

MANATEES AS A NATURALISTIC BIOLOGICAL MOSQUITO CONTROL METHOD

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John Esquemeling, a Dutch adventurer who accompanied the English buccaneer Sir Henry Morgan on the sacking of Old Panama and who later published memoirs in his book "The Buccaneers of America" in 1678, included a full page discourse about the manatee. The sea travelers of Christopher Columbus days found that the flesh of the manatee was very good to eat and whenever the opportunity arose, they welcomed a change from their hard biscuit and salt pork diet. One of the areas the sea travelers frequented for manatee provisions was a place called

Boca del Dragon which we know today as one of the inland harbors of Bocas del Toro, the northwest province of the Republic of Panama on the Caribbean Sea. According to Esquemeling, the Spaniards called them "manetines" while the Dutch called them "sea-cows" because they had a head, nose and teeth similar to that of a cow. Their flesh was the color of a land cow but the taste was like that of pork. The flesh contained a large amount of fat which the buccaneers melted and retained in earthen pots for use as grease. The manatees were reported from 20 to 24 feet in length.

¹ Mr. MacLaren arrived in the Canal Zone, July 1962, as a replacement for John P. Smith, Jr., Sn. Engr., to pick up the "unknowns" of the manatee idea originated by the latter.

In 1961, nearly 300 years later, the Division of Sanitation, Health Bureau, Canal Zone Government, became interested in

manatees, not because of their flesh, but because the manatees had been reported from British Guiana (now independent state of Guayana) as a voracious eater of aquatic vegetation. The removal of the aquatic vegetation was necessary to continue the operation of irrigation channels and boat canals in that country.

The Division of Sanitation in the Canal Zone was exploring control methods for a serious pest mosquito which continually invaded the Gamboa Townsite at the junction of the Chagres River with the Canal. The pest mosquito, species of the *Mansonia* genus, has larval and pupal development stages occurring under water where they attach their breathing tubes to aerated roots of certain aquatic plants. The *Mansonia* life stages under the water surface cannot be effectively controlled by present day larvicides. Also, the aquatic vegetation when thick and submersed was supporting anophelene mosquitoes (the malaria vectors) on the top surface where protection was provided from small underwater fish predators. Thus use of manatees, to eliminate the aquatic vegetation to remove the mosquito problem, developed as a project for a possible naturalistic biological control method in the Chagres River and adjacent Canal areas. However, information was not available concerning the handling or use of manatees. A dependable source for procurement of sufficient manatees to initiate an experimental project was not known.

Following a long letter-writing period for manatee information, a male manatee weighing approximately 150 pounds and four feet long arrived unannounced in a 6-foot crate in the Canal Zone, March 25, 1964 from Iquitos, Perú by a U. S. military aircraft. The mammal was transported to Summit Gardens where a small water pond used by the Capybara, the large South American rodent, was selected for temporary use and to allow observation by Canal Zone residents. For many inhabitants previous reports on manatees had been confined to legends from sailors. On March 30, the lone manatee provided

experience for future handling of others as he was transported by a piece of canvas back to his wooden box and placed into a prepared fenced lagoon on the Chagres River; this manatee is known by the scientists as *Trichechus inunguis*, the species that inhabits the Amazon and Orinoco drainage areas of north-eastern South America. The cost of one specimen was \$450.00.

Later in the year, a contract which had been made in October, 1963 with a former crocodile hunter, a resident of Colon, Republic of Panama, provided two female manatees from Changuinola, Bocas del Toro, R. de P., from the same area where the buccaneers hunted them in the seventeenth century. An air flight in a C-47 plane brought one female 8 feet long weighing approximately 800 pounds and a baby only 6 feet long at 300 pounds. The latter, according to the contractor, was still with its mother, which was too large at the time for the small transportation crates provided in accordance with the expected size of the one obtained from Peru. The manatees from the Republic of Panama are *Trichechus manatus*, a species which inhabits rivers entering the Caribbean Sea.

