LESSON 3

LIFE AT THE EDGE OF A FERTILE SEA

The Birthplace of Marine Science

1 Where people meet the sea
2 A fish spawning on the beach
3 Why animals are well adapted
4 Challenges of a rocky seashore
5 Beginnings of a marine biological station
6 Life in sand and mud: a secret existence
7 Life in the kelp forest

Fig. 3.01. Life is about food and reproduction. Gull chick begging for food, La Jolla Cove.

Exploration of the sea starts at the shore, whether for food or for science.

Sea birds are in evidence along practically all coasts and invite much observation and marveling about different life histories of these feathered vertebrates. Some breed locally and raise their young in full view (Fig. 3.01). Others stop over on long migrations, using marine wetlands to rest and to feed (Fig. 3.02). But beyond the many types of birds that enliven the scenery, an incredible diversity of creatures can be found along almost any rocky, sandy or muddy shore. Anthozoans, arthropods, mollusks, vertebrates and polychaete worms tend to be conspicuous, as well as echinoderms. Of course, the species differ from one place to another, depending on geography. One would not expect to find the very same organisms on the shores of Alaska and of Hawaii. However, the similarities are in many ways more striking than the differences. Thus, the exploration of shore life in any one region opens the door to the understanding of life in many such regions, even the shores of another ocean basin.

Fig. 3.02. American Avocet on migration. San Elijo Lagoon at high tide, N San Diego County.

The environmental challenges for nearshore organisms depend on the nature of the seasons, with the major contrast between subpolar regions

and the tropics, as well as on the nature of the shore itself; that is, whether it is flat and muddy, or rugged and rocky. Geology determines that nature: the flat coastal landscape is typical for general sinking, the rugged one for general uplift. Sinking shores have drowned river mouths and large estuaries. Rising shores have narrow beaches and cliffs and terraces, and small lagoons at the end of cliff-bounded river valleys.

As a pattern of exploration, the study of coastal ecology has proceeded from taking stock of what is there, to marveling about adaptations of the different species, to studying interactions between species, and finally to assessing the impact of human activities. Humans are now a dominant factor in determining the nature of life along the shores of the world. Such activities include intense fishing, introduction of nutrients and mud, and disturbance of habitat by the sheer numbers of people finding recreation along the edge of the sea. To preserve some of the rich heritage of the seashore, marine reserves have been set up, where fishing is not allowed or is strictly regulated. Questions about how large and restricted such reserves must be to be effective in regard to conservation goals are at the center of modern ecological studies along the edge of the sea.

Images

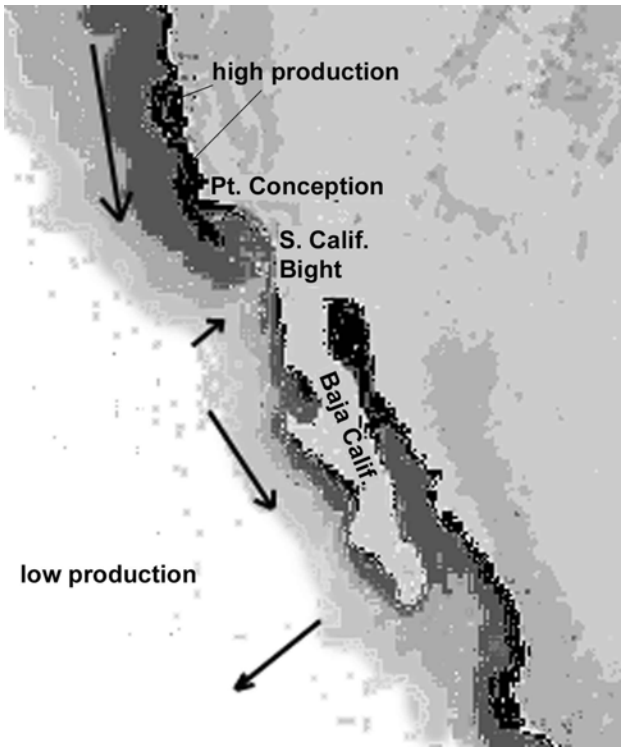

Fig. 3.03. Chlorophyll patterns off California and in the Gulf of California. Dark regions denote green waters where production is high. Arrows show general sense of current flow.

