

The Fisheries for Mangrove Cockles, *Anadara* spp., from Mexico to Peru, With Descriptions of Their Habitats and Biology, the Fishermen's Lives, and the Effects of Shrimp Farming

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Introduction

Mangrove cockles (also called ark shells) of the genus *Anadara* are harvested for food by large numbers of artisanal fishermen in the Pacific coast lagoons of 10 countries from Mexico through Central America to Peru. The extent of their range is about 6,350 km (4,000 miles) (Fig. 1). The cockles are

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by far the most important commercial mollusks along this coastline, which encompasses a biogeographic zone that Briggs (1974) defined as the Tropical East Pacific Region. Cockles occur among or near mangrove trees, mainly the red mangrove, *Rhizophora mangle*.

Three species are harvested, all by hand. In order of abundance, they are *A. tuberculosa*, *A. similis*, and *A. grandis*. This fishery heretofore has not been described in the international literature except in Nicaragua (MacKenzie and Lopez, 1997) and Colombia (Squires et al., 1975). Studies have been made

of the cockles' reproduction in Costa Rica (Cruz, 1984a, b, 1987a, b; Ampie and Cruz, 1989), population densities in Mexico (Baquero, 1980), and associated macrofauna in Colombia (Squires et al., 1975; Blanco and Cantera, 1999).

This paper reviews the literature on mangrove cockle fisheries in Nicaragua and Colombia and the ecology and biology of the cockles, and it presents the results of my recent surveys of the cockle fisheries and my biological notes in the remaining cockle-producing countries: Mexico, Guatemala, El Salvador, Honduras, Costa Rica, Panama, Ecuador, and

ABSTRACT—This paper provides the first description of the mangrove cockle, *Anadara* spp., fisheries throughout their Latin American range along the Pacific coast from Mexico to Peru. Two species, *A. tuberculosa* and *A. grandis*, are found over the entire range, while *A. similis* occurs from El Salvador to Peru. *Anadara tuberculosa* is by far the most abundant, while *A. grandis* has declined in abundance during recent decades. *Anadara tuberculosa* and *A. similis* occur in level mud sediments in mangrove swamps, comprised mostly of *Rhizophora mangle*, which line the mainlands and islands of lagoons, whereas *A. grandis* inhabits intertidal mud flats along the edges of the same mangrove swamps. All harvested cockles are sexually mature. Gametogenesis of the three species occurs year round, and juvenile cockles grow rapidly. Cockle densities at sizes at least 16–42 mm long ranged from 7 to 24/m² in Mexico. Macrofaunal associates of cockles include crustaceans, gastropods, and finfishes. The mangrove swamps are in nearly pristine condition in every country except Honduras, Ecuador, and Peru, where shrimp farms constructed in the 1980's and 1990's have destroyed some mangrove zones. In addition, Hurricane Mitch destroyed some Honduran mangrove swamps in 1998.

About 15,000 fishermen, including men, women, and children, harvest the cockles. Ecuador has the largest tabulated number of fishermen, 5,055, while Peru has the fewest, 75. Colombia has a large number, perhaps exceeding that in Ecuador, but a detailed census of them has never been made. The fishermen are poor and live a meager existence; they do not earn sufficient money to purchase adequate food to allow their full health and growth potential. They travel almost daily from their villages to the harvesting areas in wooden canoes and fiberglass boats at low tide when they can walk into the mangrove swamps to harvest cockles for about 4 h. Harvest rates, which vary among countries owing to differences in cockle abundances, range from about 50 cockles/fisherman/day in El Salvador and Honduras to 500–1,000/fisherman/day in Mexico. The fishermen return to their villages and sell the cockles to dealers, who sell them mainly whole to market outlets within their countries, but there is some exporting to adjacent countries. An important food in most countries, the cockles are eaten in sevice, raw on the half-shell, and cooked with rice.

The cockles are under heavy harvesting pressure, except in Mexico, but stocks are not yet being depleted because they

are harvested at sizes which have already spawned. Also some spawning stocks lie within dense mangrove stands which the fishermen cannot reach. Consumers fortunately desire the largest cockles, spurning the smallest.

Cockles are important to the people, and efforts to reduce the harvests to prevent overfishing would lead to severe economic suffering in the fishing communities. Programs to conserve and improve cockle habitats may be the most judicious actions to take. Preserving the mangrove swamps intact, increasing their sizes where possible, and controlling cockle predators would lead to an increase in cockle abundance and harvests. Fishes that prey on juvenile cockles might be seined along the edges of swamps before the tide rises and they swim into the swamps to feed. Transplanting mangrove seedlings to suitable areas might increase the size of those habitats. The numbers of fishermen may increase in the future, because most adults now have several children. If new fishermen are tempted to harvest small, immature cockles and stocks are not increased, minimum size rules for harvestable cockles could be implemented and enforced to ensure adequate spawning.

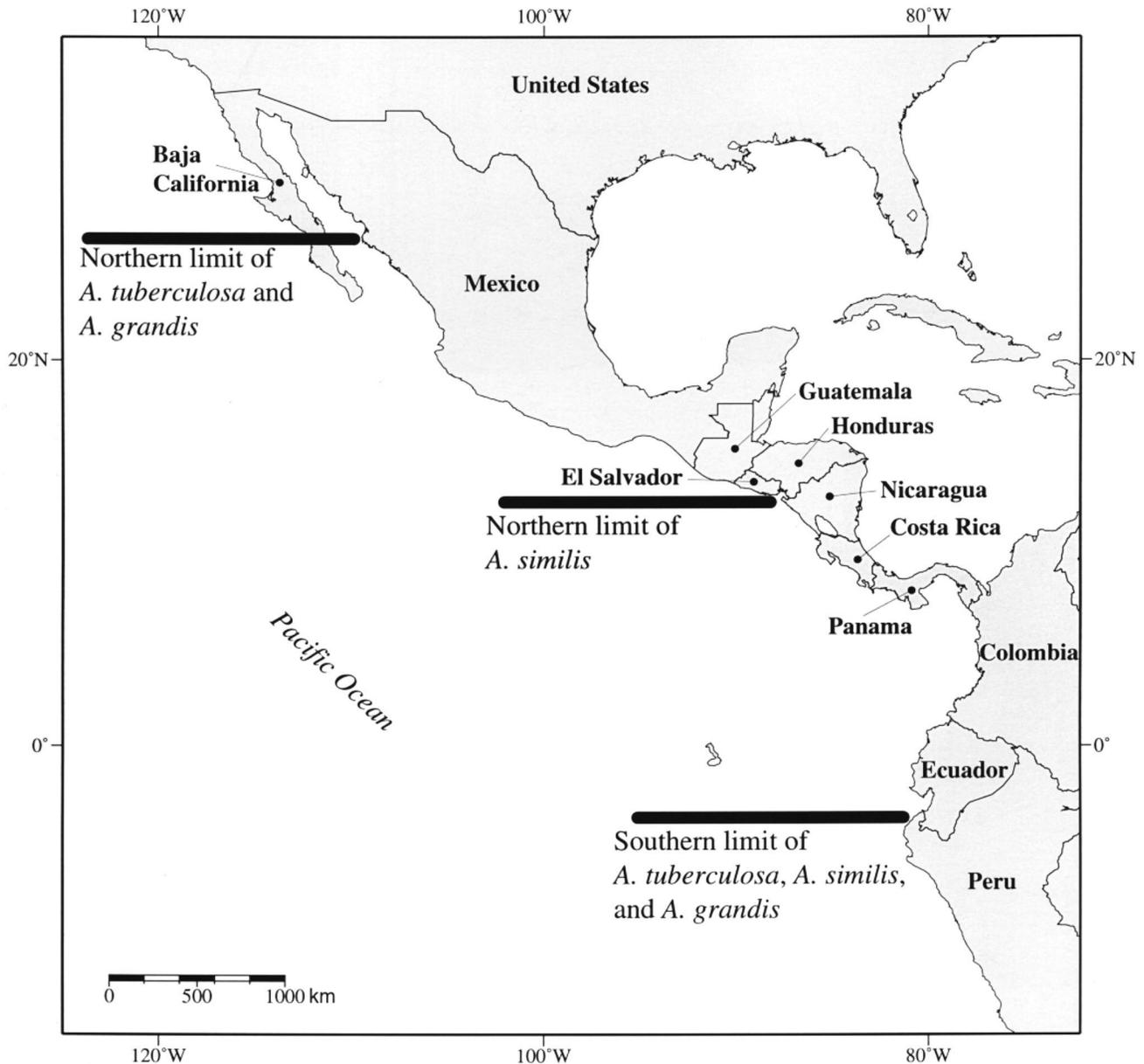


Figure 1.—Ranges of the cockles *Anadara tuberculosa*, *Anadara similis*, and *Anadara grandis*, and the countries in which they are harvested; the cockles are not harvested in the United States.

Peru. Included are the following sections: 1) the ranges, morphology, habitat, and biology of the cockles, 2) the fishermen's lives in the villages, 3) overall conduct of the fisheries, 4) data and observations in individual countries, and 5) effects of shrimp farming in Ecuador on the mangrove habitat and fishery. Suggestions follow for research and management.

The fishermen's lives are little known and largely ignored by government of-

ficials and other citizens in the Latin American countries themselves. A lengthy description of them is included so government managers can accurately predict the consequences to the fishing communities of any proposed changes in policies regarding the cockle and the mangrove resources. Such descriptions have rarely been documented in historical or current accounts of the world's fisheries (Hobart¹). This description

may also provide useful information for humanitarian groups concerned with the welfare of Latin American people.

Methods

In 1998, 1999, 2000, and 2001, I made 10 trips to Latin American coun-

¹ Hobart, Willis L., Chief, Scientific Publications Office, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., Seattle, WA 98115. Personal commun.

tries to visit all the principal mangrove cockle harvesting regions, spending 1–4 weeks in each country. I traveled with a local guide and interpreter by automobile or pickup truck from village to village interviewing fishermen, dealers, and local residents to obtain a census of the number of fishermen, and to learn about the equipment and methods used, working hours, sizes of harvests, prices, marketing, and local ways the cockles are prepared as food. I also visited some mangrove swamps to observe fishermen harvesting cockles and some markets to observe selling practices. In addition, I photographed typical scenes. In April, June, and September of 2000, and in January of 2001, while visiting villages in Honduras and El Salvador, I also asked fishermen about the condition of their lives. According to the villagers in every country, this was the first such survey made of the cockle fisheries or what their lives are like. For this paper, the monetary units used in each country have been converted to U.S. dollars. The Appendix provides additional details regarding my survey methods.

Cockle Ranges and Descriptions

Anadara tuberculosa

The geographic range of *A. tuberculosa* is from Laguna Ballena, Baja California Sur, Mexico, to Bahía de Tumbes, Peru (Mora Sanchez, 1990; Cruz and Jimenez, 1994). This species has two valves of equal shape, and they are obliquely oval (Fig. 2, 3). Each valve has 34–37 radial ribs and a dark brown periostracum with bristles between the ribs. The dorsal margin of the valves is angular. No sexual dimorphism is present in the length-weight ratio. In Costa Rica, the percentage of dry meat in *A. tuberculosa* in its length range of 42–47.5 mm is 20%; within its length range of 54–59.5 mm (when the shell was thicker), it is 16%; and for all sizes it averages 18% (Cruz and Palacios, 1983). Squires et al. (1975) said wet meat weights of *A. tuberculosa* in Colombia are 36% of total weight at small sizes (36–42 mm) and slightly more than 15% at large sizes. The blood of *A. tuberculosa* is black.

I measured the lengths of harvested *A. tuberculosa* in 7 countries (Fig. 4).

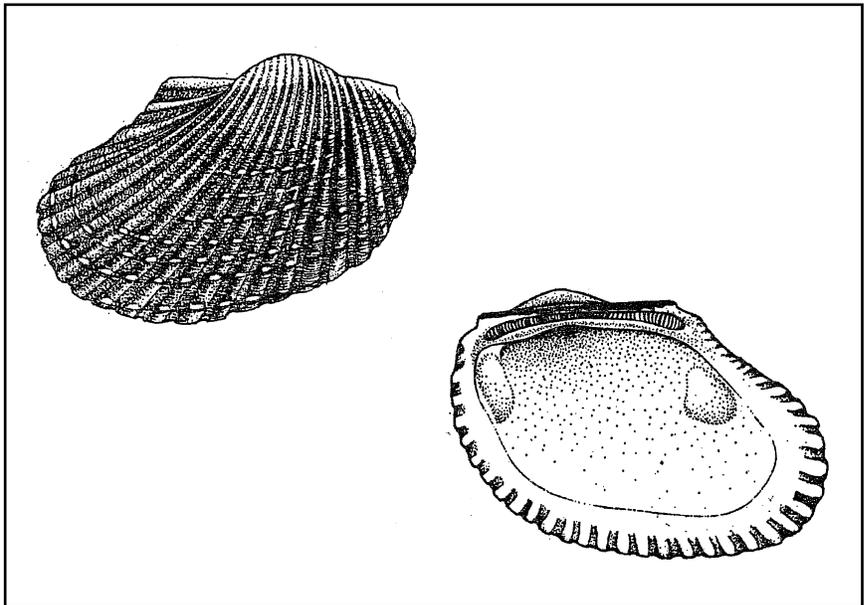


Figure 2.—Exterior and interior views of the valves of *Anadara tuberculosa* (from Mora Sanchez, 1990).

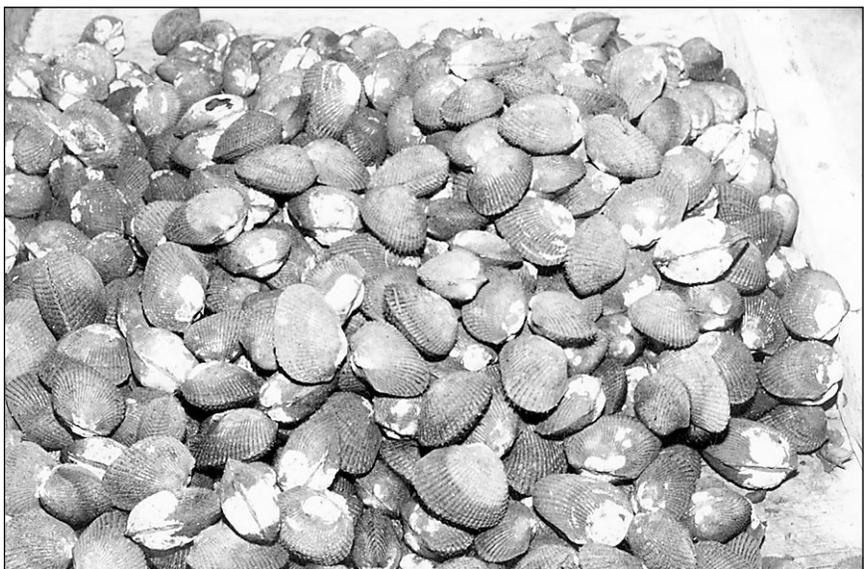


Figure 3.—Part of a pile of *Anadara tuberculosa*. The largest cockles are about 60 mm long.

Harvesting effort for cockles varies widely among countries and is described below. Where harvesting is lightest, as in Mexico, the cockles had a longer chance to grow and were as large as 75 mm. Where harvesting is heaviest, as in Guatemala, El Salvador, and Peru, the

cockles were the smallest because they had the least time to grow, and nearly all were under 55 mm. The mid-sized cockles were in Honduras, Panama, and Ecuador. All harvested cockles in every country had attained a size at which they were sexually mature.

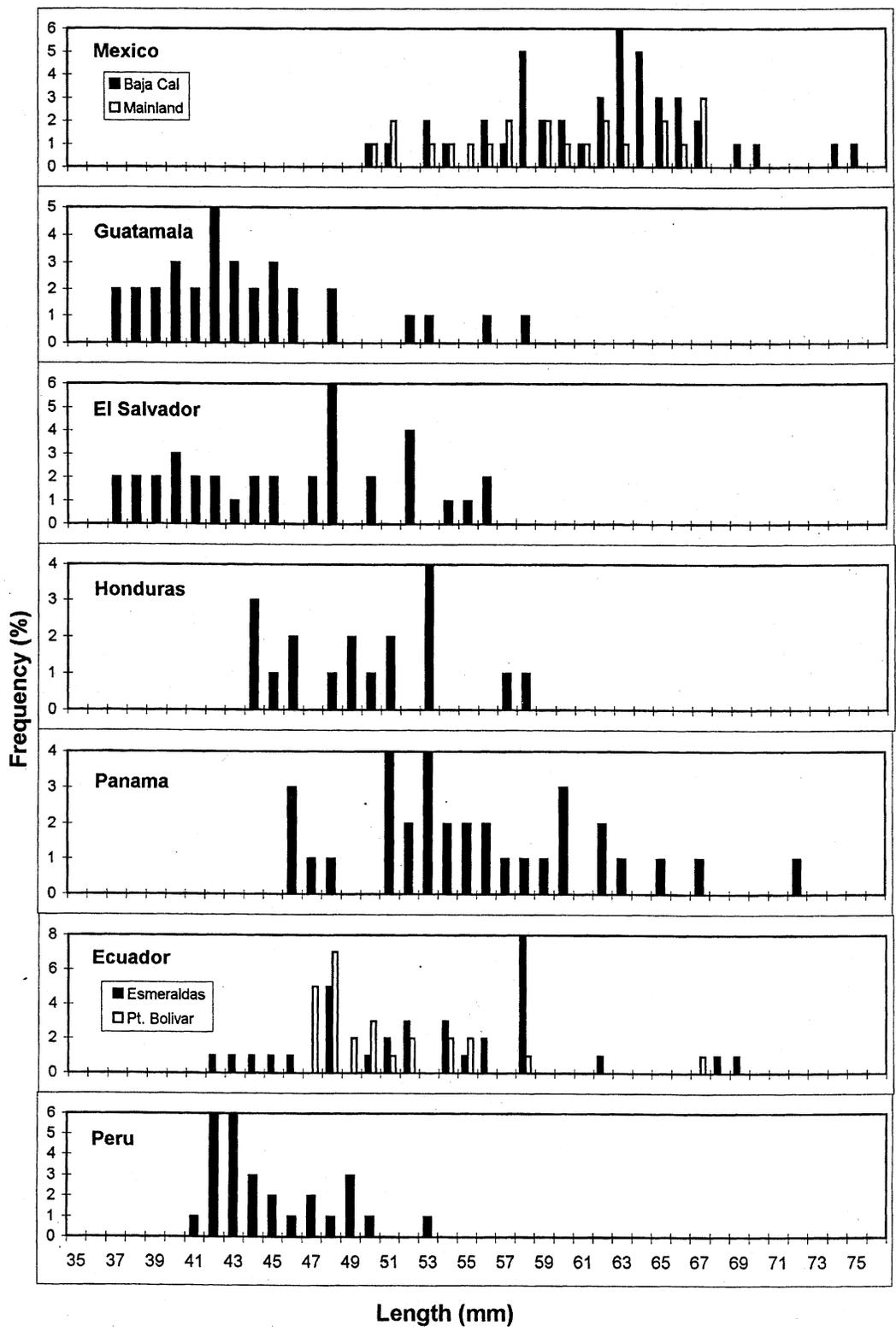


Figure 4.—Length-frequencies of commercially-harvested *Anadara tuberculosa* in selected countries.

Anadara similis

A. similis ranges from the Golfo de Fonseca, El Salvador, to Bahia de Tumbes, Peru (Cruz and Jimenez, 1994). *A. similis* is similar in size and appearance to *A. tuberculosa*, except that each valve has 40–44 ribs, and its periostracum is without bristles. The dorsal margin is rounder and less angular, and its shell is thinner and more fragile (Fig. 5). The blood of *A. similis* is red.

Anadara grandis

A. grandis ranges from Bahia Magdalena, Baja California, Mexico, to Bahia de Tumbes, Peru (Mora Sanchez, 1990). It grows to a much larger size than the other two cockles. Its valves are almost square, and their length almost equals their height. The valves are convex with high umbos, and they have 26 ribs separated by deep interspaces (Fig. 6). The shell has a dark periostracum, and the blood of *A. grandis* is red.

