peninsula Herald* titled "Ed Ricketts Covers the Waterfront for 20 Years" (1942), Ricketts reminisced about his many collecting trips, via small boats on the bay and by automobile along the coast.

> I went out myself on the boats occasionally (often with the results not encouraging to delicate stomachs), scoured the bay in a row boat for jellyfish and other floating organisms; got curious animals even from the San Francisco drag boats—again very much troubled by that famous indisposition related to small boats and bad weather; collected in the then-wilderness down the coast and made long trips into Mexico, Canada and Alaska, coming back each time to a larger town.

While gathering specimens for his business, Ricketts, with a pencil in hand, filled his notebooks with descriptions of the shores he visited. The shoreline habitats Ricketts surveyed ranged from the wave-swept shores of the open coast to the wooden pilings beneath coastal piers. His detailed notes outlining the various physical and biological features associated with the shoreline habitats formed the foundation of *Between Pacific Tides*.

Sea of Cortez

In April 1939, the first edition of *Between Pacific Tides* made its way to press with the printing of 1,000 copies. Twelve months later, Ed Ricketts departed for a 6-week collecting trip in the Sea of Cortez aboard a 77-foot fishing vessel named *Western Flyer* with John Steinbeck and his wife, Carol, and a crew of four. For Ricketts, the principal reason for the trip was to advance his scientific understanding of the zoogeography and ecology of marine invertebrates of the Gulf of California, and upon their return, he and Steinbeck would write a book.

In addition to chronicling the journey, Ed Ricketts, with the help of the Steinbecks and the *Flyer*'s crew, gathered thousands of littoral invertebrate specimens as they surveyed various habitats associated with each collecting station. Upon his return from the expedition, Ricketts began what was a common exercise associated with his collecting trips—the meticulous and painstaking task of shipping the specimens gathered to invertebrate specialists for proper species identification.

The information and separates he received back from the specialists resulted in his creation of an appendix for the book consisting of an "annotated catalogue of the species encountered, a bibliography and resume of the literature, and a summary of the present state of… knowledge with regard to the littoral natural history of the Gulf of California," basically a "source book on the marine invertebrates" of an area that was little known at the time (Steinbeck and Ricketts 1941). Ricketts took copious notes during the 24 days of observation at 21 locations (see Brusca, this volume) and sent these to Steinbeck so he could begin writing the narrative part. The result was the 1941 *Sea of Cortez: A Leisurely Journal of Travel and Research.* ✣

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The Tangled Journey of the Western Flyer: *The Boat and Its Fisheries*

Kevin M. Bailey and Christopher Chase

Introduction

In 1940 the *Western Flyer* carried John Steinbeck and his comrade Ed Ricketts on a remarkable 6-week voyage to the Sea of Cortez. After they wrote a book (*Sea of Cortez: A Leisurely Journal of Travel and Research*, 1941) about their adventure, the *Western Flyer* became an icon in American literature. Some say that it is, perhaps, the best-known fishing vessel in history. Ever since the *Western Flyer* arrived in Port Townsend for renovation work in 2012, a constant stream of visitors has paid homage to the boat. One of them pinned a picture of John Steinbeck to its hull as if the vessel was the casket at his wake.

For many readers of John Steinbeck and followers of Ed Ricketts, the *Western Flyer* represents a deeply personal symbol—adventure, freedom, camaraderie, or perhaps even refuge. Steinbeck's prose planted a vision of the *Western Flyer* in his readers' minds and the seed took root, establishing a place there—like something Steinbeck called a "sea-memory" (Steinbeck 1951).

> And now the wind grew stronger and the windows of houses along the shore flashed in the declining sun. The forward guy-wire of our mast began to sing under the wind, a deep and yet penetrating tone like the lowest string of an incredible bull-fiddle. We rose on each swell and skidded on it until it passed and dropped us in the trough. And from the galley ventilator came the odor of boiling coffee, a smell that never left the boat again while we were on it. (Steinbeck and Ricketts 1941)

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Captain Tony Berry (left) and John Steinbeck (right) on the flying bridge of the Western Flyer, *1940*. With permission of the Martha Heasley Cox Center for Steinbeck Studies, San José State University.

However, the fame of the *Western Flyer* didn't come to pass overnight. At first, *Sea of Cortez* wasn't a best-selling book. Word of the book spread from person to person among those who'd been touched by the story and resonated with it. It's not a book that people forget easily. As time has passed, the collective memory of the book has grown, along with the legend of the boat.

We know a lot about the Steinbeck-Ricketts voyage to the Sea of Cortez on the *Western Flyer* from their writings and those of many others. But what do we know of the boat's beginnings and of its 83-year history outside of the famous voyage with the author and scientist? Our intent in this narrative is to describe some of the boat's history before and after the *Western Flyer's* keystone journey.[1]

Building the Boat

The *Western Flyer* was built in 1937 in Tacoma, Washington, as a state-of-the-art purse seiner to fish for sardines out of Monterey. The builder was Martin Petrich Sr., owner of the Western Boat Building Company. Petrich would co-own the boat with fisherman Frank Berry (aka Bertapeli) and his son Tony, who was to become the boat's skipper. The Petrichs and the Berrys were Croatians from the island of Hvar with a strong fishing tradition.

In 1937, the world was reeling in the depths of the Great Depression. Many refugees had moved to California in search of employment and better times, but some migrated to Oregon and Washington. Near Petrich's boatyard in Tacoma there was a camp called "Hollywood on the Flats," on the east side of the Puyallup River, that held about 2,000 hobos. The residents lived in shacks made of wood scraps. For a while, even work in Petrich's boatyard came to a standstill. But it was to pick up again because the sardine fishery in California was thriving and the fishermen needed more boats. Historian Arthur McEvoy called Monterey, the center of the fishery, "a local island of prosperity in a sea of depression" (McEvoy 1995).

Martin Petrich was a tall man with broad shoulders. He was born in 1880 on the island of Hvar. After his parents had immigrated to the United States, Petrich went to work as a young man in the cedar and shingle mills of Tacoma where he learned the craft of woodworking. He began building houses, but the business was slow so he fished for some extra money. Petrich and his friend Joe Martinac heard that other Croatians in Tacoma were making good money building boats.

In 1917, Petrich and Martinac founded Western Boat Building on the site of the former Tacoma Mill at the foot of Starr Street. A year later, they realized that there wasn't enough money in the business to support two owners, so Martinac split off to work in another boatyard, and later he formed Martinac Shipbuilding. In 1922, Petrich moved Western's boatyard to East 11th Street on the waterway.

Petrich was a perfectionist and an innovator in wooden boat construction. He was known for exceptional work and for making fine seaworthy boats. He was a tough boss, and he demanded hard work and precision from his crew. The business of building fishing boats was thriving as Western's reputation for constructing seaworthy boats spread. In 1934, sardine catches picked up and so did the boatyard's orders for new fishing vessels. By 1937, the Western Boat Building shipyard was operating at nearly full capacity and employed about 80 workers in the yard.

The fishery for sardines had started in California, where many of the Western-built boats were fishing, but by the late 1930s the harvest extended all the way north to British Columbia. The new sardine canneries on the northern coast gave the fishermen a place to offload their catches. Business was good. Orders for Petrich's most popular line of boats, sardine seiners for the booming fishery, were stacking up.

Petrich specialized in building vessels for the local Croatian community. He often entered into partnerships with the Croatian fishermen whose boats he built. Frank Berry (or Franjo Bertapeli, in Croatian) was a salmon fisherman who worked the off-season in the boatyard. Frank was known as a "highliner" or a "top boater," meaning that Berry was a very good fisherman. Frank's son Tony (Anton) Berry also worked at the boatyard with him and was trying his hand at sardine fishing.

The two fishermen, Tony and Frank Berry, and boat builder Martin Petrich entered into partnership to build the *Western Flyer*, which would be a state-of-the-art purse seiner. The boat was designed for the Monterey sardine industry, but could also seine for salmon in Alaska during the off-season. The *Flyer* was the 2nd of 7 seiners that Western Boat Building constructed in 1937, and the 122nd boat to emerge from the shipyard since its founding 20 years before—their 86th seiner. Petrich and Western Boat Building would own 50% in shares of the *Flyer*, with 25% going to Anton "Anthony or Tony" Berry and 25% to his father, Frank Berry. The Petrich ownership was further divided among three of Martin's sons.

Many of the Western boats were built "by eye," which was based on experience and information on what the buyer wanted. A sketch was drawn, then a model was constructed, and design modifications were made. Petrich specialized in working with old-growth fir, which was abundant in the Pacific Northwest. Old-growth fir is tight grained and resistant to rot.

> Apparently the builder of a boat acts under a compulsion greater than himself. Ribs are strong by definition and feeling. Keels are sound, planking truly chosen and set. A man builds the best of himself into a boat—builds many of the unconscious memories of his ancestors. (Steinbeck and Ricketts 1941)

The shipwrights laid the fir keel of the *Western Flyer*, sawed and shaped the stem and stern, and then bolted the pieces together. They braced the skeleton upright, and built scaffolding and stairs around it. The rib cage, made out of oak, was added to the backbone. The stringers and bulkheads were connected. The woodworkers reinforced the stringers on the port side with extra pieces to account for the stress of a net full of fish pressing against it.

The carpenters steamed fir planks in a box to make them pliable, and immediately fitted, sawed, and shaped them in place. Each plank was butted tight against each other, edge to edge, a technique known as carvel planking. The planks were fixed to the structure with heavy spike-like nails, and then cracks were caulked with oakum. The fir decking was laid longitudinally on top of the stringers. At last the deckhouse was built and fastened on top.

Once the roof was on the deckhouse, the boat was moved out of the shed and onto the water. When the boat was dry-docked, workers had to spend so much time climbing up and down the scaffolding for tools and materials that floating the boat at the dock was more time efficient for the finish work. The immersion in water would also allow the wood planks to swell and create a tight seal, so any leaks could be noticed and fixed.

Electricians, plumbers, welders, finish carpenters, and painters went to work on the boat. The interior was fir, trimmed with mahogany around the table in the galley, window frames, bunks, and in the pilothouse. The cabinetry was made of white oak. The fittings were brass.

The *Western Flyer* was built to 77 feet in length. At 93 gross tons, she could carry a crew of 10. The skiff and seine net were carried on the aft deck on a turntable with rollers. The hull and house were painted a bright white with black trim.

On 3 July 1937 the *Western Flyer* left the Western Boat Building yard. It headed out of the sheltered Puget Sound inland sea, rounded the corner at Cape Flattery, and was buffeted by fresh winds blowing down the coast. Over the next year, the boat went down to the Columbia River to fish for salmon and then to Monterey to fish for sardines. The next spring it sailed to the Aleutian Islands and into Bristol Bay on a salmon survey for the U.S. Bureau of Fisheries. From Alaska the *Flyer* headed down to Baja California to fish for tuna. The boat arrived in Monterey in the autumn of 1938 with Tony Berry at the helm to join the fleet of sardine purse seiners.

The Fisheries and Owners of the *Western Flyer*

By 1937, when the *Western Flyer* started fishing, 230 seiners delivered 726,000 tons of sardines to 52 processing plants in California. There was rampant underreporting of catches. It's said that canneries would underreport catches by tampering with the weighing scales to cheat the fishermen. Some claimed that the skipper would collude with the cannery in the underreporting scheme so he could share less with the crew and keep more for himself. About 80% of the catch went to reduction. Catches far surpassed the post hoc levels of estimated maximum sustainable yield[2] for the fishery, which was later estimated for that period at 250,000–300,000 tons.

At the high point of the fishery in Monterey, there were 80 purse seiners delivering to 20 canneries along Cannery Row. Catches of sardines multiplied through the 1930s, and then something went wrong. The fishery was overcapitalized, which means that there were too many boats for the amount of fish that could be caught. In 1940 there were more than 300 seiners fishing for sardines up and down the Pacific Coast. There were no limits placed on the catch levels other than those imposed by the fish themselves.

In 1945, 554,000 tons were harvested off the California coast alone from a total stock biomass estimated at 720,000 tons of fish 2 years of age and older from Mexico to British Columbia; in other words, about 77% of the total biomass was harvested. In the 1946–1947 season, the fishery was still fairly strong in San Pedro, but they were small fish. Harvests in Monterey fell dramatically in 1946–1947. In 1948–1949 they increased slightly, and increased again in 1949–1950, as there was a moderate recruitment of the 1946 and 1947 year classes into the fishery. The fishing pressure on these fish was intense because of high prices. It was a brief hiccup. The Pacific sardine fishery was exhausted.

When the sardines collapsed, the fishing families diversified and moved. Many changed careers; others targeted alternative fisheries like tuna and squid, and some moved out of the area. The fish-meal industry needed more supply, and much of the reduction fishery shifted to the Peruvian anchoveta. There aren't any boats fishing for sardines out of Monterey now. Cannery Row and Monterey Harbor are tourist destinations.

Why the fishery collapsed is a matter of debate, even now. Was it a changing climate or the intensive harvesting that caused the demise of sardines? Or a combination of both? The canneries used the war as a justification in lobbying efforts to get catch limits taken off sardines and the fish managers capitulated.

> It was done for patriotic reasons but that didn't bring the fish back.… It was the same noble impulse that stripped the forests of the West and right now is pumping water out of California's earth faster than it can rain back in. When the desert comes people will be sad; just as Cannery Row was sad when all the pilchards [sardines] were caught and canned and eaten. (Steinbeck 1954)

Fishery biologist and sardine expert Garth Murphy later reported: "The decline of the sardine was apparently the result of an intensive fishery together with a series of years in which the environmental regime was unfavorable to the sardine" (Murphy et al. 1964). This analysis was similar to Ed Ricketts's explanation: "the fishery removed the larger and older fish, thereby decreasing the population's resilience while increasing the risk of low stock production during periods of adverse ocean conditions" (Ed Ricketts's letter to Rich Lovejoy, 22 October 1946, in Rodger 2002).

Tony Berry fished for sardines on the *Western Flyer* out of Monterey until the fishery collapsed in 1946–1947. Berry said that he sold the boat in 1948; however, as early as 1945 the U.S. Coast Guard listed Western Boat Building as the sole owner. After Western sold the boat, it was registered to Armstrong Fisheries out of Ketchikan, Alaska, from 1951 to 1952 (reflecting a sale in 1950).[3]

In 1952, a Seattle fisherman named Dan Luketa bought the *Western Flyer*. Like Petrich and the Berrys, Luketa was of Croatian descent. He was a hardworking, innovative, and skilled fisherman. Luketa converted the boat to a trawler and fished the deep waters off the coast from Oregon to British Columbia for Pacific ocean perch, Petrale sole, black cod, and Pacific cod.

Finding success as a trawlerman, Luketa had earned enough money to buy a bigger boat when the *Western Flyer* came up for sale. Since the boat had been built at Western Boat Building, Luketa knew that this was a sturdy working vessel. But he needed to convert the *Flyer* from a seiner to a trawler. The Atlas engine was replaced with a bright yellow, more powerful D353 Caterpillar. Luketa removed the turntable, which was a platform on deck for stacking the seine net. He installed a powered trawl reel, introducing a new technology to West Coast trawlers, whereas previously it had only been used on seiners and gill-netters. Other fishermen thought the oversized winch installed on deck would capsize the boat. The big winch was chain driven but had a "self-spooler" to keep the cables on track, whereas the old winch required a man with an "imbecile stick" to guide them into place.

A crackerjack fisherman and known as a hard-driven "tough son of a gun," Luketa was also a shrewd businessman who hated to waste fishing days. He often ran three boats and jumped from boat to boat to supervise the fishing while the boat that was full-up steamed in to unload the catch. It's said that Luketa only ate carrots at sea because "you fished better if you were hungry." Running for shelter in rough seas was unheard of, and in a storm he preferred to hold his position and tough it out.

Luketa operated the *Western Flyer* out of Ballard (a Seattle neighborhood) in the 1950s and early 1960s, dragging the deep water along the coast mainly for Pacific ocean perch, but also Petrale sole, cod, and whatever other bottom fish came up in the net. It was hard work trawling the ocean floor. Often they would drop the net 300 fathoms, paying out a half mile of cable, which took 45 minutes to haul back in.

The Western Flyer *rigged as a trawler in Bellingham, Washington.* Permission of Whatcom County Museum.

Dan Luketa was inventive and played a visionary role in the fishing industry. Referring to the developing trawl fishery off the Pacific Coast, he said, "What is happening now is a dramatic and fantastic thing. It is skyrocketing." He saw that the lower-priced bottom fish would be more economically important to the region than salmon or halibut because of the sheer volume. He noted that the trawl fleet had been operating about 60 trawlers out of Puget Sound with an average length of 72 feet and said, "We should be running 90 to 100 foot boats out of Seattle, and about 200 of them" (Patty 1966).

The West Coast fishery was to experience another major disruption. In 1960, the Soviets and Japanese started fishing for Pacific ocean perch in Alaska. They would work their way down the coast as the northern populations crumbled under the intense fishing pressure. The foreign fishery for Pacific ocean perch reported a catch of 6,000 tons that year. Many scientists now believe these numbers were grossly underreported. In 1962, the fishery boomed in Alaskan waters. Within 6 years, almost a half-million tons were extracted from the Gulf of Alaska and Aleutian Islands region. The fishing pressure increased. The foreign fishing boats spread south. In 1966, during the first year of the foreign fishery operation off Oregon and Washington, catches reached 15,600 tons, the highest level they were to attain. Luketa complained, "The Soviet fleets could easily reduce the fishery stocks off the coast to the extent West Coast fishermen may not be able to catch enough fish to stay in business" (Anon. 1965).

Dan Luketa was right; the process of depletion took just a few years. By 1969 the Pacific ocean perch population had been decimated.

Luketa had already seen the writing on the wall. In 1962–1963 he chartered the *Western Flyer* to the International Pacific Halibut Commission to conduct an extensive trawl survey of the West Coast. He observed the large amounts of king crab that were coming up in his nets along the Alaska Peninsula. Some early crabbers fishing out of Kodiak were making a lot of money. By time the perch fishery collapsed, Luketa had converted the *Western Flyer* for crab fishing and headed north to the Aleutian Islands. In 1969 he changed the name of the boat to the *Gemini* (published in 1970).

American commercial fishermen started catching Alaskan red king crab in 1950. The fishery was started by salmon fishermen from Kodiak. The first year they landed 60,000 pounds by sinking small mesh trawl nets to the bottom. They let the nets sit on the sea floor so the legs of the crabs got tangled in them when they crawled over. These so-called tangle nets were banned in 1955 because they caught undersize and female crabs, which are not processed for their meat because of the small size. The fishermen switched to fishing with conical pots, and finally to square cages. The standard cage size was 7 by 7 feet and weighed about 700 pounds. One fisherman said, "When the deck rolls and pitches, the pot becomes a wrecking ball with sharp edges." It was baited with herring or other fish. They fished the cage on a single line with two floats. In those days, there was no hydraulic launcher like there is now, and the deckhands pushed the cages over the side.

In order to convert the *Western Flyer* to a crabber, Dan Luketa had an aluminum tank fabricated at Marco Marine in Seattle. The tank was installed belowdecks to hold the crabs alive in seawater. He sent the boat up to the Aleutian Islands with the cages stacked from the stern all the way to the galley door. The life raft was stowed in the bunkhouse. However, the tank was made with a substandard grade of aluminum, and it began corroding from the salt water. In July 1964, the welds of the aluminum tank ruptured while they were crossing the Gulf of Alaska, and water leaked into the hold of the ship. Normally this is not desirable, although fixable, but this time the lines of the buoys stowed belowdecks floated in the water and got caught in the *Flyer*'s pumps, causing them to malfunction. The ship began to sink.

In spite of the calamity, the skipper wouldn't let the crew set out the life raft until the last minute; he couldn't swim and didn't want the raft to drift out of reach. The skipper smelled something burning, and he scrambled about the boat looking for the source. After a brief search, he found the cook grilling steaks in the galley who said, "If we are gonna go in the water, we are gonna go in with a full stomach" (Carlough 2011). The Coast Guard heard their Mayday call, flew out in a helicopter, and dropped some new pumps on the bow. The pumps saved the ship.

When fishing for crab, the *Western Flye*r usually sailed with the skipper and two crewmen on deck. One of the crew would cook. The skipper was selective and looked for good crew, and one who could cook was a bonus. Crewing on a small crabber in the north Pacific Ocean was grueling work. Fishermen could expect storms, high winds, cold temperatures, and heavy seas. In winter frostbite was a danger, and waves frequently swept the aft deck. Another hazard of winter was the icing of the metal parts of the ship, which could happen quickly in windy conditions when the sea spray from the ocean blew off the surface and froze on anything metal. The ice could accumulate in a flash. On a crab boat the peril escalated when ice piled up on the mesh of the pots. The weight of the ice on such an expanse of surface area could flip the ship. Sledging the ice off with mallets or baseball bats took place on a slippery deck.

The *Western Flyer* worked the sea for red king crab from Attu to Dutch Harbor. This was a virgin fishery and crabs were abundant. After some exploration, the fishermen discovered where the crabs gathered and where the catches were largest. Red king crabs were most abundant from 30 to 70 fathoms, or even out to 80 fathoms. The skipper also studied the fathometer for crabs accumulated in large mounds on the bottom. They dropped their pots near these pods. Each boat was subject to a 30-pot limit. Usually the *Flyer* would carry about a dozen out, put them in the water, and then return to shore for another load. When the fishing was good, they left the pots in overnight; if it was slow, they let them soak for a couple of days. They retrieved the pots by snagging the line between the float and the pot with a grapple pole or by throwing a rope ended with a treble hook.

The *Flyer*'s crew delivered their catch to a freezer processing ("factory") ship called the *Merkatur* owned by Pan Alaska Seafoods in Adak. In the 1960s, Adak was an isolated U.S. Navy base. The *Merkatur* tied up at the navy dock and bought crabs. Alternatively, there was a cannery at Captain's Bay in Dutch Harbor. And there were tenders like the *Bethell-1*, a converted World War II minesweeper, that roamed the crab grounds to buy crabs from the fishing boats and deliver them to a processor.

The red king crab fishery in the Aleutian Islands started in 1960. Places like Adak and Attu are about as close to the end of the Earth as you can get. The catches of king crab increased with breathtaking speed and peaked in 1964/1965 at 21 million pounds. After the apex, catches dropped just as quickly. Two years later, the catch fell to 6 million pounds. Catches rose again in the early 1970s as fishermen prospected for new populations hidden among the islands, venturing clear out to Attu. Then the sputtering harvest belly-flopped in 1973 to less than 1 million pounds. The fishery expanded eastward toward Unalaska. This part of the fishery peaked in 1966/1967, and catches dropped less steeply than harvests near Adak, but this fishery finally closed in 1983. The number of boats had increased from 4 in 1961 to 41 in 1970, and then 104 in 1980.

When the red king crab in the Aleutian Islands got played out, fishermen ventured into Bristol Bay and deployed their pots on Slime Bank. The crab population there was on the rise. Since this fishery was far away from the port of Dutch Harbor, the boats had to venture out farther from shore. There were fewer places in this open water for the smaller boats like the *Western Flyer* to hide from storms. Longer trips needed bigger boats that could stay at sea more days and with bigger holds to contain more crabs. When the king crab stock in the Aleutians started declining in abundance, Luketa decided that he needed a bigger boat to fish offshore, and he sold the boat (then known as the *Gemini*) in 1970 (published in 1971).

At this point, the story of the *Western Flyer* gets a little fuzzy. But here is a sketch of the situation. The *Gemini* was registered under the ownership of Whitney Fidalgo Seafoods from 1971 to 1974. The boat worked as a salmon tender, and possibly at times as an inshore crabber.

As a tender, fishermen transferred their salmon to the *Flyer*, which carried the fish to the cannery so the fishing boats didn't have to make frequent long runs back to harbor when their holds were full. In 1971, the boat grounded on a reef in SE Alaska and was nearly lost. Sailing in heavy seas, the *Flyer* was laden with 120,000 pounds of Alaskan salmon when there was a loud "crunch" and a jaw-clenching shudder. They had hit a reef near Tolstoi Island, close to Ketchikan. The skipper, Rudolph Young, sent out a Mayday, and the crew was rescued. But the keel of the boat was damaged and the on-site inspection by the Coast Guard declared, "This SE Alaskan fish packer is considered a total loss." A diver was sent down to put a plywood patch over the hull, and the boat was refloated. The catch was salvaged, and the boat was sent to Ketchikan for repairs, where they reinforced the inside of the hull.

In 1974, the Japanese fishing company Kyokuyo bought Whitney Fidalgo (in 1972–1973 the *Western Flyer* is not listed in the Coast Guard's *Merchant Vessels of the United States*). About the same time, the *Flyer*'s ownership was transferred to Citicorp Leasing Company for 10 dollars. Citicorp apparently leased the boat back to Whitney Fidalgo. As a "cannery boat" the skippers changed frequently. Much of the boat's history during this time is obscured.

Whitney Fidalgo often entered into partnerships with fishermen; in 1976, skipper Clarence Fry "bought" the boat, although Citicorp was still registered as the owner. He tendered herring and salmon for Whitney Fidalgo, and fished for crab and shrimp. In 1985 Kyokuyo sold its ownership of Whitney Fidalgo to Farwest Fisheries. The *Flyer* was sold at auction in 1986 to a fisherman named Ole Knudson and his father. Knudson was listed by the Coast Guard as the owner.

The *Western Flyer* (still called the *Gemini*) moved to Puget Sound where it tendered salmon, another troubled fishery. Man's impact on salmon populations has been devastating. Starting from the first Euro-American exposure, about 29% of 1,400 Pacific salmon runs from California to Vancouver Island no longer exist. In the Georgia Basin, which includes the Puget Sound region, 15 of 55 historical chinook salmon populations are now extinct, as are 6 of 14 sockeye and 6 of 36 pink salmon runs. Coho and chum salmon have fared better in the Georgia Basin, with 0 of 50 and 3 of 56 becoming extinct, respectively.

Not only have populations gone extinct, but the remaining populations are smaller. In Puget Sound, the historic run size of Pacific salmon has gone from 13 million–27 million fish to 1.6 million, or about 8% of the original size. Despite ongoing hatchery efforts to "enhance" them, the

National Academy of Sciences reported in 1996 that less than half of the salmon runs in Puget Sound are healthy. Furthermore, many of the "healthy" stocks have been buttressed and genetically contaminated with hatchery-produced fish. Puget Sound salmon fared better than those in the Columbia River, where only about one-quarter of salmon populations were rated as healthy.

The Gemini (*aka* Western Flyer) *moored in the Swinomish Slough, Washington, March 2011.* Photo by K. M. Bailey.

In 1990, Knudson reported that the boat was in pretty bad shape, but he planned to restore it (Hutson 1990). Meanwhile, Bob Enea, nephew of Tony Berry, had been searching for the boat. In 1986, he located it in Anacortes through the boat's official call sign WB4044. Along with Michael Hemp of the Cannery Row Foundation, they attempted to buy the boat from Knudson, but they were rebuffed. In 1990 an article appearing in the *Anacortes Times* described the *Flyer* as a ship with turquoise tarnished brass fittings, rusted instruments, missing bulwarks, rotten boards, and a greasy engine. The owner said that he wasn't impressed by the boat's history with Steinbeck (Hutson 1990).

Knudson stopped working the boat as a tender in 1993 because it was too slow and too small to be an efficient vessel to taxi salmon to the cannery. Old boats are expensive to maintain. At the end of its working life, the boat was used as a channel marker and a LORAN station in Puget Sound.