The manatee contract was cancelled on the 24th of December 1964, with the arrival of the ninth manatee from Changuinola. Five separate flights were made, courtesy of United States military aircraft, which began on the 29th of May for the three females and six males, weighing 300 to over 1,000 pounds and from 8 to over 10 feet in length. The manatees cost \$300 each for the first pair and \$200 apiece for the remainder. Each had been caught by a rope net on the upper Changuinola River by the contractor who had pulled them to a lagoon to await air transportation. From the lagoon they were manually pulled onto a canvas tarp and lifted onto a truck for the 20 minute ride to the airport. A special box, usually 2' x 3' x 10', lined with plastic material kept them stationary and allowed for water applications to keep their skin surfaces

wet during the trip. The boxes were slid from the airplane into trucks at the Howard Air Base. A Dredging Division crane lifted the special boxes from the trucks to a Dredging Division barge at Gamboa. The barge was pushed up the Chagres River by a launch to the 7-acre lagoon selected for the manatee observation and the manatees were dumped unceremoniously into the lagoon after nearly a 10-hour period outside protective waters.

In July 1964, the original jungle pole fence, built across a 200 foot water gap separating the lagoon from the Chagres River and supported by a steel cable, broke and five manatees, 2 females and 3 males, fled to freedom in the Chagres River and Lake Gatun waters. The immediate installation of a section of a metal mesh net, by the Dredging Division provided a permanent home in the lagoon for the last five manatees, one female and four males. The female was observed to be pregnant on her arrival (Fig. 1) and a small manatee observed later in the lagoon has increased the herd. Since December 1964, these five original manatees plus any increases have been under observation.

In October 1963 inspections of the offending aquatic vegetation were made of the Chagres River, Cocoli Lake on the west bank of the Canal and the Cameron Lake past Fort Clayton on the right, north of the Gaillard Highway. The abundance of a wide variety of aquatic plants in the Chagres River as compared to a few in the Cocoli and Cameron lakes determined the selection of the 7-acre lagoon for the manatees on the east side of the Chagres. The lagoon, approximately 20 to 30 feet deep in the middle, had two fingers of engulfed water, and two-thirds of its surface plants included *Sagittaria* sp. (arrowhead) *Eichornia crassipes* and *Eichornia azurea* (water hyacinths), *Pistia stratiotes* (water lettuce), *Jussiaea natans* (water piers), *Pontederia rotundifolia* (pickerelweed), *Polygonum* sp. (smartweed), *Nymphaea ampla* (water lily), *Azolla* sp. (water velvet),

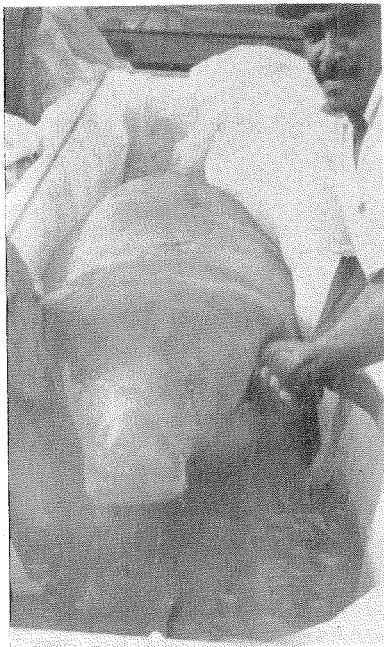


FIG. 1.—One of the female manatees received was observed to be pregnant. She was 10 feet long and weighed 800 lbs.

Salvinia auriculata (water fern), *Spirodela polyrrhiza* (duckweed), *Luziola subintegra* (grass) and *Paspalum repens* (grass). Dominant submersed plants near the Canal channel included *Cerathophyllum demersum* (coontail), *Elodea* sp. (waterweed), *Utricularia* (bladderwort) and *Najas marina*. *Chara* and *Cabomba* (fanwort), two submersed plants reported in the past associated with dense mats of *Najas* and *Utricularia* supporting anophelene breeding on the top surfaces were not observed. However, *Cabomba* has been observed to be reappearing in 1966. (See Figs. 2 and 3).