Cockle Habitats

A. tuberculosa and *A. similis* inhabit level mud sediments in mangrove swamps which occur along the mainlands and islands of lagoons. *A. tuberculosa* occurs among the aerial prop roots and under the canopies of the mangrove trees; most are about 15 cm deep in the mud (from the tips of one's fingers to the wrist). *A. similis* occurs in open areas away from the prop roots but also under the tree canopies, and most are about 45 cm deep (from the tips of one's fingers to the elbow). The distribution of the two species overlaps a little. In addition, sparse quantities of *A. tuberculosa* and *A. similis* occur in intertidal mud flats between the mangrove trees and the low tide line (Rosero²). In the northernmost countries at least, *A. tuberculosa* is found deeper in the mud and fewer can be harvested during the winter. It was not determined whether the cockles are nearer the mud surface during high tides. The location of *A. tuberculosa* is shown by a round 2–3 mm hole on the mud surface, but the fishermen just feel

² Rosero, Javier, Chief of Fisheries, Technology Area, Instituto Nacional de Pesca, Letamendi 102 y La Ría, Guayaquil, Ecuador. Personal commun., November, 1999.

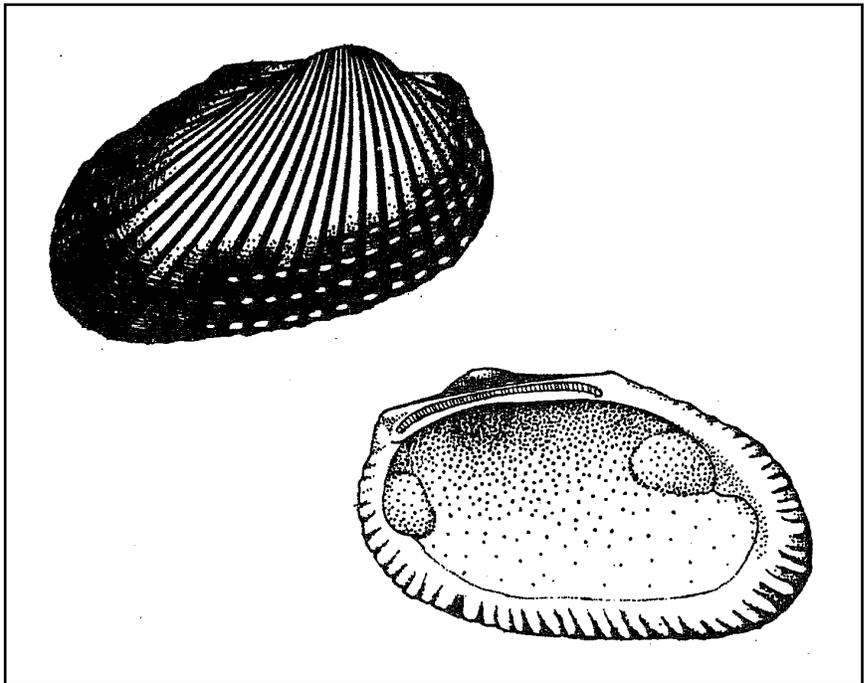


Figure 5.—Exterior and interior views of *Anadara similis* valves (from Mora Sanchez, 1990).

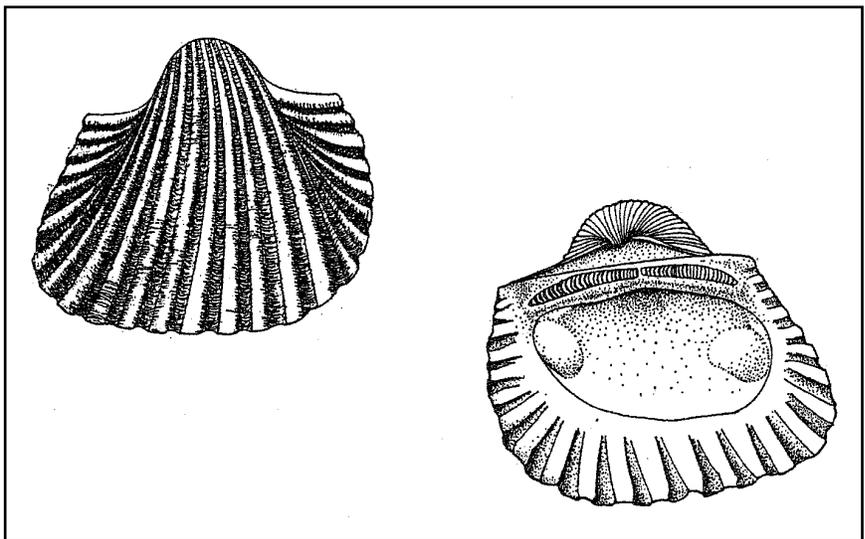


Figure 6.—Exterior and interior views of *Anadara grandis* valves (from Mora Sanchez, 1990).

around the prop roots to find them. *A. similis* can be found by spotting a 2 × 8 mm oval hole without fecal material around it on the mud surface. A burrowing crab makes a similar hole with feces on the surface.

The swamps become flooded with estuarine water during mid and high tides, and their mud substrates are covered by 1 m or more of water. The water drains off during ebbing tides, and their substrates are left bare for about 4 h during



Figure 7.—The edges of a Honduran intertidal mud flat and mangrove-cockle swamp at low tide; many flats are broader than this. The fisherman is seeking *Anadara tuberculosa* and *A. similis*.

low tides (Fig. 7). The widths of the zones (from the edge of the mangrove canopy and prop roots near the water to high ground inland) inhabited by *A. tuberculosa* and *A. similis* vary from about 7 to 200 m but are mostly 50 to 100 m wide. Squires et al. (1975) said the overall widths of the mangrove swamps in Colombia average 150 m with about 100 m of this occupied by cockles.

A. tuberculosa is most abundant in the mud zones of the red mangroves, *R. mangle*, while much lower densities occur in such zones of the black mangroves, *Avicenia germinans*, where sediments are more compact and have more woody fiber. This species is never found in sandy or shelly bottoms even in the presence of red mangroves (Baquero, 1980). Elba Mora de Banos³, with the Instituto Nacional de Pesca in Guayaquil, Ecuador, believes the *A. tuberculosa* likely are abundant in the mangrove swamps because the prop roots offer them cover from predators, while noting that the *A. similis*, with less root protection, are much deeper in the mud. She believes the two species may

set in the flats and subtidal areas beyond the extent of the flats bordering the mangroves, but that most are probably eaten by predators.

A. grandis inhabits intertidal flats and some subtidal areas beyond the edges of mangrove swamps and is much less abundant than the other two species. Harvested over much of its range, its abundance has declined in recent decades.

The associated macrofauna of *A. tuberculosa* and *A. similis* in Colombian mangrove swamps include the tree-climbing crab, *Goniopsis gaudichaudi*; hermit crabs of several species; various shrimp species; small fishes (Squires et al., 1975); and at least five gastropod species (Blanco and Cantera, 1999). Cockle fishermen (personal commun.) related they found some dead cockles with bore holes made by gastropods. The associates also include alphaeid shrimps that make a loud snapping or popping noise when the tide is low and has left the mangrove substrates bare (Squires et al., 1975). The noise is made in mangrove swamps from Mexico through Peru at least once or twice a minute. Fishes swim into the swamps during high tides seeking food. One fish group, tetradonts, eats small cockles, at least in Mexico (Luis⁴) and Ecuador (Mora de

Banos³), and perhaps Honduras (personal commun., several fishermen).

The mangrove swamps are in a nearly pristine condition in all countries except Honduras, Ecuador, and Peru. In Honduras, the construction of shrimp farms and Hurricane Mitch (November 1998) have destroyed large areas of several mangrove swamps, some harboring cockles, but most are in good condition. In Ecuador and Peru, shrimp farms have removed even larger sections of mangrove swamps (as later discussed). The governments of Honduras (Anonymous, 1999a,b) and Ecuador (Altamirano et al., 1998) have declared that some mangrove areas will be protected from human destruction.

Cockle Biology

A critical aspect in the management of the mangrove cockle fishery is the shell length at which the cockles become mature and spawn. Researchers in Costa Rica have determined these lengths for *A. tuberculosa* and *A. grandis*, but as yet no one has reported on it for *A. similis*. In *A. tuberculosa*, maturity and spawning begin at shell lengths of 23–26 mm (Ampie and Cruz, 1989), while in *A. grandis* they begin at lengths of 21–24 mm (Cruz, 1987b).

In Costa Rica, ripening and fully ripe *A. tuberculosa* are present throughout the year; also, its sex ratio is 1:1, and there is no sex reversal. Its period of greatest spawning activity is during May–September, with 70% of the cockles spent in May and 50% spent in September (Cruz, 1984a). In *A. similis* (Cruz, 1984b) and *A. grandis* (Cruz, 1987a; Fournier and de la Cruz, 1987) also, gametogenesis occurs year round, their sex ratios are 1:1, and there is no sex reversal (Fig. 8). In *A. similis*, in 1981 and 1982, specimens were of maximum ripeness in December 1981 and in February and December 1982 (Cruz, 1984b). In *A. grandis*, spawning individuals were most prevalent in November and least prevalent in April, and mature individuals appeared most commonly between July and September, the months preceding the November peak

³ Mora de Banos, Elba, Departamento de Recursos Pesqueros, Instituto Nacional de Pesca. Guayaquil, Ecuador. Personal commun., November, 1999.

⁴ Luis, J., Biologist, La Pontilla, Mexico. Personal commun., March, 1999.

(Cruz, 1987a), and its males' sex products are white or cream colored while those of the females are orange (Cruz, 1987a; Fournier and de la Cruz, 1987).

In Ecuador (Altamirano et al., 1998) and other countries (personal commun., various fishermen), juvenile *A. tuberculosa* and *A. similis* are found attached by byssal threads to adult cockles and mangrove prop roots from July into September. *Anadara tuberculosa* and *A. similis* apparently grow from seed (probably 15–30 mm long) to marketable sizes within a few months. An experiment conducted in Ecuador with the cockles held in a submerged tray showed the time was 3–8 months (Mora de Banos³). Fishermen who were asked about this in every country confirmed this growth rate. They based this on observing seed in swamps where they were harvesting cockles and then observing harvestable-sized cockles in them a few months later. *Anadara tuberculosa* grows slightly faster than *A. similis*, and, in scientific tests, both grow faster if constantly submerged in water (Bravo and Abarca⁵).

Baqueiro (1980) reported on population densities of *A. tuberculosa*. He dug them with a fork from four to six 1-m² areas in eight locations in Bahia Magdalena and Bahia de Las Almejas, Baja California Sur, Mex. He did not state how much commercial harvesting was being done at those locations, but based on the mean lengths of the cockles, they may have been lightly harvested if at all. The smaller cockles were not sampled, and thus the following values do not represent total densities. The mean densities/m² (followed in parentheses by the smallest cockle lengths taken at each location) were: 8.8 (16 mm), 23 (42 mm), 17.2 (36 mm), 15.5 (32 mm), 24.1 (24 mm), 12.2 (36 mm), 6.6 (40 mm), and 7 (18 mm).

Physical Setting and Human Life in the Cockle Fishing Villages

This section describes the lives of the fishermen⁶ who harvest mangrove

⁵ Bravo, M., and N. Abarca. 1999. Potential de concha prieta (*Anadara tuberculosa*) en policultivo con camarón blanco (*Litopenaeus vannamei*). Unpubl. manusc. Inst. Nacional de Pesca, Guayaquil, Ecuador.

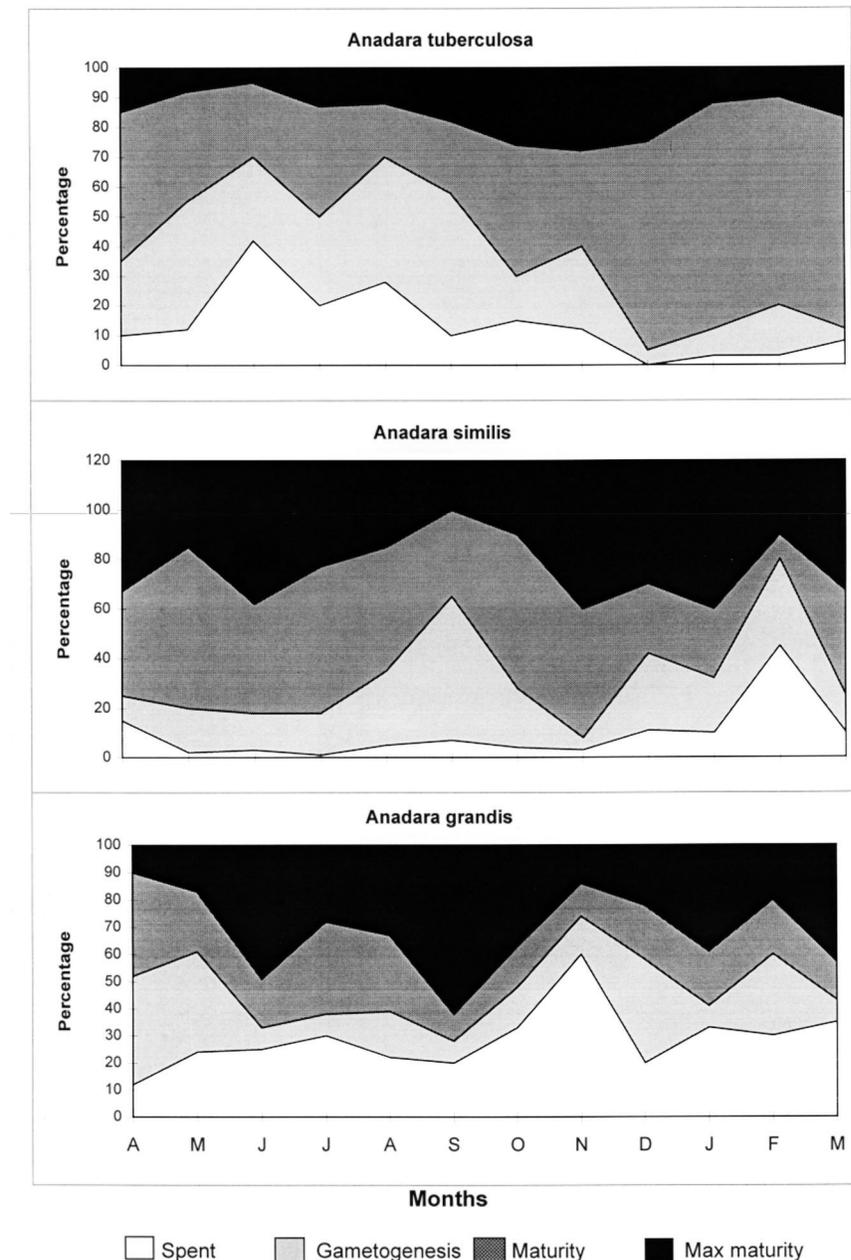


Figure 8.— The gonadal stages of the three cockle species, by month, in Costa Rica. The *A. tuberculosa* data are adapted from Cruz (1984a), the *A. similis* data from Cruz (1984b), and the *A. grandis* data from Cruz (1987).

cockles from Mexico to Peru, but with particular emphasis on villages around the Golfo de Fonseca (El Salvador and Honduras) surveyed in April, June, and

⁶ Cockle harvesting is done by people of both genders and many ages, from youth on up. The term fisherman covers all harvesters.

September, 2000, and January, 2001 after the fisheries in the other countries had been studied. The appendix describes my investigative methods. The main aspects covered were settings of the villages, economics, types of dwellings, personal possessions, water sources, food, marital unions and family

size, social life, schooling, medical and social care, and longevity.

Nearly the entire coastal region from Mexico to Peru is at low elevation, at most a few meters above sea level. Moderately warm temperatures (in the 80's in the afternoons), humid air, and gentle breezes prevail. It rains, often heavily, at least 2–3 times a week during the rainy season, which runs from May through November (but mainly September through November) in Central America, but from December through April in Ecuador and Peru. Rainfall is rare during the succeeding dry season. The landscape becomes green during the rainy season, but is brown, except for a few evergreen tree species, during the dry season. There are no recognized winter, spring, summer, and fall seasons, at least in Central America. The capital cities of most countries (i.e. Mexico, Guatemala, El Salvador, Honduras, Costa Rica, Colombia, and Ecuador) are located inland from the coast at much higher elevations, where temperatures are considerably cooler. The exceptions are Nicaragua, Panama, and Peru, where the capital cities are at low elevations.

The fishing villages in all the countries are located on or near estuarine shores, and most have fewer than 100 dwellings; some fishermen live in scattered dwellings along roadways. Access to the villages typically is via dirt roads 3–25 km from paved highways and often at much further distances from towns. The roads become muddy and have large potholes full of water during rainy periods, and they become rutted by truck and bus traffic. The ruts remain afterward.

Most residents, young and old, have always lived in their villages as had many of their parents and grandparents. Many are highly dependent upon the cockle resources for income and food, but finfish, shrimp, crabs, and in some places other such mollusks as oysters are also taken, and some residents have other types of employment besides fishing.

The fishermen are universally poor. Their living conditions are roughly similar in all the countries, although Honduras might have been slightly poorer as a consequence of Hurricane Mitch which

destroyed some cockle harvesting areas and weakened the country's economy. The fishermen have little money and can afford only the barest necessities, including an extremely meager diet. Families in Honduran fishing villages survive on earnings of \$1.00–\$1.50/day. The proportion of families in most villages that makes its living harvesting mangrove cockles ranges mostly from about one-fourth to one-half, but it varies considerably. For example, one tiny village of 6 families in Mexico is entirely dependent on cockle harvesting, whereas in the port city of San Lorenzo, Honduras, less than 1% (about 30 families living along water's edge) of its population harvest cockles. In some villages, harvesting cockles is one of the lowest occupations in terms of prestige, because it is about the least remunerative.

The only documented data on job distribution in coastal villages is from Bravo (1994), who described village life in Bunche, Ecuador, where it was: cockle harvesting, 28%; harvesting post larvae of shrimp for farms, 28%; farm work, 14%; day labor, 11%; caring for animals, doing artisanal work, finfishing, and other jobs, 19%. Another type of employment for at least one family in nearly every Central American village is operating a tiny store that sells a few types of canned and packaged foods (such as potato chips), simple pharmaceuticals (such as aspirin), and soft drinks. The stores are located in the front room of their dwellings. Such dwellings have wooden walls with a 1 × 1 m opening at waist level facing the street through which sales are made.

During weekends, tourists from distant cities arrive in buses to visit the beaches of some villages, affording local residents an opportunity to sell cockles, home-cooked tortillas, potato chips, and soft drinks to them. In addition, some women make a few dresses for sale or wash neighbors' clothes to earn a little money. In Honduras, some village men work for sugarcane mills from December through early May, i.e. during the dry season, or in melon fields during all months except December and January (melon farmers get an average of 2.5 crops/yr) (Tay⁷). If married, their wives harvest cockles at this time.

During the remaining months, the men harvest cockles with their wives.

Cockle fishermen do not have enough money to keep any in banks and have little money at home. Some are financially solvent by having sufficient money in reserve to pay for their food for a day or two, while some cannot make ends meet: Many are slightly in debt, perhaps by \$20, and others are in debt "up to their necks." Those deeply in debt can pay only the interest on the money owed. Some obtain food from the local grocer on credit.

However, nearly all Latin Americans, at least from Mexico to Peru, have little money (little passes through anyone's hands in a day) mostly due to scarce agricultural potentials and weak industrial bases in their countries as Guillermprieto (2001) describes for Mexico. She said such poverty has people "living on the very edge of precipices."

A few factors keep the fishing villagers poor.

- 1) They must purchase all their food because the soil along the Pacific coast is so poor they cannot raise vegetables and root crops for themselves in family or public gardens. Soil humus seems to be totally lacking. Sachs et al. (2001) said that a) high tropical temperatures reduce soil organic matter to minerals and intense rainfall leaches them from the soil, b) the high temperatures also result in a rapid loss of soil moisture, and since precipitation is highly variable even during rainy seasons vegetable growing is difficult for that reason alone, and c) besides, diverse pests (insects and diseases [and also foraging pigs in fishing villages, author's addition]) can devastate crops. They also said that historically many attempts have been made to improve food output in the region but they have all ended in failure. The attempts were made first by the European colonists and more recently by donor agencies.
- 2) Villagers have few opportunities to earn money except by selling fish and cockles, both of which have

⁷ Tay, Carlos, Quimicos Industriales, Grupo Disagro, Guatemala. Personal commun.

limited abundances and sell for low prices.