Knudson eventually offered to sell the boat to the Western Flyer Project, but the nonprofit's finances fell short. The boat was purchased by Gerry Kehoe in January 2011. Kehoe, a real estate developer, was renovating some buildings in Salinas. He announced that he intended to restore the *Flyer* and install it in a hotel, using the boat—floating in a moat—to accessorize a café in the lobby.

> Some have said they have felt a boat shudder before she struck a rock, or cry when she beached and the surf poured into her. This is not mysticism, but identification; man, building this greatest and most personal of all tools, has in turn received a boat-shaped mind, and the boat, a man-shaped soul. (Steinbeck and Ricketts 1941)

In January 2011, the *Western Flyer*, still named the *Gemini*, was moored under the Twin Bridges near Anacortes. At this point the boat was a sorry-looking sight: streaked with rust, the deck was covered with blue tarps. In September 2012, a plank in the hull ruptured and the *Flyer* sank. Two weeks later and much worse for wear, it was refloated. In

The Western Flyer *dry-docked in Port Townsend, Washington, August 2013.* Photo by K. M. Bailey.

January 2013, the boat sank once again. This time the *Flyer* remained submerged for 6 months. Finally, in June 2013 she was raised from the bottom and towed to dry dock in Port Townsend. The *Flye*r resembled a ghost ship, caked with mud, and bearing sun-bleached wisps of hairy filamentous seaweed.

As a Research Vessel

Sea of Cortez

On their expedition to the Sea of Cortez, Steinbeck and Ricketts covered 4,000 miles, collected over 500 different species of invertebrates, bottled thousands of specimens, and discovered at least 40 new species (see Brusca, this volume). Their account of the trip, *Sea of Cortez: A Leisurely Journal of Travel and Research,* was published in 1941 and is considered by many to be a seminal work in ecological holism.

Steinbeck and Ricketts saw their voyage as a great success. They even compared their cruise to that of Darwin on the HMS *Beagle.* But the voyagers complained that whereas they only had a day or two to observe and sample in any one location, Darwin had months. The duration of their trip was measured in weeks, while Darwin's took years. They seemed to replicate many elements of Darwin's cruise, sampling different marine habitats, and even—like Darwin—traveling inland on horseback. Ricketts wrote to Steinbeck on 22 August 1941: "It would be an understatement for me to say that this little trip of ours is proving to be an important expedition, and that out of it are coming some fairly significant contributions to invertebrate zoology, to marine sociology, and even—I wouldn't be surprised—to human thought" (Ed Ricketts's letter to John Steinbeck, in Rodger 2002).

There was more to the cruise than science. Steinbeck had been learning from Ricketts that ecology was a way for people to understand their relationships with one another and with nature. After the journey, they wrote:

> This trip had dimension and tone. It was a thing whose boundaries seeped through itself and beyond into some time and space that was more than all the Gulf and more than all our lives. Our fingers turned over the stones and we saw life that was like our own life. (Steinbeck and Ricketts 1941)

Halibut Commission

When the Japanese and Soviets started fishing off the coast of North America, Canadian and U.S. agencies took notice. In 1962–1963, the International Pacific Halibut Commission chartered the *Western Flyer* from Dan Luketa to conduct a trawl survey to assess the abundance of Pacific halibut on the West Coast. A further goal was to evaluate the impact of the foreign coastal dragging activity on the halibut fishery. They were looking at the bycatch of halibut in trawling operations and were particularly concerned about the impact of the foreign trawl fisheries. The survey was the most extensive of its type ever conducted to that point, covering 40,000 square miles and 1,560 stations with several vessels; the *Flyer* did 877 of those hauls.

Bureau of Commercial Fisheries

In the summer of 1965, the *Western Flyer* was contracted by the U.S. Bureau of Commercial Fisheries to conduct an exploratory trawl survey of the Oregon-Washington coast. The purpose was to examine the biology and abundance of Pacific hake, which was of growing interest to both the U.S. and Soviet fisheries.

Conclusion

In February 2015, a marine geologist named John Gregg, who has had a lifelong interest in Steinbeck and Ricketts, bought the *Western Flyer* from Gerry Kehoe. Gregg and a new nonprofit, the Western Flyer Foundation, are employing the talents of shipwrights in Port Townsend, Washington, and are currently in the process of restoring the *Flyer* (see Gregg, this volume).

> The *Western Flyer* hunched into the great waves toward Cedros Island, the wind blew off the tops of the whitecaps, and the big guy wire, from bow to mast, took up its vibration like the low pipe on a tremendous organ. It sang its deep note into the wind. (Steinbeck and Ricketts 1941)

Perhaps it is Steinbeck's aforementioned "sea-memory" that devotees of the *Western Flyer* look for in their own dreams, a deep connection with the sea enabled by their relationship with the vessel—as Steinbeck wrote, man has received "a boat-shaped mind." They yearn for the sun on their faces, the rhythm of the swell, and a stiff ocean breeze to hear the *Flyer* hum "its deep note into the wind" once again.

The recent accessibility of the *Western Flyer* to the public has opened new doors to the history of the boat. Our knowledge of the *Western Flyer* is evolving as people hear that the boat is still viable, and they step forward with their own experiences and stories about it. History, after all, is an amalgam of many different versions of events. It is never quite true to any one person's individual recollection. ✜

Notes

1. Much of this manuscript is condensed from Bailey (2015). More detailed references can be found therein.

2. Also known as MSY, the maximum sustainable yield is an estimate of the catch that the population can sustain each year, while maintaining a level of the population great enough to replace what was caught.

3. Most of the dates of ownership are listed in the *Merchant Vessels of the United States* published by the U.S. Coast Guard. Vessel names and ownership are recorded on January 1 of the year of publication, reflecting any changes that occurred in the previous year.

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John Steinbeck and Ed Ricketts: The Influence of a Scientist on an Author

Katharine A. Rodger

The friendship between John Steinbeck and Ed Ricketts is well known and has been the subject of academic inquiry and public fascination for decades. The images of the two men sharing deep conversations in Pacific Biological Laboratories, Ricketts's lab on Cannery Row, and of them exploring the intertidal zone in the Sea of Cortez have become iconic symbols of their deep connection. In biology, mutualism is a form of symbiosis in which the relationship between two (or more) organisms benefits both. Unquestionably, both Steinbeck and Ricketts benefited from their 18-year friendship. Critical attention to date has focused largely on how the men exchanged ideas about philosophy and science and how these shared interests influenced Steinbeck's themes. But Ricketts also had a considerable impact on *how* Steinbeck wrote and how he viewed the importance of form in his writing—an influence that developed during the first years of their friendship and continued through their journey to the Sea of Cortez.

John Ernst Steinbeck Jr. (1902–1968) grew up (and was buried) in the Salinas Valley of California. In his youth he worked in the agricultural fields and processing plants of the region, although he knew early on that he was destined to be a writer. Beginning in 1919, he took sporadic classes at Stanford University for about 6 years, including a summer (1923) marine biology course at Hopkins Marine Station, in Pacific Grove, California. However, he eventually dropped out of college without graduating. Steinbeck had already developed a strong fascination with the sea, and it was, in part, his love of the sea that drove him and his new bride, Carol, to move to Pacific Grove in 1930, where Steinbeck planned to sit out the Great Depression in his father's cottage. This move set the stage for his inevitable meeting with Ed Ricketts (1897–1948), which was the beginning of an 18-year friendship between the two men—probably the most important friendship of Steinbeck's life.

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In many ways, Steinbeck and Ricketts traveled parallel paths before their apocryphal dentist office meeting in 1930. Both had left college to pursue life and careers on their own terms, both were fascinated by scientific theories about the interactions among individuals and within groups, and both were water gazers, pulled by, and held close to the Pacific by, their love of the sea (Shillinglaw 2006). When they met, the two became fast friends and began the rigorous dialogue and exchange of ideas and philosophies that would mark their years of friendship, severed only by Ricketts's death in 1948. *Cup of Gold* (1929) had just been published when Steinbeck moved to Pacific Grove in 1930, and during his 6 years there he went on to publish four more well-received novels. Clearly, Steinbeck finding his voice was due in no small part to the inspiration provided by Ed Ricketts (Fontenrose 1964; Astro and Hayashi 1971; Astro 1973, 1976, 1995). There seems little doubt that Ricketts was Steinbeck's closest friend through the 1930s and 1940s.

Evidence of Ricketts's thinking in Steinbeck's fiction has typically been found in the latter's characters (e.g., Doc Burton of *In Dubious Battle*, 1936; Jim Casy in *The Grapes of Wrath*, 1939; Doc of *Cannery Row*, 1945) and content (e.g., non-teleological thinking and holism). Yet Steinbeck and Ricketts were also engaged in an ongoing conversation about how form was paramount in writing—and in art more broadly—and how the ultimate goal of any artistic endeavor was to engage the reader or viewer in a deep form of participation. Ricketts articulated these ideas in "A Spiritual Morphology of Poetry," one of the three philosophical essays he composed and circulated among friends during the 1930s and 1940s.

Ricketts's philosophical essays were widely circulated among his family, friends, and colleagues during the early and mid-1930s, and we know from letters that Steinbeck read them and, at one point, even attempted to help get them published. Ricketts worked tirelessly on all three essays—which also included "Breaking Through" and "Non-teleological Thinking"—in an attempt to articulate abstract and complex ideas that he derived from his readings of philosophy, science, and literature. Together, these three essays articulated Ricketts's worldview, which he hoped to eventually codify into what he called his "unified field hypothesis." In 1940, when writing in his journal during their expedition to the Gulf of California, Ricketts elucidated his thinking:

> I may be able to understand, in a moment of enlightenment, and to formulate, a unified field hypothesis, but to fulfill it is another thing. And to fulfill it constantly is an impossibility: that would be

> the perfect Tao that leads to or that is Nirvanah. Or for anyone else to use that formula is difficult, although it may be correct for me, and objectively correct, too. A child may not be able to use an algebraic theorem despite its objective correctness. (Rodger 2006)

Ricketts's poetry essay has received less critical attention, primarily because of its subject matter and its less obvious connections to both his unified field hypothesis and to Steinbeck's work. The importance of the essay, however, lies in its discussion of form versus content, and participation—ideas that the two men discussed, and that directly influenced Steinbeck's craft as a writer, especially in *The Grapes of Wrath* and later in *Sea of Cortez* (1941).

Ricketts believed that only when one has mastered the form or craftsmanship of his or her art—be it poetry, prose, painting, or music—can the content or truth of that art be executed with purity. Furthermore, it is when the form and content of art coalesce that the audience may fully participate and hope to experience transcendence. The ideas in "A Spiritual Morphology of Poetry," as those in his other writings, were formed via conversations and letters over a span of years. Ricketts's correspondence chronicles the development of his thinking, and in one letter he articulates how through a kind of collapsing of form and content into each other, a freedom from them both may occur:

> Most of the writers whose work appears not to be circumscribed by form are those who have got to use it as familiarly as a person uses his senses. And I suppose most of them went through a conscious struggle on that score before finally getting into their own peculiarly characteristic and individual form, or becoming free of it altogether.… The only person who is free of form is the person who's been through it, knows it, and has come out on the other side. A mystic might say that such a one had super-form, or had emerged from it. (Rodger 2002)

The result of one who has "emerged" from his or her form—as a poet, or as any kind of artist—is the creation of an experience for the reader, listener, or other participant.

The notion of readers truly experiencing a work of art, especially a poem, fascinated Ricketts, and was part of the larger philosophical idea of *participation* that was central to his unified field hypothesis. Ricketts often referred to participation as "the deep thing," as he believed it to be one of the great powers of art, and a catalyst to the universe itself. In a typed fragment left among his papers, he elaborated on this concept:

> I think that participation is, if not the most dramatic, at least the most deeply interesting thing in the world. To the degree of its intensity or depth, it's "all things" not superficial or spread out—diffused, but deeply participatingly, all-things, and so, in its absolute sense, beyond life but often glimpsed nevertheless—as considered in the essay on poetry. (Rodger 2006)

As with all of his ideas, Ricketts developed his definition of participation not only through writing, but through conversations with friends, including Steinbeck.

Without question, Ricketts and Steinbeck discussed participation, and the other ideas Ricketts grappled with in his poetry essay. We know that the men met almost daily while John and Carol Steinbeck lived in Pacific Grove; even after they moved to Los Gatos in 1936, Steinbeck and Ricketts were said to have exchanged letters on at least a weekly, if not more frequent, basis. Ricketts was circulating his philosophical essays to friends during this period—often mailing copies out for feedback and response. It is therefore no coincidence that when Steinbeck began work on *The Grapes of Wrath* in May 1938, he was attuned to the connections between artistic form and content and to the concept of participation articulated by his friend.

Steinbeck composed *The Grapes of Wrath* in one hundred working days. In composing the novel, he consciously struggled to integrate form and content in order to do justice to the work as a whole. He kept a journal, in which he would "warm up" each day before resuming work on the novel, and in that record, he echoes many of the ideas that he shared with Ricketts. On 31 May 1938 (Day #2), he writes, "I have seven months to do this book and I should like to take them but I imagine five will be the limit. I have never taken long actually to do the writing. I want this one to be leisurely though" (Steinbeck 1989). In using the term "leisurely," a term he repeats throughout his journal, he references not only the manner in which he plans to compose the novel, but how he wants the structure and pace of it to be perceived by readers. Such reflections reveal his desire to create a form that not only complements the story, but actually becomes a part of it.

The disciplined writer wrote almost daily for approximately five months, and documented his work also through letters sent to friends, family, and colleagues. In a letter to friend and agent Elizabeth Otis, he notes, "The new book is going well. Too fast. I'm having to hold it down. I don't want it to go so fast for fear the tempo will be fast and this is a plodding, crawling book. So I'm holding it down to approximately six pages a day" (Steinbeck and Wallsten 1975). His journal is punctuated with comments about the pacing of the story—how he was writing it, and how it would be ultimately read and *felt* by readers.

When friend and editor Pascal Covici questioned the "abrupt" final scene of the book, Steinbeck replied:

> I've been on this design and balance for a long time and I think I know how I want it.... You know that I have never been touchy about changes, but I have too many thousands of hours on this book, every incident has been too carefully chosen and its weight judged and fitted. The balance is there. One other thing—I am not writing a satisfying story. I've done my damndest to rip a reader's nerves to rags, I don't want him satisfied. (Steinbeck and Wallsten 1975)

Steinbeck wanted not only to engage and interest readers, but to affect them deeply as they experience a kind of participation akin to the concept that fascinated Ricketts. In the same letter to Covici he continues: "Throughout I've tried to make the reader participate in the actuality, what he takes from it will be scaled entirely on his own depth or hollowness. There are five layers in this book, a reader will find as many as he can and he won't find more than he has in himself" (Steinbeck and Wallsten 1975). Years later, in 1953, a student wrote to Steinbeck and included a paper he had written about *The Grapes of Wrath* for a class. Steinbeck replied, noting that

> ...the purpose of a book I suppose is to amuse, interest, instruct but its warmer purpose is just to associate with the reader.... You say the inner chapters were counterpoint and so they were—that they were pace changers and they were that too but the basic purpose was to hit the reader below the belt. With the rhythms and symbols of poetry one can get into a reader—open him up and while he is open—introduce things on an intellectual level which he would not or could not receive unless he were opened up. (Steinbeck 1990)

Like the best poets in Ricketts's estimation, Steinbeck is conscious of how the form will convey the content. But most interesting is Steinbeck's association of his work with poetry, and that it is his desire to "get into a reader" and connect—in this statement we see a clear articulation of Ricketts's notion of participation. The impact of *The Grapes of Wrath* on readers fulfilled Steinbeck's hope for a participatory experience—the book remains among the most powerful novels in the canon of American literature. But as we know, the immediate response to the novel was mixed, and Steinbeck suffered from professional and artistic exhaustion after it was published. So he turned to Ricketts—and to science—for a new way of thinking, and of writing.

The expedition to the Gulf of California in 1940 is often heralded as the pinnacle of Steinbeck and Ricketts's friendship and professional collaboration. The details of the trip have been well documented, and we know that Ricketts's own written log was Steinbeck's guide in composing the narrative portion of *Sea of Cortez* (Steinbeck and Ricketts 1941). The book is arguably the writer's most complex text, and the ideas within it must be attributed to both men, as should the form it took.

The way that Steinbeck assembled the book—or "built" it, as Ricketts once wrote in a letter—is an extension of their thinking about not only *what* they saw in the Sea of Cortez, but *how* they saw it. That is, they explicitly considered their presence in the natural environment, and how it necessarily altered the reality of that environment, and thus their observations of it. "We knew that what we would see and record and construct would be warped.... By going there, we would bring a new factor to the Gulf" (Steinbeck and Ricketts 1941). Thus the book is—much like *The Grapes of Wrath*—Steinbeck's expression of the ideas that he and Ricketts shared about form.

Likewise, the organization of *Sea of Cortez* invited deep participation with readers. In a letter to Joseph Campbell, written soon after the book's publication, Ricketts noted:

> I was very charmed with the book. Jn [John] certainly built it carefully. The increasing hints towards purity of thinking, then building up toward the center of the book, on Easter Sunday, with the non-tel[eological] essay. The little waves at the start and the little waves at the finish, and the working out of the microcosm-macrocosm thing toward the end. (Rodger 2002)

The inclusion of Ricketts's "Non-teleological Thinking" essay as the Easter Sunday chapter confounded many readers and contemporary critics, who found the departure from daily observation and anecdote to be abrupt and abstract. Yet both Steinbeck and Ricketts knew that not all readers would experience the book that way, nor would they find it disjointed. As Steinbeck noted to Pascal Covici in a letter he sent while writing *Sea of Cortez*, "This book is very carefully planned and designed, Pat, but I don't think its plan will be immediately apparent. And again there are four levels of statement in it and I think very few will follow it down to the fourth. I even think it is a new kind of writing" (Steinbeck and Wallsten 1975).

Letters from this period further reveal the extent to which Steinbeck was immersed in that "new kind of writing" as he composed *Sea of Cortez.* He sought a kind of scientifically objective acceptance of the world—that is, a non-teleological and ecological perspective of how life was assembled as a whole from its disparate bits. Not insignificantly, while in the Gulf of California, Steinbeck and Ricketts saw evidence of America's impending war all around them, and both men returned home anxious about what was to come. Within months of their trip, Steinbeck was resolved to go to war as a journalist—and his letters reflect the jarring effect that decision was having on his thinking and writing:

> My own defeatist attitude has resolved itself to this—in the thinking of the present, there is a lot of nonsense, a lot of word and conception bondage. Very well let's tear the thing down and start again with a new Cogito ergo sum. Dead word and litter accumulates so rapidly in the thinking patterns. All this sounds like a lecture. It isn't. I'm trying only to tell you the direction my poor puzzled mind has been taking. I have found so little that is satisfying in the thinking of the non scientific men of the present.... The invertebrate book is not done yet. It is a long hard job but I think a good one. It too will resolve itself into a plea for observation and that in this time is a meaningless plea. But one does what one does. (Benson 1984)

Perhaps most interesting about this passage is the way that Steinbeck saw himself as a writer, and the ultimate role of the finished *Sea of Cortez* book. In spite of what he felt is the futility of his writing and even of the book itself, he was resolved to keep working: "one does what one does."

Soon after the Sea of Cortez expedition and publication of their book, Steinbeck and Ricketts found themselves on opposite coasts. The men would never again live and work in the proximity that marked the first decade of their friendship. Ricketts's influence on Steinbeck's work did not end with that distance, but the trajectory of Steinbeck's career as a writer continued to evolve and develop in ways that diverged from those that marked his collaboration with Ed Ricketts. Yet without question, in later works—including *Cannery Row* (1945), *The Wayward Bus* (1947), and *The Winter of Our Discontent* (1961), among others—Steinbeck continued to experiment with the concepts of form and participation that he first shared with Ricketts. ✣

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Got Squid? Changes in the Ecological State of the Gulf of California Since the 1940 Steinbeck-Ricketts Expedition with a Focus on Humboldt Squid

W. F. Gilly, Unai Markaida, Carlos Robinson, and Bilin Liu

Introduction

Although the exact number of invertebrate species collected by Steinbeck and Ricketts in conjunction with the 1940 Sea of Cortez expedition on the *Western Flyer* is uncertain (Brusca, this volume), it is clear that the number of cephalopod species observed was small—fewer than 1% of the species collected. In particular, *Dosidicus gigas*, the Humboldt or jumbo flying squid, was apparently not seen during the expedition. This stands in contrast to the remarkable ease with which this species was observed north of Santa Rosalía in the Guaymas Basin region of the Gulf of California during a 2004 retracing of the 1940 expedition during the same time of year and using the same type of vessel and similar observational methods (Sagarin et al. 2008). *Dosidicus* is a monocyclic, short-lived species that matures only once at a broad size range. During favorable years, large squid prevail and commonly reach a mantle length (ML) of >60 cm and a mass of 20 kg or more at maturity, with a life span of 1.5–2.0 years in the Sea of Cortez (Hoving et al.

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2013). Large squid of this sort supported the third- or fourth-largest commercial fishery in Mexico for the decade preceding the 2004 trip, with the vast majority of landings coming from the Guaymas Basin area (Rosa et al. 2013). These factors made it hard for even a casual observer in the Central Gulf to be unaware of *Dosidicus gigas* between 1995 and 2009.

It thus seems that large Humboldt squid were likely not to have been abundant in the Gulf of California in the spring of 1940, and reasons for the apparent change in the status of Humboldt squid since that time have been discussed without reaching any firm conclusion (Sagarin et al. 2008). Shortly after publication of the 2008 paper, a strong El Niño in 2009–2010 influenced the Central Gulf in a profound way. Humboldt squid in this region responded to this climatic anomaly by taking on a characteristic of the tropical portion (Costa Rica to Ecuador) of their large range, where squid mature at extremely small size (~30 cm ML, ~0.1 kg) and live for only about 6 or months (Hoving et al. 2013). In addition, commercial landings crashed. Both phenomena also occurred in conjunction with the strong El Niño of 1997–1998 (Bazzino et al. 2007; Morales-Bojórquez and Nevárez-Martínez 2010). Although recovery of landings and return to a large size at maturity occurred within a few years after the 1997–1998 event (Markaida 2006), recovery has not occurred during the years after El Niño 2009–2010, a period characterized in the Central Gulf by reduced wind-driven upwelling and productivity (Robinson et al. 2016) and, as documented in the present paper, increased warming at depth (see also Frawley et al. 2019). Another strong El Niño occurred in 2015–2016.

These observations suggest that the ecological state of the Gulf of California can show drastic, long-lasting alterations that involve the size of Humboldt squid. Although small Humboldt squid are probably still abundant in the Gulf (Hoving et al. 2013 and unpublished jigging data), they are clearly much less obvious (and more difficult to capture by jigging) than larger squid were a decade ago. This new awareness is relevant to the question of why Steinbeck and Ricketts did not record this species in the Sea of Cortez in 1940.

We examine several possibilities in reassessing this question. First, squid may not have been of much interest to the intertidal explorers in 1940, so not much attention was paid to this group. Second, small, juvenile specimens of *Dosidicus gigas* were in fact collected but misidentified. Third, large Humboldt squid were temporarily absent from the Gulf during their visit because of the effects of El Niño. Fourth, large (and potentially smaller) squid were absent because of chronically unfavorable oceanographic conditions in the Sea of Cortez. We assess these alternatives by (1) examining the original text of *Sea of Cortez* (1941), along with relevant field notes (Ricketts 2006 [1940]) and correspondence of Ricketts, (2) documenting reports of Humboldt squid in the Gulf of California, as well as in U.S. Pacific waters, and analyzing these records in conjunction with (3) improved historical indices of El Niño and (4) available hydrographic data from the 1950s through the present.

Methods

Ricketts Correspondence

Unpublished correspondence between Edward F. Ricketts and S. Stillman Berry regarding the identification of cephalopods collected on the 1940 Sea of Cortez expedition was obtained from the Smithsonian Institution, Washington D.C., by Donald Kohrs of the Harold A. Miller Library at Stanford University's Hopkins Marine Station. This material consists of 14 letters and a record of specimens exchanged between Ricketts and Berry between 21 May 1940, shortly after the return of the *Western Flyer* to Monterey, and 18 November 1941, a few weeks before publication of *Sea of Cortez.*

Historical El Niño Activity

An improved Multivariate ENSO index (MEI.ext) indicative of historical El Niño activity from 1872 to 2005 (Wolter and Timlin 2011; https://psl.noaa.gov/enso/mei.ext/table.ext.html) and more recent MEI.v2 data from 1979 to 2020 (https://www.psl.noaa.gov/enso/mei/) were used to create a bi-monthly MEI time series for 1900–2020. Values for the years of overlap (1979–2005) were averaged.

Historical Hydrographic Data

Temperature-at-depth data for the Gulf of California and surrounding Pacific Ocean waters of all available data types (CTD, XBT, Bottle) were obtained from World Ocean Database 2013 (www.nodc.noaa.gov/OC5/

WOD13/readwod13.html). We also used our data from a total of 516 CTD casts conducted in the southern half of the Gulf of California between 2006 and 2018 from a variety of vessel platforms, including the research vessels *New Horizon* (UNOLS), *Pacific Storm* (Oregon State University), *BIP XII* (CIBNOR, La Paz), and *El Puma* (UNAM), as well as numerous private vessels, including *Soledad* in collaboration with the staff of Minera y Metalúrgica del Boleo, Santa Rosalía, BCS, Mexico. These measurements employed a SBE19 or SBE19plusV2 profiler equipped with a SBE43 oxygen sensor (Seabird Electronics, Bellevue, WA, USA). Data collected in conjunction with NSF OCE support have been deposited in the BCO-DMO database (Gilly 2013; Gilly 2015); data collected with NSF IOS support (August 2015) are available on request. Other data are unpublished. All hydrographic data were imported into Ocean Data View 4.78 (https://odv.awi.de/) for analysis and graphics generation.

Historical Squid Sampling

Dates of the appearance and size of mature Humboldt squid in the Gulf of California, including the area around the mouth of the Gulf and the region of Cabo San Lucas, and in U.S. waters, were gleaned from all available literature sources that we are aware of, and in several cases personal interviews with reliable sources. During the period of 2005 through 2018, we sampled squid in the Central Gulf directly through jigging sessions on the same vessels used for CTD casts and determined mantle length, sex, and maturity state as described elsewhere (Hoving et al. 2013). Between 2013 and 2015, we randomly sampled squid from commercial fishing operations in Santa Rosalía, BCS, as part of the SURMAR program (Sustainable Use and Research of the Central Mar de Cortés) in collaboration with ITESME (Instituto Tecnológico Superior de Mulegé), under the auspices of the Ocean Foundation, Washington, D.C. (www.oceanfdn.org/projects/host-project/surmar-asimar). In April 2002, we sampled 996 squid for tagging off Guaymas and measured mantle length but not maturity state (Markaida et al. 2005). In September 2001, we sampled 1,000 squid for tagging off Santa Rosalía but routinely measured neither size nor maturity. We did measure mantle lengths of particularly large individuals, several of which exceeded 95 cm.

Results

Were Squid Neglected on the 1940 Sea of Cortez Expedition?

Only 3 squids and 2 octopuses are listed in the Phyletic Catalogue of *Sea of Cortez* (Steinbeck and Ricketts 1941). Of the squid, Ricketts identified *Loligo opalescens*, the common California market squid, and noted that the specimens collected off Guaymas, Sonora, represented the southernmost records for the species (Table 1; the tables appear in the appendix at the end of the text). The other squid specimens were also identified as loliginids, members of the same family to which *Loligo opalescens* (now *Doryteuthis opalescens*) belongs.

