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## COCONUT CRABS (*Birgus latro* L.)

The coconut crab, also known as the "robber" crab, is a "large, nocturnal, terrestrial hermit crab" (Helfman 1977a). It is a crustacean of the *decapoda* order in the phylum *arthropoda*. The coconut crab (*Birgus latro*) is the only species of the genus *Birgus*. The two genera *Birgus* and *Coenobita* comprise the family *Coenobitidae* of the *anomuran* group of land crabs of the *paguridea* type. The species gets its scientific name from its habit of making off with various items that may or may not be edible. *Latro* is Latin for "robber," "bandit," "brigand," or "hunter." Its common name is derived from its preference for coconuts. The Tahitian name for the coconut crabs is "*ua vahi haari*," which has been translated as "crab that breaks the coconut" (Reyne 1939). The coconut crab's habit of dragging items some distance before determining whether or not its booty is actually edible can be something of a nuisance. Gibson-Hill, a biologist who observed coconut crabs on islands in the Pacific, wrote:

I have seen sandals, sticks, cooking-tins and even knives and forks stolen from jungle camps and abandoned, and I once found a pair of crabs fighting over a silver wrist-watch, taken from a pile of clothes fifteen yards away. (1947:52)

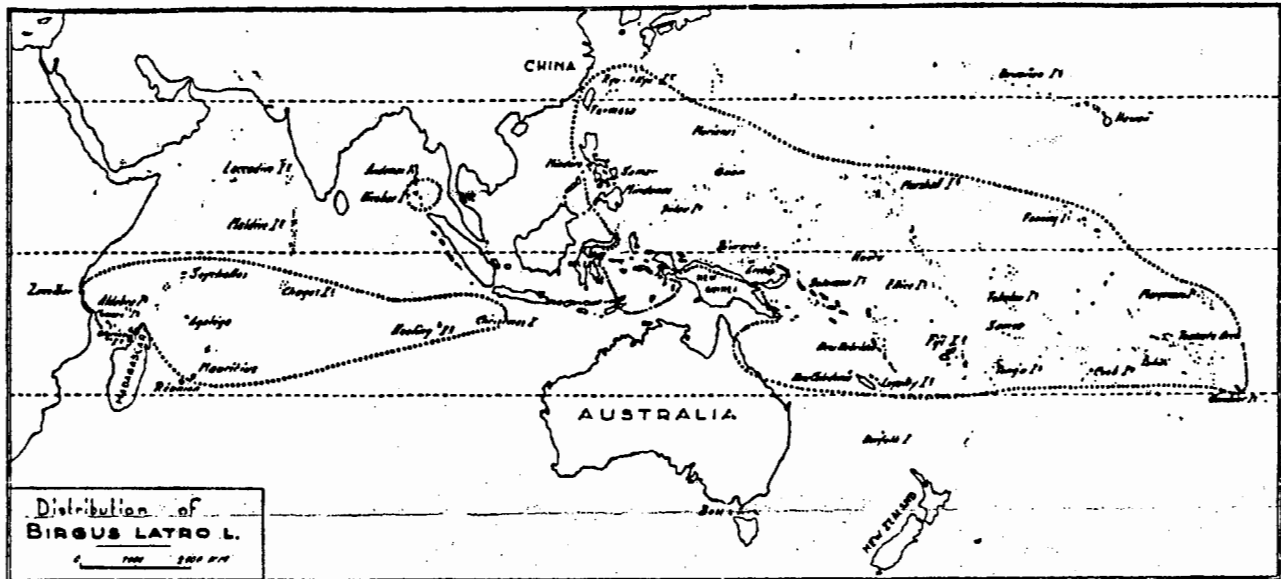
Another biologist commented that:

Nothing could be left out at camps in safety; cooking utensils, cutlery, machetes; all were taken, and on one occasion a Primus stove was dragged off into the bush. On another occasion a *Birgus* was observed on the coastal strand line towing a whiskey bottle behind it. (Alexander 1976)

Coconut crabs gained a certain reputation among American marines during the second World War. At night the crabs joined the marines in their trenches (occupied as part of the Guadalcanal and Pacific defense), and made off with items that had, according to the crabs, some possible food potential.

### HABITAT

The coconut crab is primarily a nocturnal creature, although in the absence of daytime activity and presence of nocturnal competition (such as the presence of rats scavenging for food), the *Birgus* will be active during the daytime. The crabs are always in danger of desiccation, however, and prefer to venture out in the evening when the humidity is greater and surface temperatures are cooler. The coconut crabs inhabit small volcanic islands and coral atolls in the tropical Indo-Pacific. Their distribution is roughly from the east coast of Africa (from Dar es Salaam or Zanzibar) to the Christmas Islands in the Indian Ocean, between the Equator and the Tropic of Capricorn, and from the southern coast of China (the Island of Formosa) diagonally south to Gambier Island and as far west as Indonesia in the Pacific Ocean (between the Tropic of Cancer and the Tropic of Capricorn).



(Reyne 1939:315, Fig. 1.)