- 3) Most women have several children to feed and clothe. With the addition of each new child, the limited quantity of food available to a family has to be divided more finely among family members, and Sachs et al. (2001) said when women are pregnant they can do little work outside their homes to bring in money.

Tempering this poor economic condition of the villagers somewhat is their living in a consistently comfortable climate year-round and a naturally beautiful, nearly unspoiled tropical landscape. The villagers also appear to be free from robbery and other major crimes. They are friendly and are quick to smile and laugh. They desire relief from poverty, and some seek a richer life in the United States. But for many, the cockles will likely mean economic survival and some nutrition for the rest of their lives.

Guillermoprieto (1994) describes dwellings, similar to most of those in the fishing villages, as “huts that represent the lowest rung of Latin-American poverty: dirt floors, no windows, wide gaps between uneven wall boards, a wood-burning hearth for cooking corn and beans. There is little else” (Fig. 9). Around the Gulf of Fonseca, the fishermen’s dwellings are single level. Their walls are constructed of either: 1) cinder blocks or bricks held together with cement, which last many years; 2) tree saplings, 5–6 cm in diameter, which last about two years until the wood decays or a wind storm blows them over (Fig. 10); 3) tree sapling-mud walls which last for several years (the mud is packed between the saplings and dries hard); or 4) boards. The dwellings do not have windows and their roofs are constructed of orange tiles, palm leaves, plastic sheets, or corrugated galvanized iron sheets. Some roofs extend beyond the front of the dwellings providing the family with sort of a porch to sit and to cook their meals. Floors consist of hard sand or cement, or a combination of the two. Many families rent their dwellings for \$20–\$30/month. The adults, including married couples, sleep individually in hammocks which they wrap around



Figure 9.—A Honduran family supported by cockle harvests relaxing in their home near Puerto Grande.

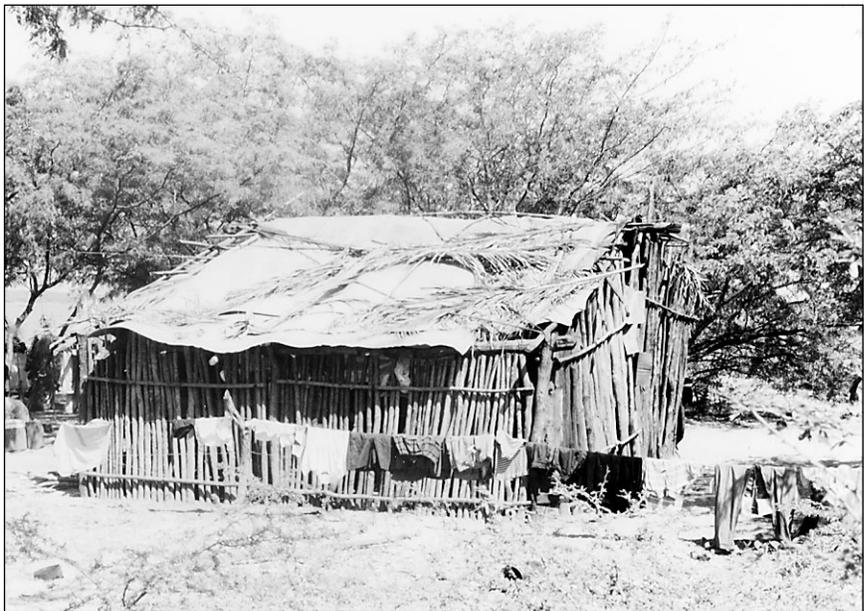


Figure 10.—A typical fisherman’s home in Honduras with walls of tree saplings.

ceiling beams out of the way during the day. As many as 3–4 small children and infants commonly sleep in a rudimentary bed along with their mother, and everyone sleeps in their day clothes. The yards around houses consist of sand rather than grass because the soil is nutrient poor and becomes too dry during the dry season.

Fewer than half the homes have electricity (power comes from large inland hydroelectric dams), and none have telephones. Electric power is used to light a plain bulb (which typically hangs loosely from a beam lying across the ceiling of one or two rooms, which are separated by a cloth or plastic sheet) and a tiny radio usually tuned to



Figure 11.—Cooking a tortilla on a typical stove in Honduras.

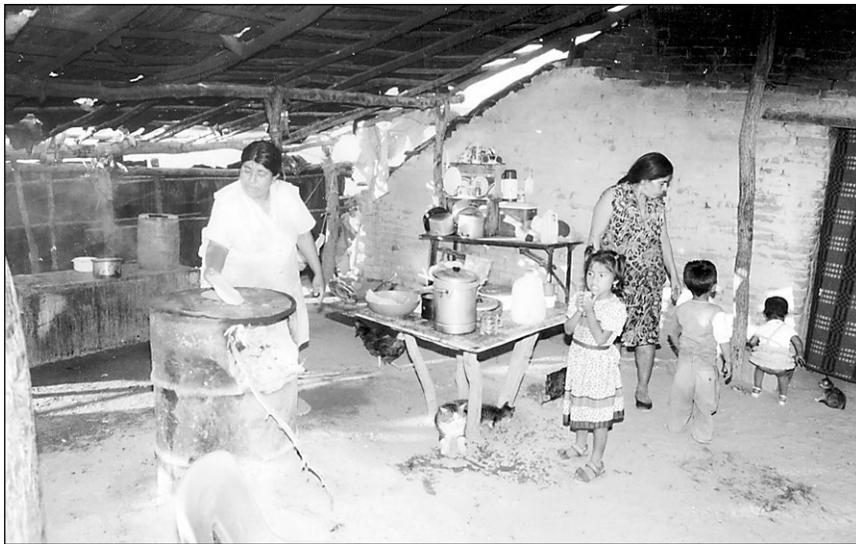


Figure 12.—Preparing tortillas for a family meal on stove made from an oil barrel in La Herradura, Baja California, Mexico.

a local music station. One home in San Lorenzo, Honduras, paid \$1.00/month for its electricity.

Foods are cooked in pans on stoves constructed of a mixture of dried mud and sand. Their design is similar throughout the region (Fig. 11), but converted 50-gallon oil barrels are also used as stoves (Fig. 12). Most stoves are located out-of-doors yet under a roof. Thin tree saplings, cut about 2 m long, are the universal fuel used in the mud-sand stoves. Bundles of saplings are purchased for \$1.00 each from men who cut them in wild public lands. A bundle lasts a household about a week.

Most villagers simply relieve themselves out-of-doors on the ground, using toilet paper (\$0.027/roll), though some have outhouses. Pigs, which roam at will, root around in the feces for nutriment. If living near a beach, villagers wade into the water and relieve themselves there and clean themselves with the water while the currents carry away their wastes.

Fishermen have few personal possessions. Each house has 1–2 crude wooden tables, about three plastic or crude wooden chairs, several plastic bowls and dishes to prepare and serve food, and some have a few photographs of relatives and a drawing of a religious figure displayed on a wall. Adult clothing is purchased in second-hand stores in nearby cities. Women have about two good dresses to go visiting and marketing and three house dresses, while men have two pairs of pants and 2–3 sport shirts. Most adults wear sandals, while some go barefoot and others wear shoes. Fishermen do not have money to purchase such items as women's monthly sanitary napkins (a piece of cloth is used), eye glasses, hearing aids, vitamin pills, or cigarettes. Men and women have their hair cut by relatives or neighbors, usually for a small fee, such as \$0.65, or for no cost.

None of the fishermen have automobiles, but some have bicycles. Nearly all walk, hitch rides on pickup trucks (the wait for one may be as much as 2 h), or take buses, which come once or twice a day, to travel from place to place.

At Christmas, parents give each of their daughters one new dress costing

about \$10, and their sons get a new pair of pants and a sport shirt; this is the only clothing the children will receive in a year. Toys rarely are given due to a lack of money. The family and relatives share a Christmas dinner featuring tamales and fried chicken, which costs about \$20. Families have to save money for about 1.5 months to pay for Christmas, by eating little food other than rice and beans.

In every village, some families own a pig or two and a few chickens, none of which are penned. A typical village has 10–20 pigs. Families could not provide enough food for them if they were penned, and so they let them forage around the villages to find scraps of food wherever they can. During low tides, the pigs also forage on intertidal mud flats. About every six months, a technician from the local health clinic inoculates most of the pigs, chickens, and dogs against diseases.

The fishermen do not have magazines or books in their homes, and they do not read newspapers. They rarely send or receive letters or other types of mail. Contacts with distant relatives can be made by using a public telephone present in each village. Any money from abroad comes to a local Western Union⁸ office. Mail can be sent to a radio station, which announces over the air that mail for a specific person has arrived and then the person goes and gets it. The villages do not have movie theaters or other entertainment, except for television in some; most villagers have never seen a movie.

Nearly all households obtain water from public wells. It is carried home in plastic jugs and buckets, usually by children. In one town, the water from a public pump costs each household \$1.30/month, the money being used to maintain the pump in operating condition. If residents purchase water from a neighbor, drinking water costs about \$0.07/bucket while washing water costs \$0.05/bucket.

The fishermen must harvest cockles or catch fish almost daily to obtain suf-

ficient money for their bare necessities, spending nearly all of it on purchases of rice and beans, which constitute nearly their entire diet. If the fishermen do not harvest cockles to obtain some money, they cannot purchase any food to eat. Since cockle harvesting gains them only a little money, they can afford to eat chicken and less often pork or beef only about once a week; even rice is eaten in limited quantities owing to its expense. The fishermen receive little information about proper nutrition.

After being weaned from their mothers' milk, children rarely have milk to drink, and only then powered milk mixed with water. Breakfast for children and adults usually consists of a single item, such as a cup of beans, or 1–2 pieces of bread, or, once in a while, some fried fish, or an egg. Lunch usually consists of two items, perhaps 2 cups of beans and rice or a fried fish and 1–2 tortillas, or 1.5 cups of beans alone or with cheese. Dinner usually consists of a cup of beans and some rice, or 1–2 tortillas, or beans and tortillas; sometimes fish, cockles, an egg, or a thick slice of cheese or, when the fishermen have a little extra money, some chicken or pork may be substituted. But some families have just one daily meal, such as a large dish of boiled rice and chicken, or two meals of rice and beans and sometimes fish, and, for breakfast, coffee. The food is eaten from the plastic dishes with one's fingers or plastic spoons. Green vegetables and fruits, except for some mangoes and watermelon, are rarely eaten because they are not grown locally and are too expensive to purchase. The foods of the villagers lack essential nutrients to maintain them in good health and vigor. The children, being malnourished, are small for their ages relative to most children in the United States, Canada, and Europe.

When couples pair off to form households, the females typically are 14–16 years old while the males are 20–25 years old; by that age males have some gainful employment. The females "marry" because they are in love, want their own home and children, and are offered some financial support (gainful employment for them is scarce). Few such unions have a legal backing, few

are united by a church ceremony, and many do not endure. The couple usually have children right away. Condoms (at \$0.80 each) and birth control pills are too expensive to be used, and so women may have 3–5 children, but 6 and 7 are common, too. Abortion is rare because it is frowned on by the culture, condemned by the Catholic church, and is illegal. The large families also result because few activities are available for people to occupy their free time. In Honduras, families in villages with television sets have fewer children than those in villages without them (personal commun., several villagers). Nearly all babies are born at home with the aid of a midwife, though some are born in a local clinic. Boys do not wear clothes or sandals until they are about three years old, while the girls wear only panties until that age.

Fishermen spend much of their free time resting and socializing with their immediate family and neighbors, while their children play near them with simple objects (a bicycle wheel with no spokes is a common object). The villagers are used to being consistently amongst a group of relatives and neighbors from the time they are infants through their entire lives. Family relationships are close. (The villagers social lives contrast with those in many parts of the United States in which people live more solitary lives. Individuals feel lonely when isolated from such family groupings.) A typical daytime scene outside a fisherman's residence is a family group of 2–4 adults (a grandmother and her adult children), 6–12 school-age children (mostly girls 9–15 years old who do not attend school), besides 1–2 babies. There is consistent chattering and playing among the children while the adults discuss their family matters and also their quiet village life. Little happens in Latin American countries, and there is little national news to discuss—home life would amount to considerable boredom without the children.

The smallest children go to bed right after dark (usually around 6 p.m.) and awaken around dawn, 6 a.m. Where television is available, the older children, whose usual bedtime is around 8 p.m., remain awake until 9 p.m. to watch

⁸ Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

soap operas. The 6–8 television programs shown are Mexican-made soap operas that feature beautiful women, dubbed shows from the United States, a wacky comedy, and 2–3 news stories that are usually about small national development projects, such as dwellings being constructed for the homeless, or disasters, such as a bus crashing, a river overflowing, or a landslide damaging homes.

Husbands appear to be less responsible than their wives, because they frequently spend some of their money to get drunk on beer (about \$0.60/bottle). The heavy drinking helps them “to escape from their poor life and disappointments.” Alcoholism is higher among male fishermen than among their counterparts living in inland towns due to their deeper poverty (Gonzalez⁹). On the other hand, women use their money for food and child care.

Besides, husbands often desert their wives and young children for good, seek relationships with younger women, and provide no further support. Caring for small children does not go with their macho nature, that features dominance of males over females. The mothers are “left with nothing,” and have almost the entire burden of supporting themselves and their children. They are provided moral help and assistance in child care by an extended family of relatives and neighbors who can be in a similar circumstance, but they assist the others in child and elderly care. A family member with a little extra cash usually shares it with needy relatives. About the only work for most mothers and their older children is harvesting cockles.

To attend public grammar school, the children must have a uniform (in Honduras, a white blouse and blue skirt for girls, and a white shirt and blue pants for boys in accordance with the country’s national white and blue colors), shoes, a backpack, separate notebooks for each subject, and pencils. Their purchase, at about \$25/child, amounts to a relatively large expense for parents, and most cannot afford to

send all their children to school. One or two typically are sent but few finish the six grades of primary school due to the expense, and some parents remove them to harvest cockles or do other work to bring in some money. Most school-age children, especially the girls, remain idle at home playing and doing a few simple household chores, such as fetching water from a well—there is little to do. Often, a child attends school for 2–3 years, drops out for a year or two due to a lack of money, and then, if the parents can afford it, returns to school. A child is able to read and write marginally after completing three grades of school. Perhaps half of the children never learn to read and write. A child of a cockle fisherman rarely can become a teacher or nurse, because his or her parents cannot afford that much schooling. Besides a lack of money, another reason for the low attendance at schools is a lack of jobs for adults that require reading, writing, or much knowledge.

Some schools have 3 rooms for the primary grades; as many as 65 children in 2 grades are seated in each room with 1 teacher. The teacher gives instructions to one grade, while the other grade does written work for about an hour. Afterward, she goes in front of the other group and instructs them while the first group does written work. The teacher alternates back and forth during the school session. In some areas, school class schedules are adjusted to the changing tide levels to allow the students to harvest cockles every day. If the tides are low in the morning, the classes are held in the afternoon, and vice versa.

Illnesses may be treated at home or in a local government-funded health clinic. When mildly sick, people consume chamomile tea, eucalyptus tea, or shark liver oil. For more serious illnesses, they go to the local clinic in or near their village for inexpensive medical attention. Doctors do not treat people in their homes. (In Honduras, the health clinic in Monjaras which serves at least 3 fishing villages (i.e. Cedeno, Puerto Nuevo, and Punta Raton) required traveling 8, 9, and 18 km, respectively.) Some medications are issued free by the clinic; people pay for others at a store. Children commonly have intestinal worms picked up

by walking in their bare feet over pig feces. The clinics or their mothers give them pills or a powder mixed with water to kill the worms about once every three months. Diarrhea and mosquito-borne dengue and malaria are also contracted. If anyone is seriously ill and has to go to a hospital, he or she may have to borrow money from the neighbors to pay the bill and pay it back later with earnings from selling cockles. The fishermen have excellent teeth, probably because they do not have the money to purchase candy, cookies, or fruits. Some brush their teeth regularly.

Honduras and El Salvador have no public support (welfare) for destitute citizens. Villagers are “on their own;” grown children have to take care of their elderly parents and infirmed relatives, and families often band their resources together to aid any members in desperate need. Gonzalez (2001), a newspaper reporter restating comments by a visiting researcher from the United States, said officials in Central American governments have little concern and respect for their country’s farmers (and this applies to fishermen as well). The officials do not have any tradition for providing rural services, because they do not see the payback in human terms but rather in production goals. From my experience of interviewing fishery and environmental officials in these countries, they view their country’s fisheries and environments in the same way: production statistics and environmental protection, but without concern for the fishermen’s lives.

Data are unavailable on the average longevity of people in the fishing villages, but 2 interviewed religious leaders (Gonzales,⁹ Valladares¹⁰) believe it is shorter than the established national figure of 62 years of age in Honduras (Targ and Brill, 1995) because the fishermen live far from towns where people have closer access to food, medical attention, and medicines. A funeral costs about \$200 (for plain wooden casket, clothes for the dead person, and bread and coffee for relatives and neighbors).

⁹ Gonzales, Florentino, Catholic priest of Marcovia area, Monjaras, Honduras. Personal commun., September, 2000.

¹⁰ Valadares, Jesus Francisco, Catholic priest, Catedral Choluteca, Honduras. Personal commun., October, 2000.

Its cost often is shared by the village community.

“El Telegrafo,” a newspaper in Guayaquil, Ecuador, published an article by Manuel Bravo (1994) that described similar life conditions of the cockle harvesters of DeBunche in the province of Esmeraldas, Ecuador. The adults there did not finish school and more than half were illiterate. The women marry at a young age and their husbands are 7–9 years older. In that village, all adult cockle harvesters were women, each of whom had 4–5 children. The village had 51 adults and 28 minors ages 8–13 who harvested cockles with their mothers during school vacations. Most harvesters were 20–40 years old, but their overall age was 8–70 years. Bravo believed the women were more responsible to their families than were the men, because they earnestly harvested cockles to earn money to feed and clothe their children. The preschool children were left in the care of neighbors and relatives while they were harvesting. For most fishermen, cockle harvesting brought the only income to their homes, but some also kept pigs and chickens to sell. Nearly all their earnings were spent on food. To keep the residents from abandoning DeBunche, Bravo recommended that a pharmacy and an agency which provides health seminars be established.

Javier Rosero² said that in the cockle harvesting communities of the same Esmeraldas Province in Ecuador, about 75% of the people are listed as extremely poor, only 30–44% receive health services from public clinics, and about half the women do not receive any medical attention while they are pregnant or giving birth. From 38% to 43% of children attend the first 2–3 grades of school.

O. G. Plaza¹¹ describes a similar condition of life among the cockle fishermen in Colombia. The fishermen comprise the lowest economic group in the Tumaco area; their only source of income is cockle harvesting. Their houses have a poorer quality than those in urban areas, most fishermen are il-

¹¹ Letter from O. Gustavo Plaza, Microempresarial, Tumaco, Colombia, dated April 4, 2000.



Figure 13.—Some mangrove cockle fishermen in A, Mexico; B, El Salvador; C, Costa Rica; D, Honduras; E, Panama; and F, Ecuador.

Table 1.—Estimated numbers of fishermen harvesting mangrove cockles daily when conditions allowed it in each country.

Country	No.
Mexico	645
Guatemala	235
El Salvador	2,850
Honduras	225
Nicaragua	160
Costa Rica	500
Panama	220
Colombia	5,000 ¹
Ecuador	5,055
Peru	75
Total	14,965

¹ This estimate could be low.

literate, the few who can read and write finished only 3 years of primary school, and more than 75% of the people have no subsidiary health care.

Cockle Fishing

Over the entire cockle range from Mexico to Peru, about 15,000 fishermen actively participate in the harvests

Table 2.—Local names for the cockle, *A. tuberculosa*, in each country (*A. tuberculosa* is referred to as the male cockle and *A. similis* is referred to as the female cockle).