Although the primary focus of the 1940 expedition was the intertidal region, squid were observed from the deck of the *Western Flyer* at night at San Lucas Cove and San Carlos Bay (near Punta Trinidad) on the Baja California Peninsula, and they were captured by shrimp trawlers operating off Guaymas (Figure 1). It is obvious by comparing the *Sea of Cortez* (Phyletic Catalogue and Log) with Ricketts's field notes that good agreement exists between these sources, although a lack of mention of the squid at San Carlos Bay in the Phyletic Catalogue seems peculiar given the small total number of cephalopods collected. Squid are mentioned in no other passage in either of the sources, so it is unlikely that they were observed elsewhere. These locations are in the Central Gulf, an area that was the center of commercial fishing activities for Humboldt squid in the Gulf in 2004, and this species was readily observed every night from the deck of the *Gus D* during our expedition at the same peninsular locations and others in this area (Gilly 2004; Gilly et al. 2006a; Sagarin et al. 2008).

Ricketts directly addresses the question of potential neglect of cephalopods in the Summary U-118 to the Cephalopoda section of the Phyletic Catalogue (Steinbeck and Ricketts 1941) and suggests that they did their best:

> In checking over our records, it becomes apparent to us that we failed to get a representative cephalopod picture of the region. In an area presumably ideally adapted to these animals (to octopi especially for which the Gulf is noted) and where even the most cursory collecting, such as that of the Bingham Expedition, turned out 5 species, we report only 2 octopi and 2 or 3 squid. Why this

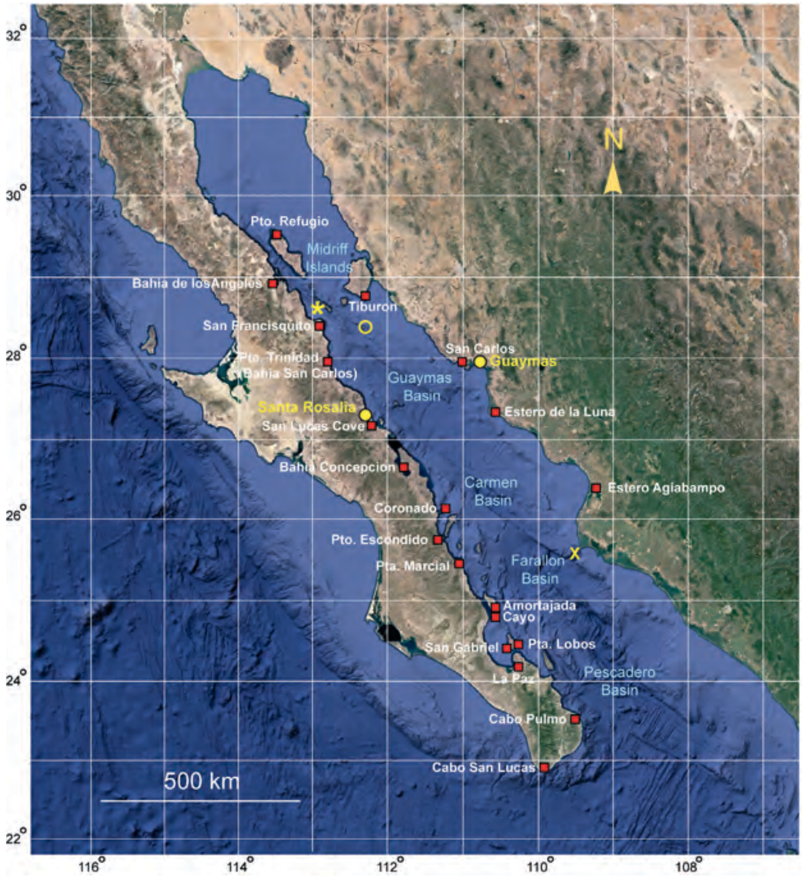

Figure 1. Map of relevant locations in the Gulf of California. Collecting stations of Steinbeck and Ricketts in 1940 are indicated by red squares. The locations of the Salsipuedes Basin (*), Isla San Pedro Mártir (o), and Farallón de San Ignacio (X) are indicated by yellow symbols. Adapted from Google Earth.

should be is hard to say. We covered the region fairly carefully, considering the time limitations, and devoted a fair pro ratum of our attention to this group, capturing, with one exception, every cephalopod encountered. Of our few certainly identified species, the octopus is definitively Panamic, reaching in southern California its northern limit. One squid [*Loligo opalescens*] is northern (occur-

> ring to Puget Sound), the other [*Lolliguncula panamensis*] ranges from Guaymas south to Ecuador, both species, strangely enough, having been found at the extremes of their respective ranges, the one at its northernmost limit, the other being by those reports extended many hundred miles to the south.

Were Squid from the 1940 Sea of Cortez Expedition Misidentified?

All the squid cataloged in *Sea of Cortez* are members of the family Loliginidae. Humboldt squid belong to an entirely different family, the Ommastrephidae. Squid in these families belong to two different orders and are easily distinguished, even at small size, by the presence (Myopsida: loliginids) or absence (Oegopsida: ommastrephids) of a transparent cornea over the eye. It is therefore highly unlikely that Ricketts would have misidentified the squids in Table 1 as loliginids if they were, in fact, ommastrephids.

Ricketts actually took considerable pains to ensure the correct identification of these specimens by consulting with S. Stillman Berry, a recognized expert on cephalopod taxonomy. In July 1940, Ricketts sent the San Lucas Cove squid and several specimens of (putative) *Lolliguncula panamensis* taken in the Guaymas shrimp trawls to Berry for identification, with a list of specimens from the 1940 expedition (Ricketts 1940):

> A record of cephalopods, marine pulmonates and chitons sent to Dr. Berry, from Gulf of California PBL trip.
>
> 28 Mch 1940. San Lucas Cove (S of Santa Rosalia). Minute pelagic squid taken at night by light. No duplicate.
>
> 9 Mch 1940. Jap shrimp dredger S of Guaymas. Squid. Several duplicates at hand.

In May 1941, Berry confirmed the identification of the San Lucas Cove squid as a juvenile loliginid (species not determinable) and the Guaymas specimens as *Lolliguncula panamensis* Berry (Berry 1941a). The copy of Ricketts's original record has hand-written notations of "larval ♂ Loliginid" for the March 28 entry and "*Lolliguncula panamensis* B." for April 9, presumably added by Berry after he examined the specimens.

In June 1941 Ricketts (1941a) followed up with:

> List of additional cephalopods and chitons sent to Dr. Berry as a result of the PBL Gulf 1940 trip.
>
> April 9, 1940. Squid taken aboard Jap shrimper off Guaymas. One of these you determined to be *Lolliguncula panamensis*, another was *L. opalescens*. The 3 additional specimens being sent you seem to be *L. opalescens* also, but I am sending them on to be sure. They need not be returned.

This exchange with Berry indicates that Ricketts had tentatively identified the second species of squid taken in the Guaymas shrimp trawls as *Loligo opalescens* but had enough doubt to send additional specimens to Berry for confirmation. In subsequent correspondence (July through November 1941), there is no mention of these squid though they continue to discuss octopus and chiton specimens at length. In late July, Ricketts tells Berry, who is about to go to Montana for the month of August, that the deadline for *Sea of Cortez* copy is September 1, and that Berry should "send me at this time (within the next two weeks) whatever additional information you find available, together with whatever photos you have been able to secure, and that you don't worry about any obscure or undecided identifications" (Ricketts 1941b).

Ricketts sent the final draft of the cephalopod and chiton sections for *Sea of Cortez* to Berry in September 1941 and asked if Berry could make any needed corrections. Other than adding three references, Berry had only two comments on the cephalopod section (Berry 1941b). The first was a question:

> What is the Boone 1928 paper to which you refer? It seems to be something I do not know about.

Boone's paper reported *Loligo diomedeae* from the Gulf of California in 1928. This species is now recognized as *Lolliguncula diomedeae*. Surprisingly, Berry mistakenly described this squid as a new species a year after the Boone paper—*Loliolopsis chiroctes* from the Gulf of California (Berry 1929; Vecchione et al. 1998). Historic confusion of this species with *Loligo opalescens* (now *Doryteuthis opalescens*) has also been noted (Jereb et al. 2010), and indeed the two are very similar in appearance (Figure 2).

Figure 2. Comparison of Doryteuthis opalescens and Lolliguncula diomedeae. Specimens of both species were fixed in 10% formalin in seawater and then stored in 70% ethanol. Both specimens were captured by jigging—D. opalescens in fall 2018 from Pacific Grove, Monterey Bay, CA, and L. diomedeae in summer 2015 from the Gulf of California off Santa Rosalía, BCS, Mexico. Identity of the latter species was confirmed with molecular methods (Fernández-Álvarez et al. 2017). Photo by Ben Burford.

Berry's second comment was a criticism of Ricketts's entry U-115 in the draft Phyletic Catalogue for *Loligo opalescens* that read: "Taken in some quantity, with the above *Lolliguncula panamensis* aboard the Japanese shrimp dredger south of Guaymas." Berry responded, "U-115 *above* is an adverb, not an adjective, in spite of the prevalence of loose usage." There was no mention of the identification question. Whether Berry ever examined the "*Loligo opalescens*" specimens after he returned from Montana in late August 1941 is unclear. A final exchange of letters in mid-November 1941 had no mention of squid—they focused on chitons and octopuses. *Sea of Cortez* was published less than one month later.

Despite the almost certain misidentification of *Loligo opalescens* in *Sea of Cortez*, it is clear that all squid from 1940 were loliginids, meaning that juvenile or small specimens of *Dosidicus gigas* (or any ommastrephid squids) were not collected.

Were Large Humboldt Squid Absent in the Sea of Cortez Because of a Strong El Niño?

Addressing this question necessitates examining the relationship between size of Humboldt squid and environmental features. When conditions are favorable, Humboldt squid live for up to 2 years and reach very large size, especially in the Humboldt Current of the Southern Hemisphere (Arkhipkin et al. 2015). On the other hand, if conditions are chronically less favorable, such as in the equatorial portion of their range, they mature in about 6 months at a ML of ~30 cm. If conditions are marginal, they can mature at an intermediate length (and age) (Hoving et al. 2013). This has led to the idea of three "forms" of Humboldt squid—small (ML = 13–34 cm), medium (ML = 24–60), and large (ML >50 cm) (Nigmatullin et al. 2001). These forms are now thought to represent phenotypes that are differentially expressed depending on environmental conditions, primarily temperature and food availability (Hoving et al. 2013; Arkhipkin et al. 2015), with no known genetic differentiation based on size class or geographical distribution (Staaf et al. 2010).

We define these size classes slightly differently in an attempt to minimize overlap in size at maturity: small = <30 cm ML; medium = 30–50 cm ML; large = >50 cm. In terms of age, small squid would live for about 6 months, medium for 1 year, and large for >1 year. All three size classes are evident in offshore waters of the Humboldt Current system (Peru/Chile, Figure 3A), but large squid are absent in equatorial waters of Ecuador and Costa Rica (Costa Rica/Ecuador, Figure 3B).

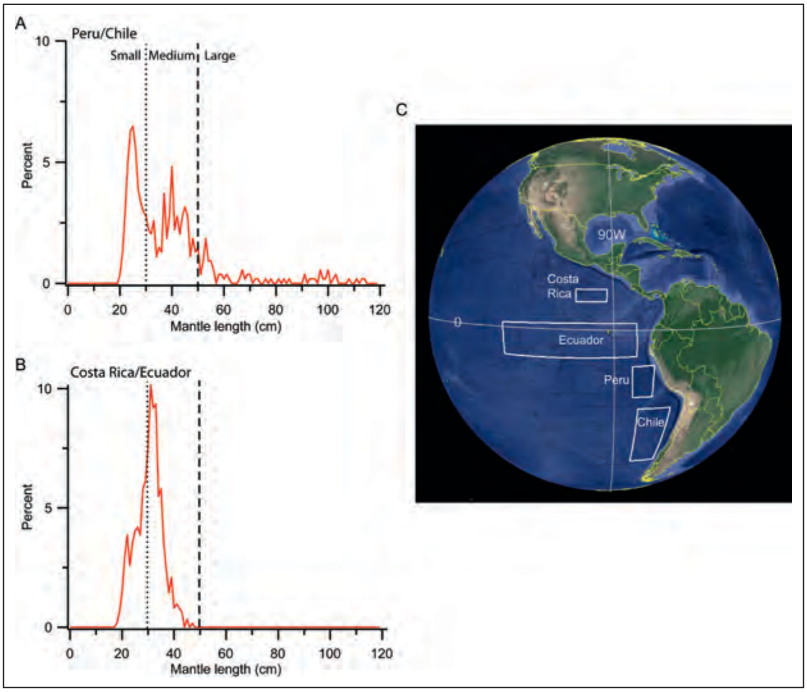

Figure 3. Size distribution of mature Humboldt squid in four major fishing areas. (A) The Humboldt Current system (Peru/Chile) and (B) equatorial areas (Ecuador/Costa Rica). (C) Map showing locations of the fishing zones. Numbers of squid analyzed and years: Peru (n = 442, 2008–2016), Chile (n = 98, 2006–2015), Ecuador (n = 413, 2012–2017), Costa Rica (n = 207, 2009). Percent is percentage of mature individuals in total catch in each area over the indicated years. Data courtesy of Bilin Liu.

Multiple size classes of mature Humboldt squid can thus coexist in a given area and time period. In the Central Gulf (Guaymas Basin region, Figure 1) prior to 2009 mature squid were primarily of the large type (Figures 4A,B), and this area supported the commercial fishery based in Santa Rosalía and Guaymas beginning in 1994 (Markaida et al. 2005; Rosa et al. 2013; Robinson et al. 2016). The only significant sampling of medium-sized mature squid (along with large ones at the same place and time) occurred in May 2008 in the Southern Gulf (Farallón Basin area, X in Figure 1). El Niño 2009–2010 was accompanied by the appearance of small mature squid (Figure 4C) in the Guaymas Basin area, and large squid were essentially restricted to the Salsipuedes Basin

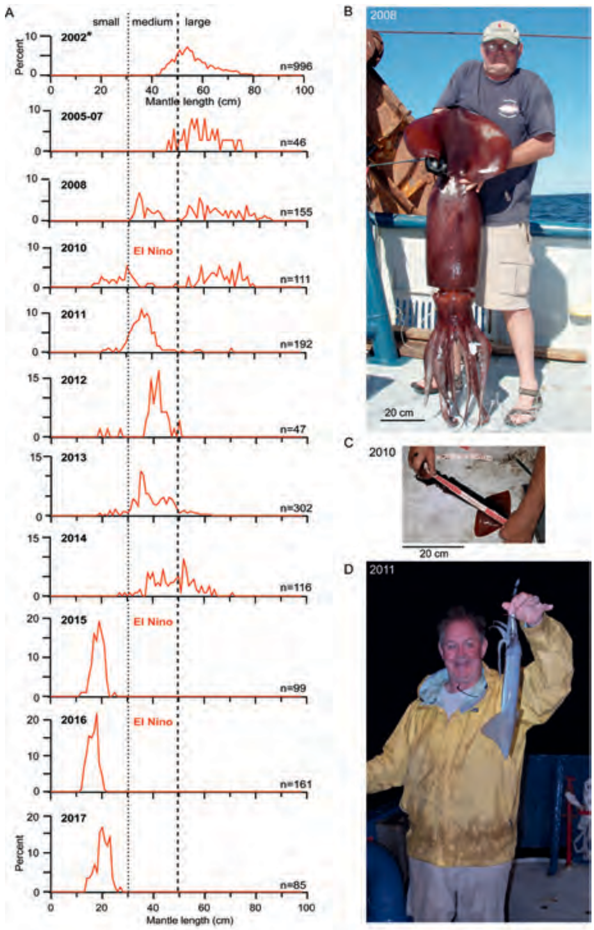

Figure 4. Changes in the size distribution of mature Humboldt squid in the Central Gulf of California since 2005. (A) Prior to 2010, squid in the Central Gulf were of the large type. Maturity was not assessed in 2002, and squid in the medium category were probably mostly immature. Medium-sized squid in 2008 were sampled farther south, near Farallón de San Ignacio (X in Figure 1). The shift to small body size at maturity farther north began with El Niño 2009–2010, and this condition was reinforced by El Niño 2015–2016. (B) A large squid (84.5-cm mantle length) in November 2008 on the BIP XII between Santa Rosalía and Punta Trinidad. (C) A small squid (26.5-cm mantle length) in June 2010 on the New Horizon near Santa Rosalía. (D) A medium squid (36.4-cm mantle length) in June 2011 on the New Horizon off Bahía San Carlos. Lower scale bar applies to panels C and D.*

area in the Midriff Islands region (* in Figure 1). Nearly all squid were medium-sized (Figure 4D) during the subsequent 3 years, although a few large individuals were recorded in 2013. During the summer of 2014, both medium and large mature squid were present in late summer, but Hurricane Odile struck in September, and by spring 2015 another strong El Niño was underway. Since that time we have found only small mature squid in the Gulf of California, despite extensive sampling over much of the region between the Midriff Islands and the Farallón Basin area, with the most recent sampling being carried out in autumn of 2019.

Thus, strong El Niño events (2009–2010 and 2015–2016) appear to have led to a change in life history strategy of Humboldt squid in the Gulf of California that is characterized by precocious maturation at small size in ~6 months, at a body size that is markedly smaller than the large form (compare Figures 4B and 4C,D). A similar phenomenon occurred in conjunction with the strong El Niño of 1997–1998 (Markaida 2006; Robinson et al. 2016). This is thought to be an adaptive response to the low-productivity conditions that can accompany a strong El Niño (Hoving et al. 2013).

With this trait of the species in mind, we can examine the historical record of El Niño and compare it to reports of Humboldt squid of different sizes in the Gulf of California (Figure 5 and Table 2). The first large Humboldt squid in the Gulf were reported in 1976 (Sagarin et al. 2008), and exploratory fishing for this species began in the late 1970s with medium squid dominating until 1980 when all three forms were reported (Ehrhardt et al. 1982a,b). In 1981 only small squid were caught (Ramírez and Klett 1985), and the strong El Niño of 1982–1983 followed. Effects of this event on the size of Humboldt squid in the Gulf are unknown, but we assume that the small form dominated for at least several years thereafter before the first confirmed appearance of large squid in 1989 (Morán-Angulo 1990). A second phase of large-scale commercial fishing started in 1994 (Rosa et al. 2013) based on the continuous presence of large squid in the Gulf (except for a few years after El Niño 1997–1998) until large squid disappeared from the Gulf after 2010.

Prior to 1976, there are numerous reports of small and medium-sized squid in the Gulf, going back to the early 1930s. The first properly identified Humboldt squid was collected near Cabo San Lucas in 1932 (Crocker 1933), and the first in the Gulf proper was from the Carmen Basin area in 1959 (Wormuth 1976). Given the substantial number of reliable reports of small and medium Humboldt squid during the period

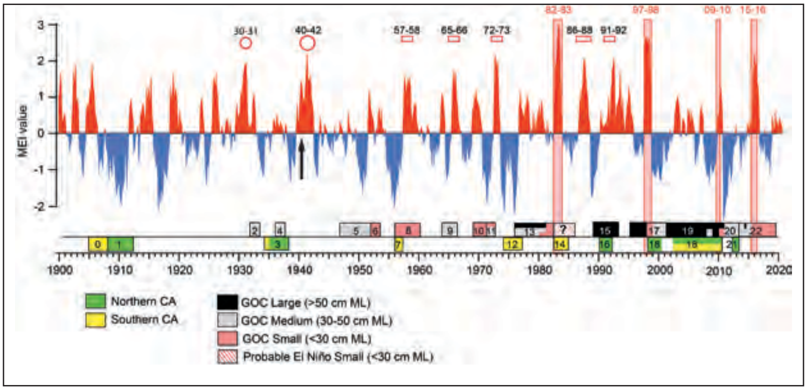

Figure 5. Historical El Niño activity and the size of mature Humboldt squid. Upper panel: Strong El Niño events are recognized by prolonged high values of the MEI (in red). Events of 1982–1983, 1997–1998, and 2015–2016 are generally recognized as being very strong and all had obvious ecological consequences along the Pacific Coast of the U.S. The 2009–2010 event was classified as a strong El Niño Modoki (Ashok et al. 2007; Barnard et al. 2011), and indices for traditional (canonical) El Niño, including MEI.ext and MEI.v2, do not recognize it as a strong canonical El Niño event. Ecological effects of this event were stronger in the Gulf of California (GOC) than in U.S. waters. These four events are indicated by solid pink rectangles. Five additional, relatively strong El Niño events recognized since 1950 are indicated by open rectangles (https://psl.noaa.gov/enso/). Similar events were identified for 1930–1931 and 1940–1942 (open circles) by considering the cumulative frequency of ranked El Niño events by 3-month season based on MEI.ext data from 1895 to 2015 (https://www.esrl.noaa.gov/psd/enso/climaterisks/years/top24enso.html). Lower panel: Timeline of reports of small, medium, and large mature Humboldt squid in the Gulf of California (above horizontal line) and California (below horizontal line). Numbers in the color-coded boxes correspond to the references in Tables 2 and 3. Black arrow indicates the time of the 1940 Steinbeck-Ricketts expedition.

1932–1976—but not of large ones—it is unlikely that large squid would have been present when Steinbeck and Ricketts explored the Gulf in 1940 (upward arrow in Figure 5), regardless of any El Niño activity around the time of their trip. As discussed elsewhere (Sagarin et al. 2008), we are unaware of any reports of Humboldt squid in the Gulf before 1932. Overall, it would seem that the years immediately preceding the 1982–1983 El Niño marked a period of major transition in regard to Humboldt squid ecology in the Sea of Cortez.

Were Large Squid Absent Because of Chronically Unfavorable Oceanographic Conditions?

Adaptability of Humboldt squid in regard to temperature and oxygen concentration of the water column is relevant to their migrations, both vertical and horizontal—including episodic range expansions to higher latitudes in the California Current system (Gilly et al. 2006b; Zeidberg and Robison 2007). Work on large Humboldt squid with archival tags that log temperature and depth revealed complex patterns of vertical movements, but two features were consistently observed. First, squid spend the majority of nighttime hours in the upper 75 m of the water column, where they forage on micronekton, primarily mesopelagic fishes, krill, and molluscs that also make nighttime migrations into near-surface waters. This generalization is true everywhere squid have been tagged—Central Gulf of California (Gilly et al. 2006b; Markaida et al. 2008; Gilly et al. 2012), Pacific Ocean off Baja California Sur (Bazzino et al. 2010), California Current (Stewart et al. 2013; Field et al. 2013), and Humboldt Current off Peru (unpublished data).

A second generalization is that Humboldt squid spend very little time at temperatures above 22°C–23°C (Gilly et al. 2006b; Gilly et al. 2012; Stewart et al. 2013). Lack of tolerance of temperatures above this range is probably due to a substantial increase in metabolic rate (Rosa and Seibel 2008) and decrease in the oxygen-carrying capacity of blood (Seibel 2013), as demonstrated under laboratory conditions. Subsurface water temperatures exceeding this level are regularly found only in the Gulf of California during warm months (July–October), when surface temperature in the Central Gulf (Figure 6A) can reach 30°C (Figure 6B), and oxygen concentration in the upper water column decreases (Figure 6C).

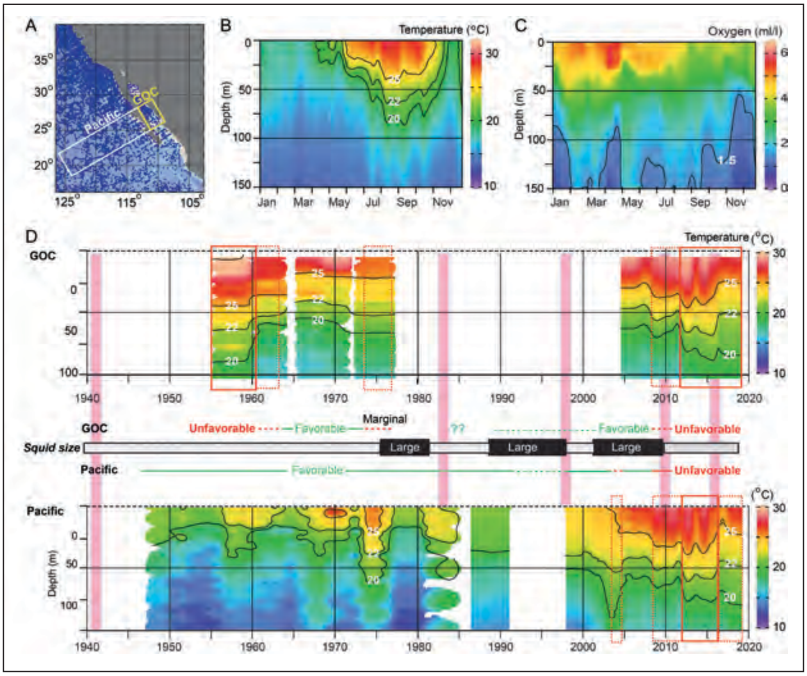

Figure 6. Hydrographic changes in relation to the size of Humboldt squid in the Gulf of California. (A) Map showing the areas analyzed in the Gulf of California (GOC) and adjacent Pacific Ocean waters (Pacific). (B) Annual temperature variation in upper 150 m of the water column for the GOC area (pooled data from 1955 to 2017). (C) Annual variation in oxygen concentration for the same data set as in B. The 1.5 ml/l isopleth is indicated, because this marks a range considered to be hypoxic for many organisms. (D) Change of the temperature profile for the upper 100 m of the water column since 1940 for the GOC (upper panel) and Pacific areas (lower panel) during warm months (July through October). Pink bars denote major El Niño events. Unfavorable periods are indicated by solid red rectangles; marginal phases are indicated by dotted rectangles. A simplified timeline indicating the documented presence of large Humboldt squid separates the two panels with an indication of the environmental status. A presumptive favorable period is indicated by the dashed green line; marginal periods are indicated by dashed red lines.

We propose that if the 22°C isotherm extends to depths of 50 m or more, this favored nighttime foraging zone becomes a hostile environment for foraging Humboldt squid. Defining unfavorable habitat in this way facilitates interpretation of the historical hydrographic record for the Central Gulf and adjacent Pacific Ocean waters in terms of habitat (temperature at depth) suitability for large Humboldt squid.

Hydrographic data for the Central Gulf are most plentiful after 2005 (Figure 6D, upper panel). It is evident by inspection that the 22°C isotherm descended from ~40 m in 2005 to >75 m by 2015–2016. Although this period includes two strong El Niño events, it is overall cool with respect to the MEI (Figure 5). According to the above definition of unfavorable habitat for large Humboldt squid (22°C isotherm at depth of >50 m), the period prior from 1990 to 2008 is favorable, 2009–2010 is marginal, and 2011–2016 is clearly unfavorable. During the latter period, large Humboldt squid were essentially non-existent in the Gulf (Figure 5). Hydrographic conditions in adjacent Pacific Ocean waters largely mirrored those in the Gulf since El Niño 2009–2010 (Figure 6D, lower panel), and (to our knowledge) large squid have also been absent there as well.

Unfortunately, no hydrographic data for the Central Gulf are available for the critical years after large squid first appeared (mid to late 1970s) until 2005. During this period large squid were present throughout the southern and Central Gulf, and we assume that conditions were favorable—as they appear to have been in the Pacific. Hydrographic data are more abundant between 1955 and 1975 in both locations, and both areas would have been reasonably favorable for large squid after 1960. Before 1960 an unusual situation is evident in which the Gulf was clearly unfavorable (similar to 2011–2019), but adjacent Pacific waters were very favorable. Although only small and medium squid appear to have been present in the Gulf prior to 1960, size of squid in the Pacific is unknown, and it is possible that that area could have supported large squid during this period.