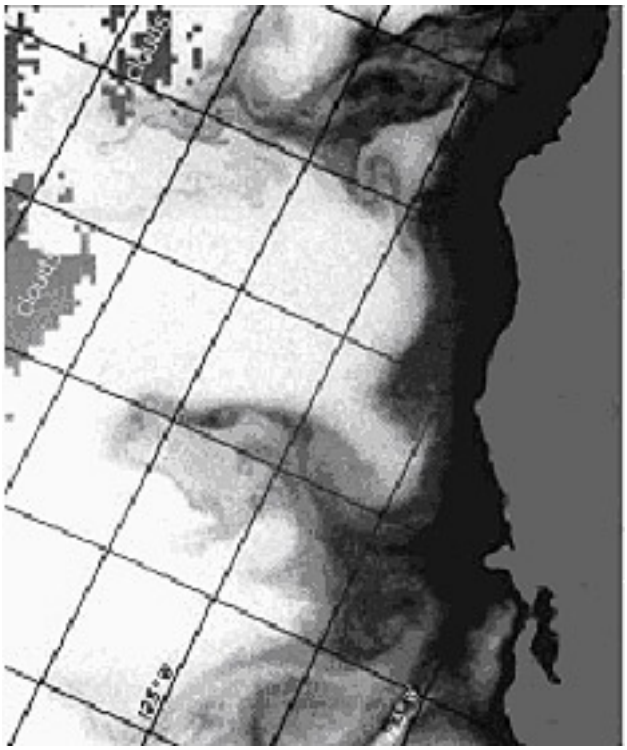

Fig. 3.04. Mixing in coastal waters: eddies and filaments in the coastal waters off California, seen in thermal infrared from space (dark is cold and denotes rising water along the coast).

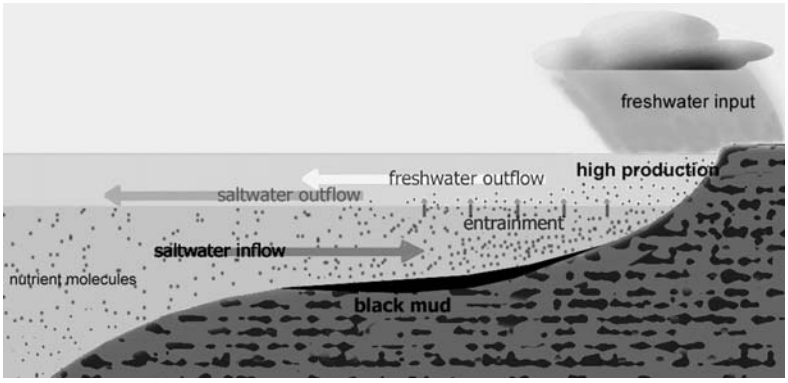

Fig. 3.05. In estuarine circulation, the entrainment of saltwater into the outward flowing surface layer brings deeper water rich in nutrients inshore. Nutrients are trapped in the inner end of the estuary.

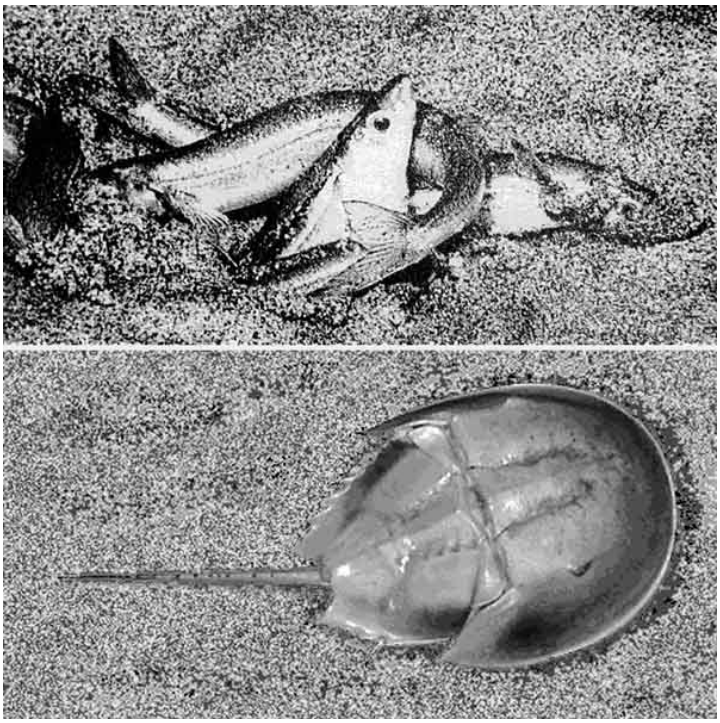

Fig. 3.06. Spawning on the beach. Upper: grunion (La Jolla); lower: horseshoe crab (Woods Hole).