Country	Local names
Mexico	
Baja Calif.	Pata de mula
Mainland	Pata de mula, almeja negra, almeja candelon, almeja canaval
Guatemala	Concha negra, curile
El Salvador	Concha negra
Honduras	Curile, curile negro
Nicaragua	Concha negra
Costa Rica	Piangua
Panama	Concha negra
Colombia	Piangua
Ecuador	Concha, concha prieta (also piangua, sangara)
Peru	Concha

(Fig. 13; Table 1). The trade employs a variety of common names for the cockles, some being unique to a country while others are more universal (Table 2). Harvests in all countries usually run about 15–20 days a month. The days missed are during neap tides or heavy

rains when harvesting is difficult or impossible, and in some countries no harvesting is done on Sundays. Also, women usually wash their family's clothes one day a week.

The governments of some countries have a regulation regarding the minimum harvestable size of *A. tuberculosa* and *A. similis*, to prevent the harvest of immature cockles and maintain adequate spawning stocks. The minimum harvested length appeared to range from about 47 to 60 mm, depending on the country (personal commun., various fishermen), but some cockles under 60 mm are taken. The harvests are rarely, if ever, checked for sizes by government wardens, perhaps because cockle reproduction does not appear to be threatened anywhere by low spawning stocks, and the markets do not want small cockles. The smallest cockles bring the lowest prices because consumers get the least quantity of meat from them, so market demand affects the sizes harvested.

The cockle harvesting areas usually are 1–4 km or even farther from the villages. In part because of this distance and the estuarine waters of the harvesting areas intermix with clean Pacific Ocean waters, the cockles appear to be uncontaminated by domestic pollutants. No mention anywhere was made of human illnesses caused by eating cockles.

In every country, men and women harvest cockles, but children as young as 7 years old commonly join their parents as harvesters. The oldest male fisherman interviewed was 87 years old (in Honduras), the oldest female harvester was 72 years old (in Panama). Many are lifelong cockle harvesters, though they have to quit when their health (often eyesight) fails.

The fishermen harvest cockles during low tides when they can walk in the mangrove swamps. They spend about 4 h/day harvesting, and since the tidal cycle advances about an hour each day, the working hours advance by that much each day. The fishermen reach down and feel in the mud for the *A. tuberculosa* and *A. similis*. They find most *A. tuberculosa* near the bases of the mangrove prop roots. Their hands penetrate the mud to their wrists for *A.*

tuberculosa (Fig. 14) and commonly to their elbows for *A. similis*. They find an *A. tuberculosa* every several probes. The *A. grandis* are spotted sticking slightly out of the muddy sand. During the part of the day when the tides are too high for harvesting cockles, the men often try to net some finfish in the lagoons. In some areas, cockle harvesting is seasonal, alternating with catching finfish or shrimp, or working as farmers in sugarcane and melon fields.

Cockle harvesting is not difficult or onerous, because it does not involve any heavy lifting. Cockles are harvested in the cool shade under the mangrove canopies, and the fishermen are autonomous, but it is unpleasant walking and probing in soft mud. As they walk to a new place, stop, and reach around some aerial prop roots for cockles, their legs may sink in mud half way to their knees, and much effort often is expended squeezing their bodies between the roots to gain access to places where they can get cockles. Some groups of prop roots are too densely spaced for fishermen to penetrate.

The fishermen have a short walk from their homes to their boats and then a 30–120 min boat run to harvesting areas. Nearly all fishermen travel to and from the cockle harvesting areas in wooden canoes (6–7 m long, 0.75 m wide) or fiberglass boats (4.75–6 m long). The canoes, which usually last 3–6 years, are propelled by using wooden paddles or by small outboard motors, while the fiberglass boats, called “pongos,” are propelled by outboard motors. A group of 2–5 people, usually family members, two of whom paddle, go together in the canoes (Fig. 15), though some fishermen go in them alone. The pongos carry 6–10 (but sometimes more) people.

The persons who operate the pongos drop off the fishermen, one at a time, along the mangrove banks and pick them up about 4 h later to return home (Fig. 16). They go to a different area each day, leaving harvested sites alone for about 7–14 days to allow the cockle seed to grow. They do not know whether anyone else may have harvested there while they were gone. If the cockles are scarce, they move to another location. Nearly all the fishermen harvest cockles

to sell, but some harvest them only for their own food.

The fishermen's expenses are small. If a person or family does not own a canoe, they pay the owner a small amount, commonly about 25 cockles/day from each person's harvest, to take them to and from the harvesting areas in a canoe or pongo. Many go barefoot when harvesting cockles, but some wear tennis shoes, heavier shoes, or boots. Fishermen usually harvest barehanded, but some wear gloves, and some in Peru wear cloth tubes tied onto each finger (Fig. 17). Net or cloth baskets or sacks (Fig. 18) or small plastic buckets are used to hold the cockles during harvesting.

Biting insects are universal pests, and mosquitos can be abundant during the rainy season. Fishermen repel them with sprays, creams, or petroleum (mixed with butter so it will not burn) applied to their skin, or by using smoke from a burning a bundle of palm branches, dry cow or horse dung, incense held in one hand, or, in El Salvador, with smoke from hand-rolled cigarettes, or, in Honduras, from inexpensive cigars.

A danger in Ecuador are fishes with the common name pejesapo (Eleotridae and Gobidae families), that are buried in the mud. A fisherman can get a pejesapo bone stuck in his or her arm, foot, or leg, causing pain, swelling, and fever. Cockle fishermen also get swollen hands and feet and itchy skin even without interacting with fish (Rosero²). Besides, some prop roots are covered with animal growth which can cause skin abrasions if the fishermen rub against them.

After harvesting, the fishermen return to their boats, slosh their cockles in the water to wash off the mud (this may also be done back at the village shore), go back to their villages, often set 1–2 dozen cockles aside for home use, and then take the remainder to dealers in the villages or keep them at home until a dealer comes for them. The fishermen rest and socialize in the mornings when tides are low in the afternoons, or in the afternoons when tides allow them to harvest in the mornings.

The dealers save some cockles for sale to neighbors and then pack the remainder whole in bags, usually about



Figure 14.—Reaching for *Anadara tuberculosa* amidst mangrove prop roots, *Rhizophora mangle*. Top and middle photographs were taken in Esmeraldas Archipelago (near the Colombian border), Ecuador; photograph at lower left is from Puntarenas area, Costa Rica.

500–1,000/bag, for delivery by pickup trucks or public buses to market brokers in population centers 2–3 times a week. Ice is not used in transit because its cold temperature would kill the cockles, but they are kept out of the sun. The brokers sell them to merchants in central mar-

kets and street markets and to restaurants (Fig. 19).

Anadara tuberculosa survive out of water about 5 days during warm periods and 8 days during cool periods before gaping and dying. *Anadara similis* live half as long and consequently usually

bring the fishermen about half the price of *A. tuberculosa*. In the trade in most countries, *A. tuberculosa* is referred to as the male cockle, while *A. similis* is referred to as the female cockle (this has nothing to do with the actual gender of the cockles), but sometimes they are referred to as the black cockle and the white cockle, respectively.

The fishery for *A. grandis* is relatively small, and it was not surveyed except when noticed while surveying the fisheries for the other cockles. *Anadara grandis* can be spotted sticking slightly out of the mud on flats (Fig. 20). Piles of *A. grandis* are placed alongside the piles of the other cockles and sell at a higher price per cockle in markets. People prefer them because they are easier to open and have more meat, although the *A. tuberculosa* are tastier. *Anadara grandis* are cut in half when prepared in seviche (cockle meats, juice of limes, *Citris aurantifolia*; and condiments), whereas the meats of *A. tuberculosa* and *A. similis* usually are served whole in seviche. It appeared as though *A. grandis* quantities had declined in all countries due to intense harvesting, and the Federal governments in Costa Rica and Honduras have banned their harvests to protect them.

Central markets in cities sell a large variety of produce (root crops, tomatoes, green vegetables, fruits) as well as fresh pork, beef, chicken, and fish, and, commonly, cockles and mussels, besides clothing and other goods. In the largest cities, the central markets usually are located within an enclosed building which occupies an entire block. Most produce is sold in large bins, while the meats, fish, and bivalves are displayed on tables. Vendors stand beside the bins and tables to serve customers. On streets along the sides of the main building, other vendors set up stands to sell similar produce. In addition, small food stands on various corners of city blocks (Fig. 21) and small stands at tiny resort areas (Fig. 22) frequently specialize in cockles. Most serve them raw on the half-shell with lime juice. Restaurants usually open the cockles with a short, but wide knife fastened at one end by a swivel nut (Fig. 23).



Figure 15.—Group of four fishermen on their way to mangrove swamps to harvest cockles in the Esmeraldas Archipelago, Ecuador. The paddler in the bow is their chauffeur, who will be paid in cockles (25 from each fisherman) for his service. The youth at the stern is along for the ride.



Figure 16.—Group of five Ecuadorean fishermen walk toward cockle harvesting areas that are amidst mangrove prop roots, *Rhizophora mangle*.

Written histories of the cockle fisheries do not exist in any country. Nevertheless, Elba Mora de Banos³ believes the fisheries undoubtedly are several centuries old. She believes that, in the 1800's, cockles were eaten in local villages, and, where possible, they were taken to distant population centers that were on or near the coasts on small sailing vessels. Her beliefs are partially substantiated by many fishermen who stated that their parents and grandparents had harvested cockles, while others were land farmers.

Cockle Fisheries by Country

Mexico

In Mexico, cockles are harvested in Baja California Sur and between Guaymas and San Blas on the northern part of the mainland's west coast (Fig. 24). The principal species harvested is *A. tuberculosa*.

Baja California Sur

Anadara tuberculosa are harvested along the west coast of Baja California Sur¹² in Laguna de San Ignacio, Canal Soledad, Bahía Magdalena, and Bahía de Las Almejas, extending over a north-to-south distance of 335 km². Lightly harvested, the cockles are underexploited and some even unexploited in many mangrove swamps. Fishermen live in Campo Rene, La Laguna, San Buto, Puerto Adolfo Mateos, Santo Domingo, La Herradura, Puerto Cancun, and a few smaller villages. In the entire Baja California Sur, about 85 men, women, and children harvest cockles: 45 in the Laguna de San Ignacio area and 40 in the 3 areas further south. Hernandez-Valenzuela (1996) reported that *A. tuberculosa* also occurs in small mangrove swamps on the east coast of Baja California in the Gulf of California, but the fisheries there are tiny or nonexistent.

Entire families harvest cockles nearly year-round, 4–6 days a week, but rarely on Sundays. Individual daily harvests usually range from 500 to 1,000 cockles/day, but can be as many as 1,200 cockles

¹² Information for this section was obtained from several individuals; the principal source was Manuel Davis, cockle dealer, Concepcion, Baja California.



Figure 17.—Cloth tubes tied onto fingers protect this Peruvian cockle fisherman from cuts. His cockles are in the bag (R).



Figure 18.—This Ecuadorean will light the bundle of coconut branches to produce smoke that repels biting insects while she harvests cockles, placing them in her mesh basket.

(Fig. 25). Cockle fishermen here feel they are doing well, because they can earn at least \$10/day. In comparison, local farm workers earn about \$4 in an 8-h day.

Baja California Sur has four cockle dealers, three of whom buy from the fishermen in the Laguna de San Ignacio area, and one buys from the fishermen in the south. The dealers have agreed

amongst themselves on prices they will pay and to divide the area into territories, and each purchases cockles only in his own territory.

The dealers have calendars marked with daily tidal cycles (Fig. 26). Each day when the calendars show the tide is rising, they drive their pickup trucks to the villages, arriving when the fisher-

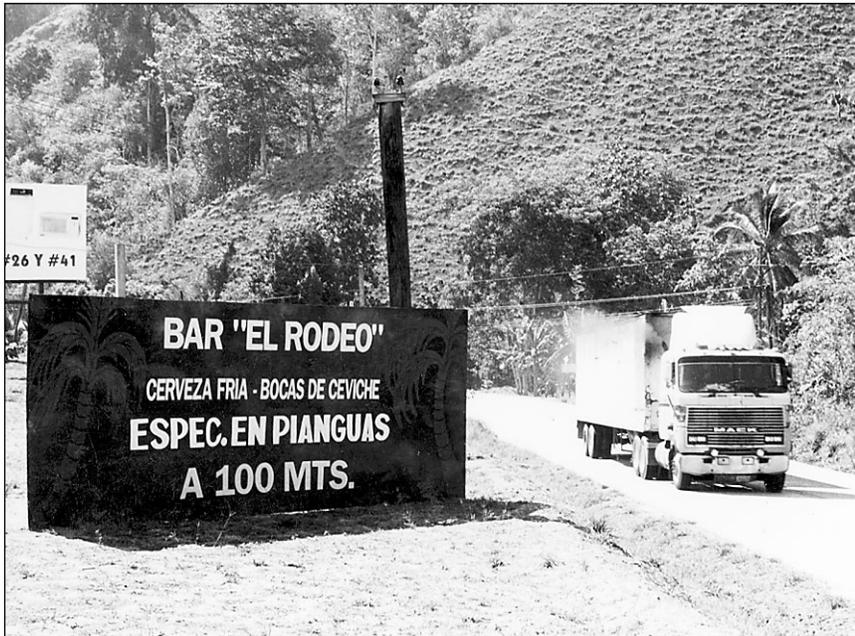


Figure 19.—Advertisement for the Costa Rican restaurant, Bar “El Rodio,” which specializes in serving cockles (Espec. en pianguas).



Figure 20.—Harvesting an *Anadara grandis* on a muddy flat at low tide in the Archipiélago de Las Perlas, Panama.

men are landing their boats and cockles. The fishermen pack the cockles in bags, 500 cockles per bag, each bag weighing 35–40 kilos. The four dealers purchase about 4 t of cockles a day and ship them to markets every second day.

The three dealers in the north take their cockles on pickup trucks northward to Ensenada and Tijuana in Baja California Norte. The dealer in the south ships his to the mainland. He takes the cockles to his home in La Constitucion, stores them in his garage for 1–2 days, and then sends them via pickup trucks to La Paz for ferry transport to Mazatlan. From there, they are trucked to brokers in Guadalajara and Mexico City. It takes 2.5 days to get the cockles from La Constitucion to Mexico City. The total shipping cost is \$5.38/500-cockle bag. The cost of shipping them by air from La Paz to Mexico City, at about \$240 per 40-kilo bag, is prohibitive.

One unusually large family of 12 (father, mother, and 10 boys and girls, the youngest of whom was 5 years old) live in a tiny village or “camp” with 5 other cockle-harvesting families at a location named La Herradura, which began as a cockle harvesting area in about 1990. The father and the 10 children usually harvest cockles every day, using 2 pongos to take them to and from the harvesting areas. The dealer drives there every 2 days to pick up about 25 bags of cockles at a time and leave sales slips with the father. The dealer pays \$0.02–\$0.025 for each cockle, or \$10.00–\$12.50/bag. Each fisherman harvests about 35,000 cockles/month.

During 1991–95, from 446 to 885 t/year of *A. tuberculosa* were landed in Baja California Sur. Production varied due to market demand (Hernandez-Valenzuela, 1996).

Mainland

The Pacific coast of the Mexican mainland¹³ has a series of large lagoons

¹³ Information for this section was obtained from interviews of 3–8 people in each village; the principal sources were Manuel Lomeli in San Blas; Jorge Avila in Villa Hidalgo; Berta Perez Gonzalez in Tepic Nay; Emilio Cega in Palmar De Cuahulla; Maria Theresa Olivas Dramos in Dautillos; Jose Luis in La Pontilla; Maria Dolores Lopez Solorrano in Navolato; and Jorge Castro Florez in Playa Colorado.

that occupy almost 80% of the 850 km distance between Guaymas and San Blas, and 3 large lagoons, Laguna Superior, Laguna Inferior, and Mar Muerto, on its south coast. The lagoons between Guaymas and San Blas contain mangrove swamps and *A. tuberculosa* and *A. grandis*, but the three large lagoons on the south coast contain neither. Mangrove swamps and cockles also do not exist along the 550 km stretch of coastline northward from Guaymas to the apex of the Gulf of California. The many villages near the lagoons between Guaymas and San Blas are located along unpaved roads 6–20 km from Mexican Highway 15.

Anadara tuberculosa between Guaymas and San Blas are harvested, but the effort here, too, is relatively light because the market is weak: Mexicans do not eat many cockles. About 560 fishermen harvest cockles along this coast: 1 in Gusimas, about 4 in Pablado Cinco, 50 in Las Guillas Margen Derecha, 20 in El Colorado, 20 in Topolobampo, 100 in Huitussi, 20 in El Tortugo, 8 in Palos Verdes, 5 in Playa Colorada, 45 in Costa Azul, 75 in Dautillos, 45 in Las Aquamitas, 15 in El Castillo, 15 in El Conchal, 20 in Cospita, 40 in La Pontilla, 40 in Palmar de Cuautla, 20 in Rancho Nuevo, 10 in Javier, and 4 in San Blas. They also seek finfish, shrimp, and crabs, with fish and shrimp being the most important. They harvest cockles mainly from February to March into July–August and net shrimp and fish during the remaining months, though some cockle harvesting always occurs. Some people only harvest cockles for personal consumption.

Most cockle harvesters are men; the percentage of women harvesters ranges from occasional participants in the village of Las Guillas Margen Derecha to about 25% in Las Aguamites. Some children harvest on weekends and during summers starting at the age of about 10, at least for boys.

Most fishermen paddle to the harvesting zones in canoes or use outboard-motor-propelled pongos. Pongos take groups of 5–7, with each person sharing the cost of gasoline or paying the boat owner \$0.50–\$1.00 a day. Some dealers pay for the gasoline used by the poor-



Figure 21.—An open-air restaurant which serves cockles, oysters, and other seafoods in Tuxpan, Mexico.



Figure 22.—Opening an *Anadara tuberculosa* to be eaten raw on the half-shell at an eating place on an El Salvador dock.

est fishermen. The remaining fishermen ride to harvesting zones overland on bicycles or on horses and then walk into them. Harvesting is done on average 3–4 days a week (5–6 days in one week, and

1–2 days in the following week due to changing tide conditions), and about 15 days a month. This includes harvesting on Sundays. The fishermen sometimes go long distances from their villages to

where the cockles are most abundant to obtain larger harvests. They camp out on high ground near the mangrove swamps, making a shelter of branches or a sheet of plastic. Their meals consist of fish, beans, and rice, which they bring with them, and some cockles.

Daily individual harvests are relatively large compared with those in the other cockle-producing countries, ranging from 400 to 600 cockles, but they can go as high as 1,000 cockles or more. The dealers pay fishermen \$2.15–\$2.75/100 cockles (\$0.022–\$0.028/cockle) and tell them how many cockles they will need in the next few days. If a dealer will need 5,000 cockles, 5–6 fishermen will harvest; if he needs more, more fishermen will harvest. Cockles from this region are sold in Tijuana, Mexicala, Hermosillo, Ciudad Obregon, Culiacan, Mazatlan, Guadalajara, Mexico City, and other population centers.

One dealer in Palmar de Cuautla buys cockles from 10 fishermen. Two or three times a week he makes day trips on a bus northwestward to Tecuela, a distance of

17 km, taking the cockles, 1–3 sacks (1,000 cockles/sack) at a time. The trip each way takes about 1.5 h and the bus costs him \$1.50. He sells the cockles in Tecuela for \$3.75/100 (\$0.038/cockle) to three brokers, who take them on pickup trucks to restaurants and street vendors for sale.

The cockles are eaten in seviche, boiled with rice, or raw on the half-shell with condiments or lime juice. Some eating places put live, unopened cockles in pans heated by a flame. The cockles open, their top shells are removed, and their meats are served in the lower shells with a lime. In cities such as Tuxpan, several small open-air restaurants serve cockles to customers raw on the half-shell with a lime (Fig. 27). The waitresses open cockles by repeatedly striking the edge of the shell with a knife to break a hole in it and then inserting the knife to cut the two adductor muscles away from the upper valve. Each restaurant sells 100–500 cockles/day. Taverns also sell raw cockles on the half-shell with a spicy sauce and lime juice with drinks.