Invasions of Humboldt Squid into U.S. Waters, and Conditions in Mexico

Favorable conditions in the Pacific, regardless of those inside the Gulf of California, may be a prerequisite for episodic northward range expansions of Humboldt squid. In this case, squid would reproduce in Mexico where suitable conditions exist (Staaf et al. 2011; Ramos et al.

2017) and migrate seasonally into U.S. waters to forage in the productive California Current, thereby sustaining a long enough life to permit growth to large size. This pattern of annual recruitment to the California Current from Mexico could continue for several generations, leading to a multi-year invasion. In fact, this is exactly what appears to have happened during the most recent invasion (2002–2010) when Humboldt squid reached a record latitude of >59° N in Alaskan waters (E. Coonradt and F.G. Hochberg, pers. comm.) and were abundant in waters off Washington and British Columbia during late summer (Gilly 2006; NOAA Fisheries 2012; Field et al. 2013). During this time, large Humboldt squid were abundant in both the Gulf and adjacent Pacific waters. Humboldt squid essentially disappeared from U.S. waters after the 2009–2010 El Niño, presumably because the short-lived small squid in Mexico cannot undertake extensive migrations, and reliable conditions conducive to reproduction (of any size class of Humboldt squid) in U.S. waters do not exist (Staaf et al. 2011).

Since a multi-year invasion of Humboldt squid requires a source of reasonably sized individuals (not necessarily mature), such events provide indirect evidence of an abundant pool of squid in Mexico that are not locked into the small phenotype and are therefore physically capable of undertaking a long foraging migration before returning to spawn. Thus, the invasion of large Humboldt squid into Northern California in 1935–1937 (Figure 5 and Table 3), some of which were purchased from a sardine purse-seine vessel by Ricketts in 1936 (Clark and Phillips 1936; Gilly 2006), would be consistent with the idea of favorable habitat for large squid in the Pacific but not necessarily in the Gulf—like the situation prior to 1960 (Figure 6D). A similar invasion of large squid occurred during the early 1900s. We propose that a multi-year invasion cannot occur without an abundance of squid of the large or medium phenotype in Pacific waters off the west coast of the southern half of the Baja California Peninsula, the closest known spawning area to California (Ramos et al. 2017). What triggers such sporadic invasions remains unknown.

Discussion

Steinbeck and Ricketts did not report Humboldt squid from their 1940 Sea of Cortez expedition, even though Ricketts was familiar with the species from a well-known invasion of Monterey Bay only several years prior to the trip. This stands in direct contrast to the large numbers of squid observed on a retracing of the trip in 2004 (Sagarin et al. 2008). The present paper considers both technical/humanistic and ecological causes for this striking difference.

Technical and Humanistic Causes: Expectation, Warp, and Taxonomy

Based on what we now know, we assume that the source of squid invading Monterey Bay in the 1930s was Mexico. Although Wormuth (1976) first suggested that Humboldt squid from the Northern and Southern Hemispheres might represent different stocks, this line of thinking was probably not mainstream in 1940. Heath (1917) of Hopkins Marine Station stated, "The so-called giant squid (*Dosidicus gigas*) occasionally migrates from the southern hemisphere, and has been captured as far north as Monterey." If Ricketts shared this belief, he probably would not have expected to find Humboldt squid in the Gulf of California. Steinbeck and Ricketts addressed expectations and the idea of "warp" in the Introduction to *Sea of Cortez*: "We knew that what we would see and record and construct would be warped, as all knowledge patterns are warped."

A migration from the center of the Peruvian squid fishing zone in Figure 3C (13° S, 82° W) to Monterey Bay (37° N, 123° W) along a great-circle route would be ~7,000 km. Large Humboldt squid can travel at least 640 km in 17.6 days (Stewart et al. 2012). At this maintained speed (~40 km/day), migration from Peru to Monterey Bay would take about 6 months (one way). Given a maximum life span of 2 years, such a journey would be conceivable, but it seems more likely that invasions of California waters have always originated in northwest Mexico. A migration from the closest known Mexican spawning area (~27° N, 116° W; Ramos et al. 2017) to Monterey Bay would be 1,250 km, a feat that could be accomplished in only 1 month. We believe that migrations of Humboldt squid into U.S. waters have always originated in northwest Mexico.

Ricketts (1948) put forth a similar idea about sardines in the Northern and Southern Hemispheres, and he proposed a dynamic connection between populations of sardines in the northern California Current and in southern California/Mexican waters:

> My own (but unproven) inference is that while the southern race always, or at least often, recruits FROM the north, it never or

> rarely feeds back INTO the north.... However, it's conceivable that if something happened to the northern race, say it should be depleted by a combination of natural causes and overfishing, the southern race very easily might increase to the point where it would infiltrate back into the depopulated north.

Ignoring the potential warp factor of *not* expecting Humboldt squid in Mexican waters, a general case for benign neglect of cephalopods on the 1940 expedition might be made. Although Ricketts directly addressed this issue, one might question the veracity of nighttime observations from the deck of the *Western Flyer*. After all, it is recorded that 2,238 specimens of 2 species of beer were consumed on the trip. Analogous data from our 2004 expedition yield a somewhat lower estimate of 1,728 specimens of 5 species (Figure 7). Given that the number of core crew members was similar in both cases (7 in 1940 vs. 6 in 2004), it would appear that a specific nocturnal neglect of cephalopods due to this factor cannot be realistically attributed to the 1940 expedition.

Figure 7. The complete collection of 1,728 specimens sampled in the 2004 retracing of the 1940 Sea of Cortez expedition (original collection as delivered to Monterey, CA, in preparation for trip).

Although it is clear that no squid of the ommastrephid family, to which *Dosidicus* belongs, were collected on the 1940 trip, expectation and warp almost certainly played a role in the misidentification of *Loligo opalescens* (now *Doryteuthis opalescens*) in the Phyletic Catalogue. In this case, the warp appears to have at least partially manifested itself in the apparent ignoring (by both Ricketts and S. Berry) of the identification of *Lolliguncula diomedeae* (as *Loligo diomedeae*) in the Gulf (Boone 1928). Warp is suggested by Ricketts's annotation to Boone's paper in the S-4 entry of phylum Mollusca references: "Probably this, like others of the Boone papers, should be used with caution." The whole episode constitutes an ironic sidebar and illustrates how intense focus on an exciting new puzzle (unknown species of chitons and octopuses) can result in a lack of proper attention to seemingly familiar and resolved questions—even by experts. As Steinbeck and Ricketts themselves point out in Chapter 10 of *Sea of Cortez*, "It is amazing how the strictures of the old teleologies infect our observation, causal thinking warped by hope."

Our research group had the good fortune to encounter *Lolliguncula diomedeae* in the Gulf after El Niño 2009–2010 (Fernández et al. 2017). While it is completely understandable that Ricketts mistook the species for *Loligo opalescens* (now *Doryteuthis opalescens*) at sea on the deck of a shrimp trawler in 1940 (Figure 2), the failure to properly follow up on these specimens by both Ricketts and Berry in the final workup for *Sea of Cortez* is unfortunate.

Ecological Causes: El Niño and More

We now recognize that strong El Niño events can lead to a drastic change in size and age at maturity of Humboldt squid in the Gulf of California, and that this change can persist for at least several years. For example, the small-size-at-maturity phenotype has been fixed in the Gulf since 2011, and the fishery has completely collapsed.

Although early spring of 1940 appears to have been the beginning of a reasonably strong El Niño (Figure 5), observable biological effects of the event, specifically the appearance of small, mature Humboldt squid, would probably have occurred only after the Steinbeck-Ricketts expedition in March and April of that year. Another potentially strong El Niño in 1930–1931 would seem to have been too far in the past to have wreaked havoc on Humboldt squid in 1940, and medium squid were reported in the Gulf during the years between these events. In summary, there is no good reason to believe that a strong El Niño was responsible for the absence of large Humboldt squid in the Gulf of California in 1940. But why small (or medium) squid were not observed is not so easily answered.

Strong El Niño events lead to an increase in temperature at depths to at least 100 m in the eastern Pacific, and this may be a key signal that triggers expression of the small-size-at-maturity phenotype of Humboldt squid in the Gulf of California (Hoving et al. 2013). During the years between El Niños 2009–2010 and 2015–2016, a subsurface warming trend in both the Gulf of California and adjacent Pacific Ocean pushed the 22°C isotherm to well below 50 m (Figure 6; see also Frawley et al. 2019), and this phenomenon thus resembles the hydrographic signature of El Niño. In addition, temperatures above 22°C are avoided by large Humboldt squid, and if such warm water covers most of the upper 75 m of the water column, nighttime foraging by squid is likely to be compromised. This stressful situation and the potential decrease of caloric (food) consumption have probably acted to keep squid in the Gulf locked in the small phenotype, just as they are in equatorial waters.

Small Humboldt squid in the Central Gulf tend to disperse into the open waters of the Guaymas Basin area, away from the continental shelf habitat that is favored by large squid (and squid fishermen) (Hoving et al. 2013). In this area of the Baja California coast, the edge of the continental shelf is generally quite close to shore, and anchoring at night therefore places a vessel relatively close to this feature. At night, large squid in this region migrate toward the surface but also onto the shelf, often coming close to shore (Benoit-Bird and Gilly 2012). Thus, in 2004 when large squid were abundant, we saw squid at various anchorages between San Lucas Cove and San Francisquito (unpublished notes). We also observed Humboldt squid at the surface as our boat drifted offshore at night in the San Pedro Mártir region of the Guaymas Basin area (Gilly 2004; Gilly et al. 2006a), but the *Western Flyer* did not engage in this activity (it is doubtful that Captain Tony Berry would have allowed this).

Daily vertical and horizontal migrations of small-phenotype squid have not been specifically studied, but they are generally not as obvious at the surface (night or day) as are larger individuals (pers. observ.). This feature probably reflects dispersal from the continental shelf habitat, and Steinbeck and Ricketts may have simply been unlucky at spotting small or medium-sized squid at their near-shore anchorages at night. Alternatively, small/medium squid may not have been particularly abundant in 1940, because hydrographic conditions were unusually poor or food was scarce in previous years. Determining when the unfavorable phase for large squid in the Gulf began prior to the 1950s could be key to knowing why Steinbeck and Ricketts did not see Humboldt squid of any size in 1940. The years following the 1940–1942 El Niño, until the mid-1970s, were largely MEI neutral or negative (Figure 5) (Wolter and Timlin 2011), and perhaps small and medium Humboldt squid became increasingly more abundant in the Gulf during these decades. This would be consistent with the lack of properly identified *Dosidicus gigas* in the Gulf prior to 1959 (Table 2).

Ecosystem Changes in the Sea of Cortez

It is clear from observations of Humboldt squid, particularly their size at maturity, that the ecological state of the Gulf of California can show drastic, long-lasting alterations. To what extent these changes are manifested in other species is not yet clear, but certainly sperm whales, which were once abundant in the Guaymas Basin area when squid were large (Jaquet and Gendron 2002; Jaquet et al. 2003; Davis et al. 2007), now appear to be rare (pers. comm., D. Gendron, and unpublished data from Lindblad Expeditions). Sperm whales prefer large Humboldt squid as prey (Clarke and Paliza 2001), and these cetaceans seem to be sending another biological signal that the Gulf of California has become more tropical and an unfavorable location for large squid. Steinbeck and Ricketts mentioned no sightings of sperm whales in the Gulf (or any whales for that matter).

How long will this situation continue? Unless the subsurface warming trend that has characterized the Central Gulf for the last decade (Figure 6) is reversed, there would seem to be little reason to expect a return of large Humboldt squid to that region or to the California coast. Although NOAA was issuing an El Niño advisory throughout much of 2018 and 2019, its forecast changed to El Niño neutral in September 2019, and a La Niña watch was announced in July 2020 (www.cpc.ncep.noaa.gov/products/expert_assessment/ENSO_DD_archive.php). While this may signal the onset of a cooling phase, it is unclear how long it might take for Humboldt squid to return to the multi-year life cycle that is necessary to achieve large size. Probably the most optimistic estimate would be based on a recovery period of 3 to 4 years during a strong La Niña phase that followed El Niño 1997–1998 (Figure 5). But an equally strong La Niña following El Niño 2009–2010 was accompanied only by a brief appearance of large squid in late summer of 2014, and conditions since El Niño 2016–2017 have generally been moderate.

Reliance on only the MEI record for predicting the future of squid ecology in the Sea of Cortez is likely to be simplistic. NOAA's El Niño forecast of 2009–2010, the event that marked the beginning of the current era of small squid, did not appear until June 2009: "El Nino Watch: Conditions are favorable for a transition from ENSO-neutral to El Niño conditions during June–August 2009." This event was later classified as an El Niño Modoki, meaning that it did not generate a strong MEI anomaly (see Figure 5) and was thus largely overlooked by forecasters. This distinction made little difference to the Humboldt squid and sperm whales in the Gulf of California.

Given the massive increase in monitoring and basic understanding of El Niño that has occurred over the last several decades, we can still miss predicting—or understanding—El Niño-like events, including multi-year ones like the northeastern Pacific warm-water "blob" that has been largely coincidental with the subsurface warming trend in the Gulf of California and the West Coast drought (Swain 2015; Swain et al. 2017). How these events connect and how they will affect not only Humboldt squid but much of humanity are pressing questions.

In 1940, "El Niño" was a term used only by observant Peruvian fishermen who recognized a seasonal warming trend around Christmas, but it was clear to Steinbeck and Ricketts that

> …most of the feeling we call religious, most of the mystical outcrying which is one of the most prized and used and desired reactions of our species, is really the understanding and the attempt to say that man is related to the whole thing, related inextricably to all reality, known and unknowable. This is a simple thing to say, but the profound feeling of it made a Jesus, a St. Augustine, a St. Francis, a Roger Bacon, a Charles Darwin, and an Einstein. Each of them in his own tempo and with his own voice discovered and reaffirmed with astonishment the knowledge that all things are one thing and that one thing is all things—plankton, a shimmering phosphorescence on the sea and the spinning planets and an expanding universe, all bound together by the elastic string of time. It is advisable to look from the tide pool to the stars and then back to the tide pool again. (1941)

Much remains to be learned. ✣

Acknowledgments

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Appendix: Tables 1–3

Table 1. Verbatim entries describing the squid specimens collected during the 1940 Sea of Cortez expedition from the Phyletic Catalogue and Log portions of *Sea of Cortez* (Steinbeck and Ricketts 1941) and Ricketts's field notes (Ricketts 2006 [1940]).

Date & Location	*Sea of Cortez*, Phyletic Catalogue	*Sea of Cortez*, Log	Field Notes
3/29/1940 San Lucas Cove 27.200 °N	"U-113. Two juvenile loliginids, as yet undetermined, and possibly indeterminable because of their immaturity, were taken as minute pelagic squid at San Lucas Cove, south of Santa Rosalía, attracted to the light hung overside at our night anchorage."	"That night we hung the light over the side again and captured some small squid, the usual heteronereis, a number of free-swimming crustacea, quantities of crab larvae and the transparent ribbonfish again."	"At night by light hung over side, San Lucas Cove (S of Sta Rosalía): small squid; usual heteronereis and crustacea, crab larvae, transparent fish."
3/30/1940 San Carlos Bay (Punta Trinidad) 27.833 °N		"That night, using the shaded lamp hung over the side, we had a great run of transparent fish, including a type we had not seen before. We took another squid, a larval mantis-shrimp and the usual heteronereis and crustacea."	"9–10 PM by light hung over side: another squid, a larval *Squilla* (?), a great run of transparent fish, including a new type; the usual heteronereis and crustacea."
4/8/1940 Guaymas 27.883 °N	"U-114. *Lolliguncula* (?) *panamensis* Berry 1911. A squat, chunky squid, females only of which were taken aboard the Japanese shrimp dredger off Guaymas. At first not distinguished from the more abundant *Loligo opalescens*.	"The big scraper closed like a sack as it came up, and finally it deposited many tons of animals on the deck—tons of shrimps, but also tons of fish of many varieties: sierras, pompano of several species, of the sharks,	"One magnificent anemone, several sponges and/or tunicates, quite a few grass-like gorgonians, an arborescent gorgonian, one sea horse, several squid…. Many many fish, possibly several tons per haul, which were thrown back; the Japanese saved only the shrimps."
	Berry writes: '…the first material of the species which has come to hand since my description of the species in 1911'…."	smooth-hounds and hammerheads; eagle rays and butterfly rays; small tuna; catfish; puerco—tons of them. The sea bottom must have been scraped completely clean…."	

Table 1. *(continued)*

4/8/1940 Guaymas 27.883 °N	"U-115. *Loligo opalescens* Berry 1911. Taken in some quantity, with the above *Lolliguncula panamensis* aboard the Japanese shrimp dredger south of Guaymas. This constitutes the southernmost record of this common Californian form."	"We liked the people on this boat very much. They were good men, but they were caught in a large, destructive machine, good men doing a bad thing. With their many and large boats, with their industry and efficiency, but most of all with their intense energy, these Japanese will obviously soon clean out the shrimps of the region. And it is not true that species thus attacked comes back. The disturbed balance often gives a new species ascendancy and destroys forever the old relationship."	"This is not Mexico for the Mexicans, at least not in the long run, anyway, because soon the Japanese will have cleaned out the fishing banks, a purely Mexican resource will be depleted and the Mexicans will have nothing but the taxes they collected."

Table 2. Reports of Humboldt squid in the Gulf of California with size classes designated: small (Sm), medium (Med), large (Lg) as defined in the text and in Fig. 4. Figure code refers to the boxed numbers indicated in the timelines for squid in Fig. 5. CAS-IZ = California Academy of Sciences, Invertebrate Zoology and Geology Collections (http://researcharchive.calacademy.org/research/izg/iz_coll_db/index.asp) with catalog number indicated. GOC = Gulf of California. SURMAR = Sustainable Use and Research of the Central Mar de Cortés, a program in Mexico conducted under the auspices of the Ocean Foundation, Washington, D.C.

Figure Code	Year	Size class	Reference	Location	Collection Notes
2	1932	Med	Crocker 1933; CAS-IZ 30481.00	Mouth of GOC	CAS-Templeton Crocker Exped. 1932
4	1936	Med	Beebe 1938	GOC: Farallón Basin	NY Zool. Soc. Templeton Crocker Exped. 1936
5	1947–1952	Med	L. Lewis, pers. comm.	GOC: Guaymas & Carmen Basins	Commercial tuna fleet
6	1952	Sm	Wormuth 1976	Pacific: SW of Cabo San Lucas	Shellback Station
8	1959	Sm	Wormuth 1976	GOC: Isla Monserrat	
9a	1964	Med	Lindsay 1964; CAS-IZ 25248.00	GOC: Las Animas rocks	CAS Sea of Cortez Exped. 1964
9b	1965	Med	CAS-IZ 31006.00	GOC: Isla Espíritu Santo	CAS Sea of Cortez Exped. 1965
10a	1969	Sm	Wormuth, 1976	Pacific: Salado Canyon, SE of Cabo Pulmo	E. B. Scripps
10b	1970	Sm	F. Hochberg, pers. comm.	Pacific: Cabo San Lucas	R/V *Cayuse*, cruise Cortez, station SP-65
11a	1971	Med/ Sm	Sato 1975	Pacific: off BCS	Japanese exploratory fishing
11b	1971	Sm	Sato 1975	GOC: Farallón Basin	Japanese exploratory fishing
13a	1976	Lg	Sagarin et al. 2008	GOC: Isla San Marcos	In shrimp trawl (first time since 1941)
13b	1976–1980	Sm/ Med/ Lg	Ehrhardt et al. 1982a,b	GOC: Pescadero to Guaymas Basins	
13c	1981	Sm	Ramírez & Klett 1985	GOC: Guaymas & Farallón Basins	
15a	1989–1990	Lg	Morán-Angulo 1990	GOC: La Paz to Guaymas Basin	

Table 2. *(continued)*

15b	1991	Lg	Guerrero-Escobedo et al. 1992	GOC: La Paz to Guaymas Basin	
15c	1992	Lg	De la Rosa et al. 1996	GOC	
17a	1995–1997	Lg	Markaida & Sosa-Nishizaki 2001; Morales-Bojórquez & Nevárez- Martínez 2010	GOC	
17b	1998	Sm	Markaida 2006; Morales-Bojórquez & Nevárez- Martínez 2010	GOC	
17c	1999	Med	Markaida 2006; Morales-Bojórquez & Nevárez- Martínez 2010	GOC	
17d	2000	Med	Morales-Bojórquez & Nevárez- Martínez 2010	GOC	
19a	2001–2007	Lg	Bazzino et al. 2007; Morales-Bojórquez & Nevárez- Martínez 2010; Nevárez-Martínez et al. 2010	GOC	2005–2006: *Marylee* 2007: *Pacific Storm, El Puma*
19b	2008	Lg/Med	Hoving et al. 2013	GOC: Guaymas & Farallón Basins	Stanford Holistic Biology class, *BIP XII, El Puma*
19c	2006–2009	Lg	Hoving et al. 2013	GOC: Guaymas Basin	*New Horizon, El Puma*
20a	2010	Sm/ Lg	Hoving et al. 2013	GOC: Guaymas & Salsipuedes Basins	*New Horizon, El Puma*
20b	2011–2012	Med	Hoving et al. 2013	GOC: Guaymas & Salsipuedes Basins	*El Puma*
22a	2013	Med	Gilly, unpublished	GOC: Santa Rosalía	SURMAR, *BIP XII, El Puma*
22b	2014	Lg/ Med	Gilly, unpublished	GOC: Santa Rosalía	SURMAR, *El Puma*
22c	2015–2018	Sm	Gilly, unpublished	GOC: Santa Rosalía	*Sandman,* SURMAR, *El Puma*

Table 3. Reports of Humboldt squid in U.S. and Canadian waters with size classes designated: small (Sm), medium (Med), large (Lg). Figure code refers to the boxed numbers indicated in the timelines for squid in Fig. 5. CAS-IZ = California Academy of Sciences, Invertebrate Zoology and Geology Collections (http://researcharchive.calacademy.org/research/izg/iz_coll_db/index.asp) with catalog number indicated. SBMNH = Santa Barbara (CA) Museum of Natural History collection. GOC = Gulf of California. ROV = remotely operated vehicle.

Figure Code	Year	Size class	Reference	Location	Collection Notes
0	Pre-1908	Lg	Holder 1908	So CA	Channel Islands, sport fishing
1a	Pre-1911	Lg	Berry 1910, 1911 CAS-IZ 30494.00	No CA	
1b	1908–1912	Lg	Heath 1917	No CA	
3a 3b	1934-—— 1935–1937	Sm Lg	Clark & Phillips 1936; Croker 1937	So CA /No CA	Monterey Bay, interference with fishing operations
7	1956	?	Hochberg, pers. comm.	So CA	
12	1974–1976	Sm	Hochberg, pers. comm.; SBMNH 42144	So CA	
14	1982–1983		Hochberg, pers. comm.	So CA	
16	1990–1991		Hochberg, pers. comm.	No CA	
18a	1998–2005	Lg	Zeidberg & Robison 2007	So/No CA	Northward wave of strandings, ROV in Monterey Bay
18b	1998–2010	Lg	Stewart et al. 2014	So/No CA	ROV in Monterey Bay
18c	2002–2011	Lg	Chesney et al. 2013	Oregon	
18d	2004–2005	Lg	Gilly 2006; Cosgrove 2005	No CA, British Columbia, Alaska	Alaska invasion
18e	2003–2009	Lg	NOAA Fisheries 2012	No CA through British Columbia	NOAA trawls in conjunction with hake surveys
18f	2004–2009	Lg	Litz et al. 2011	Oregon	
18g	2007–2010	Lg	Field et al. 2013	So/No CA through British Columbia	NOAA sampling
18h	2008	Lg	Holmes et al. 2008	Washington, British	Interference with
				Columbia	commercial hake fishery
21	2012	Sm	Gilly, unpublished; Greene 2014	So/No CA	Southward wave of strandings

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To Look from Heliaster to the Stars and then Back to the Tide Pool

Susan Shillinglaw

> It is advisable to look from the tide pool to the stars and then back to the tide pool again.
>
> —John Steinbeck and Edward F. Ricketts, *Sea of Cortez: A Leisurely Journal of Travel and Research*, 1941

> The stars are the apexes of what wonderful triangles!
>
> —Henry David Thoreau, *Walden*, 1854

> A writer out of loneliness is trying to communicate like a distant star sending signals. He isn't telling or teaching or ordering. Rather, he seeks to establish a relationship of meaning, of feeling, of observing.
>
> —John Steinbeck to Peter Benchley, 1956 (in Steinbeck and Wallsten)

Writing to his godmother after completing a draft of *Sea of Cortez* in 1941, John Steinbeck notes that "there are four levels of statement in it and I think very few will follow it down to the fourth. I even think it is a new kind of writing."[1] He said something similar about his 1939 novel, *The Grapes of Wrath,* which, he claimed, had "five layers…a reader will find as many as he can and he won't find more than he has in himself."[2] The 1945 novella, *Cannery Row,* had four levels of meaning, Steinbeck later asserted. Ever experimental, although hardly recognized as such by early reviewers and literary critics, John Steinbeck forged new literary forms and teased his readers into diving deep, discovering layer after layer. Each book, Steinbeck asserts, is as "profound as the person reading it." He asks that we read closely, participate in the Narrative,

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engage—and at points, glimpse something more, a deep, holistic, even mystical and transformative appreciation of the whole of life. That may be level four.

Stars take us there, to what Edward F. Ricketts, marine biologist and Steinbeck's closest friend from 1930 to 1948, called "breaking through," to a vision that is holistic and profound, a vision that embraces both the tide pool and the stars, the physical and the spiritual.

Sea of Cortez, Steinbeck would tell his third wife, Elaine, was his favorite among all his books. Maybe it was those layers. Maybe nostalgia. Maybe the subject, an open-hearted expedition to a relatively unexplored sea with his best friend, Ed. Or maybe, as I suspect, this book expresses his and Ricketts's hearts' desire—to articulate a holistic appreciation of life itself, in all its complexity. *Sea of Cortez* captures what was best in their long association: keen perceptions, curious minds, and questing souls. I'll go with that, and fold in with Steinbeck's levels my own story about stars—sea stars and celestial stars.

The Tide Pool

From 2006 until 2012, my biologist husband and I co-taught a course in Baja California Sur called Holistic Biology. The Stanford students began the course peering into Monterey (California) tide pools, and ended it pondering operations at a shrimp farm in Sonora (Mexico)—a physical, psychological, and spiritual journey that in many ways replicated, we hoped, Steinbeck and Ricketts's voyage of discovery to the Sea of Cortez in March 1940. Like Steinbeck and his first wife, Carol (also on the 1940 trip, although not mentioned in the book), I went to the Sea of Cortez as a scientific amateur, and like them, I got my hands wet in the intertidal—immersing myself in a participatory appreciation of life itself: "We have looked into the tide pools," Steinbeck writes at the beginning of the Narrative of this trip, "and seen the little animals feeding and reproducing and killing for food. We name them and describe them and, out of long watching, arrive at some conclusion about their habits" (p. 15; page numbers cited throughout are from the 1995 edition of *The Log from the Sea of Cortez*).