Fig. 3.07. Beach and cliffs north of La Jolla, a favorite site for studying the rocky intertidal and other shore life.

Fig. 3.08. The small acorn barnacle *Chthamalus fissus* grows in the spray zone (note the closed doors) and also settles on mussels and limpets, below this zone.

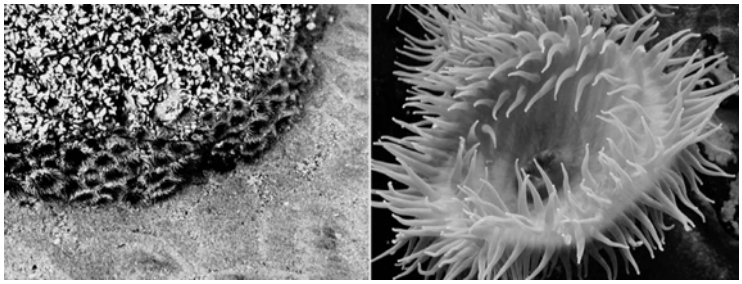

Fig. 3.09. Two kinds of sea anemones: colonial and solitary.

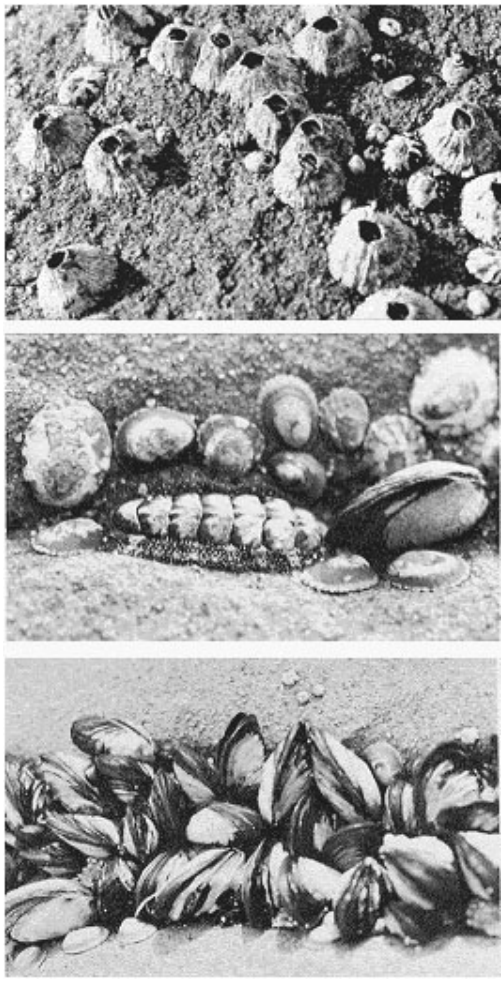

Fig. 3.10. Clinging to the rocks: acorn barnacles (cement), limpets and chiton (suction foot), mussels (glue strings).