Anadara grandis in Mexico

On the Mexican mainland, *A. grandis* is harvested fairly intensely in only Ensenada Pabellones, a bay 40 km south of Culiacan. Fishermen from the villages of Las Puentes and Las Arenitas gather them from March through August. (They seek shrimp during the remainder of the year.) In Las Puentes, about 60 men out of 300 total fishermen harvest *A. grandis*. Each harvests for 3–4 h and gets as many as 300 *A. grandis*/day. A sample from a fisherman's harvest averaged 70 mm long (range, 62–77 mm). The fishermen were paid about \$10.75/100–150 (\$0.07–\$0.11/cockle) for them. In Las Arenitas, 70–80 fishermen regularly seek *A. grandis*. Each gets about 100/day, a bucketful, and gets \$8–\$9 for them. They harvest for 7 consecutive days, take 4 days off, and then repeat this work-rest cycle. No one there normally harvests *A. tuberculosa* though they are abundant, because no one will purchase them when *A. grandis* are available. The fishermen harvest *A. tuberculosa* only when they cannot find many *A. grandis*. The fishermen eat some *A. grandis* at home in cocktails with tomato, lime, catsup, and onion.

Guatemala

Some small estuaries with mangrove swamps and *A. tuberculosa* indent the entire coast of Guatemala¹⁴ (Fig. 28). They have only local names; the communities near them are Tilapa, El Chico, Manchon Muchual, Sipacate, and the four communities (Casas Viejas, Las Vivas, El Ahumado, and Barra del Jiote) in the Las Lisas area. About 235 fishermen harvest cockles daily in the country. Las Lisas is the most important area with about 200 fishermen. Entire families harvest when the children are not in grade school. The schools are in session from 7 a.m. until 12 noon, and, whenever the tides are low in the afternoon, parents bring along their children to help harvest. If the male fishermen are harvesting in the mangrove swamps during



Figure 23.—An anvil-knife for opening cockles; cockle blood runs down a groove and collects in a bowl (not shown). This type of opener is common in most cockle-producing countries.

¹⁴ Information for this section was obtained from interviews of 3–8 people in each village; the principal sources were Jose Domingo Cortez and Carlos Enriquez in Las Lisas; Very Alberto Cambera in Las Vivas; and Pedro Estrada and Oscar Martinez in El Ahumado.

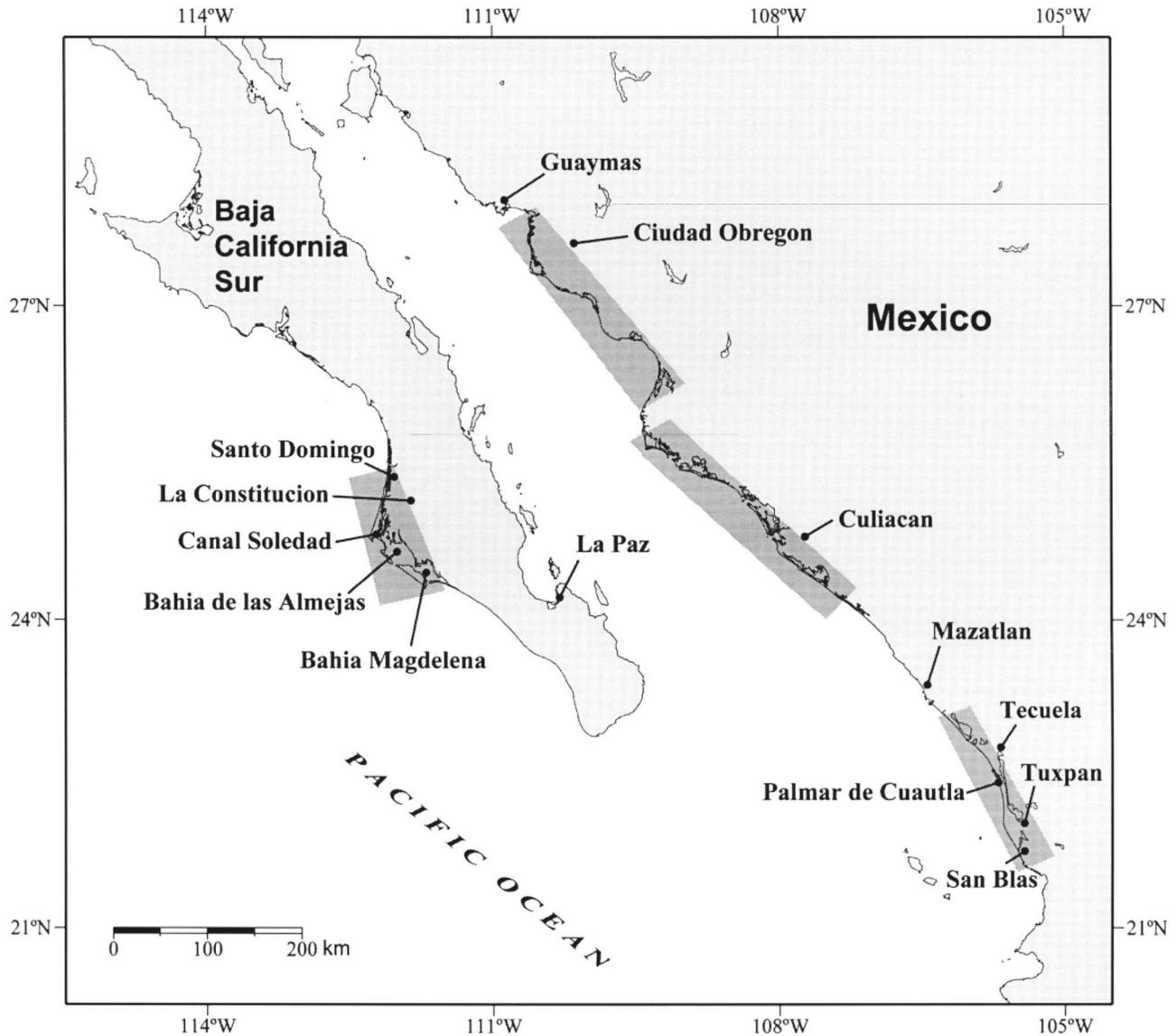


Figure 24.—Shaded areas of the Mexican coast show cockle harvesting regions.

lunchtime and they are hungry, they often eat some mussels that are attached to the aerial prop roots, breaking them open with their teeth to get at the meat. From 70 to 100 cockles/day typically are harvested/person, while the best fishermen may take 110 to 130 cockles/day.

Dealers pay \$0.83–1.00/dozen cockles (\$0.07–\$0.08/cockle), and they sell them to brokers for \$1.00–\$1.17/dozen (\$0.08–\$0.10/cockle). The brokers take them to cities, mainly Guatemala City, the capital, on pickup trucks, using no ice, and sell them whole to restaurants

and retailers. From Las Lisas, the trip to Guatemala City is 130 km and takes 3–4 h. Brokers get them there the day after the cockles are harvested. They also sell cockles to their neighbors, a dozen or two at a time. Dishes of seviche or boiled rice and cockle meats are prepared with them. Markets in Guatemala City also import some cockles from Panama and El Salvador which also arrive on pickup trucks. Upscale restaurants in Guatemala City charge \$4 for small serviches and \$13 each for the largest. In small local markets,

cockles sell for \$1.33–\$2.50/dozen (\$0.10–\$0.21/cockle).

Anadara grandis in Guatemala

Guatemala has a small fishery for *A. grandis*, most being harvested from intertidal flats. In a typical day, each fisherman harvests 1.5–3 dozen and also may net some finfish. In a river near Champerico, five teenage boys were observed harvesting *A. grandis* that were growing along the river bottom at water depths of 2–3 m. The boys, who used a face mask and towed a 2.5 m canoe with



Figure 25.—Young harvesters carry cockles from the boat up a Baja California, Mexico, shore.



Figure 26.—Mexican dealer in La Constitucion, Baja California, Mexico, examines a calendar marked with tide levels to determine when to pick up cockles at the shores.



Figure 27.—A knife is used to crack the edge of an *Anadara tuberculosa* for removal of its upper valve; meats will be served raw on the half-shell with a lime on plate at left in Tuxpan, Mexico.

a light line from their waists, dove to the bottom and felt through the muddy sediments for them with their fingers. When successful, they brought up an *A. grandis* each dive and put it in their canoe (Fig. 29). Each boy usually harvests about two dozen/day and sells them for \$1.70/dozen (\$0.14/cockle).

Near the diving boys, a woman was standing at low tide beside and facing the sloping river bank lined with mangrove trees, the water level being slightly above her waist. She was reaching through the prop roots and harvesting *A. grandis* and *A. tuberculosa* in the muddy bank. She wore two dresses tied tightly at her waist; she put the cockles between the dresses and they collected at her waist.

El Salvador

El Salvador¹⁵ has by far the largest number of cockle fishermen in Central

¹⁵ Information for this section was obtained from interviews of 3–8 people in each village; the principal sources were Maria Guadalupe Moran in Zagote; Maritza Granadeno Climaco in La Herradura; Rosa Castro in Puerto Abalos; Rodrigo Saloman Romero in La Parada; Jose Emilio Martinez and Felix da Jesus Logano Sanchez in Puerto Parada.

America, a total of about 2,850. The major harvesting area is Bahía de Jaquilsisco located near the center of its coast, and about 2,000 people harvest cockles in its mangrove swamps daily. The remaining areas are a lagoon near the city of El Zapote with 200 active fishermen, Estero de Jaltepeque with 350, and the Golfo de Fonseca with 300 (Fig. 30).

Cockle resources in El Salvador are under heavy fishing pressure due to the large number of fishermen, and individual harvests are relatively small. Each adult fisherman usually takes 50–75 cockles/day when the tides remain low, and about 40/day during neap tides or when it rains steadily; the children harvest about half as many. As elsewhere, the fishermen lead a close “hand-to-mouth” existence (Fig. 31).

Many children harvest with their parents. School sessions are arranged so that the children can harvest every day. If the tide is low in the morning, then the school session is in the afternoon. When the tide is low in the afternoon, then school is held in the morning.

Cockles are sold here by the “basket” (60 cockles) rather than by any of the groupings used in the other countries. The dealers pay \$3.00–\$3.80/basket (\$0.05–\$0.06/cockle), and then sell them for \$3.45–\$4.15/basket (\$0.056–\$0.07/cockle).

Individual dealers buy cockles from as few as 10 to as many as 50 harvesters. Most dealers sell the cockles to brokers who ship them to cities, such as San Salvador, the capital, or take them to restaurants. One dealer in La Herradura, near the estuary of Estero de Jaltepeque, purchases cockles from 22 fishermen in Triunfo and 8 fishermen in Puerto Parada. He loans boats and motors to some fishermen so they will sell cockles to him, and he sometimes loans them money a day or two ahead. If the fisherman does not come through with the cockles or return the money, the dealer has to drop him as a seller. His principal markets are 2 restaurants in Acajutla and 5 restaurants in San Salvador; each buys about 200 cockles/day from him. The rest of his customers come to his house and buy 1–2 dozen at a time.

Fishermen from the town of Puerto El Triunfo harvest around the islands

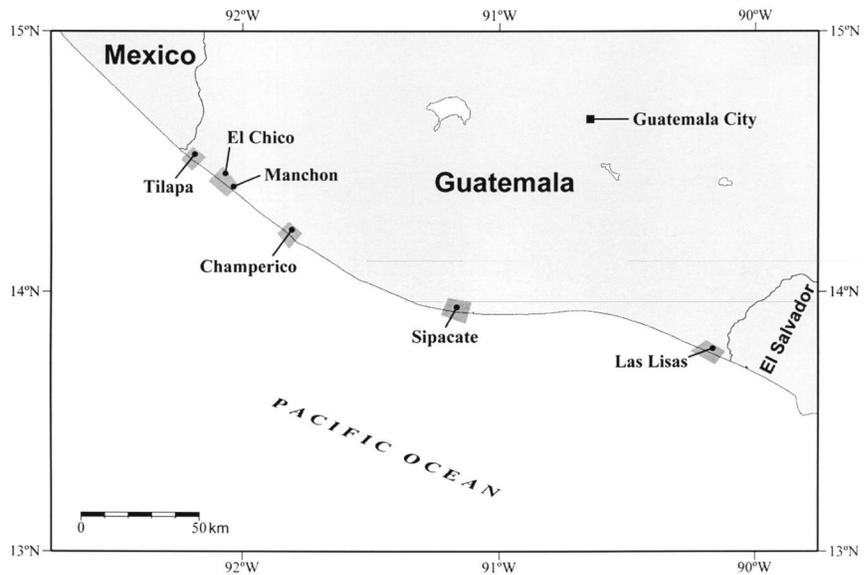


Figure 28.—Guatemala’s Pacific coast showing areas where cockles are harvested.



Figure 29.—A fisherman rests by his canoe after diving for *Anadara grandis* near Champerico, Guatemala.

of Madresal and Isla de Mendes in the Bahía de Jaquilsisco. One major cockle landing site is a large dock, about 8 m wide and 200 m long. The dock is paved, handles trucks, and points into the bay like a large finger. Every day, about 20 dealers (men and women) wait along its sides, each at the same site, for the fishermen to return with their cockles, each buying from 10 to

25 fishermen. Some dealers rent dugout canoes with paddles to the fishermen for \$0.70/day; when more than one fisherman goes in a canoe, they divide the rent cost among themselves. Some of the dealers also loan money to the fishermen 1–2 days in advance. The fishermen return with 1–2 baskets each on most afternoons, but with only about 40 cockles on days with unusually high

tides. The dealers count the cockles into bags and then pay the fishermen at the rate of \$3.50/basket (\$0.06/cockle) (Fig. 32). A typical dealer buys about 25 baskets (1,500 cockles) a day and packs them into 2-bushel bags. Nearly all the cockles are shipped to San Salvador on public buses the following

day. The cockles are loaded onto the buses in the early morning, which leave around 4:30 a.m. to avoid the sun, and arrive 2 h later. The bus driver delivers the cockles and brings back the money to the dealer, who is paid \$4.00/basket for them. The driver charges about \$1.45/bag for this service.

The largest port on the Golfo de Fonseca is La Union. From there and nearby El Salvadorian villages, about 65 boats with 300 fishermen leave to harvest cockles along the gulf's western shores, most of which belong to Honduras. (Some resentment exists among Honduran fishermen about Salvadorian fishermen harvesting cockles in their country.) The immediate area of the city has 13 cockle brokers. One broker buys from 7 dealers, who in turn collectively buy from 20 harvesters. This broker stores the cockles in her house. She pays the dealers \$3.80/basket and sells *A. tuberculosa* for \$4.14/basket and *A. similis* for \$1.72–\$2.07/basket. When the market is slow, she sells the cockles at her purchase price to pay the dealers. With the aid of a hired man, she takes the cockles in bags, which hold as many as two bushels, to markets in San Miguel and San Salvador on public buses. After she returns with the money, she pays the dealers for them.

Of the one of several small-scale cockle merchants in the coastal villages, the one in Huisquil, about 3 km north of La Union, buys cockles from her hus-

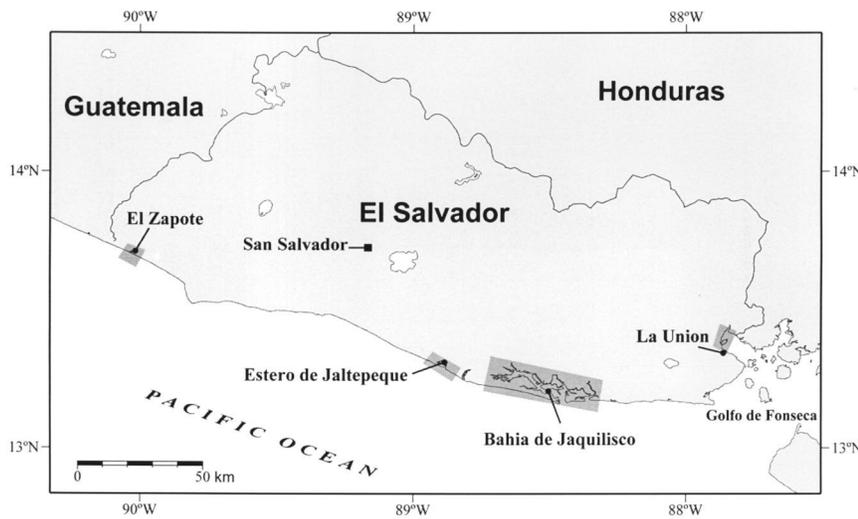


Figure 30.—El Salvador's cockle harvesting areas.



Figure 31.—Three El Salvador fishermen walk to a dealer to sell their bagged cockle harvests. They will purchase their daily food with the money they receive.

band and two other fishermen. During the day, she sells them at her stand in an open-air market in La Union, walking there and back with one or two of her six children who help to carry them.

Honduras

Honduras¹⁶ has a cockle fishery in the Golfo de Fonseca (Fig. 33). Sections of the coastlines of El Salvador, Honduras, and Nicaragua border on the gulf, but about 80% of its shoreline is in Honduras. The principal areas for harvesting cockles are the mangrove swamps

¹⁶ Information for this section was obtained from 3 to 8 people in each village; the principal sources were Carlos Antonio Reina in Cedeno; Richard Alvarez, Santo Teodoro Alvarez, Carlos Ivan Cabrera, Luis Alberto Alvarez, Jose Manuel Montoya, and Salvador Rodriguez Ortiz in Guapinol; Sonia Patricia Carcamo and Sulma Marisol Carcamo in Punta Raton; Jose Fuentes, Imperitris Fuentes, Natividad Vasques, and Felicitita Flores Ziniga in Pueblo Nuevo; Maria Ernestrina Amador, Marlon Flores, Federico Pastrana, Romunda Posada, and Fausto Flores Sanchez in San Lorenzo; Maria Elsa Chirinos in Los Guatales; Jose Vaca in Los Langues; and Aureliano Avila, Maritzo Corales, Filomon Gonzales, and Rafael Rivas Gonzales in Puerto Grande. The principal sources in Huisquil, El Salvador were Thomas Contreras, Zapatos Garbales, and Maria Teofila Granados.

surrounding Bahia Chismuyo and those continuous with it to the south and west that border on the Bahia de La Union near the El Salvadorean border. Other less productive areas are the mangroves on the northwest side of Bahia de San Lorenzo and those on the east side of the Golfo de Fonseca in the Pueblo Nuevo-Cedeno area.

About 225 Honduran fishermen, besides nearly all the 300 fishermen from the La Union-Huisquil area in El Salvador, harvest cockles daily in the Honduran mangrove swamps. The fishermen live in various villages around the gulf, and as many as 30–50 Honduran fishermen live in each of the largest villages, such as Puerto Grande, Punta Raton, Pueblo Nuevo, and Cedeno, and the coastal edge of the city of San Lorenzo (Fig. 34).

The regular fishermen harvest cockles 5–7 days a week, while some others harvest as few as 1–2 days a week. Their harvests usually are relatively small, 30–50 cockles/day, but some fishermen gather as many as 100/day. The harvests consist of *A. tuberculosa* and *A. similis*, but not *A. grandis*, which is now pro-

tected because it has become extremely scarce. Fishermen receive about \$0.04/cockle except in March and April when they can get as much as \$0.07/cockle. On most days, a typical fisherman earns from \$1.00 to \$1.50.

The cockle harvests were larger before Hurricane Mitch in 1998. Individual cockle harvests were 200–300/day and included some *A. grandis*.

Most fishermen go to the mangrove areas in canoes or pongos, but some go on foot. In addition, some beginners with no boats have had to swim across rivers as wide as 200 m to reach harvesting areas on the opposite side. If a small group, such as a family, does not own a canoe, which costs \$100 new and can last 12 years, it pays about \$10.00/month to rent one. Fishermen who go in a pongo usually travel with its owner who serves as a chauffeur. Some harvesters are barefoot, while others use low rubber boots, that are tied at their ankles; some use thin rubber gloves to protect their hands from cuts. To repel insects some fishermen wear long-sleeve shirts, and adult males often smoke cigars (which cost \$0.17 each),



Figure 32.—An El Salvador cockle dealer counts the harvest into her bag while the fisherman counts with her.