A book, a course, and recognition begin here, with attentive seeing. In company with a biology major named Matthew Mendoza, who created the project, I focused steadily on the sea star, *Heliaster kubiniji*, wishing to arrive at some conclusions about its stomach contents. *Heliaster* inspired in me poetic outbursts; in Matt, scientific precision. Both responses had their place. Phylum Echinodermata, order Forcipulatida, *Heliaster* is a lovely invertebrate. In outline it looks like the suns that children paste in second-grade skies. Colors range from deep to pale green, with bands of pink around the surface. *Heliaster* can grow to over 9 inches, but in the Gulf most are 6-, 7-, and 8-inch adults. Smaller juveniles slide into crevices, which provide shelter from low-tide sun. An even number of arms radiate from *Heliaster*, maybe 20, 22, or 24. If an arm is broken, another grows in its place, so an overlapping appendage is sometimes traced. They cling with hundreds of tiny suckered feet to intertidal rocks or other substrates; the feet wave frantically when the animal is plucked from a rock to examine its underside—as when we poked gingerly at the outer lining of stomachs. Often, their hold on a rock surface was mighty; only a crowbar, gently applied, loosened their grip. *Heliaster* lives a solitary life, camouflaged against rocks that are also mottled green and pink. Matt's little study arrived at the conclusion that, in the Sea of Cortez, *Heliaster kubiniji* grazes primarily on *Brachidontes semilaevis,* a tiny mussel that lives on intertidal rocks with barnacles and algae.

That year and in subsequent years, I learned a great deal about the historical presence of *Heliaster* in the Gulf. Ricketts placed *Heliaster kubiniji* at the top of his list of "outstanding ubiquitous animals" in the Gulf, finding them "practically everywhere" in 1940.[3] Disease decimated *Heliaster* populations in the late 1970s, however, and the animal was slow to recover. When our 21st-century boat—a bit larger and far clumsier than Steinbeck and Ricketts's purse seiner, the *Western Flyer*—stopped at the intertidal locations where Steinbeck and Ricketts anchored some 70 years earlier, the *Heliaster* team had to search hard for the solitary wanderers (while other students bent over a transect line stretching 20 meters up from low tide, counting limpets and barnacles, littorine and nerite snails along that line—and the occasional *Heliaster*: "Here's one for you," they would cry out). Like so many other intertidal species in the Gulf, *Heliaster* has decreased in numbers in the past decades. No longer is it one of the common species that drew Ricketts and Steinbeck's gaze: "Most of the biological accounts of expeditions have featured and illustrated only the rare forms," writes Ricketts in his *Sea of Cortez* log:

> This is understandable; the more common animals have been described and possibly illustrated years ago—often, however, in publications now difficult of access. But it seems to me that the

> purposes of travelers and even of zoologists can be served best by accounts and illustrations of the common forms, particularly the ubiquitous forms, or the horizon markers. When I go into a new region, I am only secondarily curious about the occasional animals, unless they represent spectacular or curious types. But I do want to know something about the common, the obvious, the ubiquitous, and the economically important forms. Sometimes it's a job just to satisfy that simple requirement.[4]

So how does the lovely and ubiquitous *Heliaster*, a sea star, connect with celestial stars?

To answer that is to tease out the essence of *Log from the Sea of Cortez*—and Holistic Biology, for that matter. The intertidal and the extratidal are triangulated, the human gaze one point on the triangle. As in Thoreau's *Walden,* Steinbeck's Narrative builds steadily from "little animals feeding" to metaphysical speculation to holistic, transcendent awareness. The process is embedded in the text from the opening pages. Early chapters connect human consciousness to physical objects—a fish, a boat, a name of a place—noting again and again how our minds necessarily "warp" what "is" so that facts become personal, more expansive, sometimes fanciful, sometimes profound. When building a boat, for instance, humans receive "a boat-shaped mind, and the boat, a man-shaped soul" (p. 14). As Steinbeck repeatedly demonstrates in the *Log,* human consciousness moves from sharply observed physical reality to the abstract warp of ideas and then to connections that ultimately spark universal feelings, spiritual unities, a holistic vision. Human consciousness connects sea stars and heavenly stars, forming a "wonderful" triangle. Sharp sight (level one) is a bridge to noting connections among animals—the intertidal communities that captured Ricketts's lifelong attention (level two). Conversation and reflection lead to insight (level three), and insight is the path to deep connection, what Ricketts called "breaking through" to a cosmic, holistic, nearly mystical understanding of life itself (level four).

Participation: "Our own interest lay in relationships of animal to animal"

Active participation in invertebrate/human communities, levels one and two, demands that the observer first see each animal clearly and then note connections among animals that feed, breed, and protect themselves in intertidal/terrestrial worlds, level two. "Our interest had been from the first in the common animals and their associations," Steinbeck and Ricketts write, late in the Narrative (p. 178). ALL life is relational.

Flamboyant *Heliaster* ate what other Stanford students were counting in intertidal transects, dependent on the intertidal community. Forming a unit, students and professors searched and collected together at dawn, when the sea was matte gray, the Gulf lonely and lovely. We too formed a community, and studied animal communities.

Full participation is a concept that Steinbeck and Ricketts parsed repeatedly throughout their long association. From the time that Ricketts moved from Chicago to Pacific Grove in 1923, his interest in intertidal animals "possessed him," claimed his sister, Frances.[5] His was participatory seeing, studying intertidal animals with clarity and appreciation—his "little beasties"—and the interconnections between animals and their habitats. Taking note of connections and associations of common species, as did Ricketts in his intertidal studies, is more or less what Steinbeck was doing in his observations of the peopled world, his participatory gaze similarly turned on the ordinary and ubiquitous, working men, southwestern migrants, Cannery Row bums, and Monterey paisanos. Before embarking on their 1940 trip to Mexico, Ricketts and Steinbeck each had published in 1939 seminal studies of the commonplace in their respective fields, *Between Pacific Tides* and *The Grapes of Wrath*—each book remarkable because each considers community dynamics, Ricketts on the shore, Steinbeck in the fields. Ed Ricketts and Jack Calvin's *Between Pacific Tides*, published by Stanford University Press, was and remains an extraordinary tome because it catalogues animals by habitat, not by scientific nomenclature. Chapters cover "Outer-Coast Rocky Shores," "Outer-Coast Sandy Beaches," "Open-Coast Rocky Shores," "Open-Coast Sandy Beaches," "Rocky Shores of Bays and Estuaries," the "Exposed Piles" and "Protected Piles" of wharfs. What interests Ricketts is species interactions in each habitat. Meant as a handbook to the intertidal, *Between Pacific Tides* examines the substrate between low and high tides, with Ricketts's gaze fixed attentively on the interconnected groups of animals that populate each region. It's an optics handbook, teaching the uninitiated to see, to name, to note connections.

Steinbeck's fictional terrain was also circumscribed: the marginalized and economically doomed, ordinary men and women who populate his protest novels of the late 1930s—*In Dubious Battle* (1936), *Of Mice and*

Men (1937), and *The Grapes of Wrath* (1939)—as well as the regularly unemployed who cluster together in the Monterey novellas, *Tortilla Flat* (1935), *Cannery Row* (1945), and *Sweet Thursday* (1954). In each fictional landscape, Steinbeck portrays lives of the "common, obvious, and ubiquitous" of the human species—working men and women, labor organizers and strikers, ranch hands, Oklahoma migrants, and Monterey ne'er-do-wells—those who are the horizon markers of the human condition, like *Heliaster* was to Ricketts's intertidal. Central to *The Grapes of Wrath,* Steinbeck insisted, was a reader's full participation in the actuality of the Joads' poverty and marginalization. After he finished the novel, he wrote his editor that "I've tried to make the reader participate in the actuality, what he takes from it will be scaled entirely on his own depth or hollowness."[6]

Vital to both men's work, scientific and cultural, in short, is appreciation not of charismatic megafauna (whales! captains of industry!) but of lowly creatures that seek shelter under rocks. The commonplace is the marrow of life, the bedrock of what "is." Ricketts called this understanding of life seen clearly and without blinders non-teleological or "is thinking"—focusing not on what might be or should be, but instead tackling the sufficiently difficult task of considering what *is*—the situation itself. Steinbeck embraced the term as well, and Chapter 14 of the *Log,* essentially written entirely by Ricketts, articulates a concept vital to both men's appreciation of the world. "Is thinking," notes Ricketts, is not "supine and non active acceptance of whatever is dished up. Actually nothing could be more untrue. Through acceptance of the being situation, the most active participation is involved which results in creative expression of some sort possibly 'becoming' (again in the directional sense)."[7]

Conversations—Becoming

Ricketts and Steinbeck's participatory vision balances on the fulcrum suggested in the previous sentence—being/becoming. *Being* is active participation, ferocious looking, our *Heliaster* study. Although theirs was a broader focus on all animals, "everything we could see," Steinbeck and Ricketts did the same, so that the main task on the voyage was to stop at 20 locations in the Gulf, mark environmental conditions at each site, collect a range of invertebrates, process specimens back on board the *Western Flyer*, and catalogue and identify each species. In paragraph-long descriptions of animals that punctuate the Narrative, Steinbeck describes the various substrates and animal communities, noting contrasting "conditions for living, such as wave shock, bottom, rock formation, exposure, depth." These are the bedrock of the text and of understanding—naming what *is* in different environments—exposed rocks, a coral reef, a bouldery shore. "Among the many values of marine sociology," notes Ricketts at the end of an essay about plankton, "not the least is the fact that whereas humans may say one thing and be another, the sea animals be only themselves; we would do well to observe them."[8] Observe and become more aware.

"Becoming" is what occupied the crew shipboard, "everything we could see and think and even imagine" (p. 1)—the "warp" of the human mind observing reality. As Ricketts notes in a letter, *Sea of Cortez*

> is so much a jonEd sit-by-the-fire…. Of course I am in a funny position….in all the places that Jon has gone out of his way to shock his readers I have just relaxed most comfortably and mumbled something about "yes, [Jon], I'll have just a spot more rum in my coffee."… It's all so darn familiar…. Of course I love it…. Only I am having an awful time with all my friends who are worshippers of the gem-like, clean cut Steinbeck novel and story technique…. They don't understand and their feelings are hurt.[9]

Today's readers may sympathize, as their readerly sensibilities are repeatedly stretched from the invertebrate catalogues to speculative thoughts and back—level three, noting how ideas resonate across time and place. The Narrative captures the friends' yeasty conversations about science and scientists, physics and oceanography, Jung and Darwin, sea monsters and Our Lady of Loreto. *Log from the Sea of Cortez* is dialogic, a conversation, a compendium of ideas debated and discussed by the two men for a decade previous, when they lived cheek by jowl in Pacific Grove, California (a "Chioppino of Biology and Philosophy," said a 1941 reviewer). "The passage on non-teleological thinking was perhaps the result of six months or more of discussion," Steinbeck admitted to a friend in 1964.[10] For Ricketts, years of conversations helped generate a series of essays that he revised throughout the 1930s and 1940s and sent to friends and tried to publish: "Essay on Non-teleological Thinking" (incorporated into *Sea of Cortez* as Chapter 14 of the Narrative); "Wave Shock," "A Spiritual Morphology of Poetry," and "The Philosophy of 'Breaking Through.' " The titles themselves suggest the man's philosophic range, from the particular to the metaphysical, from the tide pool to the stars. Steinbeck's mind was similarly expansive. Indeed, as Ed Ricketts's sister noted, the two men "sparked one another" throughout the 1930s.[11] Ricketts and Steinbeck shared ideas about dominance of certain species, about survival under stress, about depletion of resources, about the colonial/group behaviors of humans and animals. Conversations and ideas (recorded in the letters of both men) moved from particular to speculative, from empiricism to broader truths, from the Sea of Cortez to the world at large.

Breaking Through: "We search for that principle which keys us deeply into the pattern of all life"

Edward F. Ricketts and John Steinbeck relished their conversations. "We had a game which we playfully called speculative metaphysics," Steinbeck writes in "About Ed Ricketts," a portrait of his friend. "It was a sport consisting of lopping off a piece of observed reality and letting it move through the speculative process like a tree growing tall and bushy" (p. 256). Dialogues grew toward the light, toward something profound, an ever-expanding sense of the whole, an ineffable spiritual connection. Ricketts called this emergent sensibility "breaking through," the title of one of his seminal essays.

In the *Log*, Steinbeck calls it ALL, or a fourth level: If a man has "strength and energy of mind the tide pool stretches both ways, digs back to electrons and leaps space into the universe and fights out of the moment into non-conceptual time. Then ecology has a synonym which is ALL" (p. 72).

And when Ricketts sent the published book to close friend Joseph Campbell (who visited the Monterey Peninsula in 1932, conversing deeply with both Steinbeck and Ricketts), Campbell wrote back in praise of the book and its structure, articulating in yet another way the meaning of ALL and level four: "gradually....the dominant theme of the work is emerging," wrote Campbell, "and from this remark and from that, we understand that society itself is an organism, that these little intertidal societies and the great human societies are manifestations of common principles; more than that: we understand that the little and the great societies are themselves units in a sublime, all inclusive organism, which breathes and goes on, in dream-like half consciousness of its own life processes, oxidizing its own substance yet sustaining its wonderful form."[12]

In *Log from the Sea of Cortez,* ALL enfolds collecting stations, *Western Flyer* banter, and the Gulf itself. ALL subsumes spirit as well, a holistic and spiritual awareness that Ricketts struggled to achieve. It is this aspect of Ricketts's character that is perhaps least appreciated—his yearning for transcendence and the "deep thing." Ricketts sought to embrace, clarify, and identify "breaking through" in poetry, in music, in philosophy, and in life. This is the man whose favorite poet since childhood was Walt Whitman, the American bard who asserts that the body and the soul are of equal importance. This is the man who, after all, was schooled in eastern religions in the early 1930s by a close friend, watercolorist Jim Fitzgerald—who discussed Taoism, Buddhism, and Hinduism with Ricketts. This is the man who admired spiritual philosopher Jiddu Krishnamurti, a frequent visitor to the Monterey Peninsula in the 1940s and an associate of Ed's. "Ed's big attraction to John—the big bond between them," insisted Toni Jackson, Ed's partner throughout the 1940s, "was the mystical. Ed was quite mystical." She clarified, adjusting her meaning: "Ed wasn't a 'mystic' whatever that connotes, but he was interested in the metaphysical-philosophical." Steinbeck also wrestles with paradoxical Ed's penchant for abstract thought in "About Ed Ricketts," explaining that his friend "thought in mystical terms and hated and distrusted mysticism." Indeed, in Toni's eyes Ed "really wasn't a scientist….the important thing in his life was not intense curiosity about the intertidal zone. The Lab was not Ed's life. Ideas, music, living, relations with people….that was terribly important. He was a people person."[13] Ed's sister, Frances, concurred: "John was a practical person. Ed was not."

Marine biologist, conversationalist, and philosopher Ricketts was drawn to the "true things," in his words an "alignment of 'acceptance' (= being) with 'breaking thru' (= becoming)."[14] That equation is vital in appreciating Ricketts's mental horizons. He found true things in mystic Emanuel Swedenborg, in Taoism, in psychoanalyst Carl Jung. Writing to a friend, Ricketts conveys the complexity of his notion of "breaking through," which he believed was synonymous with Jung's " 'ocean sense'…the 5th or emergent psychic function. To which thinking, feeling, intuition and sensation all contribute, and in which they all merge. A super intuition. The junction of Swedenborg's divine love and divine wisdom. The result of what I call 'breaking through,' for which there are many vehicles. And which elevates anything else or everything else as valuable and dear only as it has contributed to the breaking thru—the Tao. But which at the same time enriches everything potentially, since potentially anything may be a vehicle for breaking thru."[15]

That scope must be absorbed gradually, all perceptions alive.

Ricketts found "vehicles" for breaking through in art and music—pure expressions of the human spirit that took the listener or the viewer/reader out of themselves into some higher, holistic, spiritual awareness, often fleeting or dreamlike. Bach's "Art of the Fugue," Ricketts believed, was a nearly perfect piece of music. Robinson Jeffers's "Roan Stallion" was the canonical "vehicle," the source of the phrase "breaking through" itself:

> Humanity is the mold to break away from, the crust to break
>   through, the coal to break into fire
> The atom to be split.
> Tragedy that breaks a man's face and a white
>   fire flies out of it; vision that fools him
> Out of his limits, desire that fools him out of his limits.
> ....
> These break, these pierce, these deify, praising their God
>   shrilly with fierce voices

In a 1948 letter to Toni Jackson, Ricketts expands on his ideas about "breaking through," folding in James Joyce as well:

> Of the very greatest things *The Art of the Fugue*, Don Giovanni, Goethe's *Faust*, the Beethoven *Quartette No. 16*, and *Finnegans Wake*. Now I know the *Wake* is the greatest book I've ever come in contact with, greater even than *Faust*. I got excited to the point of translating again the last few lines of the 2nd part.
>
> ....
>
> Don Giovanni, Contrapunctus XIX of *Art of the Fugue*, and the Beethoven late quartettes finally break, and go down into noble tragedy.... All of these show magnificent tragedy, but tragedy nevertheless. But then consider the affirmation of Goethe and the *Wake*. It's funny, of the two very greatest—for me the greatest in the world; one—the *Fugue,* is "negative," the other, *Finnegans Wake*, is affirmation.[16]

The agonies and the ecstasies of human experience are the "vehicles" which tease us from complacency. Struggle, pain, death, joy, and exuberance may result in a " 'new thing' which completely transcends the old, which is part of it in a rooty sense only," Ricketts writes.[17] Poets and artists, he asserts, best convey this new thing—"It" an "un-named quality," "breaking through," an "emergent joy—achieving things which are not transient by means of things which are."[18] Ricketts cites Emerson in his essay "Breaking Through," because the Romantic writer captured transcendence so well: "brief moments which constrain us to ascribe more reality to them than to all other experiences."[19] And Ricketts refers to many other poets who embraced the notion that he called "breaking through." According to Toni Jackson, "Out of the Cradle Endlessly Rocking" was Ricketts's favorite poem, and Whitman's figure of death is, in Ricketts's eyes, an emergent vehicle that helps the poem's speaker "break through" to an acceptance of life and death. That awareness "never comes without birth struggle," Ricketts writes, "and its most common vehicle is something with which we have association of fear or evil."[20]

Ricketts completed a final draft of his ambitious essay on "Breaking Through" in Mexico City in 1940, as he was working in a library on the Phyletic Catalogue for *Sea of Cortez*. The essay might well have been included as a chapter in *Sea of Cortez*—as was his essay on non-teleological thinking, Chapter 14—for "breaking through" is as essential to the Narrative's meaning as is "non-teleological thinking." ALL punctuates the text, suggesting realms and meanings beyond the physical, beyond the rational. ALL sweeps up *Heliaster* and *Brachidontes*, intertidal collections and surveys, discussions of the Old Man of the Sea, visits to the Lady of Loreto church, the lonely young men in Cabo San Lucas drinking beer in the cantina, and the flickering shrine to a deceased fisherman.

The Log from the Sea of Cortez gently and insistently prods readers toward the mysterious and mystical, toward emergence and transcendence. Early on, the crew playfully speculates on the existence of sea monsters, and Steinbeck concludes that "men really need sea-monsters in their personal oceans. And The Old Man of the Sea is one of these" (p. 27). Discussing how place names make things "a little less dangerous to us," Steinbeck muses that "when the horizons stretch out and your philosopher is likely to fall off the world like a Dark Ages mariner, he can save himself by establishing a taboo box which he may call 'mysticism' or 'supernaturalism' or 'radicalism.' Into this box he can throw all those thoughts which frighten him and thus be safe from them" (p. 46). The taboo box houses all that eludes that "poor blunt weapon of reason." During the hunting trip out of Puerto Escondido, Steinbeck suggests that church mysteries—natural phenomena not accessible to reason—also belong in a taboo box. Things like tree frogs living in a completely isolated pond (how did they get there?), fish all pointing in the same direction (why?), or pelagic tunicates which are individual animals and a colonial animal as well (how?) are part of a greater pattern we may not fully know. At Isla Tiburon, bats and werewolves and vampires get tossed in as well, "memory like patterns" of instinctive fears, things irrational.

Insistently and repeatedly, *Log from the Sea of Cortez* posits the notion that what we see is only a small part of a larger, ineluctable whole. At Cabo San Lucas, a fisherman's grave becomes a symbol of cosmic yearning: "And the man who tried to get home and crawled this far—we never knew his name but he stays in our memory too, for some reason—a supra-personal being, a slow, painful symbol and a pattern of his whole species which tries always from generation to generation, man and woman, which struggles always to get home but never quite makes it" (p. 59). Mirages in this "unsubstantial and changing" landscape tease out the miraculous (p. 68). The Indians of the Gulf, a dreaming people whose "time-world" differs from the crew's, they "seemed to live on remembered things" (p. 63).

Each of these reflections differ, to be sure: superstitions and irrational phenomena, the deeply felt holism, the symbols and the dreams—later in the book the "sound symbols in the unconscious." Each passage nudges the reader beyond reason. Steinbeck's prose insistently moves the reader from the mundane to the reflective to a "far deeper understanding of us and our world" (p. 137). To a super-reality, accessed not with reason but intuition. To reality that is shadowy, insubstantial, mystical. The hazy Gulf is the signifier of the book's essential meaning, that everything is itself and also part of a shadowy, cosmic, even mystical whole. The dreaming, almost spirit-like Indian residents in the Gulf are intimately connected to the "miraculous air" and mirages of the Sea of Cortez. The Gulf and people who live "inward, closely related to time; a cousin of the sun, at feud with storm and sickness" are one (p. 171). And the trip itself is in sync with place, indigenous peoples, and message: a shifting, moving, expanding and contracting expedition to places beyond the self, beyond reason—as on Good Friday in La Paz: "Sometimes one has a feeling of fullness, of warm wholeness, wherein every sight and object and odor and experience seems to key into a gigantic whole. That day even the [foul smelling, impenetrable] mangrove was part of it. Perhaps among primitive peoples the human sacrifice has the same effect of creating a wholeness of sense and emotion—the good and bad, beautiful, ugly, and cruel all welded into one thing" (p. 101).

Our Lady of Loreto is another "vehicle"—to use Ricketts's terminology—of breaking through to cosmic appreciation. Not to understand the Virgin's power is not to understand the faith of Loreto and the spiritual world: She has "a powerful effect on the deep black water of the human spirit. She may disappear and her name be lost, as the Magna Mater, as Isis, have disappeared. But something very like her will take her place, and the longings which created her will find somewhere in the world a similar altar on which to pour their force" (p. 145).

All these holistic, visionary moments in *Log from the Sea of Cortez* coalesce in Chapter 21. The most eloquent, expansive statement of "breaking through" concludes this chapter, seven chapters after the core explanation of non-teleological thinking in Chapter 14. At Stanford, Steinbeck was interested in alchemy, spells, and numerology, checking out from the library the *Hermetica* of Hermes Trismegistus three times, according to a college friend.[21] *Hermetica* is an ancient mystical text that includes discussions of numerology—particularly the significance of the number 7. The number 21 is often considered a divine number, associated with perfection, the unity of the trinity, the harmony of creation in the Bible. I want to suggest that Steinbeck intentionally placed the key to the *Log* here, a harmonious, cosmic, divine moment.

Chapter 21 considers the interdependence of species, and here Steinbeck suggests that taxonomic names might be replaced with numbers, surely calling attention to the importance of numbers. The lens shifts to wide angle, to relational considerations—animal to animal, culture to culture, history to an expanded time sense. The Mexican Indians might consider that our "mechanical toys" are "not related to very real things." The "seldom seen and unnamed animal" is less interesting to the crew of the *Western Flyer* than the "common, known, multitudinous animals" that depend on one another. And for the crew sailing in the Gulf, "the great world dropped away very quickly on the voyage" and minds turned to the universal and the eternal. In the final paragraph of the chapter, he elaborates on relational identities, expressing most fully the meaning of "breaking through":

> [E]ach species is at once the point and the base of a pyramid, that all life is relational to the point where an Einsteinian relativity seems to emerge. And then not only the meaning but the feeling about

species grows misty. One merges into another, groups melt into ecological groups until the time when what we know as life meets and enters what we think of as non-life: barnacle and rock, rock and earth, earth and tree, tree and rain and air. And the units nestle into the whole and are inseparable from it. Then one can come back to the microscope and the tide pool and the aquarium. But the little animals are found to be changed, no longer set apart and alone. And it is a strange thing that most of the feel we call religious, most of the mystical outcrying which is one of the most prized and used and desired reactions of our species, is really the understanding and the attempt to say that man is related to the whole thing, related inextricably to all reality, known and unknowable. This is a simple thing to say, but the profound feeling of it made a Jesus, as St. Augustine, a St. Francis, a Roger Bacon, a Charles Darwin, and an Einstein. Each of them in his own tempo and with his own voice discovered and reaffirmed with astonishment the knowledge that all things are one thing and that one thing is all things—plankton, a shimmering phosphorescence on the sea and the spinning planets and an expanding universe, all bound together by the elastic string of time. It is advisable to look from the tide pool to the stars and then back to the tide pool again. (pp. 178–179)

After that ecstatic moment of holistic understanding, some of the air goes out of the trip and the text and mood begin to darken. At San Francisquito they capture a malevolent horn shark with hateful, baleful eyes that refuses to die. There is a "sinister feeling" at Bahía de los Ángeles. The Seri Indians of Isla Tiburon are feared to be murderous and cannibalistic (although Steinbeck playfully suggests that human flavors might be improved, if one shifted perspectives on the subject). Guaymas is "outside the boundaries of the Gulf," a place of gimcracks for tourists. Offshore a shrimp trawler is a "large destructive machine, good men doing a bad thing," producing a vast amount of bycatch to obtain a few shrimp. And at Estero de la Luna, a "bad place," they meet unfriendly Yaqui Indians for the first time. At their last station in Sonora, Estero Agiabampo, they were "sad in this place" and found it to be disappointingly sterile: "undoubtedly there were many things we did not see. Perhaps our eyes were tired from too much looking" (p. 217).

Why the shift in tone? In part, perhaps, because they were tired, and the journey was rapidly ending, the company soon to disperse. And in part, I believe, because Steinbeck concludes by embracing all—ecstasy and woe, the fullness of human/spiritual experience. The largest picture contains and subsumes. Steinbeck and Ricketts's trip to the Sea of Cortez was a "thing whose boundaries seeped through itself and beyond into some time and space that was more than all the Gulf and more than all our lives." Level four is the knowledge that "The brown Indians and the gardens of the sea, and the beer and the work, they were all one thing and we were that one thing too" (p. 224). The *Log* concludes with a powerful image, a vibrating guy wire, the music of the spheres.

"It is advisable to look from the tide pool to the stars and then back to the tide pool again"

I heard those notes too. On one of the Holistic Biology outings at San Francisquito, arguably the high tide of exuberance on the 1940 expedition, my eyes tired of the *Heliaster* search and I wandered off alone to an isolated section of the beach, walled off from the other students. There I saw hundreds of small manta rays, mobulids, gliding near the shore, edging toward one another, swirling and covering one another, large and small. Hundreds of silent, mating mobulids. I thought of Melville's *Moby-Dick* and, late in the book, of Ishmael's gaze into the deep clear water, where mother and baby whales are connected in heaving, ecstatic life. In this moment of recognition, Ishmael finds solace and a life-affirming, spiritually sustaining vision that counters Ahab's monomaniacal quest. Transfixed by the manta rays, I thought of Ishmael, of the whales, of what it means to be a water gazer, and of the thrumming, mysterious life of a manta ray—for a moment, I was part of ALL in the miraculous Sea of Cortez.

Only recently did I add another piece to the puzzle, "Breaking Through." In Nancy Ricketts's collection of her father's papers, there is a note that Ricketts wrote to himself: "At the charge that I have inclinations toward mysticism, I say only that if in observable phenomena such as tides, earthquakes, growth patterns of animals, marine sociology, 'prenatal' behavior pattern which impels grunions toward discharging their eggs on the shore at extreme high tide, that sends marine salmon back into perhaps parental fresh water for spawning—if in all this there is mysticism, then I'm of course a mystic."