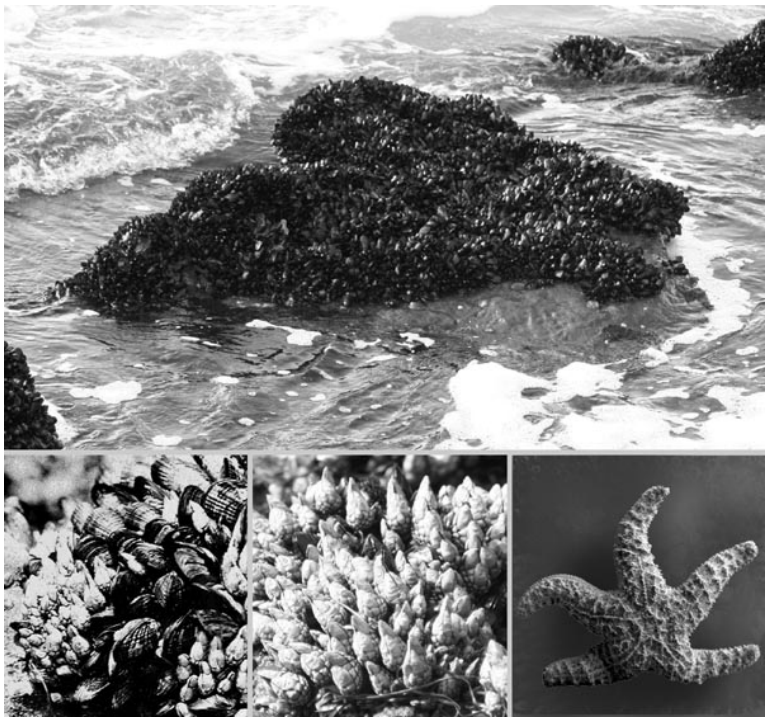

Fig. 3.11. The mussel-bed assemblage of the Californian rocky shores: California mussel and gooseneck barnacles. The sea star *Pisaster* preys on the mussels.

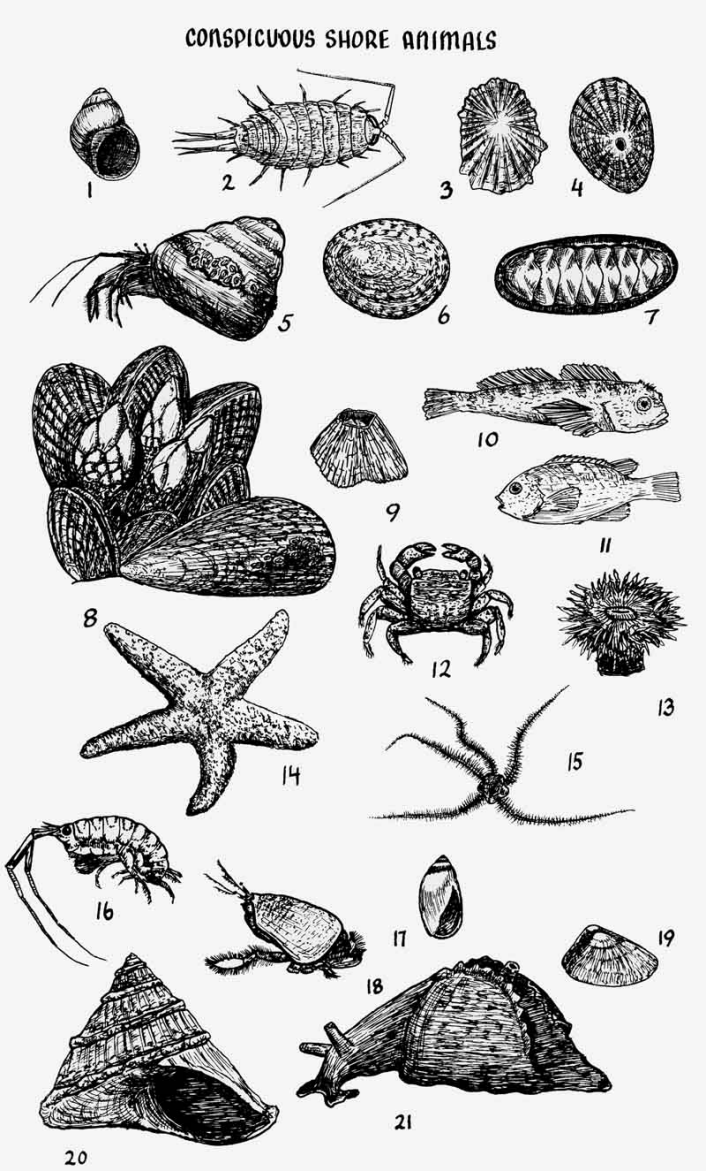

Fig. 3.12. An amateur's guide to the animals of the sea shore near Scripps illustrates the diversity of marine life in the vicinity of the institution

Fig. 3.13. Mollusk morphology as art, at the beginnings of marine biology. (E. Haeckel)

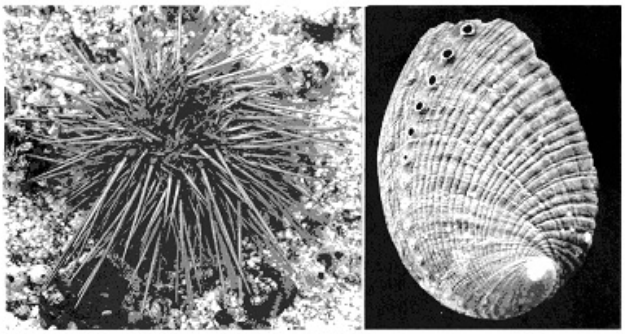

Fig. 3.14. Examples of illustrations in the guidebook by Edward Ricketts and Jack Calvin: giant red sea urchin and green abalone. Jack Calvin was the photographer.