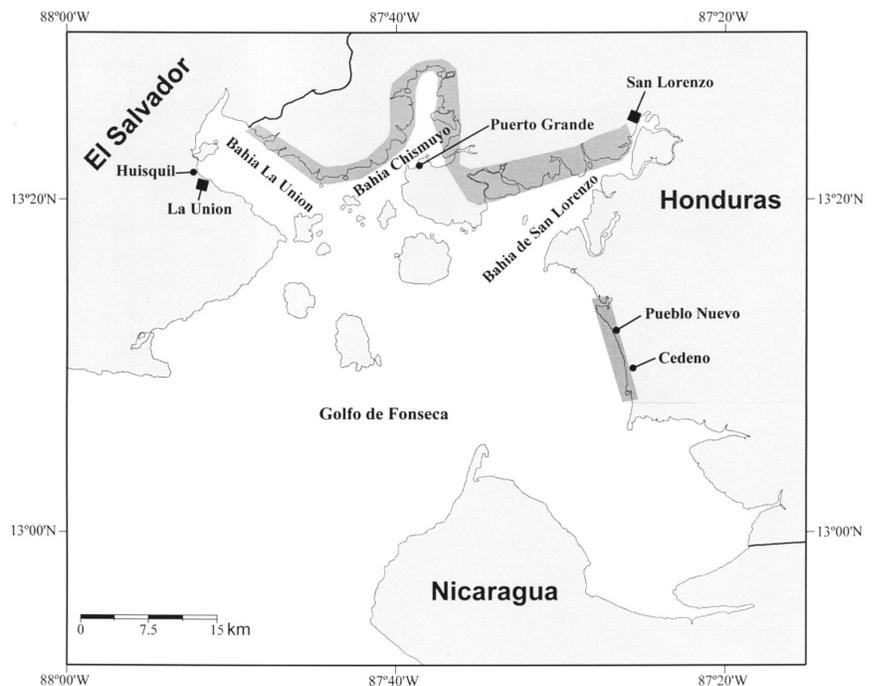


Figure 33.—Cockle harvesting areas in the Golfo De Fonseca coastline of Honduras and (partially) El Salvador and Nicaragua.



Figure 34.— A gathering of Honduran villagers answering questions about their lives. The author's interpreter (arrow) relays questions and answers.

while others burn bundles of small palm branches or dry cow and horse manure which is held in one hand while they harvest with the other.

As a consequence of Hurricane Mitch, some fishermen have found cockles so scarce in their local swamps that they move about in groups seeking more productive ones. One group of about 15 men, 16–35 years of age, from San Lorenzo had set up a camp in a field near Cedeno 30 km south of that city. They slept in hammocks hung between trees and in primitive huts they had built. They cooked their food by setting five rocks on the ground, setting fire to wood they placed on them, and holding a pan with food over it. A woman from the neighborhood set up a stove to cook tortillas which she sold to them. When the group had no food or money, they knocked mangoes out of trees, *Mangifera* sp., in the camping area to eat. Each man harvested cockles 3–4 days/week, going in groups in canoes to the mangrove swamps.

Hondurans do not eat many cockles, and they are displayed only sparingly by produce vendors on their street and market stands. Fishermen eat cockles once in a while. The cockles are sold to dealers, who take them on pickup trucks to market outlets mainly in Tegucigalpa,

the capital, but many are sold in El Salvador. One buyer in Puerto Grande buys fish and shrimp for 6 months of the year and 750–1,000 cockles/day year-round. He delivers the fish and shrimp to a processing plant in Choluteca, 64 km away, every 2–3 days, and delivers the cockles in bags holding 400–500 to the central market in Tegucigalpa, 115 km away. He operates a small grocery store which occupies a room facing the street in his stucco house to enhance his income.

The main building of the huge central market in Tegucigalpa is divided into sections, with each section specializing in certain foods and other items. The tiny cockle section consists of four small restaurants, two on either side of a walkway. Each has 3–4 tables for serving customers and a bench placed alongside the walkway for holding 1–2 dishes of cockles, limes, and a couple of knives; all tables and benches in each are painted green. During June 2000, the restaurants purchased cockles from dealers for \$48/1,000 (\$0.048/cockle). They charged \$1.70–\$2.00/plate of 12–14 cockles on the half-shell (about \$0.14/cockle), and each sold 20–30 such plates/day

Effects of Shrimp Farms

During the 1980's and 1990's, about 185 small and medium-sized shrimp

farms and 38 large ones were established around the Golfo de Fonseca, mainly in its eastern half (Fig. 35). In 1999, the farms had 15,700 ha of ponds, and they produced 7,124 t of shrimp (Morales¹⁷).

The gulf has about 155,000 ha of mangrove swamps, of which the shrimp farms have developed 20,000 ha or about 13%. Of that, 2,000–3,000 ha were cockle habitat. Government officials had informed the local people that the demand for high priced shrimp in the United States was strong, and so some mangrove swamps had to be sacrificed to build shrimp ponds. In recent years, the shrimp farmers have been trying to protect the remaining mangroves in part by constructing their ponds on higher grounds on which different tree species grow (Mendoza¹⁸).

While construction of the shrimp farms has led to some habitat losses (and consequent fishing opportunities) for such commercial species as cockles and crabs, the farms have hired some local people to work for them. The farm workers are paid \$3.78–\$4.13/day; the legal minimum wage in Honduras is \$3.44/day.

Environmental Support Groups

The Honduran government and a private company sponsor three agencies which have been active in protecting and enhancing mangrove swamps and cockles (preserve-the-environment awareness is prevalent in Central America). One is Promangle, a government office, established in 1998 to promote mangrove conservation and management in the Golfo de Fonseca to counter the environmental devastation caused by Hurricane Mitch, which also destroyed many villagers' homes. Since "Mitch," the villagers have cut down some mangrove trees to be used for house construction and fuel. Promangle has encouraged people to use other types of wood, and has planted other tree species which can be used for wood. In 2000, Promangle, with assistance from villagers, replanted 150–160 ha of mangroves (Mendoza¹⁸).

¹⁷ Morales, Luis, Honduras Oficina de La Pesca, Tegucigalpa, Honduras.

¹⁸ Mendoza, Carlos V., Agronomy Engineer, Promangle, Honduras.

Another Federal agency is Progolfo, while “CODDEFFAGOLF” (Comite para la Defensa y Desarrollo de la Flora y Fauna del Golfo de Fonseca [Committee for the Protection and Development of the Flora and Fauna of the Gulf of Fonseca]) is a private agency. The goals of the three agencies somewhat overlap, and among them they attempt to 1) teach the fishermen to protect the mangroves, 2) work with the shrimp farms to achieve the least environmental damage, 3) help the fishermen write proposals to groups offering development money, and 4) recommend new government laws and rules to improve the finfish and cockle economies.

Nicaragua

Fishermen in Nicaragua¹⁹ harvest *A. tuberculosa* and *A. similis* in Estero Real which faces the Golfo de Fonseca, and in about six small estuaries along the Pacific coast (Fig. 36). About 160 fishermen harvest cockles daily in the country: 30 in Estero Real, 60 in Estero Padre Ramos, 30 in Bahia de Corinto, 10 in Puerto Sandino, and perhaps 30 in all remaining estuaries combined. Each fisherman harvests 120–475 cockles/day. They usually walk them to a dealer’s house who then sends them on pickup trucks to markets in towns and cities, such as Managua, the capital. The dealers pay US\$0.36–\$0.39/dozen (\$0.030–\$0.033/cockle) for them. The cockles are sold in central markets, along city streets, in many small roadside eating stands, and also in city restaurants, which use them in seviche. One restaurant sold seviches with 6 cockle meats for \$1.95, while another more upscale restaurant in a hotel sold seviches with 12 cockle meats for \$4.50.

Costa Rica

The principal *A. tuberculosa* and *A. similis* harvesting areas in Costa Rica²⁰

¹⁹ This section was condensed from a previous paper by MacKenzie (1997).

²⁰ Information for this section was obtained from interviews of 3–8 people in each village; the principal sources were Dr. Jose A. Vargas Z, University De Costa Rica, San Jose; Navidad Urena Moraga in Chomas; Jaime Gonzales in Palmar Norte; Rodrigo Benavidez in Ciudad Cortez; Jose Antonio Araya Abarca in the Sierpe area; Francisco Chavez Mariano Barquero and Elias Rodriguez in Golfito; and Huber Gonzalez, Inopesca Office in Golfito.



Figure 35.—A shrimp farm (middle) and mangrove swamps and canals (foreground) in Ecuador.

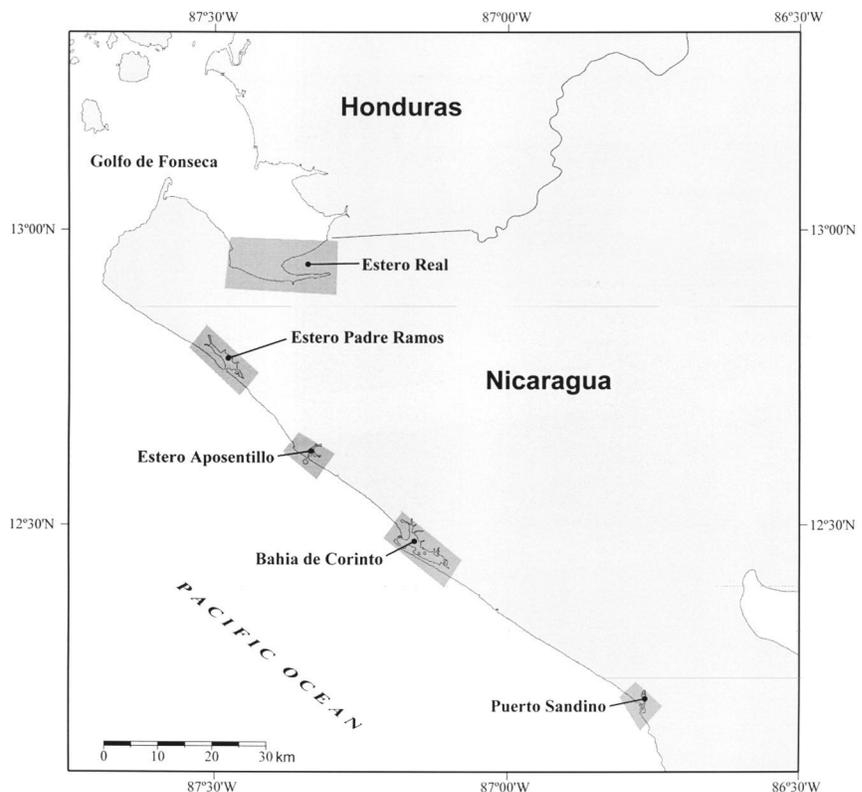


Figure 36.—Pacific coast cockle harvesting areas of Nicaragua.

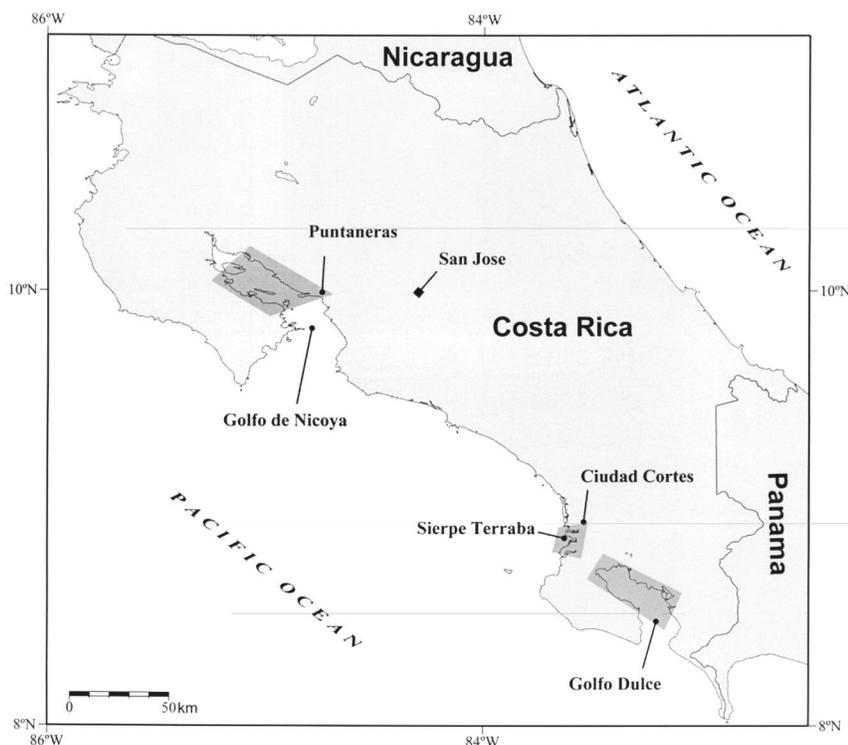


Figure 37.—Cockle harvesting areas in Costa Rica.

are the Golfo de Nicoya, Sierpe-Terraba, and Golfo Dulce (Fig. 37). About 200 fishermen harvest cockles around the Golfo de Nicoya, and 300 harvest them in Sierpe-Terraba and Golfo Dulce combined, for a total of about 500 cockle fishermen in the country. The fishermen's children harvest cockles whenever schools are not in session, and they eventually leave school and harvest cockles full time, with their parents, when they are 10–13 years old. Each fisherman harvests from 145 to 500 cockles/day, while each family of 3–5 members harvests about 700 cockles/day. Dealers pay \$0.29–\$0.38/dozen cockles (\$0.024–\$0.032/cockle).

About 15 families and some individuals, totaling 30–40 people, harvest cockles in the village of Chomes, just north of Puntarenas on the northeast side of the Golfo de Nicoya. Each fisherman harvests 200–350 cockles/day. One, a housewife, harvests cockles by herself 7 days/week. She walks to the shore, paddles her canoe to a harvesting site, and collects the cockles in a plastic bucket (Fig. 38). Later, at home she puts

them in an onion sack on the days she is going to sell them. Each week, she sells the cockles she collected in 4 days and retains those taken the other 3 days to prepare for her family (which includes her husband and four children) to eat at home. The cockles are eaten for lunch and dinner and are prepared three ways: 1) boiled with rice, 2) in seviche, and 3) in soup. For variety, her family also eats finfish and chicken with the staple rice. A dealer comes to her house in a pickup truck to purchase her cockles on Wednesdays and Saturdays, paying her \$4.00/100 cockles (\$0.04/cockle). Market demand is strongest from November through April, the dry season.

Some fishermen live long distances from good cockle areas and must travel and camp out for a few days while harvesting. One fisherman in the small community of Purrujas near Golfito does this 3–4 times a month with 1–2 of his sons. They travel to good sites in their motor-powered canoe, live in a primitive camp on high ground near the mangrove swamps, and gather cockles daily during low tides. They remain

there for 4 days each time subsisting on rice, beans, and spaghetti, with each person harvesting 200–250 cockles/day. They keep the cockles fresh by holding them in net bags set in the mud in the mangroves where the water can cover them during high tides. A small quantity is set aside to eat at home, and a dealer comes to their house weekly to purchase the remainder, paying \$0.36/dozen cockles (\$0.03/cockle).

Some Costa Rican dealers shuck the cockles, selling the meats and giving the blood separately to restaurants and fish markets sparing them that task. As mentioned, the dealers in most other countries sell whole cockles. One dealer in Ciudad Cortez opens cockles in a shed located on a high bank off the Grande de Terraba River. He has a marble-topped table about 3 m long and 2 m wide. He and his helper each use a “knife,” about 7 cm wide and 5 cm high, that is fastened to wooden block on the edge of the table. They put the edge of each cockle on the knife, hit them with a wooden hammer to open them, and then remove their meat with their fingers and put them in a bucket with ice. The cockles' blood runs down the sides of the knives, then into a groove in the table top, and finally collects in a bucket on the floor. The shells are discarded down the bank. The meats are counted into plastic bags, either 100 or 500 meats/bag (Fig. 39), and the blood is poured into plastic bags, about 500 ml/bag. Both are placed in a refrigerator. The meats and blood are taken about 200 km to San Jose, the capital, in a cooler on a pickup truck.

In Costa Rica, about 90% of the cockle meats are served in seviche, with the rest as whole meats boiled with rice. The selling price for a seviche with cockle meat is \$2.00–\$3.60, depending on its size (a large seviche has about 30 meats mixed with an equal volume of condiments). The selling price of cockle meats with rice is \$2.40 for a medium portion and \$3.60 for a large portion (about 2 large cups of rice and 12 cockle meats). Cockle blood can be added to seviche with the meats, onions, and spices, or drunk as seviche juice. Served in small glasses, seviche juice is sold in bars for \$0.50 a glass to be drunk with beer. It consists of cockle blood, lime



Figure 38.—The hands of a female Costa Rican cockle harvester who probes in the mud only with her right hand, scarred from the activity.

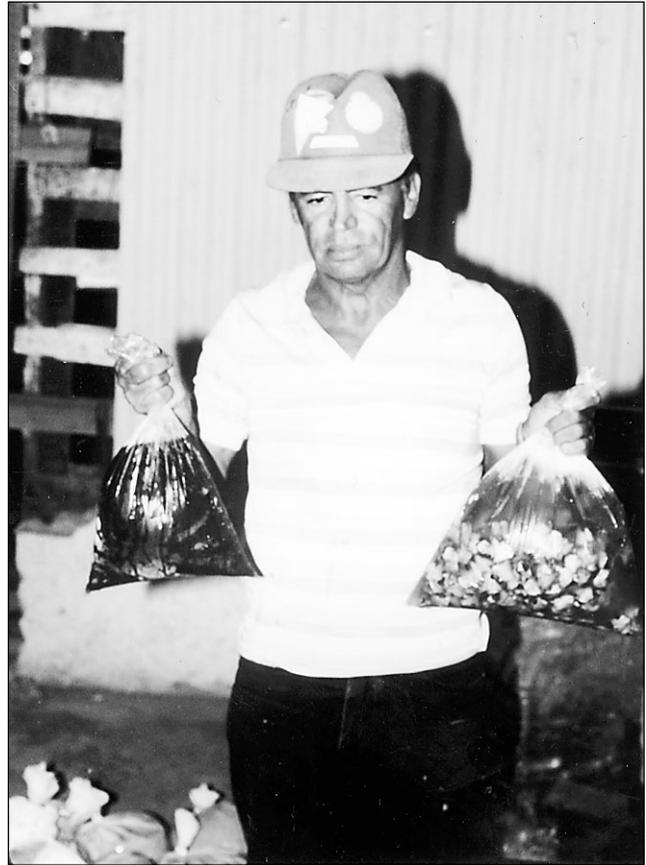


Figure 39.—Bags of blood (L) and meats (R) of *Anadara tuberculosa* ready for transport to San Jose, Costa Rica.

juice, onion, chile peppers, and tabasco sauce. Male bar patrons believe the juice increases their virility.

Panama

The principal *A. tuberculosa* and *A. similis* harvesting areas in Panama²¹ are between the border with Costa Rica and the Peninsula de Azuero (Fig. 40). About 220 cockle fishermen harvest daily in the country: 125 in Bahia de Muertos and Boca San Pedro in the David area, 6 in the Santa Cruz area, 10 in the Gualaba area, 20 in the Golfo de Montijo, 12 in Mensabe port, and 20 in Bahia de Charme. Each fisherman in the David

area gathers 180–240 cockles/day, while in other areas, less-intensely harvested, about 480–600/day are taken. Dealers pay \$0.20–\$0.25/dozen (\$0.017–\$0.02/cockle) for them.

One dealer in the David area sells cockle meats and has the cockles shucked by a team of three. Harvesters from Isla Savilla and Isla Mono bring their cockles to him in net bags, 50 dozen/bag. When 4 such fishermen delivered 10 such bags to this dealer, the first shucker lowered the bags, one at a time, into a tub of boiling water for a couple of minutes to kill the cockles and make them easy to open and then lifted them onto a table (Fig. 41). The second person, standing beside the table, opened the cockles using a hatchet (Fig. 42), and the third person standing alongside removed their meats with his fingers and put them in a large bowl. The 10 bags were processed in 2.5 h. The meats were packaged in 1 lb bags, chilled, and then delivered to mar-

kets. One market, two blocks away, purchased about 25 bags of meats a week from the dealer for \$1.25–\$1.75/bag and resold them for \$2.00 each. A large store in Santiago retailed cockle meats for \$2.50–\$2.75/pound.