The crabs occupy deep burrows beneath the roots of trees, under fallen trees or debris, and in rock crevices. Their burrows, which may be on an inland plateau as far as three or four miles from the sea (Gibson-Hill 1947), may accumulate a "bed" of the picked fibers of coconut husks (Reyne 1939). Where the ground is very damp (as in a mangrove forest), crabs have been found living in the trees from which they descend at night in order to forage.

Coconut crabs encounter no known natural predators in their habitat except for other coconut crabs and man. The meat of the coconut crab is considered quite a delicacy by Indo-Pacific Islanders and others. Due to over-harvesting of the coconut crabs, there are now restrictions on their exportation, and commercial harvesting has been banned altogether on the Solomon Islands. We are lucky to have the twelve, healthy coconut crabs on exhibit at the Aquarium.

#### THE EXHIBIT

All the coconut crabs in the exhibit (all twelve are male crabs) are from the Solomon Islands in the Pacific. Most weighed about five pounds when captured. They lost some weight in transit, but have since gained back more weight than they lost. The crabs will be in a perpetual quarantine at the Aquarium, which means that none of their waste water or other substances from their environment can be disposed of without primary and secondary treatment from Metro, or according to prescribed disposal of solid wastes. The three fiberglass palm trees in the exhibit were donated by a subsidiary of Weyerhaeuser. The palms, the natural vegetation, the mural, and the theatrical lighting replicate a tropic island at sunset. The glass-laminate in the exhibit which separates visitors from the coconut crabs and hermit crabs is six feet high and 9/16ths of an inch thick. The photo-periods in the exhibit have been reversed, since the crabs are nocturnal.

animals. During our daytime, the theatrical lighting gives an impression of dusk--a time when the crabs become active. During our nighttime, the exhibit is lit with large, high-density discharge lamps that will supply the brightness and heat associated with daytime in the tropics. The exhibit makes use of radiant heating and is intended to make the surface of the substrata the warmest place, and therefore the place of choice for the crabs. The coconut crabs and hermit crabs have both a coral rubble "beach" and a substrata made of a soil-less mixture in which to burrow. There are regularly scheduled "rain" showers in the exhibit (achieved by strategically placed garden misters) in order to maintain the high level of humidity immediately above the surface, in imitation of the crabs' tropical island habitat.

## PHYSIOLOGY

The coconut crabs are relatively recent inhabitants of land and have developed an effective means of restricting their loss of moisture. Their exoskeleton (the tough cuticle that covers their entire body) is heavily calcified for protection. Even so, they are very susceptible to desiccation and must have access to both fresh and salt water. These crabs also possess a very unique and complex air-breathing mechanism. The branchial chamber (called a "lung" by some) is expanded and includes a lining with a "treelike structure" in the central cavity of the chamber (Burggren and McMahon 1988). The gill surface area is the smallest of any land crab. There is some indication that the flow of air and hemolymph shares some features in common with the multicapillary system found in birds (McMahon and Burggren 1981 based on Harms 1932).

These crabs are the largest terrestrial decapod. The leg span of large males may be close to thirty inches or greater, and they may weigh as much as six or seven pounds or more (Burggren and McMahon 1988). The first and second pair of walking legs (pelipeds) have sharp, pointed ends. The fourth pair of walking legs is the smallest and, although adapted for an ambulatory function, remains tucked underneath the abdomen much of the time. Their two chelipeds (claws) are very strong and capable of exerting enough force (1.5 times the force of a human bite; Hicks, et al 1984) to chip glass or coconut hulls and to bend metal objects.

Crabs have compound eyes containing several thousand optical units (ommatidia) (Warner 1977). Their sense of taste and smell (their chemoreception) is achieved through detection by sensory hairs (Warner 1977). There is evidence that coconut crabs, like various other crabs, have a sensitivity to low frequency sounds. They are able to hear both airborne and substratum-borne sounds. Their "hearing" is achieved through a perception of the vibrations generated from paired or layered sheets of their cuticle (Warner 1977).

## LIFE-CYCLE

Coconut crabs are terrestrial animals whose eggs are hatched at sea. The female, once her eggs have been fertilized by a male crab, will release her eggs into the sea with a new moon and a spring tide, when the humidity and temperature are right. The number of eggs she releases may be as great as 138,000. These eggs hatch on contact with the saltwater upon their release and float freely as zoea plankton, in a pelagic

larval phase, for twenty to twenty-three days (Helfman 1977b). They then settle out of their larval state and find a gastropod shell. Soon after, they return to land where they will continue to live in a shell until after their first or second molt, or for about a year. Then, unlike hermit crabs, they abandon their shells for more mobile "free-living." Once they achieve a free-living stage, their fourth pair of pelipeds grows somewhat in order to function as true walking legs. When a crab first emerges from its shell, its abdomen is asymmetrical, but after another molt or two, the abdomen achieves its symmetrical shape and is tucked underneath the body.