As am I. As are Ricketts and Steinbeck. As they suggest for readers of the *Log*, which was Steinbeck's favorite of all he wrote: Be awed by sea stars—physical life—and transfixed by celestial stars—yearning to "break through." ✥

Notes

1. "new kind of writing": Steinbeck and Wallsten (eds.), *Steinbeck: A Life in Letters*, p. 523.

2. "more than he has in himself": Steinbeck and Wallsten (eds.), *Steinbeck: A Life in Letters*, pp. 178–179.

3. "practically everywhere": Rodger (ed.), *Breaking Through*, p. 157.

4. "satisfy that simple requirement": Rodger (ed.), *Breaking Through*, p. 169.

5. "possessed him": Frances Strong to Joel Hedgpeth, May 3, 1970, Ed Ricketts Jr. collection.

6. "depth or hollowness": Steinbeck and Wallsten (eds.), *Steinbeck: A Life in Letters,* p. 178.

7. "possibly 'becoming' (again in the directional sense)": Box 11, Folder 13, Ed Ricketts Papers, Stanford University.

8. "we would do well to observe them": Plankton Essay, Ed Ricketts Papers, Stanford University.

9. "their feelings are hurt": Box 10, Ed Ricketts Papers, Stanford University.

10. admitted to a friend in 1964: John Steinbeck to John Bivins, March 16, 1964, author's collection.

11. "sparked one another": Frances Strong to Joel Hedgpeth, May 3, 1970. Ed Ricketts Jr. collection.

12. "Wonderful form": Joseph Campbell to Ed Ricketts, December 1941, Box 9, Ed Ricketts Papers, Stanford University.

13. "interested in the metaphysical-philosophical" and "a people person": Author interview with Toni Volconi, June 3, 1994.

14. " 'breaking thru' (= becoming)": Box 10, Folder 30, Ed Ricketts Papers, Stanford University.

15. "anything may be a vehicle for breaking thru": Ed Ricketts to Heinz Koester, July 11, 1942, Ed Ricketts Papers, Stanford University.

16. "*Finnegans Wake*, is affirmation": Rodger (ed.), *Renaissance Man of Cannery Row*, pp. 267–268.

17. "rooty sense only": Rodger (ed.), *Breaking Through,* p. 104.

18. "by means of things which are": Rodger (ed.), *Breaking Through*, p. 95.

19. "all other experiences": Rodger (ed.), *Breaking Through*, p. 89.

20. "association of fear or evil": Rodger (ed.), *Breaking Through*, p. 99.

21. "according to a college friend": Author interview with Robert Cathcart, 2005.

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The Other 1940 Expedition to the Sea of Cortez: E. Yale Dawson

Richard M. McCourt and Josie Iselin

Introduction

The expedition of John Steinbeck and Ed Ricketts into the Sea of Cortez in 1940 lasted only 6 weeks but became a landmark in exploration at a time when little was known of what was then a very remote region of North America's Pacific Coast. The cruise was immortalized by a classic narrative of littoral literature and a taxonomic catalogue of creatures, *Sea of Cortez: A Leisurely Journal of Travel and Research* (1941), co-authored by Steinbeck and Ricketts. A little earlier in 1940 another less well-known but better-funded cruise also went into the Sea of Cortez. It included a Berkeley undergraduate with boundless energy and ambition to match. This fledgling biologist was E. Yale Dawson, whose passions were marine algae and cacti. He wrote a tome that, while not immortalizing his cruise, would provide a flora of the Sea of Cortez that was a parallel to the faunal taxonomic catalogue in the Steinbeck and Ricketts volume. Here, we give an overview of Dawson's legacy and its relation to that of Ed Ricketts.

17 January–20 February 1940: Sea of Cortez, Mexico

A ship cruises this 800-mile arm of the Pacific Ocean that washes the coastline of mainland Mexico on the east and the desiccated peninsula of Baja California to the west. There are marine scientists on board and

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they have been meticulously scouring the littoral rocky crags and tide pools and nearby shallows, collecting and preserving the many species that thrive in this desert sea. They collect hundreds of specimens, many recognizable species and others that few but stray Mexican fishers and Comcaac (Seri) Indians have even seen, much less given a Latinized scientific name. The specimens are stored carefully on board, and copious notes are scribbled on labels and recorded in journals and in the ship's log—locations, dates, substrate, water conditions, neighboring species, colors and shapes of the collected specimens that may change during preservation. A hefty scientific volume will be published later with the findings, during wartime; it will be part of an emerging wave of modern explorations in the Sea of Cortez. The ship's collectors will continue their work, up and down the Pacific Coast and in landmark publications that are still read today. But a tragedy will befall one young collector, a life cut short by an accident still not fully understood. That, however, is years away. In this spring of 1940, the young biologist is energized by new discoveries, as the vessel sails southward out of the Sea of Cortez and then north, to home port in California, specimen treasures safely stowed.

Barely a month later, the *Western Flyer,* memorialized by John Steinbeck and Edward F. Ricketts in *Sea of Cortez*, will enter this same arm of the Pacific Ocean. This ship will also bring a young scientist eagerly anticipating a chance for scientific collecting in the region, and the world-famous writer. The *Western Flyer*'s voyage comes close on the heels of the first, following an independent route that crisscrosses that of the earlier vessel. Only the *Western Flyer*'s journey will achieve widespread notoriety, but the two cruises are oddly complementary bookends to a remarkable year of discovery in the Sea of Cortez.

The less well-known cruise was that of the *Velero III*, sponsored and captained by George Allan Hancock and the foundation bearing his name (Meredith and Hancock 1939; Brusca 1980). On board was an ambitious, energetic, Berkeley undergraduate algal biologist named E. Yale Dawson. Dawson will bring back a store of dried, pressed seaweeds. Ricketts and Steinbeck would return with a trove of pickled invertebrate marine creatures. The two scientists apparently never met, and their ships did not pass in the night. Although Ricketts and Dawson will later correspond, and Dawson will thank Ricketts for providing some algal specimens for his PhD thesis, the report on the fauna from the *Western Flyer* and the account of the flora from Dawson's collecting on the *Velero*

III will not be combined or even recognized as related despite being timely pieces of the same ecosystem. This remains an irony, especially from the standpoint of Steinbeck and Ricketts, who aimed for a holistic view of the communities of the Sea of Cortez but who only infrequently noted the plant life surrounding the sea creatures they collected. Dawson also seemed to have a single focus, the algae (and an occasional seagrass) of the region. When combined, the two cruises yield something like a technical version of the holistic vision that Steinbeck and Ricketts philosophized about in *The Log from the Sea of Cortez*,[1] but the two cruises have not been jointly recognized in the literature of the region.

The scientists Ed Ricketts and E. Yale Dawson were similar in some ways, with matching passions for the biotic objects of their affections. Both died young in tragic accidents. Both were broad thinkers and had lasting impacts on the burgeoning study of their beloved Pacific Coast marine life. But the two scientists were also different in many ways, personally and professionally. This article examines the similarities and contrasts and the legacies of their twin 1940 voyages to the Sea of Cortez.

Algal Exploration in the Sea of Cortez

Seaweeds, the target of Dawson's collecting, are marine algae—the terms are interchangeable and we use them that way in this paper. The scientific study of seaweeds is called phycology (not to be confused with psychology, an interest of Ricketts's!) and algal biologists call themselves phycologists. Seaweeds include several familiar types of large algae (also called macro-algae) that live along the Earth's marine shorelines and are anchored in deeper water where sunlight can penetrate for photosynthesis. In a sense, marine algae are the "grasses" of the ocean, the base of the food chain that feeds life in the sea. Algae are plants in the common sense that they get their energy from sunlight, but they are actually on several distant branches of the tree of life and differ in their structure and details of reproduction, and many are even single-celled (Graham et al. 2016). The three main kinds of marine algae are called red, brown, and green algae, and they more or less correspond in color to their names. The reds and browns are found mostly in the ocean. They include the delicate and lovely branching red algae, as well as the giant brown algae known as kelp. The green algae are generally smaller and somewhat less common than red or brown algae on Pacific coastlines. However, many relatives of green algae live in fresh water, and some are among the closest evolutionary cousins to the green plants on land. Dawson collected all three of the main groups of marine algae, which are abundant in the Sea of Cortez. (For more scientific details on algae, see the online textbook by Graham et al. 2016: http://www.ljlmpress.com/algae.html.) For an introduction to the aesthetic appeal and lore of seaweeds and color illustrations of some of the most beautiful species, plus a profile of the California community of phycologists, see the books by Iselin (2014, 2019) and Abbott and Hollenberg (1976).

Norris (2010) and McCourt (2010) summarized the history of algal exploration in the Sea of Cortez, or Gulf of California (referred to in this article as "the Gulf" for brevity), from the 1870 collection of a red seaweed by Edward Palmer, to the late 20th and early 21st centuries. Dawson himself (1960a) included a brief history of algal collections from the area up to 1960 in a paper written as part of a symposium on the Gulf. Study of marine algae in the Gulf prior to and including Dawson's rather explosive output was closely tied to that of marine algal studies on the California coastline, with many early explorers coming from West Coast academic institutions in the U.S. (McCourt 2010; Abbott and Hollenberg 1976). The scope of the present article is mainly the early work of Dawson and its relationship to the 1940 Gulf cruise of Steinbeck and Ricketts, but we do not wish to diminish the importance of later contributions, particularly those of Mexico since the 1950s and from the University of Arizona in the 1980s.

Dawson's Early Training and the 1940 Cruise

E. Yale Dawson was by all accounts a precocious intellect who was fascinated by unusual plants (Hawkes 1996, 2005). Strongly encouraged and assisted by his parents and teachers, he was an avid cactus cultivator and had explored the Baja California Peninsula several times by the time he graduated from high school in Southern California (Garth 1967). Dawson collected and grew many of these cacti in his backyard and in the greenhouse that he built (Hawkes 2005 includes many photos of the young Dawson and his cacti). This fascination with collecting and natural history blossomed when he attended the University of California at Berkeley in 1936. There he fell under the spell of algae through working with Dr. William Albert Setchell, the "grandfather" of California seaweed scholarship. The elder scientist was near the end of his formal career, but he had an immense influence on Dawson, who affectionately dedicated a number of publications to the mentor that his students called "Uncle Bill."

In 1940, Dawson was a senior at Berkeley when he went on the *Velero III* cruise, a highly unusual scientific role to take on at such a young age. The cruise that preceded Steinbeck and Ricketts's journey into the Gulf was sponsored by the G. Allan Hancock Foundation, and it was Hancock himself who captained the expedition. The *Velero III* expedition was an intense 5-week cruise (Fraser 1943). This was roughly the same length as that of Steinbeck and Ricketts (6 weeks) and covered many of the same general colleting areas. But there the comparisons ended.

The *Western Flyer* was a 77-foot converted sardine boat, the *Velero III* a twin diesel 195-foot research vessel outfitted with abundant gear and collecting skiffs. Dawson in his dissertation described the *Velero III* accommodations in glowing terms:

> The splendid dredging equipment afforded by the *Velero III* permitted the carrying out of extensive sublittoral collecting, much of which was exceedingly profitable from the phycological point of view. Deep-water dredgings were made mostly off the bow of the *Velero* by means of the ship's dredge, while shallower areas were dredged by means of a motor dredge launch. A glass-bottomed skiff was used for inshore raking, grappling, and diving. The small dredge boat, being best suited for work over the most excellent sublittoral vegetation areas, yielded the most interesting sublittoral algal collections. Much of this material has never been taken in any other way. (Dawson 1944, p. 191)

Comparing these luxurious conditions to those of the *Western Flyer* is almost painful. For example, contrasted with Dawson's loving account of the glass-bottomed skiff, the infamous difficulties that Steinbeck and Ricketts had with the recalcitrant engine (renamed the Hansen Sea-Cow) on their collecting boat (without a glass bottom) exemplify the difference between the two cruises:

> Our Hansen Sea-Cow was not only a living thing but a mean, irritable, contemptible, vengeful, mischievous, hateful living thing… [it] loved to ride on the back of a boat, trailing its propeller daintily in the water while we rowed…when attacked with a screwdriver [it] fell apart in simulated death…. It loved no one, trusted no one, it had no friends. (Steinbeck and Ricketts 1941, pp. 21–22)

Steinbeck's evil personification of the Hansen Sea-Cow may have been an exaggeration, but even allowing for artistic license the difference in collecting conditions is clear. Most likely Ricketts was referring to the Hancock and similar expeditions when he wrote in a letter to Steinbeck, "It seems gratifying to reflect on the fact that we, unsupported and unaided, seem to have taken more species, in greater number, and better preserved, than expeditions more pretentious and endowed" (Ricketts 1941).

Ricketts's claim that their expedition captured more species and more of them is of course referring to invertebrate animals. Brusca (this volume) has compiled a detailed account of the collecting stations and species taken by Steinbeck and Ricketts, and the *Sea of Cortez* Phyletic Catalogue contains a somewhat less detailed list (many specimens were not identified until long after the Sea of Cortez book was published), photographs, and references for the collections (Steinbeck and Ricketts 1941). Dawson's collections were almost as impressive, though restricted to seaweeds and a few seagrasses. Dawson counted 90 collection stations stopped at by the *Velero III*, and he collected algal specimens from about half of them. He also included a detailed list of his collecting sites in his dissertation (Dawson 1944). His published record benefited from the detailed records kept by other members of the 1940 cruise and others supported by the Allan Hancock Foundation and published in a series of volumes (listed in Dawson 1944).

For the seaweed collections themselves, Dawson's thesis (1944) provides the type of scholarly writing with meticulous notes on the collection and identification of known and new species that is required in technical publications. The Phyletic Catalogue of the complete volume of the *Sea of Cortez* is comparable in its scientific treatment of the invertebrates collected and identified. The task of identification of the greater diversity of animals was probably more difficult for a single person, even for one with Ricketts's knowledge of the Pacific fauna, and this no doubt accounts for the need to send out many specimens to experts on some difficult-to-identify groups of animals. Dawson had the herbarium resources and his mentors at Berkeley and Stanford to assist him, and given the more circumscribed range of organisms, seaweeds compared to invertebrate diversity, it is likely that Dawson had less difficulty making his taxonomic inventory. Nevertheless, *Sea of Cortez* was published on 5 December 1941, two days before the attack on Pearl Harbor, and three years before Dawson's PhD thesis was published as a formal monograph, the latter being delayed due to the war. Interestingly, both

Ricketts and Dawson had their careers interrupted by serving in the military during the war. However, each was posted to relatively amenable duty at nearby coastal installations—Ricketts at the Presidio (Hedgpeth 1978a) and Dawson at the Scripps Institution of Oceanography (Hawkes 2005).

Dawson's (1960a) paper on biogeography of the marine flora (including the few seagrasses that grow in the Gulf) published two decades after his major 1940 expedition provides a picture of how he viewed his own contributions. He notes that after the early work of Setchell and Gardner (1924, 1930) based on the collections of Ivan Johnston on a cruise supported by the California Academy of Sciences, Gulf seaweed study was relatively moribund until he went on the 1940 *Velero III* cruise. For the next two decades, he asserts, he was "almost the sole investigator of algae in the region" (Dawson 1960a, p. 93). This is a bold claim, but it has merit given that Dawson went on 20 major cruises and he wrote that he amassed nearly 50,000 specimens in that 20-year time span. Included among his publications were major works, particularly on the red marine algae of the Gulf (e.g., Dawson 1953, 1954b, 1960b, 1961)

The Fate of Dawson's Collections

Because seaweeds, like many marine creatures, are nearly impossible to examine in detail in the field, they have been collected and preserved for centuries around the world. Dawson was a stupendously prodigious collector of seaweeds,[2] and he followed the standard practice whereby each specimen is pressed and dried on herbarium sheets of paper. Such sheets, when properly curated in dry, cool, insect-free cabinets in a museum herbarium, will last for centuries. An example of an artfully prepared specimen is shown in Figure 1.

Herbarium collections are part of the larger universe of natural history collections, which comprise 1 billion to 2 billion specimens in natural history collections worldwide (Bakker et al. 2020). Each specimen is a physical voucher of an organism that lived in a particular place at a particular time and was collected/identified by a scientist. The data attached to each specimen are what make it valuable; without the information on time, place, collector, identifier, and information about habitat and associated species, a seaweed or seashell would just be a curio. Collections are increasingly important for studying change in the

Figure 1. Herbarium sheet of the red seaweed Scinaia johnstoniae (Setchell), collected by E. Yale Dawson, Puerto Refugio, 26 January 1940. University Herbarium, University of California, Berkeley, no. 1882565. Dawson had pressed this specimen of red algae, which when wet is a drooping clump of red branches, so that it is fanned out on the page in a way that allowed the scientist to see its morphology and also appreciate its beauty. The image of the herbarium sheet has been modified slightly to remove a color bar and ruler for aesthetic reasons; the original image is online at the website of the University of California, Berkeley.

biosphere, especially so in the face of global changes in climate and human-induced changes in the land and oceans.

After collections are made, specimens are deposited in museums, but not always in the same ones. Different museums may specialize in certain groups of organisms or certain regions of ecosystems. This means that collections may be broken up and dispersed to various places, which makes keeping track of specimens difficult. Like a misshelved book in a large library, a specimen misplaced or sent to an obscure herbarium can fall off the grid, so to speak, and might languish in obscurity even when stored safely in a cabinet but nearly forgotten by science. Dawson originally brought his Gulf specimens back to the University of California at Berkeley, where he used them for his PhD thesis. Most remained there (more than 400); however, approximately 200 were sent to the University of Michigan, and approximately 60 went to the Smithsonian Institution's National Museum of Natural History.

Until recently, scientists would have had to visit museum collections in person to see specimens and their original data. But recent advances in digitization of collections have made many hard-to-find specimens accessible to the community of scholars via the internet. A recent program funded by the National Science Foundation (NSF), Advancing Digitization of Biodiversity Collections (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503559), has brought natural history collections across the U.S. online; that is, data and, in many cases, photographs of the specimens have been put online for use by scientists, artists, and scholars worldwide. One project funded by this NSF program is the Macroalgal Herbarium Portal (https://macroalgae.org/portal/index.php). This online database includes data from 49 different institutions and spans 150 years of collecting by scientists in the United States and many other countries. Included in the total of about 780,000 specimens in the portal are the hundreds of specimens that Dawson collected on his senior-year expedition. In essence, scientists can re-explore Sea of Cortez algae through virtual visits to the institutions where Dawson's collections are housed.

For example, a search of the portal using the following terms brings up a list of Dawson's specimens and their data:

Collector's Last Name: Dawson

Country: Mexico

Collection Date: 1940 [leave the second field for the range of dates blank]

This search will turn up the 561 algal specimens from the 1940 *Velero III* cruise. Searching in various other ways will lead to 11,772 specimens collected by Dawson, over half of them (6,536 are from Mexico) that are held by the 49 institutions that are part of the Macroalgal Herbarium Portal. Hawkes (2005) estimated that in his career Dawson collected over 40,000 seaweed specimens, but this seems low given that Dawson himself reported he had collected some 50,000 specimens from the Gulf of California alone (Dawson 1960a). Again, an exact tally is difficult to come by without further research on other herbaria. A complete inventory of Dawson's specimens awaits the digitization of herbaria worldwide. Because Dawson was such a prolific collector, even this list is not a complete inventory of his collections because some specimens were not part of the Macroalgal Herbarium Portal (e.g., the Smithsonian's collections of algae are posted on its website, https://naturalhistory.si.edu/research/botany, and unknown numbers are housed elsewhere).

Dawson was hired as the curator of algae at the Smithsonian Institution the year before his untimely death in 1966; this appointment might have finally given him the freedom from administrative work and other duties that could have unleashed another period of intense research, collecting, and productivity. Alas, this was not to be, although Dawson did enlarge the collection at the Smithsonian herbarium greatly in the year he was there. It is sad to imagine how many more specimens Dawson would have gathered, and how much more of an influence he would have had on students and colleagues, had his life not been cut short by tragedy.

A Last Visit to the Sea of Cortez and the Accident in the Red Sea

The year 1966 was a seminal and fateful one in Dawson's life. In April he visited his colleague and friend Robert W. Hoshaw (McCourt 1996) at the University of Arizona (UA) in Tucson, which included a visit to the marine biology station about 4 hours away at Puerto Peñasco, Sonora, Mexico, in the Northern Gulf of California. The UA had a growing program in marine science supported by marine biologists Donald A. Thomson and John Hendrickson, and the phycologist Robert Hoshaw (Turk 2007; Brusca 2018). Despite being just 1 hour south of the U.S.-Mexico border, the flora and fauna of the Northern Gulf were still poorly known, despite Dawson's work in the Gulf at large (Dawson 1944, 1954, 1960b). The relative proximity to the bimonthly low tides made Puerto Peñasco an ideal research site, but compared to the better-known California coastline, the Gulf was virtually *terra incognita* in terms of convenient field guides. The Gulf was an exotic and rewarding place for the many graduate students from the UA and other universities in the U.S. and Mexico who worked there in the second half of the 20th century (Brusca 2018).

In large part, this gap in knowledge was what inspired the Steinbeck-Ricketts cruise and the explorations of Dawson and earlier Berkeley biologists. But the marine algae of the Northern Gulf had received little attention before Dawson arrived in 1966 with his collecting buckets and typewriter.

Dawson visited Hoshaw at the UA in the spring of 1966 and this gave him the chance to write a brief field guide to the marine algae of the vicinity of Puerto Peñasco. He did it in the rapid-fire manner typical of his workflow. Teaching a class on marine algae and going on field trips to Puerto Peñasco (Figure 2), Dawson quickly assembled the specimens and information necessary to write the short guide, which was the first in a planned series for the region (Dawson 1966). Dawson had written and illustrated various other guides to the seaweeds of California, with titles such as *How to Know the Seaweeds* (Dawson 1956) and *The Seaweed Story* (Dawson 1954a). He was always concerned with bringing the world of seaweeds to the broadest possible audience. The little Puerto Peñasco field guide, a spiral-bound booklet printed in Courier font, was an identification key without any drawings or illustrations, but with references to publications where illustrations could be found (many were California species or had been written up in Dawson's other works). Though without pictures and written in scientific style, it was widely used as the primary resource on marine algae in the area for the next 40 years until the monographs of Norris (2010, 2014) and the short nontechnical guide by Readdie et al. (2006). Dawson's guide was published posthumously, one of the last products of this remarkable phycologist.

Dawson returned to California and in May departed on a worldwide collecting trip with his family. After an international oceanographic congress in Moscow, he traveled to the Red Sea in Egypt, where he was collecting seaweeds with his daughter. On June 22 tragedy struck. The details are sketchy, but E. Yale Dawson drowned near the shore, possibly in an attempt to help his daughter who may have been struggling in the water (M. J. Wynne, pers. comm.). He may have suffered a heart attack

Figure 2. E. Yale Dawson (right-center, with bucket) collecting seaweeds from tide pools on the coquina reef and granite boulders of Playa Estación (Station Beach) in Puerto Peñasco, Sonora, Mexico. Dawson is discussing the local seaweed flora with George Hollenberg (professor at the University of California, Berkeley) and graduate student Elizabeth Dewer (far right; University of Arizona). Photograph taken 11 April 1966 by Robert W. Hoshaw. Photograph provided by Ruth Hoshaw.

or other medical emergency, but no autopsy was done. Whatever the case, the world of phycology lost "one of its best friends and most active contributors, in a tragedy that brought grief into the hearts of all who knew and admired him" (Silva 1967, p. 225).

E. Yale Dawson's Legacy

To assess Dawson's work ethic and productivity, one need only look at what he published just before his death. In the scientific world, when an author publishes more than one article in a year, the references are given letters following the year to distinguish them, i.e., *a, b, c*, etc. Dawson, in the year he died, was up to *k* (Silva 1967). That's 11 and counting when he died about halfway through 1966. The number of scientists who reach *k* in their citation alphabet for a single full year is rare, especially for works by a single author, which was the case for almost all of Dawson's publications. Obviously, Dawson was productive to the very end and was on an upward trajectory. But Dawson's legacy is more than his academic output. He was a humanist as much as a scientist. He donated thousands of butterflies to the natural history collections at the University of Southern California, he wrote about the Seri (Comcaac) Indians of coastal Mexico, and he wrote a charming book for the children of Ecuador, in Spanish and English, explaining the wonders of the Galapagos Islands (Dawson 1970).

Dawson published his first paper at the age of 17 about a trip he and his father took to Mexico over a Christmas vacation (Dawson 1936). Predicting a later fondness for unusual plants other than algae, this and numerous later publications were about cacti and succulents, which Dawson eagerly cultivated in his home greenhouse (Hawkes 2005; Silva 1967). A complete recounting of Dawson's prolific output is beyond the scope of this article, and it was even daunting for Paul Silva, another luminary of California phycology, to assemble a year after Dawson's death (Silva 1967).

Silva, a faculty member and curator of algae at the University of California at Berkeley, visited the Northern Gulf with Dawson in the spring of 1966 (Figure 3). In a remarkable obituary published the next year, Silva (1967) recalled Dawson's personality: "With singleness of purpose bordering on compulsion, directness of approach leading to expediency, and enthusiasm easily mistakable for brashness, he was in almost a perpetually ebullient mood, his mind racing ahead on new projects while previous commitments were being fulfilled with extraordinary dispatch" (Silva 1967, p. 226). This ebullient nature resulted in a prodigious output of scientific papers, books, field guides (some in Spanish), checklists, and travelogues. Dawson was interested in virtually all of marine phycology of the West Coast of the United States and beyond. He published on seaweeds from the Pacific coasts of Alaska to South America, with a breadth of focus similar to that of Ed Ricketts, who went on collecting trips to Alaska and was planning another expedition and future publication on these "outer shores" at the time of *his* death (Hedgpeth 1978a,b). Like Ricketts, Dawson was concerned that the marine life of the coastal world be communicated to everyone.

Another of numerous obituaries for Dawson was by Isabella (Izzie) Abbott, the doyenne of California phycologists, who was in constant

Figure 3. Two phycological giants of the 20th century, Paul Silva (left; University of California, Berkeley) and E. Yale Dawson. The two are standing outside the marine lab of the University of Arizona in Puerto Peñasco, Sonora, Mexico. Photograph taken 11 April 1966 by Robert W. Hoshaw. Photograph provided by Ruth Hoshaw.

correspondence with Dawson, their letters sparkling with affection and playfulness. E. Yale Dawson was contracted to be the main author of *Marine Algae of California,* and he asked Abbott to partner with him on this complete seaweed flora for the entire state. Dawson and Isabella Abbott were working on the logistics of how such a large project might be handled when he died. She took the reins, with California phycologist George Hollenberg, of that daunting project, which was completed in 1976 (Abbott and Hollenberg 1976). Her obituary for Dawson (Abbott 1966) is heartwarming in its affection for the man and matches Silva's high estimation of Dawson's science. She noted the dogged determination Yale brought to the microscope and typewriter: "No group of red algae, his favorites, was too difficult for him—not even the Corallinaceae [pink, rocklike red algae] which most of us avoid deliberately.... Dawson was the most prolific writer on marine algae in his generation, and the major contributor to his field" (Abbott 1966, p. 130). We recommend these two obituaries, as well as accounts by Hawkes (1996, 2005) and Garth

(1967), to get a feeling for how difficult Dawson's passing was for his colleagues and friends. In *The Curious World of Seaweed*, one of the authors (JI) includes several chapters on California seaweeds that tell the fascinating stories of the scientific symbiosis (and occasional spats) between Dawson and Izzie Abbott and Paul Silva (Iselin 2019).