In Panama, cockles are eaten in 1) seviche; 2) a dish with tomato sauce and garlic; 3) soup; and 4) dishes called wacho (rice, beans, tomato, and cockle meat with spices) and sancocho (corn, potatoes, onions, and cockle meats, but usually chicken). In restaurants, a small seviche with five cockle meats sells for \$1.50–\$1.75, while a regular-sized seviche sells for \$2.50–\$3.00.

Anadara grandis in Panama

Fishermen harvest *A. grandis* to a small extent in Panama including in the Archipelago de las Perlas (MacKenzie, 1999). Its local name is cocaleca, and children remove them from muddy-sand areas during extremely low tides for consumption at home.

²¹ Information for this section was obtained from interviews of 3–8 people in each village; the principal sources were Jose Valerde and Wilfredo Pinto in Charme; Eustorgio and Emelida Florez in the Golfo de Montijo area; Victoriana Rodriguez in Quebala; Maria Isabel Carrillo, Obidio Domingoes Concepcion, Yajarra Valdez, and Alvin Vega in Chirique; Ladislao Montenegro in the Santa Cruz area; Rufina Montenegro, and Hugo and Isabel Marisqueria in the David area.

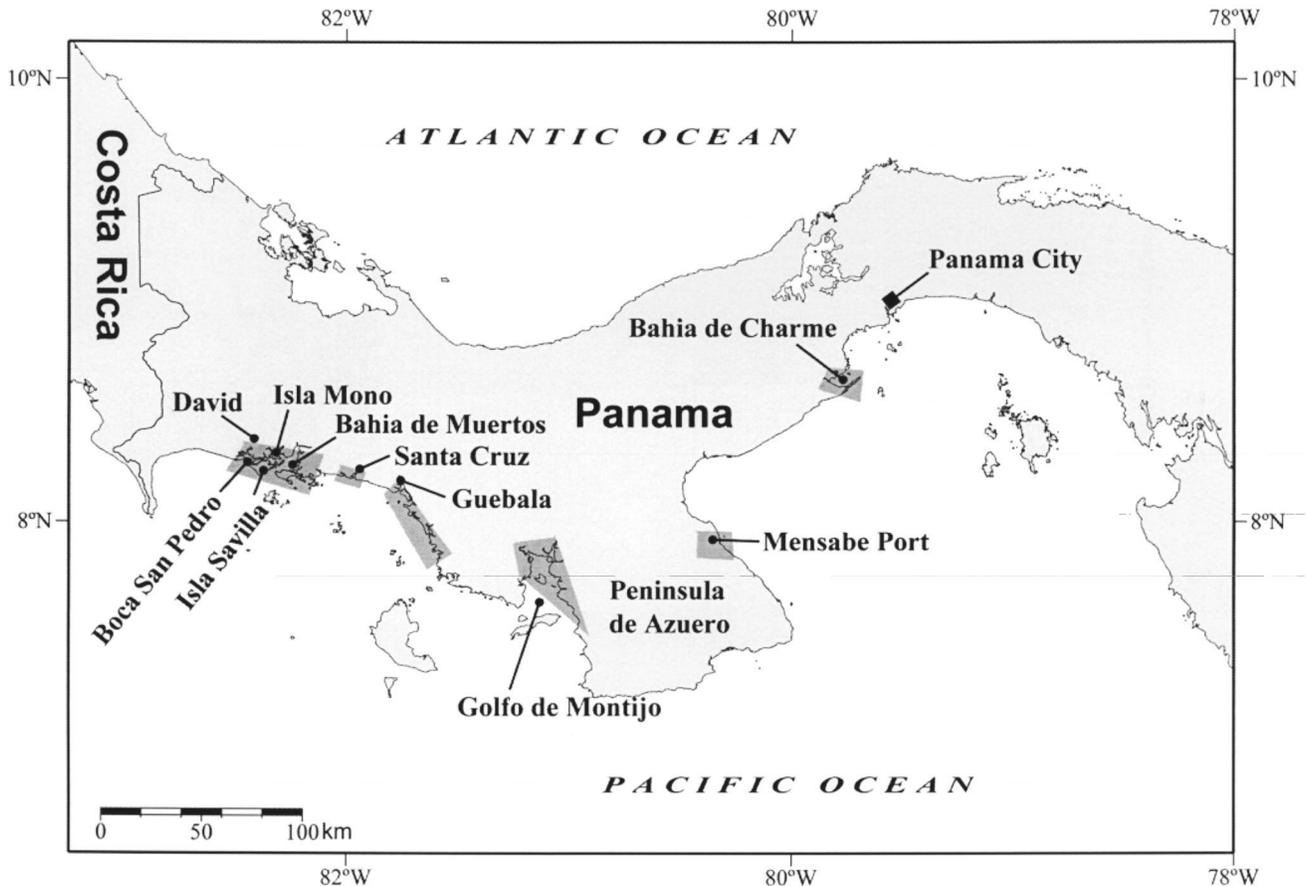


Figure 40.—Cockle harvesting areas in Panama.

Colombia

Colombia²² may have more cockle fishermen than any country except Ecuador, but a country-wide census of them has yet to be made. Cockles occur in mangrove swamps from Cabo Corrientes to the border with Ecuador (Fig. 43). In Tumaco and Mosquera, 2 towns in the southernmost mangrove area, about 800 families, with 4–5 people in each for a total of nearly 4,000 people, are engaged in the fishery. The fishermen are mainly women and children who paddle to the harvesting areas in canoes. They harvest throughout the year, but the demand is strongest in December and during Semana Santa, the

week before Easter in April (Ardila and Cantera, 1988). Each family harvests 4–5 days a week (Ardila and Cantera, 1988) and about 23 days a month (Plaza¹¹). The average daily harvest is about 215 cockles/person, but ranges from 50 to 350 cockles/person (Plaza¹¹). Cockles are an important food for the coastal people and a common species in markets. Any excess cockle harvest is held in small palm-frond houses (“piangua houses”) set in the mud in intertidal areas (Squires et al., 1975). The number of cockle fishermen from Cabo Corrientes to the city of Buenaventura, a distance of about 200 km, has not been censused (Plaza¹¹).

Squires et al. (1975) said that in 1971, about 36 t of cockles (20,000 cockles/t) were recorded in markets in the port city of Buenaventura, and an additional 36 t were shipped from Buenaventura to inland towns and the city of Cali. At

Tumaco, 44 t were exported to Ecuador and almost as many were estimated to have been sold to residents in and around Thymic, Colombia. The total marketed was at least 150 t, and a similar quantity may have been eaten by the coastal villagers. The total 1971 harvest was estimated at 300 t (6 million cockles). Artilla and Cantera (1988) said that local people prepare cockles for eating as they do in other countries, i.e. in seviche and as cooked meats in rice or soup. They also said *A. tuberculosa* is the species shipped to Ecuadorean markets. *A. similis* does not live long enough.

In describing the poverty of the Colombian fishermen, Plaza¹¹ said that some relief would follow if they could be provided with outboard motors for their canoes. This would enable many to harvest in more remote areas where cockle stocks are relatively large, thereby increasing harvests for everyone.

²² The information for this section was obtained from papers by Squires et al. (1975) and Ardila and Cantera (1988), and a telephone interview with O. Gustavo Plaza who is with Alcaldia Municipal de Tumaco, Colombia, in January, 2000.

Ecuador

Ecuador²³ has the largest number of cockle fishermen, estimated at 5,055, in Latin America (except perhaps Colombia). About 4,000 fishermen harvest in the Esmeraldas Archipelago area near the Colombian border, 130 in the Muisne-Canaveral area, 35 in the Sabana Grande-El Moro area, 90 on Isla Puna, and 800 in the Archipelago de Jambeli close to Peru (Fig. 44). As elsewhere, *A. tuberculosa* exceeds *A. similis* in landings: A late 1990's survey by Santos et al. (1998) found the percentage of *A. tuberculosa* landed was 92 in El Moro, 80 in Puerto Bolivar, and 55 in Puerto Jeli. In recent years, the unrestricted entry of people into this fishery has generated great pressure on Ecuador's cockle resources (Rosero and Burgos, 1999).

The prices paid for cockles are strongly influenced by transportation costs from the harvesting areas to the principal markets of Guayaquil and Quito, the capital (Santos and Villon, 1998). In 1999, for example, the cockle fishermen in the Archipelago de Jambeli area, located just 180 km from Guayaquil, were paid 3–5 times more for cockles than the harvesters in the Esmeraldas Archipelago, the most distant location from the main markets. Transportation from the Esmeraldas Archipelago requires an 80 km boat trip to the city of Esmeraldas, then a transfer to trucks, followed by an overland drive of 375 km to Guayaquil.

The Esmeraldas Archipelago area is comprised of an island group and mainland shores with many creeks and canals, all at least partially lined with mangrove swamps. Some swamps have been de-

²³ Information for this section was obtained from interviews of 5–10 people in each village; the principal sources were Pedro Apolinario, Antonio Arroyo, and Nircharror Garcia in Puerto Sabana Grande; Juan Garcia Georgie Lino in Puerto Morro; Filipe Medina, Euro Castro, Mauro Cruz, Pluto Torrez, and Andre Sanchez in Isla Puna; Herminizo Madrid, Uberliza Bustos, Estela Luque, Enrique Ford, and Ludy Garafalo Monte on El Balito Island; Maritza Segura on Tambillo Island; Ramon Arteaga and Oscar Regifo in Canaveral; David Cruz, Euprene Cruz, Fabricio Escobar, Nicolas Espinosa, Juan Fernando Jaramillo, Maximo Vivero in Puerto Bolivar; Francisco Solano, and Nemesio Soriano in Puerto Jeli; and Florentino Mayon and Manual Palaez in Puerto Huattaco.



Figure 41.—Hot-dipping cockles (L) and shucking them (far R) in Panama.



Figure 42.—Opening cockles with a hatchet (L) and removing the meats (R) after they were hot dipped in Panama.

stroyed to construct shrimp farms, but the area is an environmental reserve and so the government has tried to halt any further spread of shrimp farms. The mangrove swamps constitute about 16,400 hectares (Santos and Villon, 1998).

The cockle fishermen, who range in age from 7 into the 50's, live in villages on the islands and the mainland. Most are women and children; while some men harvest cockles, most catch finfish and shrimp, or seed shrimp (juveniles)

for the shrimp farms. The fishermen harvest cockles year-round, 6 days a week, but not on Sundays. They use canoes with paddles and pongos with motors of 8–40 hp to reach the harvesting areas. If fishermen do not own a boat, they pay boat owners 25 cockles or an equivalent amount in money to chauffeur them to and from the harvesting areas (Santos and Villon, 1998).

Many fishermen wear gloves on their hands and carry a bundle of burning co-

conut leaves in one hand to repel insects while harvesting with the other. Each harvests 100–300 cockles/day. They keep some small *A. tuberculosa* and some *A. similis* to eat at home in sevice and soup, and sell the rest to dealers in the villages.

Each Esmeraldas dealer buys cockles from 10 to 20 fishermen, paying \$1.05–\$1.25/100 *A. tuberculosa* (\$0.01–\$0.013/cockle) and selling them for \$1.25–\$1.50/100 (\$0.013–\$0.015/cockle). Dealers pay \$0.50–\$0.75/100 *A. similis* (\$0.005–\$0.008/cockle). Each fisherman usually averages slightly over \$3.00 a day in sales. Dealers ship the cockles mainly to Guayaquil and Quito via the city of Esmeraldas. Large cockle imports from Colombia through the city of Esmeraldas compete with Ecuadorean cockles and reduce their prices in the main markets. The principal market for imported Colombian cockles is Guayaquil (Santos and Villon, 1998).

The Canaveral area, 90 km southwest of the city of Esmeraldas, has about 50 cockle fishermen, who harvest 6 days a week, each gathering 100–150 cockles/day. Dealers pay them about \$1.55/100 cockles (\$0.016/cockle).

Puna Island, 50 km long and 25 km in breadth, lies near the center of the Golfo de Guayaquil and is 45 km due south of Guayaquil. A large 17 × 17 km mangrove swamp, with at least four islands and several canals, is situated near the center of its east side. Campo Alegre is the largest village on the island, and about 80% of its workers, all males aged 8–70, harvest cockles in the swamp. They go about 20 days/month, year-round, and each usually takes 125–250 cockles/day. The dealers pay them about \$1.90/100 cockles (\$0.019/cockle), so they earn \$2.50–\$4.40/day. The dealers pay \$0.65/bag (3,000–4,000 cockles) to have the cockles trucked from the village several km over an unpaved road to a shore location and an additional \$0.65/bag to have a fiberglass boat take them to the mainland port of Posorja. From there, the cockles are trucked 130 km to Guayaquil for sale, mainly at the fish market in Mercado Sur.

The group of islands called the Archipiélago de Jambeli, 40 × 10 km in length and breadth, lies next to the shore on the

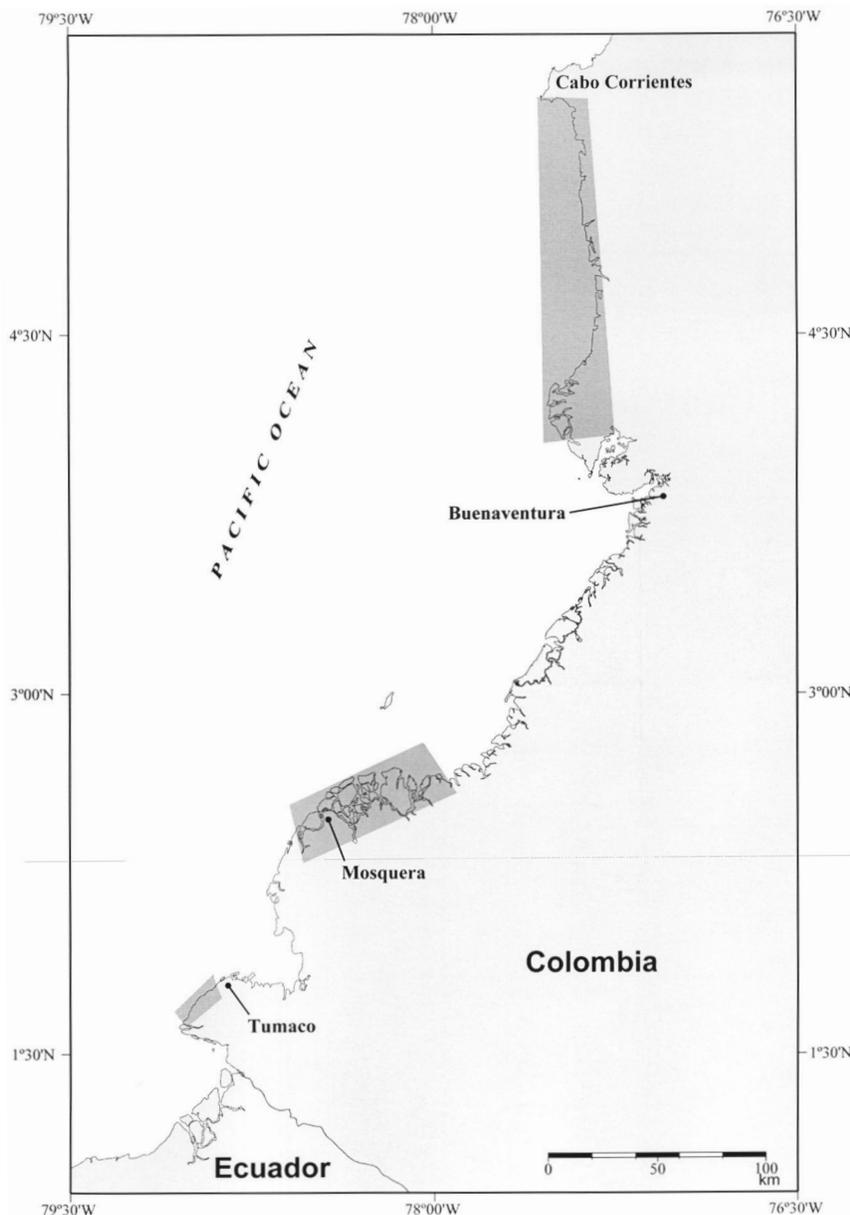


Figure 43.—A section of Colombia's Pacific coast showing cockle harvesting areas.

lower east side of the Golfo de Guayaquil. Lining the shores of the islands and many long canals are mangrove swamps with cockles. At least 7 villages on the islands are supported largely by cockle harvesting. Nearly 500 cockle fishermen, children included, reside on the archipelago, and at least 300 additional adult cockle harvesters travel there daily from 3 mainland ports, Puerto Bolivar, Puerto Jeli, and Puerto Hualtaco, which face the archipelago. Many of the 300 additional harvesters (Fig. 45) are migrants whose former harvesting areas to the north were destroyed during the 1980's and 1990's by shrimp farm construction (Altamirano et al., 1998). Other fisheries take crabs with traps, demersal finfish (covina, bagre, and pompano), and large pelagic finfish throughout the year (Santos and Villon, 1998).

Cockle and crab fishermen, nearly all adult males, from the mainland ports ride to the harvesting areas on 7.3-m fiberglass boats propelled by outboard motors; each boat carries as many as 22 harvesters to and from the harvesting areas. Some go to the archipelago and camp for 2–4 days while harvesting. Cockle harvests there also continue year-round, 6 days a week.

The usual daily harvest is about 200 *A. tuberculosa* and *A. similis*/fisherman. About 20 dealers each purchase between 2,000 and 20,000 cockles daily (Altamirano et al., 1998), paying \$3.50–\$5.00/100 *A. tuberculosa* (\$0.035–\$0.05/cockle). Most cockles are sold in Guayaquil while some go to Quito, and others go to the nearby city of Machala and other nearby population centers, i.e. Pasaja, Santa Rosa, Arenillas, and Huaquillas.

Anadara grandis in Ecuador

Small quantities of *A. grandis* are harvested in Ecuador. The fishermen are paid about \$0.16 each for them, and they are sold alongside *A. tuberculosa* and *A. similis* in roadside markets and the fish market in Mercado Sur in Guayaquil.

Southern Ecuadorean Markets

The fish market in Guayaquil is part of a large market called Mercado Sur located near the city's waterfront. Trucks deliver finfish, shrimp, cockles,

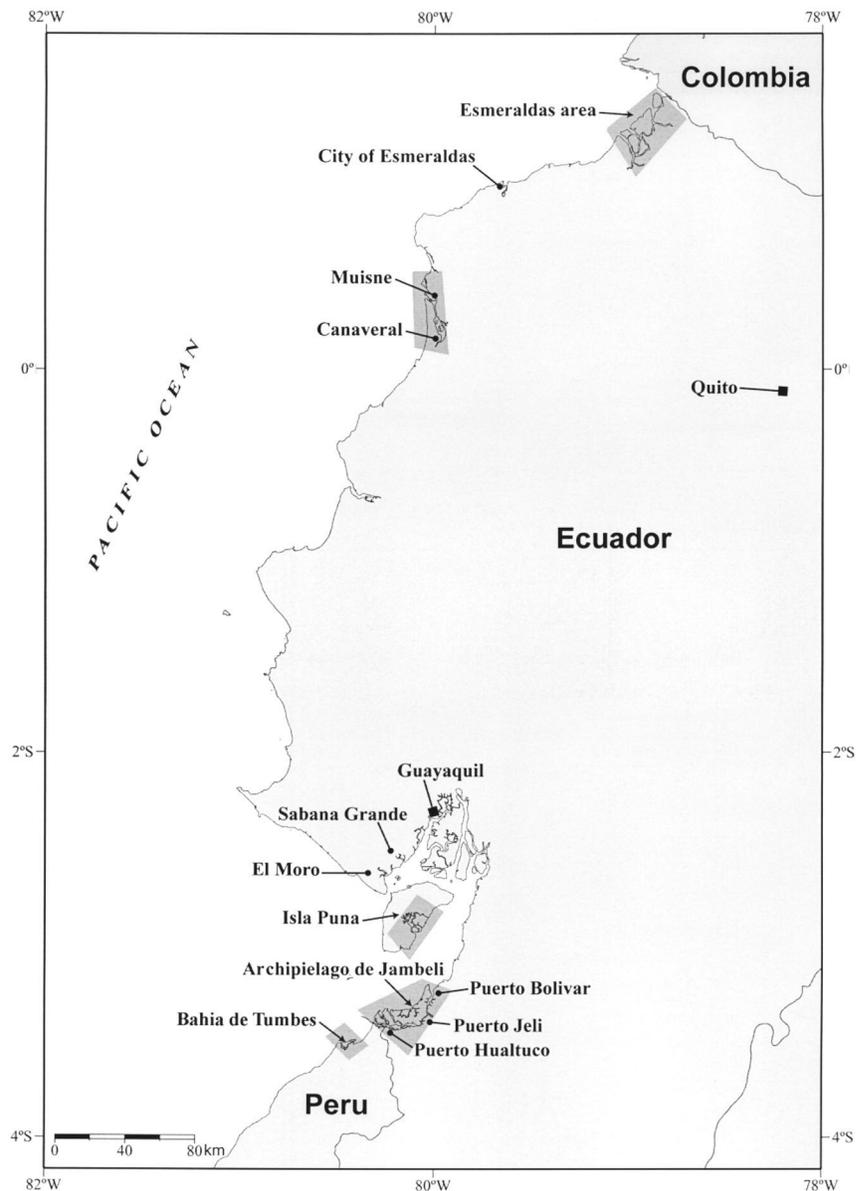


Figure 44.—Cockle harvesting areas in Ecuador and northern Peru.

and crabs from dealers in various Ecuadorean villages and ports to merchants at around 3 a.m. every morning except on Sundays. Some cockles also come in from Colombia and Peru. The merchants' produce stands line both sides of the main street, and some are within nearby buildings (Fig. 46). Cockles are sold within an area of about 1.5 blocks. Each of the larger merchants purchases bags of 3,000–4,000 cockles for \$60 (about \$0.016/cockle). During the day, they remain by their stands to

serve customers (Fig. 47 a,b), charging about \$0.062/25 cockles (\$0.025 each) for most cockles but \$0.05 each for the largest.