In conjunction with the manatee observations, further study of the aquatic vegetation in regard to sources of the *Mansonia* mosquito was initiated with the assignment of one of the entomology laboratory technicians to the Gamboa area in April 1965. The study consisted of



FIG. 2.—Aquatic vegetation on the banks of the Chagres River. Water hyacinths, water lettuce, and other types of plants are abundant. The depth of water in the center of the picture is nearly 20 ft.

trapping adult mosquitoes emerging from aerated roots of aquatic plants by the use of four $1\frac{1}{2}' \times 5' \times 5'$ floating bamboo traps (Fig. 4). The traps were placed in new locations at the first of each month over different plants in shallow and deep water depths along the banks of the Chagres River for daily collections of any adult mosquitoes which were caught as they emerged from pupa stages. Also, larvae collections were started by removing individual plants from the river banks, washing out the larvae into pans and then counting the larvae, which had dropped off the roots. Plants which have provided the largest numbers of adult *Mansonia* in the floating collection traps include *Pontederia* (pickerelweed),

Scirpus (sedge) and *Luziola* (grass). The largest larval collection has been from *Pistia* (water lettuce).

A review of early annual reports of Canal Zone Department of Health revealed that water lettuce aerated roots (*Pistia stratiotes*) was first reported in 1916 as a *Mansonia* mosquito breeding site. Later in 1927, the aquatic grass *Paspalum repens* was reported supporting innumerable larvae of *Mansonia* on the long underwater rootlets. In 1952 studies in New Jersey, U. S., reported the common pickerel weed (*Pontederia cordata*), two species of arrowhead (*Sagittaria lancifolia* and *S. montevidensis*), water hyacinth (*Eichornia crassipes*), spatter dock (*Nymphaea macrophylla*), and both species of cattail (*Typha angustifolia* and *T. latifolia*) as *Mansonia* mosquito sources.

The *Mansonia* mosquito has extensive breeding sites as indicated by the above information. The plants of arrowhead, pickerel weed and sedge (locally called sawgrass) are close-to-shore plants while water lettuce, water hyacinths and the two aquatic grasses (*Luziola* and *Paspalum*) will extend out from shore to deeper water areas. The Canal Zone studies have shown that these plants are main sources of *Mansonia* mosquitoes with other plants which have aerated roots as suspected hosts. No evidence was found that submerged aquatic vegetation such as coontail, waterweed, bladderwort and related plants were implicated in supporting *Mansonia* populations. However, they are known breeding grounds for the anophele mosquito whenever the plants form dense growths or mats on the surface of the water.

The removal of this vegetation was an expected accomplishment by the manatees to provide a naturalistic biological mosquito control method. Although two manatees in British Guiana were reported to have cleaned out an aquatic weed-grown irrigation canal 22 feet wide and nearly a mile long in 17 weeks with an estimated consumption of 100 pounds of forage per day, the size and scope of the

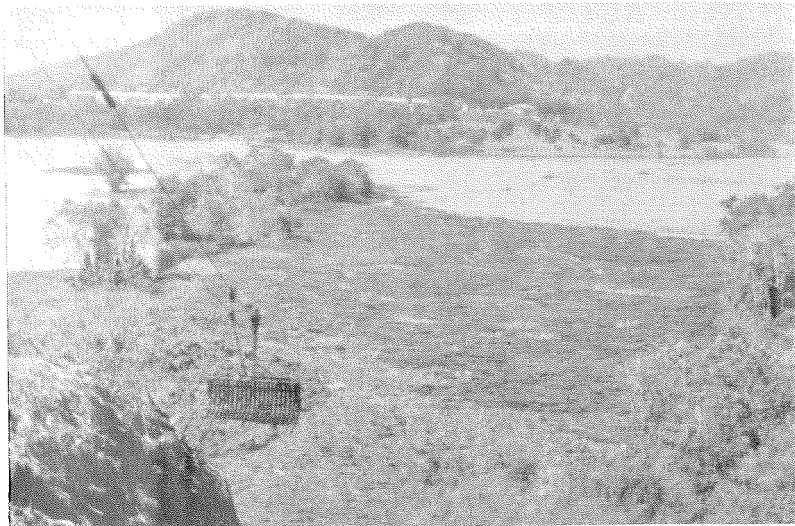


FIG. 3.—The Dredging Division, Canal Zone Company, maintains a cable hoist to pull out aquatic vegetation which accumulates on the float across the river. The plants become a navigation problem if allowed into the Canal.

aquatic vegetation problem in the Canal Zone waters is such that it does not appear to be as easily removed.