The molting process places a crab at an extreme risk of desiccation, and leaves a crab very vulnerable to attack. In order to lessen these threats, coconut crabs remain in their burrows for up to thirty or thirty-nine days at a time (Held 1963). They accumulate moisture in their burrows and in their tissues for the process. As a crab goes into a molt (for a young adult, the time between molts may be from one to five years), it stores an increased amount of fat and moisture in its abdomen, so that the abdomen becomes distended, often beyond its carapace (Reyne 1939; Held 1963; Alexander 1976). Other typical characteristics of a molt are a whiteness at the joints and eye stalks, and the evidence of new limb buds. Before leaving its burrow which is often sealed during the molting process, a coconut crab apparently consumes its entire cast exuvium (Held 1963). Even though the molt increment for land crabs is somewhat smaller than that of aquatic crabs, the *Birgus latro* is able to attain an impressive size.

There is evidence that coconut crabs reach maturity at about four years, or after their eighth molt (Harms 1932 & 1938; Gibson-Hill 1947). Their breeding season is geared toward conditions of temperature, lunar phases and tidal cycles, abundance of food and water, and salinity of the water. The coconut crab copulates on land "quickly and without the ceremony common among smaller, less formidable aquatic hermit crabs" (Helfman 1977b).

## FEEDING HABITS

The coconut crab consumes a varied diet. It likes various tropical fruits and especially coconuts, although some coconut crabs have been found on islands where there are no coconut palms. Coconut crabs also eat carrion such as dried fish, desiccated coconut crabs and hermit crabs. They will venture some thirty-two yards or more from their burrows in order to scavenge for food. Coconut crabs have also been known to forage in farmers' fields and even attack young domestic birds (Grubb 1971). Although apparently omnivorous, coconut crabs in the wild subsist largely on vegetable matter (Reyne 1939). The crabs in the Aquarium are given coconut (both the green "jelly" coconuts and hard shell coconuts) as well as various fruits, herring, krill, dungeness crab legs and dog food to eat.

The coconut crabs' interest in coconut presents some intriguing questions for biologists, among them, how the crabs actually crack open and eat a coconut. Coconut crabs have been observed eating coconuts in the wild, through the use of night-vision equipment. The crabs husk the coconuts with their chelipeds, then perforate the third eye (the germinating eye and the weakest) of the coconut with one of the first pair of pelipeds. Some crabs then scrape the coconut out through this small opening with one

of their pelipeds, while others chip away at the nut with their chelipeds until they gain easier access to the coconut meat. Another ingenious method for opening coconuts was observed in a mangrove forest on an island in the Papua New Guinea Territory. A crab husked a coconut then carried it up a tree and dropped it, whereupon the coconut cracked open (Cropp 1982). The empty coconut shells in the exhibit were cracked and eaten by those crabs in the Aquarium who were kept in small, dark, individual compartments prior to participating in the exhibit. Not all individuals have the interest or ability to crack open coconuts, however. In the wild, such individuals most likely scavenge an opened coconut from another crab.

Coconut crabs pull apart their food with their powerful chelipeds. They most often hold a food object with their left cheliped while feeding with their right. Both the chelipeds and first ambulatory legs are used to transfer food to the maxillipeds where the food is masticated further. The food is then stored in an "anterior sack-like part of the cardiac stomach" (Warner 1977:18) before being passed to the mid-gut.

## BEHAVIOR

Coconut crabs are not the social creatures that land hermit crabs are. They have little tolerance for each other, but even so, during periods of great abundance of food and water, and possibly during a mating season, groups of a dozen or more have been known to congregate in one area (Gibson-Hill 1947). When food (or the possession of a potential food item) is at stake, coconut crabs will exhibit aggressive behavior. One encounter between two crabs fighting over a coconut that had been cracked open resulted in the loss of a cheliped by one crab and the loss of a peliped by the other (the coconut was abandoned; Cropp 1982). One biologist has noted that, without an animal protein in their diet, coconut crabs will turn to cannibalism (Reyne 1939). Another biologist has suggested that "larger crabs in captivity will invariably kill and eat smaller ones" (Helfman 1977a: 426), and in fact the fishermen who capture the crabs for sale as food suspend the crabs from individual strings on a pole in order to keep them from eating each other. Smaller coconut crabs restrict their activity while the larger crabs forage (Helfman 1973), but when food is very abundant, large numbers of animals may feed in a confined area beneath fruiting palms (Hicks, et al 1984). The crabs in the exhibit are given large portions of food and water so that they will not attack each other.

Coconut crabs' aggressive or agonistic behavior conforms to several predictable stances. The first, and most likely to be exhibited, is the "ambulatory leg raise" (Helfman 1977a). A "cheliped presentation" may follow (ibid.), although it is less frequent and displays the presence of an even greater perceived threat. In addition, some coconut crabs display an acoustic "clicking" when threatened or disturbed. When frightened or disturbed, coconut crabs may assume either a high body position (on tip-toe) or a crouch position. This agonistic behavior is apparently a "highly ritualized distance-maintaining display" (Helfman 1973:145). In order to steal another crab's food or possession, they may run and pounce, all within the forward and back axis of their locomotion. They are able to move backwards at quite a rate of speed for their physiology and bulk.

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