Regarding those spats, the admiration for Dawson, perhaps like that for Ed Ricketts, was not unqualified. In their otherwise glowing assessments of Dawson's achievements, Izzie Abbott and Paul Silva did not hold back in criticizing Dawson's perhaps too-rapid-fire pace of writing and a "slapdashery if not intellectual dishonesty" (Silva 1967, p. 227). Silva also noted that Dawson was "contemptuous of those whom he considered plodders and fussers" (Silva 1967, p. 227), reminiscent of Steinbeck and Ricketts's (1941) view of academic "dry-balls" (see below). Still, Silva marveled at Dawson's ability to hammer out first drafts on the typewriter that often appeared in final printed form with barely any changes. This no doubt contributed to Dawson's productivity, but it also reflected a penchant to publish first and correct later. Paul Silva summed this up in a kindly politic way by noting that "although our knowledge of the classification and distribution of seaweeds has been greatly enriched by Dawson's innumerable studies, posterity would have benefited even more had some restraint and caution been exercised" (Silva 1967, pp. 227–228).

Dawson and Ricketts

It is irresistible to compare these two scientists, who were so similar in some ways and different in others: the proximity in time of their cruises, the attraction to an exotic Mexican shoreline to broaden their biological horizons, the ship-based collecting with meticulous notes and abundant specimens. However, few people outside of science have heard of E. Yale Dawson, no doubt in part because he was not the lead character of a best-selling book by one of the 20th century's most famous authors, namely, Steinbeck's classic *Cannery Row* with "Doc" (Ricketts) as the main character. Steinbeck needed Ricketts to delve more deeply into the biology and ecology of the tide pools around Pacific Grove and to guide Steinbeck's eyes, ears, and heart in the collecting and analyzing of invertebrates in the Gulf of California (Astro 1973). In his publications, Dawson had to have elements of both Steinbeck and Ricketts—breezily facile with words and writing, with a keen eye and memory for details in the intertidal zone, and an enormous heart devoted to the unseen ocean worlds that he believed should be shared with all. An example from an article on cacti displays a prose style reminiscent of the writing in *Sea of Cortez*:

> We explore today; we look briefly; we pick and preserve here and there fragments of what we find about us. Perhaps more important is to tell the story—that there is something here as grand, as limitless, as consumingly interesting as anything we have ever known before. (Dawson 1949, p. 52)

Dawson was a card-carrying PhD and peripatetic administrator at various institutions throughout his career, who nevertheless was hugely productive. Ricketts never finished his undergraduate studies and remained an outsider to the world of formal academe, but if anything, this may have freed him to think and write in ways that were far more influential (Hedgpeth 1978a,b; Astro 1973). Ricketts (along with John Steinbeck) and Dawson published on two tracks: dense taxonomic treatises—the Phyletic Catalogue of Steinbeck and Ricketts (1941); Dawson's series of monographs listed in Silva (1967) and Abbott (1966)—and more philosophical essays and field guides for the public—Steinbeck and Ricketts (1941) and essays by Ricketts in Hedgpeth (1978b); Dawson's guide to the Galapagos (Dawson 1970) and reminiscences of his life (Dawson 1949). Steinbeck had the more powerful writing voice for the general reader, but all three authors' prose was often filled with excitement and awe for the plants and animals of the sea.

Ricketts and Dawson did not meet in the Gulf, and their cruises did not overlap. However, the two did communicate after their expeditions. Dawson mentioned Ricketts several times in his dissertation, and Ricketts and Steinbeck sent Dawson some seaweed and seagrasses to identify from their Gulf expedition. Toward the very end of the Narrative (Log) in *Sea of Cortez*, Steinbeck and Ricketts mention a great zone of the flat, frond-like alga *Padina durvillaei*. They must have sent Dawson a sample, because this is noted by Dawson in his thesis (Dawson 1944, p. 230) and in a footnote in the Log in Steinbeck and Ricketts (1941, p. 221).[3] Later, the penultimate chapter of the Steinbeck-Ricketts Narrative starts with a description of entering a bay between sandbars at Agiabampo, where the five crew members—Steinbeck, Ricketts, and three others in the almost swamped skiff—encounter eelgrass for the first time. The flowering eelgrass prompts Ed Ricketts to bring a sample back to

Monterey and send it to none other than E. Yale Dawson, who was still working on his PhD at Berkeley. (In typical Dawson style, he finished his PhD in just two years, in 1942—almost unheard of in academics. Then again, he had a head start on it by collecting in the Gulf during his undergraduate senior year.) Dawson identified it as "the true *Zostera marina*," and informed Steinbeck and Ricketts that "it had not been reported previously so far south" (footnote in the Log in Steinbeck and Ricketts 1941, p. 263). We cannot help but chuckle over the meeting of these minds—Dawson and Ricketts—not in the waters off Cabo San Lucas, but over a specimen of eelgrass, a specimen rich in signifying the health of the oceans, not only in and of itself, but in all it supports and portends. Ricketts and Dawson shared a sensibility that was different from other scientists. They did not operate in the closed-box world so typical of academia; as Steinbeck and Ricketts (1941) put it in *Sea of Cortez*, they were scientists who were looking "from the tide pool to the stars and then back to the tide pool again" (p. 217).

Astro (1973), Hedgpeth (1978a,b), Rodger (2002, 2006), Brusca and Haskin (this volume), and others have discussed at length the philosophical side of Ricketts, who lived among writers, poets, and philosophers. Ricketts labored hard on his densely written essays such as "Breaking Through" (Hedgpeth 1978b) and "The Spiritual Morphology of Poetry" (Rodger 2006), and although his prose suffered in comparison to Steinbeck's, he took on subjects far more philosophical than Dawson did. In contrast, though, Dawson was a firehose of written words and despite the criticisms noted by even his closest colleagues above, his written record will provide scientific fodder and treasures for years to come.

Hedgpeth (1978a) mentioned that Ricketts was for a time attracted to Zen Buddhism (p. vi), and this seems consistent with his approach to ecology as taught by his University of Chicago professor W. C. Allee. Allee (1931) was an early proponent of the ecological importance of communities of organisms and their interrelatedness. This is reflected in *Between Pacific Tides* (Ricketts and Calvin 1939), a book that takes a holistic view of the ways that organisms interact and survive on the Pacific coastline. Ricketts and Steinbeck were two mavericks who looked down on the stodgy scientists who didn't seem to enjoy life or the organisms they studied. Only partly facetiously, Steinbeck and Ricketts wrote that these are not "true biologists" who were, like Steinbeck and Ricketts, "temperamental, moody, lecherous, loud-laughing, and healthy."

Steinbeck and Ricketts did their share of collecting, killing, and pickling, but they felt something more holy (to use Steinbeck's terminology) about communities of living things, and there was definitely something more to their own harmony with nature than what they perceived in most ivory tower academics:

> Once in a while one comes on the other kind—what used in the university to be called a "dry-ball"—but such men are not real biologists. They are the embalmers of the field, the picklers who see only the preserved form of life without any of its principle. Out of their own crusted minds they create a world wrinkled with formaldehyde. The true biologist deals with life, with teeming boisterous life, and learns something from it, learns that the first rule of life is living. (Steinbeck and Ricketts 1941, p. 29)

Which brings up the question, would Steinbeck and Ricketts have seen Dawson as a "dry-ball"? Or was Dawson something of a Zen monk of seaweeds? Was he, like many of us who are scientists (RMM) and artists (JI), secretly in love with the organisms he studied? And did he, like us, receive psychic pleasure from visiting the ocean and desert habitats where he found his beloved algae? E. Yale Dawson was among the first phycologists to use scuba equipment to collect seaweeds, to get down into the ocean with the algae he was studying. His writings on seaweeds and especially his early writing about cacti and the aborted autobiography he was writing before he died (Hawkes 2005) all suggest that he was entranced by the organisms he studied. We also cannot forget his ability to draw. Many of his guides were adorned with his charming illustrations of the kelps and seaweeds he is describing. Dawson's openness to different approaches to the world of the intertidal zone would have surely charmed Ricketts.

Both men were relatively young when they died (Dawson 48, Ricketts just 3 days short of his 51st birthday) and both were fully in the midst of active research projects. It's an interesting thought exercise to imagine a meeting of the two scientists on a rocky shore of some remote island in the Sea of Cortez. Yale might have been soaking wet from snorkeling fully clothed as he was wont to do. Ed would have had a hat and waders. We can picture the two with their noses close to the rocks and scraping under the overstory of seaweeds hanging down, hand lenses and buckets at the ready. Each could have rattled off the names and natural history of the fauna and flora populating the tide pools and exposed rocks, perhaps comparing them to those in their California tide pools and elsewhere. And later, would Yale have eagerly shared a beer with Ed, who so appreciated the beverage? And would they have philosophized about the Gulf creatures and those who study them?

We will never know. Because Ricketts and Dawson did not live long lives and did not interact much, it is difficult to say if they might have achieved some confluence of knowledge, a combined view of animals and plants of the ocean, that would have been a more inclusive perspective than either achieved on his own. That both men were taken in accidents seems a random and senseless theft of their futures and our expectations for them. But we have their books, and their specimens, and their stories. And as for all such scientists, that will have to be enough. ✜

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Notes

1. The Log, as it is commonly known, is the narrative first part of the book *Sea of Cortez*, which included a detailed biological catalogue of the species collected and copious scientific references. The Log was later published separately (under Steinbeck's name only, i.e., Steinbeck 1951) and has been erroneously attributed solely to Steinbeck, while the more arcane scientific section was credited to Ricketts. As Richard Astro (1973) convincingly showed in his book about Ricketts's influence on the writer, Steinbeck himself strenuously opposed this

division of authorship and insisted that Ricketts and he both be given credit for the entire book, including the Log.

2. On 28 February 1947, Dawson wrote to his mentor, Gilbert Smith at Hopkins Marine Station in Monterey. That letter begins: "Dear Dr. Smith: my wife and I returned last week from nearly five months of travel through 17 states of Mexico over 9000 miles of Mexican roads, railways and waterways. Algal collecting was good…and I think I have something like 10,000 more specimens for the study of the Pacific American tropical and subtropical flora." From the E. Yale Dawson letters at the Archives, Smithsonian National Museum of Natural History.

3. Curiously, no specimens of this brown alga appear in the Macroalgal Herbarium Portal, or in the Smithsonian collections, which only have *Padina* collected by Dawson, not Ricketts.

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An Explanation of Why I Can't Contribute to This Narrative

John Gregg

It has been one of the great, unexpected pleasures of the *Western Flyer* restoration process that I get to work with notable scientists and authors. When one of them graciously asked if I would write an explanation as to why I'm involved in this project, I said yes before I thought about it. I was caught up in the excitement of hanging out with this group, before the truth fought forward and reminded me why I wanted to decline this assignment. I can't write. I have an incomplete education and am the very personification of the problem E. O. Wilson described in his 1998 book *Consilience*. Being schooled in things technical and precise, I lack almost completely a sufficient exposure to the humanities, social discourse, and artist-y things. I am, in fact, a perfect exemplar of the problem of separation of art and science. My co-contributors, on the other hand, are examples that exceptions are, and should be, made. They are not only skilled scientists and scholars, but also philosophical thinkers and lyrical writers.

Our societal house has long been too divided between art and science. Artistic creativity has not been rewarded in the scientific milieu, and precision and validation are rarely valued in art. It has been said (not by me—I was doing math) that Mona Lisa's smile came not from divine intervention per Giorgio Vasari, but as the result of da Vinci's exacting and painstaking anatomical research—so he was an early exception, blending scientific curiosity with artistic brilliance. But, alas, there are few da Vincis. In seeking a career, we are asked to separate into two camps, like a schoolyard game of Red Rover. In choosing the technical path, we are made to abandon the personal and egocentric view of things in favor of an ordered set of impersonal and dogmatic constructs. The artists, conversely, are told to abandon the group view and interpret the world through their own eyes and sensibilities. For the artist, the ordered

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process is anathema, and group approval and peer review the road to ruin.

Science has sought to suppress spurious creativity in its formulation. It rewards repetition and exactness, while art specifically frowns on anything that appears derivative.

And yet, Piero Scaruffi noticed that all major scientific revolutions have coincided with a climate of creativity. This fact was also graphed by Ed Ricketts on butcher paper hung on the walls of his lab. He (without Google or Wikipedia) mapped all major events in human history throughout the world and noticed that similar patterns emerge in countries far removed from one another. Periods of great advances in both art and science were followed by long periods of quiescence—that was true in Japan and in Europe. This is what Stephen Jay Gould and Niles Eldredge called "punctuated equilibrium" in 1972. This is contrasted against phyletic gradualism—the idea that evolution occurs as a slow and steady transformation.

One of these rapid steps forward seems to have occurred on the *Western Flyer* in 1940. For Steinbeck and Ricketts—an artist and a scientist—the dichotomy of art and science could be bridged by immersive observation. That is what Ricketts and Steinbeck did on their 6-week voyage. They observed. Deeply. The science that followed gave truths about nature. The art generated a series of notable books and essays.

By listening to ribald stories from the crew about life in Monterey (and from living "down on his soles" in the 1930s on the "Row"), Steinbeck—a notorious "lint picker" of facts—penned *Cannery Row* and *Sweet Thursday.* Many nights during the voyage, Steinbeck huddled close to the *Flyer*'s shortwave radio and listened to the unfolding drama of the Nazi invasion of Norway and the brave resistance that became the material for *The Moon Is Down*. Their self-described Homeric journey also included a story gathered in La Paz, which became *The Pearl,* as well as greater familiarity with Mexican history and culture—which may have inspired Steinbeck to write the film scripts for *Viva Zapata,* and *The Forgotten Village.*

The late-night talks that Ricketts and Steinbeck had after watching schooling fish further refined their views regarding the individual versus the "group-man," as set forth in Steinbeck's 1932 reflections, "The Argument of Phalanx."

This is all very derivative and in line with my training. But in order to describe my involvement with the *Flyer*, as requested by this volume's guest editor, I must become subjective instead of objective/factual. At age 10, I grabbed a book from a bookmobile by mistake, and was forever changed by it.

The Library Service Act of 1956, and subsequent efforts by Jacqueline Kennedy, brought the miracle of bookmobiles to poor rural communities such as mine in Brunswick, Georgia. Upon the bookmobile's eagerly anticipated arrival to our street, we had only a few minutes to turn in our old books and grab an armful of new titles to read before the bookmobile's return in two weeks. I would gravitate toward anything adventurous, such as Jack London's *White Fang* or Jules Verne's *20,000 Leagues Under the Sea*. Anything about a pirate, an abandoned racehorse, or an aggrieved whale would feed my pre-teen hunger for adventure.

During one of those mad bookmobile scrambles, I grabbed *The Log from the Sea of Cortez,* since it sounded adventurous. And it was. The dust jacket showed a drawing of a fishing boat in big green waves under a yellow sky. Originally published in 1941 with the ponderous title (and contents) *Sea of Cortez: A Leisurely Journal of Travel and Research*, the book was cut in two and re-issued in its more tractable version in 1951. During that intervening decade, 80 million people perished in the Second World War, 22 billion sardines were killed in Monterey Bay, and Edward Flanders Ricketts died at a railroad crossing on Cannery Row.

It was the 1951 edition that I grabbed in 1969, and with which I have been intrigued ever since. I realized then that a person could, with their friends, go to a remote place, and do real science while having breathless adventure. My 10-year-old self, in my mind, traveled with this band of characters on what Joseph Campbell, who was heavily influenced by Ricketts, would later describe as a "hero's journey." In 2015 it was definitely my subjective, 55-year-old self that purchased the boat that took Steinbeck and Ricketts to the Sea of Cortez, the *Western Flyer*. The boat and its history mean more to me every day.

Steinbeck wrote about the duality of the mind when discussing man's relationship with boats. The brain, with a perfect balance of the artistic and the utilitarian, shaped the boat into a "lasting thing of useful beauty." He said, "Of all man's tools, the boat is personification of man's soul." And, "There is an ancient ancestral memory at work which has shaped that man's mind into a boat shape. The boat, in turn has received the man's soul." The boat will identify with those aboard and respond with human-like moods and intelligence.

In the intervening years between Steinbeck and Ricketts' voyage and now, the *Western Flyer* has displayed an awareness that defies calling her an inanimate object. She refused to sink many times, and when she did, it didn't take. She rewarded loving captains with a hold full of fish or crab. When she got a bad captain, maybe one who had previously sunk his charges, or who had a penchant for abusing both vessel and crew, well, that bad captain may have found himself dragged off the deck by a fouled crabpot line and taken to the bottom. Perhaps the boat responded a little slowly to the man overboard. Maybe the crew reacted a bit more deliberately than hastily when recovering the gear from the ocean depths with the lifeless captain in tow. These moments, though forgotten by men, seem to be remembered by the boat. It is palpable when you board the *Western Flyer*, to feel the presence of the captains and crews and scientists and fishes that were there before. And with this awareness, it doesn't seem like a question of "if" the *Western Flyer* should be returned to her former usefulness, but rather the question is how best to move her to her new mission while respecting her history and form.

Steinbeck and Ricketts were not sentimental men. They bristled at old traditions and focused their creativity and logic on looking ahead. It is with this awareness that I, as the boat's owner, and we as an organization—the Western Flyer Foundation—are tasked with preserving the historical significance of the boat while also fitting the *Western Flyer* for her new mission.

The vessel was built at the end of the sail era, and her hull lines retained the sleekness and efficiency necessary for sail-powered vessels. The elegant wineglass hull of the *Flyer* makes her slippery in the water and highly efficient for the battery-powered electric motors that will replace the original diesel engine. The original Atlas engine weighed over 9 tons, and was the size of a Volkswagen van, yet produced a scant 160 horsepower. Such power was, however, adequate to propel the *Flyer*, laden with 70 tons of fish, at a speed of 11 knots—an attestation to her excellent hull design. The new electric motor, by contrast, will be the size of a microwave oven, and will provide 450 horsepower, enough to reach similar speeds with much more torque.

The electric propulsion system will allow the *Flyer* to glide quietly across the water. She will be able to approach wildlife with minimal disturbance, allowing a substantial increase in lethality in harpooning marine mammals (just seeing if you're still reading). The lack of diesel fumes, along with stability provided by a pair of Seakeeper gyroscopes, will provide a clean, stable environment for people prone to seasickness, and will make for a much more pleasant voyage for all. The electric propulsion system will also facilitate a dynamic positioning system, which will hold the vessel in one location while a remotely operated vessel (ROV) is deployed. The fully functional ROV will transmit high-definition video to on-board screens. Such video can also be transmitted in real time to any internet-connected monitor in the world. We will also be able to collect marine specimens, deploy data loggers, and recover derelict fishing gear with the ROV.

We anticipate that the *Flyer* will spend 26 weeks each year in its home port of Monterey. The city has offered us permanent berthing at what is now a Coast Guard pier. The rest of the year the *Flyer* will venture north, as far as Sitka, Alaska, and on alternating years, south, to the Sea of Cortez. Along the way we intend to call on small ports that are seldom visited by research or educational vessels. With its shallow draft, the *Flyer* can visit ports inaccessible to larger craft.

Each venue will be visited by an advance team that will work with local scientists, teachers, and artists, who will receive training on project-based learning. Symposia will be held each year in Monterey to "train the trainers," preparing them for our visits. This process will identify a marine issue of local concern at each stop, such as eelgrass depletion or agricultural runoff, and a long-term study will be initiated and performed using the *Flyer* and local partners. These long-term studies may be transect surveys, or water quality studies, or whatever kind of long-term data collection is needed to be meaningful for local communities.

A seafloor data logger will also be placed near each stop, with a total of nearly 60 loggers to collect continuous readings on pH, salinity, dissolved oxygen, and other parameters for 2 years with each setting.

The advance team will also supply ROV kits for clubs in high schools to assemble. When the *Western Flyer* arrives, the ROV cameras will provide video footage for a short student-made documentary about a local marine concern. We want the *Flyer*'s visits to remote ports, such as Prince Rupert or Tillamook, to be much-anticipated events.

The new explorers on board will be challenged not just by technical things, but subjective impressions will be teased out by writing, painting, photography, and documentary production, thereby engaging both hemispheres of the mind. This is where I feel I'm out of my depth. But by working together with others—the Steinbeck/Ricketts model—we will be more complete, and the creativity of others will help create a holistic vision aboard the *Western Flyer*. Often I seem blind to what Kant said was "our ability to know things through our senses but cannot directly see." The *Western Flyer* project will embrace both the seen and the sensed.

If science is stripped of emotion and creative manipulation, it cannot advance. The same rules apply to art. A large chunk of Carrara marble was just a flawed boulder until shaped into *David* by Michelangelo's precise knowledge of anatomy and use of visual tricks of foreshortening.

This duality of thought is the basic underpinning of our mission. The relationship of the artist Steinbeck and the scientist Ricketts aboard the *Western Flyer* is a perfect metaphor of our larger goal. The symbiosis, were I able to enunciate it clearly, is an elusive and fragile thing that must only be referred to in whispers, but if successfully employed will yield important lessons to those we reach. The "consilience" or merging of thought from people with diverse backgrounds will be the crop we seek to harvest.

I really appreciate being asked to share the source of my involvement in this project. Perhaps the next cohort of technical people will be more fully evolved. I feel like I stumbled upon a new phalanx, not modeled on da Vinci or Darwin, who were good at everything, rather a group of people each with a particular talent. Hopefully our combined efforts will result in a new system, with the *Flyer* as the centerpiece, of exposing people to the art of science. ✜

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Sea of Cortez: Recollections and Reflections

Richard Astro

It began very inauspiciously. I was grading freshman composition essays in my office in the Oregon State University English Department, a long day's work punctuated by periodic frustrations over the quality (or rather the lack of it) in this or that student's writing. As I was reading a particularly disturbing essay about the pollution of the Willamette River (the author saw no problem with a nearby zirconium plant using the river to dispose of its toxic waste) I looked up to see an older man with a very strange visage standing in my doorway; most certainly he was not one of my students. There were no introductions—he simply stood there, looking down at me.

Feeling slightly uncomfortable, I asked if I could help him; no response. Finally, he stepped forward and asked quizzically, "Are you the fellow who wrote a doctoral dissertation on John Steinbeck?" "Yes," I responded in a halting voice, adding that it had been accepted only two or three months ago. Again, no response. Moments later, scratching his chin, he asked if, in my manuscript, I had talked about Steinbeck's interest in marine ecology. "Yes, well sort of," I responded, qualifying my response by substituting the word biology for ecology. Appearing somewhat displeased, he stood another moment and then came into the office and sat down. "We have much to talk about," he said. "What's that," I answered. "If your dissertation is any good at all, I can help you turn it into an important book," he quipped offhandedly. Pausing, he then asked, "Is it any good?"

I smiled and tried to nod. I must admit, though, strange as this encounter seemed, my interest piqued. "Okay," I said, mustering the courage to deal with my visitor, "let's begin at the beginning…who are you?" "Hedgpeth," he responded, "Joel Hedgpeth, I run the university's Marine Science Center in Newport. I knew Ed Ricketts well. I knew Steinbeck. I know lots of people who knew them both. I said we have

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much to talk about." "Yes, it well may be," I concurred, somewhat hesitatingly—not sure I heard him correctly or, if I did, trusted what I was hearing. "I'll come over to your house later this afternoon," he said. "I live in Newport and can stay here in Corvallis a couple of extra hours. What's your address?" I told him. He left, and I read a half-dozen more student essays before going home. I wasn't at all sure he'd show up.

I got home about 4:30, about a half hour before my wife, Betty, who directed the graduate program in the College of Business at Oregon State. As I began telling her about my visit from Hedgpeth, there was a knock on the door. Closer to it than me, she opened it and there he stood. Smiling, she invited him in. Once inside, he turned toward both of us, inquiring what was for dinner. Nonplussed, I don't recall that we answered. There was no need. It came from him: "a nice steak, burned…a salad, no carrots." One of us went off to Albertson's supermarket. The other poured Joel a tall scotch—on the rocks—and then another. What would become a grand adventure was underway.

When I began my doctoral work at the University of Washington, our department chair, the noted Shakespeare scholar Robert Heilman—a giant in the academic literary world at the time—gave me and all of his new students a volume written by Richard Altick titled *The Scholar Adventurers.* He said we should read it carefully, internalize Altick's discussion about the excitement of literary research so that we might prosper not only as graduate students but as scholars, whatever our fields of specialization. I stayed up much of the night reading, and my immediate takeaway was that I could become a real sleuth, uncovering all kinds of buried secrets about writers and their work that would validate my choice of career, and, if I were fortunate, would convince my slightly skeptical in-laws that I would be able to earn a decent living.

But in the onward rush of events—classes, seminars, prelims, and then the dissertation, my work was less an adventure than pure drudgery. There were some good classes, to be sure, but imagine having to read *Beowulf* aloud to one's classmates in the original Old English! The Altick thesis seemed at best fanciful—that is, until Joel Hedgpeth came to dinner.

It took upwards of three years; I was teaching full time plus picking up evening and summer classes to supplement a very meager salary. But the end result was a new way of reading John Steinbeck's fiction—and I say this with as much modesty as I can muster—that began a complete reassessment of his work and that I would like to believe helped to enhance his reputation so that he now occupies his deserved place in the pantheon of American literature. It was a scholarly adventure of the first order that took Betty and me to Salinas and the Monterey Peninsula on numerous occasions, to the Sea of Cortez, and to New York City where Steinbeck lived during the last two decades of his life. Along the way we met or talked with and, in some cases, got to know an incredible array of fascinating people. Some were celebrities—John Cage and Joe Campbell, Henry Fonda and Burgess Meredith, and yes, Richard Rodgers (of Rodgers and Hammerstein). There were his wives—Carol, Gwen, and especially Elaine. Others were not public figures but were remarkable women and men, each in their own way: Webster "Toby" Street, Virginia Scardigli, Ed Ricketts Jr., Ellwood Graham, Fred and Frances Strong, Gilberto Valdivia and Manuel Madinabeita, and the owner and captain of the *Western Flyer*, Tony Berry. And in the end, as I put hundreds of notes, letters, interviews, and just plain conversations together along with my own analysis of them all into a book that, happily, the University of Minnesota Press agreed to publish, what emerged was my understanding of a writer whose worldview was beyond his time—a way of understanding and accepting, conveyed in narratives that when read properly help us see and know our own world in fresh and important ways. And the key to it all, I concluded, lies in the tide pools, on the rocky shores, and in towns and villages that line the shore of the Sea of Cortez. And so, let us begin.

First, a brief chronology. The facts, as it were. Joel Hedgpeth and I became quite good friends. He seemed to trust that my interest in Steinbeck was genuine and that I was capable of undertaking and completing the project that he believed needed doing. He spent a great deal of time with Betty and me, in part because we made sure we always had steaks we could "burn" when he arrived unannounced for dinner. Knowing him was a qualified joy. There were lots of laughs to be sure, despite occasional moments of distress; we shuddered when he spilled a full glass of scotch into our piano as he was regaling us (and given the volume level, also our neighbors) with a long sequence of Welsh ballads. Joel took me to San Rafael to meet Ed Ricketts Jr., who gave me access to a treasure trove of his father's notes and letters, as well as letters to his father from Steinbeck. And there were conversations about his father's work as a marine biologist, Steinbeck's involvement in that work, and how it all came together when the two men scrapped a proposed guidebook about marine life in San Francisco Bay in favor of a much more expansive journey to the Gulf of California. Ed Ricketts had gone on marine collecting expeditions as far south as Ensenada, Baja California, but this was a much bigger deal—a large and important project that he believed would expand his studies of marine life of the Pacific intertidal and so cement his thesis about the importance of the relationships of marine animals to their environments—the foundation of animal ecology.