The Canal proper has a 300 foot minimum width, and a 43 foot depth at the high water level but the problem is in the adjacent areas, behind islands, and in the shallows of rivers and Gatun Lake. The Zone has 186.07 square miles of fresh water with many rivers draining into the Canal and Gatun Lake. The Chagres River, with a flow of approximately 2,000 cubic feet per second, is the largest, and near Gamboa it is nearly a half mile wide. The rise and fall of Gatun Lake and Canal water levels, approximately 6 feet, each rainy and dry season, respectively, provides varying depth of water in swamps, lagoons, drainages and bordering terrain of the water areas in jungle surroundings. The species and amount of aquatic vegetation vary accordingly. Certain vegetation areas may be a floating island in the rainy period and a shallow marsh or solid ground in dry season. During the high water levels,

20 feet from the Chagres River shore line the edge of the extended vegetation may be over a 20 to 30 foot water depth.

The 7-acre lagoon on the Chagres River has provided a two-year observation of the manatee in a habitat of the Canal Zone (Fig. 5). Two-thirds of the lagoon has been covered with floating aquatic vegetation during the entire study. The wide variety of plants and the large abundance

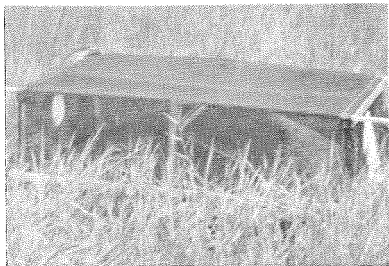


FIG. 4.—Floating bamboo trap used to catch adult mosquitoes emerging from aquatic vegetation on edge of the Chagres River. Two sleeve holes are evident in each end to remove mosquitoes.



FIG. 5.—A site for manatee activity observation at the manatee lagoon showing jungle environment. The lagoon is a 7-acre water enclosure with a 25-foot depth for the exclusive use of the manatees.

of each kind is similar to other areas on the Chagres River and in Gatun Lake. Although only five grown manatees were in the lagoon during the 2-year period, general conclusions can be made from the area observations: (1) manatees are selective in eating habits where there is abundant vegetation; (2) manatees will not remove all of offending vegetation which support mosquito breeding, either *Mansonia* or anophelene mosquitoes; and (3) the proliferous aquatic vegetation favored by the climatic conditions throughout the year will require a huge herd of manatees, possibly 1,000 to 2,000, an unrealistic number, to remove the continuous growth, if they would eat all species. The manatees, to be of assistance in mosquito control, would have to include the shore line aquatic plants producing abundant populations of *Mansonia* mosquitoes. After two years in the lagoon, the five manatees

did not appear to noticeably decrease the large amounts of floating and shore line vegetation which were originally in the lagoon. The cut tops of water hyacinths and pickerelweed were the only plants showing the results of what the manatees were eating; the pickerelweed was eaten only after the water hyacinths had been consumed.

No harmful side effects of the manatee's presence were noted. Since the temperatures of the water in the Canal Zone varies around 80° F. throughout the year, manatee deaths from pneumonia were not considered a problem for the manatee. Although one manatee calf was observed in the lagoon, where it was born, no data can be reported on reproduction by the three female manatees obtained. Reportedly, an adult female can reproduce each year.

Interest will continue with periodic ob-

ervation of the 10 manatees re-established in the Canal Zone waters. The Zone "old timers" recall the mammals in the Chagres River prior to the Canal construction days. These original manatees in the Zone areas were probably eliminated by hunters and the rural inhabitants who "live off the jungle" in search of meat for survival. The present manatees have the same dangerous environment despite a Canal Zone Code regulation prohibiting the hunting or killing of manatees in the Canal Zone. The regulations provide a fine of not more than \$100 or imprisonment in jail for not more than 30 days, or both, to whoever may be caught violating the Code. The manatee has no apparent enemies except man, and it is strictly a vegetarian that does not harm any other creatures.

Eventually, the manatees under observation in the Chagres River lagoon will be released for the freedom of the Chagres River and Canal waters. The Health Bureau Division of Sanitation personnel who have initiated and carried on the study of manatees as a possible naturalistic biological control method for mosquito sources from aquatic vegetation will direct their observations to other possibilities. The Division has gained experience in the handling of manatees, as well as changed the myth of the mermaid and the fantasy of certain sea monsters into actuality for

many Canal Zone inhabitants through the close observation of manatees being transported to the manatee lagoon in the Chagres River. Expectations are that the manatees will survive, that they will eat desired aquatic vegetation and that they will be part of the overall naturalistic environmental picture in future Canal Zone waters.

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