Individual merchants usually sell from 1,500 to 2,000 *A. tuberculosa* and *A. similis*/day during the week, but their sales increase to about 3,000 cockles on Saturdays because Ecuadoreans have a tradition of eating seviche, many made with cockles, every Saturday. A few of the smallest merchants at the edges of the main area each sell about 500

cockles/day, earning \$1.25, or enough to largely pay for their meals. The cockles remain alive for 3–4 days in the market.

Shrimp Farm Effects in Ecuador

Shrimp farming developed in Ecuador mostly during the 1980's and 1990's and is far more extensive there than in any other country of the Americas. According to Rosero², about 178,000 ha of coastal areas in Ecuador now are covered with shrimp ponds: About 49,000 ha were once pristine mangroves (27.5%), 83,000 ha (46.4%) were con-

structed on high ground, and 46,000 ha (26.1%) were constructed where salt beaches existed (Fig. 48). The ponds range from 10 to 20 ha in area and, in mangrove areas, were constructed after first removing large areas of mangrove swamps while leaving intact the mangrove fringes along the estuarine edges to protect the ponds from storm surges. Bravo and Abarca²⁴ said about 50% of

²⁴ Bravo, M., and N. Abarca. Undated. Potential of concha prieta (*Anadara tuberculosa*) in polyculture with white shrimp (*Panaeus varmamei*). Unpublished manuscript.

the shrimp farms located in the mangrove swamps had harbored cockles.

The shores of the Golfo de Guayaquil have 60% of the shrimp farms and are the principal shrimp-producing areas. About 36,600 ha of its mangroves (67.7% of the total) have been removed and replaced by the shrimp farms. The farms average at least 100 ha, but some exceed 500 ha. The northern provinces of Esmeraldas and Manabi have 9% of the farmed area, the farms there being mostly under 50 ha. Many farms rely on wild seed shrimp for stocking ponds, but most use hatchery seed at least during the summer (Griffith and Swartz, 1999).

In 1996, Ecuadorean shrimp yields were 700 kg/ha, and total production of farmed shrimp was about 110,000 t (Griffith and Swartz, 1999). Such shrimp yields compare roughly with a standing crop of 1,200 kg/ha of cockle meats. This is a maximum figure for cockle meats and is based on Baquiero's Mexican data (10 market-sized cockles/m² are present; 100,000/ha are present; they weigh 8,000 kg, and their meats weigh 1,200 kg [about 15% of whole weight]). However, while all the shrimp in the farms are harvested, probably far less than half of the market-sized cockles are taken from their habitats in a year even under heavy harvests.

Removal of the mangrove swamps and construction of the shrimp ponds and canals have led to some fishery, social, and environmental changes. The cockle fishermen's harvesting has been concentrated into smaller areas because less swamp area is available, and many fishermen have had to travel longer distances to reach good harvesting areas. The consequences have been smaller harvests for fishermen, some of whom have had to emigrate from their villages to other harvesting areas or try to find other means of earning money. For example, in 1993, a fisherman in Muisne could harvest about 400 cockles/day, but by 1997 his harvest was 120 cockles/day (Rosero and Burgos, 1998).

The fishermen's movement to other areas has placed pressure on the cockle stocks in those areas. The potential danger is that if the harvesting pressure



Figure 45.—Fishermen carry their cockle harvests ashore in Puerto Bolivar, Ecuador.



Figure 46.—Ecuadorean merchants selling cockles on a city sidewalk.



Figure 47a—A sidewalk stand displays cockles for sale in Ecuador.



Figure 47b.—Frontal view of Ecuadorean cockle stand. *A. grandis* is in lowest tubs and *A. tuberculosa* and *A. similis* are in uppermost tubs.

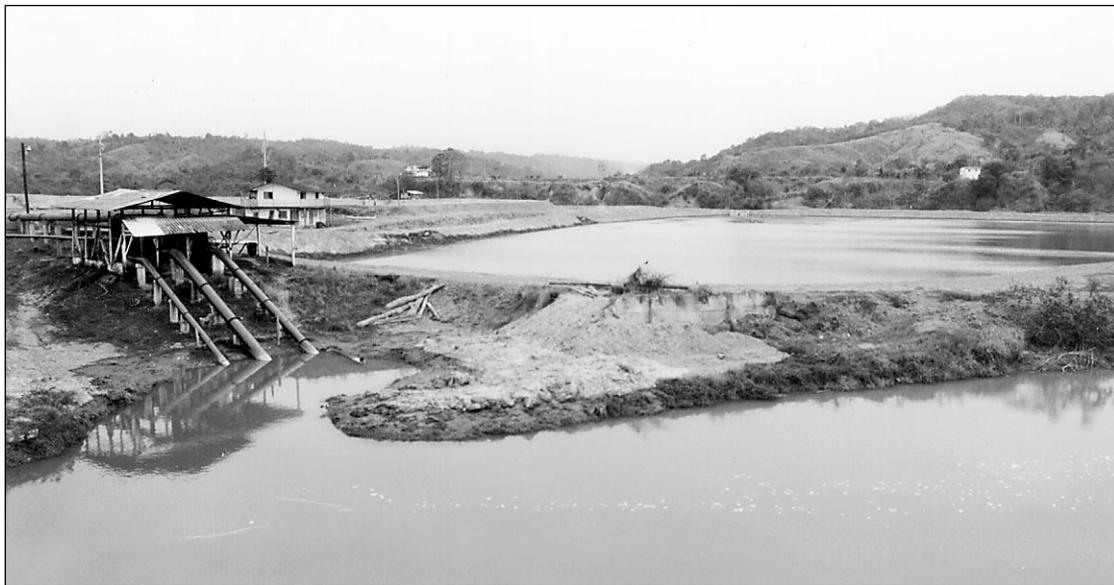


Figure 48.—An Ecuadorean shrimp pond (background) and its feed canal (foreground).

increases, the fishermen may take increasingly smaller and immature cockles and ultimately deplete the stocks (Santos and Villon, 1998).

Some fishermen who have remained in the villages where shrimp farms are extensive have had conflicts with the farmers (Santos and Villon, 1998).

If fishermen harvest near the shrimp ponds, the farmers usually drive them away or confiscate their boats, collecting bags, and cockles. The villagers

have also lost their wood supply which they had used for dwelling construction and cooking their food.

The environmental problems include: 1) loss of wildlife including estuarine life (i.e. birds, finfish, cockles, and crabs), 2) alteration of water flow in the mangrove zones, which has reduced the growth and development of the mangroves, 3) increased quantity of sediments in the water due to channeling of the water from the estuaries to the ponds, and 4) damage to the central mangrove areas from the action of storms due to the loss of protection (Boyd and Clay, 1998).

In addition, Turner (2000) reported that yields of wild shrimp declined in Ecuador (as well as in Thailand and Vietnam) when shrimp ponds were built in the mangrove zones. He explained that a strong, positive relationship exists between shrimp productivity and the areal extent of estuarine vegetation present in wetlands. In regions where substantial losses of wetlands occur, shrimp losses follow immediately.

While shrimp farming was developing in the mangrove swamps during the 1980's and early 1990's, government agencies provided little or no oversight or regulation. But during the 1990's, a government agency, Programa de Manejo Recursos Costeros (Program of Coastal Resources Management), has become involved and has attempted to: 1) strengthen the ability of the government to deal with the interactions of groups that want to use the mangrove swamps, 2) reduce conflicts between shrimp farmers and cockle and crab fishermen, 3) plan the construction sites of new shrimp farms in a way to minimize losses of mangrove swamps, and 4) restore mangrove swamps where the shrimp farmers have abandoned ponds. The agency's goal is to sustain the swamps as much as possible, so as not to diminish the livelihoods and qualities of life of future generations of coastal villagers (Altamirano et al., 1998; Anonymous, 1999a,b).

In 1996, a group named the Unidad de Conservación Y Vigilancia de Puerto Bolívar (Unit of Conservation and Vigilance of Puerto Bolívar) gave custody of 120 ha of mangrove swamps in the Archipiélago de Jambeli to a local asso-

ciation of fishermen and local residents. The objectives have been to maintain the mangroves and increase the cockle population of the area. By 1998, the group had planted mangrove seedlings in 14 ha and established 4 plots of 276 m² each to be used for planting cockle seed (Altamirano et al., 1998).

The government has regulations in place that prohibit further destruction of the mangroves, but local residents fear that more shrimp farms will be constructed in the future. The fishermen and other villagers have wanted someone to look out for their interests, because in the 1980's and early 1990's such outside support was absent.

Peru

Bahia de Tumbes, located in northern Peru²⁵ about 20 km south of the Ecuadorian border, is the southernmost extent of the mangrove cockles' range (Fig. 44). Two fishing villages border on the bay. One, Puerto Pizarro, has about 40 cockle fishermen (men, women, and children) who range in age from about 9 to 60. The men divide their time about equally between harvesting cockles and netting finfish. The fishermen usually harvest cockles in family groups, which paddle to the harvesting areas in dugout canoes 6 days/week. Each fisherman collects about 100 cockles/day. The other village is Bendito which has about 35 cockle fishermen, all adult males, each harvesting 75–100 cockles/day. The fishermen's families eat some of their small cockles in seviche or as boiled meats with rice.

Two dealers live in the villages and drive pickup trucks to the fishermen's homes to collect the cockles, paying about \$3.40/100(\$0.34/cockle) for them. When they distinguish between *A. tuberculosa* and *A. similis*, the latter brings half as much money. They take nearly all the cockles about 1,100 km southward to Lima, the capital, for sale, with the remainder going 300 km northward to Guayaquil, Ecuador.

From 60% to 70% of the mangrove-cockle areas in the Bahia de Tumbes

²⁵ Information for this section was obtained from interviews of 3–8 people in each village; the principal sources were Eminiano Medina and Jose Oyola, Puerto Pizarro.

have been removed for construction of shrimp farms, and the cockle resource has been reduced by that much, according to the villagers. Some people net seed shrimp along the shoals of the bay for sale to the farms.

Suggested Research

A plethora of studies could be made of the three cockle species. Especially lacking is information concerning cockle ecology. The most important research for obtaining information to manage them efficiently for commercial exploitation are:

- 1) An analysis of the likely predation that occurs on juvenile *A. tuberculosa*, *A. similis*, and *A. grandis* by some of their faunal associates, i.e. finfishes, shrimps, hermit crabs, and gastropods. Such studies might suggest a means of reducing predation so that stocks of cockles could be increased, thereby improving the welfare of the fishing communities. Since alphaeid snapping shrimps are predators of juvenile quahogs, *Mercenaria mercenaria*, in North Carolina, U.S.A. (Beal, 1983), the alphaeid snapping shrimps in the Latin American mangrove swamps might be predators of juvenile mangrove cockles.
- 2) Ecological interactions between the mangrove trees and the cockles.
- 3) Distribution of *A. grandis* in subtidal areas.
- 4) Sizes of spawning *A. tuberculosa* and *A. similis* stocks in mangrove swamp areas that are impenetrable by fishermen.

Suggested Management

The cockles in all countries, except Mexico, are under heavy harvesting pressure, in part because cockle harvesting is the only remunerative work available to many villagers. Thus far, cockle stocks are not being depleted because cockles are harvested at sizes at which they have already spawned, stocks of mature cockles everywhere lie within dense mangrove stands which are difficult or impossible for fishermen to reach, and the hand harvesting does not kill

juveniles or adversely affect the cockle habitat. Juvenile recruitment continues.

The laws specifying minimum sizes of cockles to be harvested protect the spawning potential of the cockles. They need to be implemented if fishermen numbers increase in the future and begin to harvest immature cockles along with adults. This potential looms because the fishermen have relatively large numbers of children surviving to ages at which they can help in the harvest. But any efforts to reduce the take of mature cockles, to prevent overharvesting could deepen the poverty in the fishing communities, and they probably will not elicit an increase in cockle recruitment. Instead, programs to conserve and improve the cockle habitats may be the most fruitful actions to take. Numerous papers describe how oyster abundance has been enhanced in North America and Europe by habitat improvement, i.e. spreading shells and predator control. Many examples are listed by Dugas et al., 1997; Ford, 1997; Gouletquer and Heral, 1997; Jenkins et al., 1997; MacKenzie, 1997a,b; and MacKenzie and Wakida-Kusunoki, 1997.

Preserving the mangrove swamps intact, increasing their sizes, and reducing predation on the cockles are sound conservation and enhancement actions. Planting mangrove seeds and transplanting mangrove seedlings to suitable areas might increase the size of the swamps. Fishes that prey on juvenile cockles might be seined regularly along the edges of swamps before the tidal rise allows them to swim into the mangrove swamps to search for food, and perhaps ways could be found to reduce the destruction of juvenile cockles by crustaceans and gastropods. Pointing out to urban consumers the health benefits of eating fish and cockles might also increase prices for the fishermen, as has occurred in the United States.

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Appendix

I collected most of the information for this paper by driving an automobile or pickup truck to fishing villages, making observations, and then interviewing as many cockle fishermen, fishermen's wives, and dealers in each village as possible and making a photographic record. I am not fluent in Spanish, and so a hired interpreter, in most cases a college student from the country being surveyed, accompanied me. The interpreters contributed information about the culture and economies of their countries and directed me to the villages. When we stopped in a village and began to ask 2 or 3 people questions, a crowd of 4–15 adults of both sexes and mixed ages and their children commonly gathered around us (Fig. 34). I asked the adults the series of questions listed below and recorded the answers in a notebook. Two to three people from the groups answered most of the questions, but I consistently sought and received further information from others. In addition, many fishermen who lived in isolated homes were asked the same questions individually. The interviews lasted 20–100 minutes each.

Listed below are two sets of questions and topics that were prepared before I visited the countries. The first set is a list I asked villagers in every country. The second set was used to obtain more information about the physical, economic, and cultural setting of the cockle fisheries. People in Honduras and El Salvador were interviewed for this topic. I asked the questions in about all villages, large

and small, where cockle fishermen lived and in several isolated homes in Honduras. The same questions were asked of several villagers in Huisquil, El Salvador. Most interviewees were women. Obviously pleased that an outsider was showing an interest in their lives, they answered nearly all questions freely and without inhibitions, but they were sensitive about those relating to food and child care. Obtaining sufficient food for each meal was a consistent struggle for the villagers, and I did not always trust the answers I was getting about food: Some people seemed to be exaggerating the quantity and quality of the foods eaten. I found the best way to obtain information I could trust was to ask individuals what they had eaten their previous meal. For example, when I asked a man, 50 years old, about this with his family present, he said they ate eggs and cereal for their breakfasts, but later when I asked his son, about 14 years old, privately what he had had for breakfast, he said 2 pieces of bread and a cup of coffee. I believed the son. Women complained that their husbands spent little time helping them care for their children, and some wives had been abandoned by their husbands. The information is presented in the section "Human Life in the Cockle Fishing Villages."

I showed a draft copy of the section, "Human Life in the Cockle Fishing Villages" to Carlos Tay and Jesus Francisco Valladares to review. Tay, a resident of Guatemala City, was 26 years old and was my guide and interpreter in Guatemala. He once had a job delivering shrimp and other fish products from the Pacific coast to Guatemala City, and so he was familiar with conditions in the fishing villages. Tay added 4–5 details to the section, but found none of mine incorrect. The Reverend Jesus Francisco Valladares of Choluteca, Honduras, related that it was accurate. At the end of the section, I added material from a newspaper article relating to the fishermen in Quayaquil, Ecuador, an email letter from Javier Rosero relating to life in cockle villages in Ecuador, and a letter received from O. G. Plaza, an official (Microempresarial) with Alcaldía Municipal de Tumaco, Colombia,

regarding the lives of cockle fishermen in southern Colombia.

Topics and Questions Used for the Surveys

Cockle Fishery, Habitats, and Biology

- 1) Number of harvesters: men, women, children.
- 2) Number of days/week they harvest.
- 3) Quantity of cockles harvested per person per day.
- 4) How much money do harvesters and dealers receive for *A. tuberculosa*, *A. similis*, and *A. grandis*?
- 5) Widths of cockle zones.
- 6) How rapidly do cockles grow?
- 7) Are *A. tuberculosa*, *A. similis*, and *A. grandis* taken in the same areas?
- 8) What cockle predators are in the swamps?
- 9) Have shrimp farms affected cockle harvesting areas?
- 10) What is the color of the blood of the three cockle species?
- 11) How often do fishermen harvest in a particular area?
- 12) What do fishermen do when not harvesting?
- 13) Are there any government harvesting regulations?
- 14) When is the peak market demand (ask dealers)?

- 15) Where are the markets (ask dealers)?
 - 16) How do people prepare cockles for eating?
 - 17) How often do fishermen eat cockles?
 - 18) In what ways do restaurants serve cockles and what do they charge for each?
 - 19) What limits cockle production, supplies or markets?
- NOTE TO MYSELF: Measure sizes of cockles from harvests

Villages and Living Conditions

- 1) What are the fishermen's homes like?
- 2) What are the sanitary conditions (indoor plumbing, outhouses, etc.)?
- 3) How is fresh water obtained?
- 4) How many homes have electricity and what is its source (personal generators, electric lines, etc.)?
- 5) Do homes have radios or television sets?
- 6) Where are schools in relation to the villages?
- 7) What are the costs of school uniforms and other school items?
- 8) What grades are children in at particular ages?
- 9) Are all grades taught in the same room?
- 10) How many years of schooling before a child can read?

- 11) Is English taught in the schools?
- 12) Age at marriage?
- 13) Marriage dissolutions?
- 14) How many children do women have?
- 15) Where are babies born?
- 16) How do children play, and what toys are used?
- 17) Any birth control methods or abortion?
- 18) Are children treated for worms?
- 19) Any medical or dental care? Do people brush their teeth?
- 20) How long do people live?
- 21) What assistance do churches provide?
- 22) Do people use eye glasses or hearing aids?
- 23) Cost of funerals.
- 24) Food for livestock (pigs and chickens).
- 25) Why no vegetable gardens?

Photographic Subjects

- 1) Fishermen harvesting cockles in natural habitat
- 2) Boats and bags
- 3) Fishermen landing cockles
- 4) Fishermen's hands and faces
- 5) Buyers purchasing cockles
- 6) Eating places preparing cockles for serving
- 7) Processing of cockles
- 8) Cockles being sold to the public