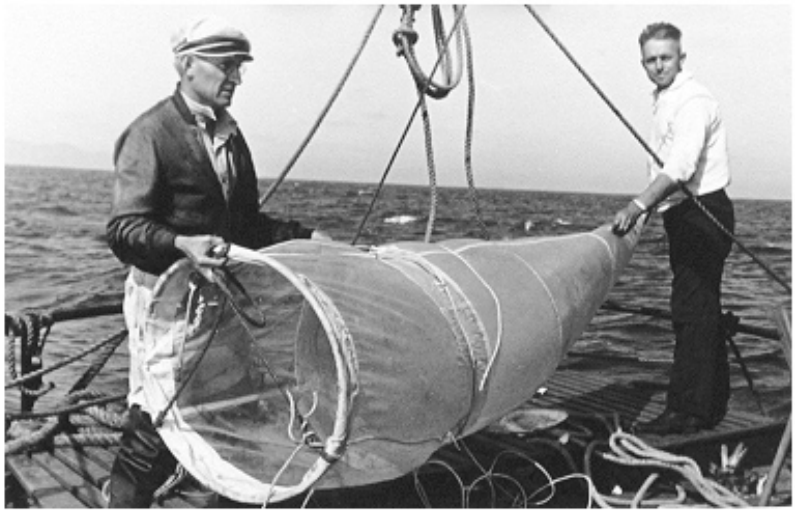

Fig. 3.15. Martin Johnson (left) and assistant, getting ready to put the plankton net into offshore waters to obtain samples of meroplankton and other zooplankton. (1950s)

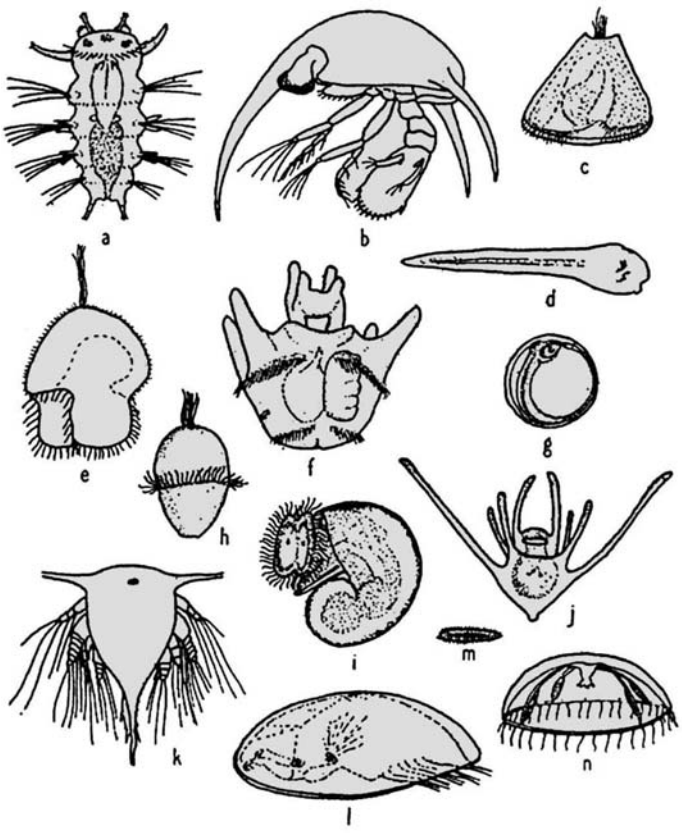

Fig. 3.16. Larvae of the meroplankton. a, annelid; b, sand crab; c, bryozoan; d, tunicate; e, nemertean worm; f, sea urchin; g, fish egg; h, scale worm; i, snail; j, brittle star; k and l, barnacle; m, cnidarian; n, medusa of hydroid. (As given by M. Johnson.)