This all began in the spring and summer of 1969. Steinbeck had died during the previous winter, on the very day (December 20) when I submitted the final revision of my dissertation to the University of Washington. At the time, his reputation was in the literary ashcan. No one had written a serious critical study of his work since Peter Lisca's *The Wide World of John Steinbeck* (1958) a decade earlier, and I vividly and painfully recall that a member of my dissertation committee was reluctant to approve my dissertation because of Steinbeck's supposed support of the American presence in Vietnam (two of his colleagues convinced him to relent). As for *The Log from the Sea of Cortez* (1951), which is the Narrative/Log part of *Sea of Cortez: A Leisurely Journal of Travel and Research* (1941), it was generally assumed that Steinbeck wrote the entire Narrative and that Ricketts's involvement in the project was restricted to compiling the Phyletic Catalogue of marine invertebrates that the two men collected during the expedition. No less a critic than Princeton's Arthur Mizener complained in the *New York Times* that even Steinbeck's best books (I assume he was talking about *The Grapes of Wrath*, 1939) are "watered down by tenth-rate philosophizing" and that his lesser works (read *Log from the Sea of Cortez*) "are overwhelmed by it."

One of my first interviews was with John Gross, the director of the Salinas Public Library, a learned man and a genuine Steinbeck enthusiast who lamented the neglect of the writer's work and could hardly dream of a day when he would be recognized even in his own hometown for his important contributions to our literature. With regard to *Sea of Cortez*, Joel Hedgpeth, writing in the *San Francisco Chronicle*, predicted "it would be an indispensable aid to students exploring life among the marine invertebrates of the Gulf of California," but the unusual mixture of taxonomic data and travelogue meant the book struggled to find an audience.

Some readers, particularly those familiar with Steinbeck's work but not knowing the facts about the authorship of the Log portion of the book, felt that even though there were moments when Steinbeck was at his best, the blending of philosophy, travelogue, and biological recording made for an uneven read. They concurred with Charles Curtis Munz who wrote in the *Nation* that "the reader will be enjoying the chase of *Tethys* the sea-hare when all of a sudden he will find himself becalmed in a soupy discussion of teleology. Most readers," Munz concludes, "will prefer *Tethys* the sea-hare."

Very few copies were printed of *Sea of Cortez* by Viking Press, Steinbeck's publisher, and the book was all but forgotten. That Pearl Harbor was attacked by the Japanese just two days after the book's publication certainly didn't help. So poorly did it sell that Ricketts's share of the revenues did not even provide him with enough money to repay Steinbeck for financing his share of the journey to the Gulf of California.

Within the California community of marine scientists, the feeling about both the Log and the catalogue of critters collected and catalogued was more positive. This was particularly true at Stanford University's Hopkins Marine Station in Pacific Grove, just down the street from Ricketts's lab at 740 Ocean View Avenue on Cannery Row and where Steinbeck had taken summer classes in marine science as a Stanford undergraduate. Rolf Bolin, a highly regarded ichthyologist at Hopkins, told me that *Sea of Cortez* "was a good book and [would be] a great aid to people going to the area." I received a similar response about the value of the Log when I talked with George and Nettie MacGinitie at their home in Friday Harbor, Washington. Both knew Ricketts's work well, even though they had relocated from Hopkins to the California Institute of Technology's Kerckhoff Marine Laboratory where George and then Nettie served as a director by the time the *Western Flyer* left Monterey for the Gulf of California.

I can recall a meeting in Corvallis at Oregon State with John Isaacs—whom former Scripps director Roger Revelle rightly identified as one "of the very small number of marine scientists who can be called true oceanographers in the sense that they are interested in everything about the ocean—the motions of the waters, the ways of life in the sea, the use of an ocean's resources, and the meaning of the oceans for human history and for mankind's future"—who said that *Sea of Cortez* was an important book, way ahead of its time in that it marked a dramatic departure from such older standards as Johnson and Snook's *Seashore Animals of the Pacific Coast* (1927), since Ricketts and Steinbeck examined the habitats as well as the habits of marine invertebrates. John Byrne, dean of oceanography at Oregon State University and chief administrator of the National Oceanic and Atmospheric Administration who came to *Sea of Cortez* somewhat later (he was a younger man than the others), also immediately recognized its importance; he wrote to me in May 2018 with fond memories of a conference Hedgpeth and I ran at Oregon State's marine station in Newport and in which he participated on "Steinbeck and the Sea."

But Rolf Bolin, the MacGinities, John Isaacs, and John Byrne were the exceptions—particularly on the East Coast at such marine facilities as the Shoals Marine Laboratory (Maine), Lewes (Delaware), and even Woods Hole Oceanographic Institute (Massachusetts), marine scientists who had heard of *Sea of Cortez* knew little about it. Mel Carricker, of the University of Delaware (Lewes) and former director of the systematics ecology program at the Marine Biology Laboratory at Woods Hole, and Dirk Frankenberg, director of the marine science program at the University of North Carolina, both of whom I met and talked with, said they knew of the book, but (it seemed to me) hadn't read it. And, quite frankly, I was rather amazed when, while running what was the first academic Steinbeck conference ever held which drew a combination of university and college folks and Steinbeck friends (including the aforementioned Peter Lisca), only Steinbeck's lifelong friend and attorney, Toby Street, who journeyed with Steinbeck and Ricketts on the *Western Flyer* as far as San Diego, recognized the book's importance. As for Ed Ricketts, he was far better known in 1970 as the enjoyable though sometimes irascible Doc of Steinbeck's *Cannery Row* and *Sweet Thursday* rather than as a serious scientist who helped revolutionize the way in which we view animals in their habitats. It was also clear to me from reading Steinbeck and Ricketts's letters to Pascal Covici, Steinbeck's longtime editor at Viking Press and an astute if measured reader of American fiction, that Covici didn't understand the importance of *Sea of Cortez* either as a book about marine ecology or as a guidepost to Steinbeck's fiction. The same seemed true of Elizabeth Otis, Steinbeck's agent who knew Steinbeck's work as well as anyone alive (probably including the novelist himself) and who was as staunch a defender of Steinbeck as anyone I have ever known. I spoke with her about *Sea of Cortez* on several occasions. She always seemed to glaze over.

All of this notwithstanding, and equipped with a greater understanding of the ecological focus of *Sea of Cortez*, I knew by the summer of 1970, just months after Earth Day when 20 million Americans took to the streets, parks, and auditoriums to demonstrate for a healthy, sustainable environment in massive coast-to-coast rallies, fighting against oil spills, polluting factories and power plants, raw sewage, toxic dumps, pesticides, the loss of wilderness, and the extinction of wildlife, that I was on to something—that the relationship between Ed Ricketts and John Steinbeck was far more complex and important than had previously been recognized, and that Steinbeck's work with Ricketts in the Gulf of California resulted in a book that could and should lead me and others to be able to accurately reassess the thematic design of Steinbeck's most important fiction. I had also become convinced that Ricketts was a genuine Renaissance man—a dedicated scientist to be sure, but also a man who worked hard to see and understand whole pictures. We see him in the Log put off by those scientists he calls "dry-balls"—specialists who examine life but miss its meaning. Ed Ricketts was at once a scientist and a philosopher, a man who, as Steinbeck writes in *Cannery Row*, was able to savor "the hot taste of life" by seeing life whole and thus understanding its sweetness and its sorrows, its uncertainty and its complexity.

When I began the process of seeking interviews with people in Salinas and on the Monterey Peninsula who knew Steinbeck and Ricketts, I found that I had a completely open field. Virtually no one had approached these folks, and most—indeed, nearly all—were eager to talk. My only potential competition was San Diego State's Jackson Benson who, like me, knew that Steinbeck's work had been undervalued and was himself in the earliest stages of researching what became the definitive biography of the novelist. Jack and I sought each other out and agreed to help one another as much as possible. We were careful not to double-team those who agreed to talk with us so as not to turn them off in any way. In some cases, this wasn't necessary. I remember a day during the summer of 1970 when we were both in the law offices of Hudson, Martin, Ferrante & Street (then Monterey's oldest and most prestigious law firm), where Jack was in one office pouring through Steinbeck's letters to Toby Street about their college days at Stanford, while I was down the hall looking through Toby's files about the chartering of the *Western Flyer*. Toby and I had a late dinner and talked long into the night; Jack did the same the next day. Over time, Jack became a good friend as well as a Steinbeck colleague. He arranged for me to give my first public lecture about Steinbeck on his campus, and we collaborated on two conferences and co-edited two books that were published by Oregon State University Press.

Talking with Toby, one thing became manifestly clear about Steinbeck and the Sea of Cortez expedition. Contrary to the general opinion of the day that he undertook and chiefly financed the trip to the Gulf of California as a means of avoiding the hostility he was encountering in some circles from the publication of *The Grapes of Wrath*, or that he sought escape from a failing marriage (not true since Carol was with him on the entire trip—though, interestingly, she is nowhere mentioned in the Log), Toby and some weeks later Tony Berry argued convincingly that Steinbeck was himself interested in collecting marine invertebrates and working with Ed to examine how they functioned in their various habitats. Both Toby and Herb Klein (the filmmaker Steinbeck worked with to bring the novel *The Forgotten Village* to the screen), who were on the *Western Flyer* as far as San Diego, told me that Steinbeck was intent about being able to validate some of his ideas about "group-man" and what would become known as his "phalanx" theory by examining life in the intertidal of the Gulf of California. Considering my conversations with Toby, Tony, and Herb, and then reading Steinbeck's notes and correspondence about the proposed and then abandoned San Francisco Bay project, it became very clear that Steinbeck was fully engaged. Indeed, as he and Ricketts were planning the Bay Area venture, he talked seriously about offering a narrative about it either to Stanford University Press (who had published Ricketts and Calvin's landmark volume *Between Pacific Tides* in 1939) or to his own publisher, Viking, whoever would pay the greatest royalties.

Steinbeck obviously learned a great deal about marine biology from Ricketts—given the incredibly close relationship between the two men and the work they did together, how could it have been otherwise? But I took and still take issue with Jack Calvin and Fred Strong (Ed's brother-in-law) who told me that Steinbeck "used" Ricketts and that, as Calvin insisted, the reason Steinbeck wrote nothing of value after Ricketts's untimely death in 1948 was because "the fountain had been turned off." After all, both *East of Eden* (1952) and *The Winter of Our Discontent* (1961), two of Steinbeck's greatest novels, were written after Ricketts's death.

I won't spend time here detailing Steinbeck's growing interest in marine biology before he met Ricketts or what he gleaned in large measure from his reading of William Emerson Ritter's theories of organismal biology and from materials he studied in marine biology courses he took at the Hopkins Marine Station in the mid-1920s. These are well documented by numerous Steinbeck scholars. But I must add that Steinbeck brought other new and fresh ideas to the Sea of Cortez expedition. He had become familiar with the work of such diverse thinkers as the French surgeon and anthropologist Robert Briffault (*The Mothers:*

A Study of the Origins of Sentiments and Institutions, 1927); South African soldier-philosopher Jan Christiaan Smuts (*Holism and Evolution*, 1926), whom Winston Churchill called a man "of a profound sagacity and a cool, far-reaching comprehension"; and Swedish-American philosopher and educator John Elof Boodin (*A Realistic Universe: An Introduction to Metaphysics*, 1916; *The Social Mind: Foundations of Social Philosophy*, 1939). Reading the works of these three men, Steinbeck discovered new and compelling ideas about human behavior that complemented his emerging view of organismal and group biology.

John Elof Boodin is little known today, but his efforts to submit metaphysics to the laws of science were in vogue during the 1930s, and it's clear from reading Steinbeck's notes and letters that he was very familiar with *The Social Mind*, published just months before *The Grapes of Wrath.* Steinbeck's longtime friend and confidant Richard Albee has confirmed that he "loaned [Steinbeck] some reprints of Boodin papers, and most importantly 'The Existence of Social Minds.' He also read my own class notes and heard me zealously expound my brand-new knowledge. He read Boodin's *Cosmic Evolution*, and I rather think he never returned it to me. He also read, later on with Ed Ricketts, Boodin's biggest tome, *A Realistic Universe.*" From Briffault, Smuts, and Boodin, Steinbeck worked to re-examine and then clarify his already developed ideas about human nature, about organismal biology, and about group behaviors that appear in his most important fiction—ideas that he wanted to test with Ed Ricketts in the tide pools of the Gulf of California.

Much has been written about the celebratory departure of the *Western Flyer* from Monterey that carried Tony Berry and his crew, John and Carol Steinbeck, Ed Ricketts, Herb Klein, and Toby Street down the California coast to San Diego (where Klein and Street disembarked) and then south to the tip of Baja, north up the west coast of the Gulf to Loreto, across to Guaymas and then back to Monterey—a trip that, for Steinbeck, was a good clearing up and out of so many thoughts and ideas, sometimes competing ones. In the Log, he and Ricketts write that their trip resembled that of Darwin on the *Beagle* (though they lament that they had but 6 weeks to accomplish what took Darwin upwards of 5 years). They write that they, like Darwin, needed time "to think, and to look and to consider" and that "out of long, long consideration of the parts," they could "emerge with a sense of the whole" and so conclude that "species are only commas in a sentence, that each species is at once the point and the base of a pyramid, that all life is relational to the point where an Einsteinian relativity seems to emerge….and that man is related to the whole thing, related inextricably to all reality, known and unknowable."

A plethora of people—Steinbeck scholars, marine biologists, friends of Steinbeck and Ricketts, and the occasional layperson—have written about the journey of the *Western Flyer*. There's no need to repeat what's been said so well by so many. But what has not been reported are the comments and reactions of people with whom Steinbeck, Ricketts, and the crew of the *Flyer* met during their trip. So, for example, I recall talking with the manager of a cannery in San José del Cabo who, 30 years after meeting and talking with Steinbeck and Ricketts, remembered the seriousness with which they undertook their work—that yes, there was more than a little consumption of beer, but there was a great deal of time spent observing the tide pools near what is now Cabo San Lucas collecting, identifying, and preserving specimens. More startling was when I met with Gilberto Valdivia and Manuel Madinabeita—two of the three Mexicans who organized the borrego adventure in the mountains and valleys west of the *Flyer*'s Puerto Escondido anchorage. Both men told me that they were struck by how Steinbeck and Ricketts were entranced by the natural beauty of the landscape; they remembered just about everything either man said during their time together, and Madinabeita had tears in his eyes when I read him the paragraph from the Log where Steinbeck and Ricketts talk about an oasis they encountered at the base of a waterfall—"fresh and cool, green; the shadow of a rock in a weary land. Or rather in a fantastic land since the plains and hills over which we came were rich with xerophytic plants, cacti, mimosa, brush and small trees with thorns." Both Valdivia and Madinabeita knew that there was some sort of book about the Steinbeck-Ricketts expedition to the Gulf, but neither man had ever seen it and I have an enduring memory of them walking away, book in hand, smiling to one another.

The *Western Flyer* arrived back in San Diego on April 17, 1940. Everyone was glad to be home, but there were feelings of nostalgia about a trip that had been so very special and during which they had accomplished a great deal—and this in a time of some angst, when Steinbeck and Carol had concluded that their marriage was at an end, Tony Berry and his crew knew they would have to retrofit the *Flyer* so as to return to their work as sardine fishermen, and Ricketts, whose home/lab he would now share with Toni Jackson and her daughter, Kay, would have to begin the arduous task of sending the specimens they had collected to experts all over the world for identification and cataloguing. Little wonder then, that on the last page of the Log, we read that "the real picture of how it had been there and how we had been there was in our minds, bright with sun and wet with sea water and blue or burned, and the whole crusted over with exploring thought."

It was "exploring thought" that would occupy Steinbeck and Ricketts for the next year as they worked on the Narrative and the Phyletic Catalogue, and as they tried to convince Pascal Covici that theirs was a true collaboration between a scientist and a novelist that would be an important contribution to science and human thought. Toni Jackson typed the entire manuscript and provided editorial assistance to the project once she fully understood that Steinbeck and Ricketts wanted the Log to include all sorts of ideas and remembrances, and even Ricketts's "Easter Sunday Sermon" on non-teleological thinking that brings together so many of the disparate strands in their thinking. There were moments of doubt. In her essay in this collection, Katharine Rodger tells us that while Steinbeck was working to "build" the Log, he wrote, "I'm trying only to tell you the direction my poor puzzled mind has been taking. I have found so little that is satisfying in the thinking of the non scientific men of the present.... The invertebrate book is not done yet. It is a long hard job but I think a good one."

Yes, it is a good one—a very good one. We can read the Log for its own sake as a first-rate piece of travel literature. But it is more, much more. It is a guidebook to the range and depth of the influence of Ricketts's thinking on Steinbeck's best fiction, for in it we see Steinbeck fusing science and philosophy, art and ethics, as he blends the compelling if sometimes abstract metaphysics of Ed Ricketts with his own ideas about the human condition—ideas that underpin the narratives of such Steinbeck masterpieces as *Of Mice and Men* (1937) and *The Grapes of Wrath*. And, as those marine scientists closest to the project knew from the beginning, it is an important exploration into animal ecology—a sometimes irreverent but always compelling analysis of interactions among organisms and their environments, a study of the complex interactions that organisms have with each other and with abiotic components of their habitats, and all of this a full three decades before ecology became a national pastime. Ricketts and Steinbeck looked deeply at the fauna of the Gulf and then concluded what the renowned British biologist Charles Elton wrote in his pioneering study of the natural world, *Animal Ecology and Evolution* (1930), that "the balance of nature does not exist and perhaps never has existed" and that "in periods of stress it is a common thing for animals to change their habitats and usually this change involves migration…. We are face to face with a process which may be called the selection of the environment by the animal, as opposed to the natural selection of the animal by the environment." It is an understanding of this fundamental truth that informs *Sea of Cortez*. It is the centerpiece of all of the work Ed Ricketts did in his lab and in the tide pools. It is the core of the thematic design of Steinbeck's best fiction.

Nearly a decade after *Sea of Cortez* appeared with little fanfare and even poorer sales, Ricketts's mentor at the University of Chicago, Warder Clyde Allee, and his colleagues published a scientific magnum opus, *Principles of Animal Ecology* (1949), about which the aforementioned Charles Elton wrote: "Francis Bacon wrote that 'Some Books are to be Tasted, Others to be Swallowed, and Some Few to be Chewed and Digested.' This book belongs to the last class. It is by far the most important general treatise on the subject that has ever been published, and one which should….be in every ecologist's library (whether he be a botanist, zoologist, or general naturalist). To any serious working ecologist, and above all to the teacher on the subject, it is above price." I would argue that *Sea of Cortez* is also "above price"—it's just a pity that neither Ed nor John could enjoy such recognition for their labor of love during their own lifetimes.

But in the world of literature, that's not at all unusual. Consider *Moby-Dick* (1851). Herman Melville's most famous work has been studied at length by literary scholars for more than 150 years. Many regard it as the best novel ever written by an American. While Melville was alive, however, it was hardly a best seller. The *Charleston Southern Quarterly Review* wrote the following on the subject of *Moby-Dick* and its author:

> Mr. Melville's Quakers are the wretchedest dolts and drivellers, and his Mad Captain….is a monstrous bore…. His ravings, and the ravings of some of the tributary characters, and the ravings of Mr. Melville himself, meant for eloquent declamation, are such as would justify a writ de lunatico against all the parties.

Or consider Steinbeck's contemporary, William Faulkner. In what is now regarded as Faulkner's greatest novel because it broke all kinds of new stylistic and social ground as it documented the fall of a prominent southern family, *The Sound and the Fury* (1929) was met with very mixed reviews, many of them decidedly negative, including one by a critic who wrote, "The deliberate obscurity of the opening pages repels rather than invites."

Upon its initial publication, F. Scott Fitzgerald's *The Great Gatsby* (1925) was called by one critic "a bewildering and tawdry performance." The *Saturday Review* suggested that the author "deserves a good shaking.... *The Great Gatsby* is an absurd story, whether considered as romance, melodrama, or plain record of New York high life."

Happily, though, because of the fine scholarship that has been done on these three magnificent books, we can enjoy them in perpetuity. And I believe that the same thing is and will continue to be true of *Sea of Cortez*. At the time though, as I pointed out earlier, critics who applauded *The Grapes of Wrath* as one of the greatest pieces of social criticism in the 20th century were at a complete loss trying to understand why the novelist would waste his time on a book about marine invertebrates. But that's all changed now, nearly 80 years later. Tony Berry and the crew of the *Western Flyer* are gone. So are Toby Street and Herb Klein. So, I'm guessing, are the two Mexican gentlemen I spoke with who took Steinbeck and Ricketts on their borrego adventure into the mountains behind Puerto Escondido. So are Toni Jackson, Ellwood Graham, Ed Ricketts Jr., and Joel Hedgpeth. But their reminiscences, some of them leading us to an understanding of the importance of that journey and the book that was its result, remain. I'd like to believe that my book (*John Steinbeck and Edward F. Ricketts: The Shaping of a Novelist*, 1973) galvanized new interest in *Sea of Cortez*, that the incontrovertible evidence I found to show that the Log was the product of the work and the thinking of Ricketts as well as Steinbeck resulted in our seeing Ricketts as much more than an idiosyncratic biologist who fooled around in the tide pools and drank beer milkshakes. Indeed, what we've seen since the mid-1970s has been an explosion of interest in *Sea of Cortez*—both the Log and the Phyletic Catalogue, as well as the journey to the Gulf of California itself. Consider just the following list:

Jackson Benson's magnificent biography, *The True Adventures of John Steinbeck, Writer* (1984), in which Benson firmly anchors *Sea of Cortez* and the Gulf of California expedition as an important cornerstone in Steinbeck's life as a writer.

Joel Hedgpeth's important two-volume collection of Ed Ricketts's essays, published by the little-known (and now defunct) Mad River Press and titled simply *The Outer Shores* (1978), the first publication of any large collection of Ricketts's papers.

Katharine A. Rodger's *Renaissance Man of Cannery Row: The Life and Letters of Edward F. Ricketts* (2002) and *Breaking Through: Essays, Journals, and Travelogues of Edward F. Ricketts* (2006), which, taken together, enable us to more fully understand Ricketts's genius as well as the impact his understanding of art and science had on Steinbeck.

Eric Enno Tamm's *Beyond the Outer Shores: The Untold Odyssey of Ed Ricketts, the Pioneering Ecologist Who Inspired John Steinbeck and Joseph Campbell* (2004), which tells us about the work that Ricketts (along with Toni Jackson) did off the west coast of Vancouver Island in the mid-1940s.

So many of the books and articles by Susan Shillinglaw, arguably the finest Steinbeck scholar of the current generation. She has been instrumental in helping both scholars and laypeople understand the importance of *Sea of Cortez* as a sort of guidebook to the literary, philosophical, and scientific achievements of both Steinbeck and Ricketts.

Donald Kohrs's important work on Ricketts's papers—those at both Stanford's main campus and the Hopkins Marine Station—shows us how his landmark study of marine invertebrates on the central Pacific Coast (*Between Pacific Tides*) was a harbinger of things to come in the Gulf of California.

The work that Cannery Row historian Michael Hemp has done for more than three decades to help promote Ricketts's lab and Cannery Row, and to showcase the contributions that Ricketts made not just to science but to life on the Monterey Peninsula in general. In his 2002 book (*Cannery Row: The History of John Steinbeck's Old Ocean View Avenue*), in the several Cannery Row Festivals he's run over the years, and in working with the lab's owners to provide access to interested Monterey visitors, Hemp's work has been invaluable.

Rick Brusca's lifetime of work, beginning with his 1973 study of the marine invertebrates of the Sea of Cortez (*A Handbook to the Common Intertidal Invertebrates of the Gulf of California*), to the 2011 field trip he led to the Gulf of California that resulted in David Wagner's *The Sea of Cortez* exhibition at the Arizona-Sonora Desert Museum Art Institute (2013), and most recently to his position on the board of the Western Flyer Foundation. (In this volume, see Brusca; Brusca and Haskin.)

> Kevin Bailey's *The Western Flyer: Steinbeck's Boat, the Sea of Cortez, and the Saga of Pacific Fisheries* (2015), a book its publisher calls "environmental history at its best: a journey through time and across the sea, charting the ebb and flow of the cobalt waters of the Pacific coast."

Speaking of the *Western Flyer*, we turn finally to the latest chapter of the Steinbeck-Ricketts phenomenon. And no, I don't mean the R/V *Western Flyer* 117-foot small waterplane-area twin hull (SWATH) boat designed and constructed for the Monterey Bay Aquarium Research Institute (MBARI) whose catamaran-like design includes the *Doc Ricketts* remotely operated vessel (ROV), which drops into the ocean through the boat's bottom, creates an exceptionally stable platform for ocean research, and was named to honor the Steinbeck-Ricketts expedition. I'm talking about Tony Berry's purse seiner that took Steinbeck and Ricketts to the Gulf of California.

We can read and ponder what life was like aboard Melville's *Pequod*, the Nantucket whaling ship commanded by Captain Ahab. But we cannot board her. In contrast, the Steinbeck/Ricketts *Western Flyer* is being fully restored and will be made available as a research vessel and a learning tool for schoolchildren up and down the West Coast of North America. John Gregg, a geotechnical marine engineer who brings a deep personal interest to the project, is working with Port Townsend, Washington, shipwright Chris Chase and a group of dedicated ocean specialists, naturalists, and educators in this very special endeavor to bring the *Western Flyer* back to Monterey Bay (see Gregg, this volume). As articulated by the Western Flyer Foundation, the goal of the *Western Flyer* of the 21st century will be "to stir curiosity by providing rich and remarkable education, research, and creative opportunities aboard a historic vessel famous for carrying one of America's greatest authors on an extraordinary voyage of discovery."

"I don't really want to see her doing sunset cruises," John Gregg said when asked whether the *Flyer* will be available to tourists. "I think its mission should be more scientific and educational. I see a bunch of kids on her." As the founder and president of the Western Flyer Foundation, I have no doubt that Gregg, working with Chris Chase and their colleagues, will make it all happen. I take the statement by the *Flyer*'s Foundation Board as truth when they write: "Perhaps it is Steinbeck's 'sea-memory' that proponents of the *Western Flyer* look for in their own dreams. The mind has grown boat-shaped. They want for the sun on their faces, the rhythm of the swell, and a stiff ocean breeze to hear the *Flyer* hum its deep note to the wind once again."

I have always tried not to second-guess the important decisions about the professional pathways I've chosen in life. I have never questioned my decision to enter and remain in academia. But I must confess that I have wondered at times if I should have done so as a teacher of literature. I chose the study of literature because I agreed with William J. Long who wrote over a century ago, "It is a curious and prevalent opinion that literature, like all art, is a mere play of imagination, pleasing enough, like a new novel, but without any serious or practical importance. Nothing could be farther from the truth. Literature preserves the ideals of a people; and ideals—love, faith, duty, friendship, freedom, reverence—are the part of human life most worthy of preservation." Long offers a compelling argument but one that is in large measure an abstraction. Over time, as I dug deeper into my study of *Sea of Cortez* and talked with those who captained, crewed, and knew about that wonderful sardine boat that took them there, I found answers.

What I have always tried to do for my students is to make good books live and breathe. To open doors for all who care to enter and to help students see how the best of our writers enable us to see and understand ourselves and the world in which we live more clearly, and with a greater understanding of the sometimes troubling but always hopeful state of our humanity. *Sea of Cortez* is arguably the best teaching tool I've ever used. In my classes, with students from all sorts of disparate disciplines, I use it to show the interrelatedness of science and literature, of all things—that life itself is a series of connections and literature helps us understand and appreciate those connections so very clearly.

As Steinbeck and Ricketts conclude their Log, they tell us that "here was no service to science, no naming of unknown animals, but rather—we simply liked it. We liked it very much. The brown Indians and the gardens of the sea, and the beer and the work, and they were all one thing and we were that one thing too." <

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