Fig. 3.18. Solutions to the problem of combining hiding and feeding in a mud flat.

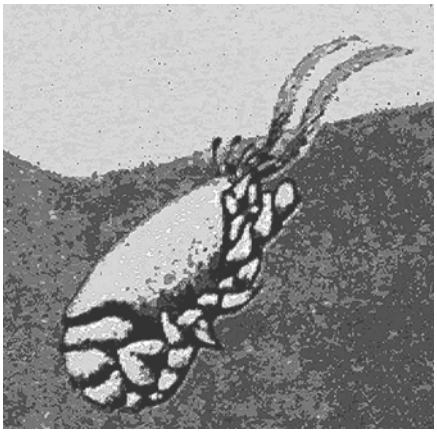

Fig. 3.17. Sand crab (*Emerita*) buried, with antennae out for

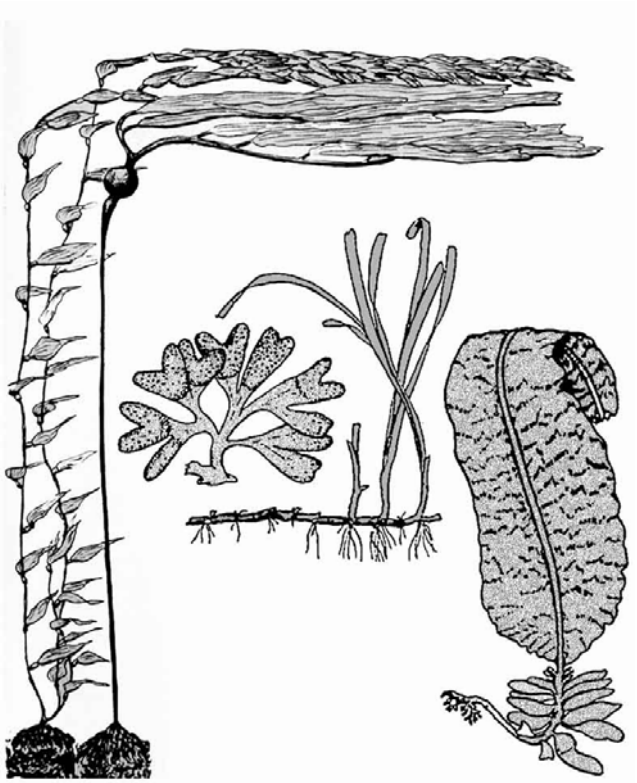

Fig. 3.19. Plants of the kelp forest and rocky surf zone: giant kelp, elkhorn kelp, the marine algae *Fucus* and *Alaria*, and the sea grass *Zostera.* Not to scale.

Fig. 3.20. Looking for food along the shore.

Figure sources (where based on sources in the literature, on the web or in museum exhibits: figures are considerably modified and adapted for present purposes, using Adobe Photoshop; drawings and photographs by the author are marked “orig.”): 1, orig.; 2, orig.; 3, MODIS Ocean Team NASA; 4, SeaWIFS NASA; R.H. Stewart, NASA; 5, orig.; 6, Korringa 1957 and orig.; 7, orig.; 8, orig.; 9, orig.; 10, orig.; 11, orig.; 12, W. Berger 1976; 13, E. Haeckel (see Ch. 1 for reference); 14, Calvin 1939; 15, SIO archives; 16, Sverdrup et al. 1942 (see Ch. 2 for reference); 17, NOAA; 18, Nat. Hist. Museum Hannover (orig.); 19. Sverdrup et al. 1942, and W. Berger 1976; 20, orig.
References: NASA, U.S. National Aeronautics and Space Administration; R. H. Stewart, 1985. *Methods of satellite oceanography.* Scripps Studies in Earth and Ocean Sciences. University of California Press, Berkeley, 360pp.; P. Korringa in J.W. Hedgpeth (ed.) *Treatise on Marine Ecology and Paleoecology,* vol. 1, The Geological Society of America (Memoir 67), New York, 1957. The photo (taken by J. Brauner) was supplied to P. Korringa by Boyd W. Walker; W. H. Berger, 1976, *Walk Along the Ocean.* Solana Beach, California, 69pp.; J. Calvin in E. F. Ricketts and J. Calvin, 1939, *Between Pacific Tides*. Stanford U. Press, Stanford.