The Panama Canal's Aquatic Weed Problem

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I believe you will be interested in a brief outline of the Dredging Division activities, as it relates to the uninterrupted flow of traffic through the Panama Canal.

The main function of the Dredging Division is to keep the channel clear of all obstructions — maintaining the canal at advertised depth, removal of slides and pushups or bottom upheavals, buoying and lighting the channel and removal of all floating obstructions. It has been determined that the Panama Canal would be completely closed to traffic in three to five years without the adequate weed and debris control program that is now in operation. There has been a gradual increase in the budget each year for the furtherance of this project, until recently.

In FY 1964 $114,000 was budgeted for this function and increased to $197,000 in FY 1966.

The headquarters of the Hyacinth Control gang are at Gamboa, from which a force of 35 employees are sent out daily. Their work area is primarily the 164 square miles of Gatun Lake, Miraflores Lake and their tributaries.

Proceeding from the Pacific Side, where the sun rises, our journey will take us to the Atlantic Side, where the sun sets. This is a specialty of the Canal Zone and is in Ripley's BELIEVE IT OR NOT.

An important river, the Cocoli, empties into Miraflores Lake, bringing with it many aquatic plants and debris. In October, 1964, we had torrential rains, causing log booms to break, dumping acres of hyacinths, logs, etc. into the Lake. Traffic was delayed somewhat until the floating islands could be boomed back into place and removed, using a derrick swinging a 30 foot, 6-ton rake built especially for removal of aquatic weeds. Aside from directly delaying traffic, sometimes a piece of drift will get behind the lock gate seat and spring the pintle bearing, causing undue costs and delay while repairing it.

The waters of Miraflores Lake are quite brackish, but it does not seem to deter the growth of elodea, as evidenced by the dense growth surrounding an old boat that is partially submerged; on closer examination, we note that the adjacent 10 foot area is completely free of aquatic growth. This was quite a phenomena, so an investigation was made, disclosing that there are quite a few copper fastenings on the hull.

We pass from Miraflores Lake through Pedro Miguel Locks into the famous Gaillard Cut, the geologist's nightmare, the dredgeman's bread and butter. Very few aquatic weeds grow along the banks of the Cut, but there are numerous streams flowing into the Channel that bring a tremendous amount of debris with them after every freshet. This has to be removed immediately as it can damage small ship's propellers, clog sea suction — causing power failure; and, again, the Lock gates. Normally log booms would be used to keep this material from entering the channel, but due to the steep banks through the Cut section, this is impossible.

At the north end of Gaillard Cut is the mighty Chagres River with the town of Gamboa, Dredging Division headquarters, on its north bank.

One of our main weed troubles stems from the Chagres River that has an average flow of 2,000 c.f.s., bringing with it many thousands of all kinds of aquatic growths, such as water hyacinths, water lettuce, elodea, coontail, cabomba, grasses and several others, and hundreds of cords of driftwood. This is caught, to a large extent, by a huge boom across the river, which funnels the drift into a lagoon where it is removed by a large rake operated from a Sauerman. Much of this drift will go under or over the boom and has to be gathered up by workboats operated for that purpose. The debris that gets by the boom is usually fine material that would cause damage to ship engines.

Seven miles up river from Gamboa is Madden Dam, which was constructed in 1930 for a threefold purpose: reserve water supply (each ship lockage requires 50 million gallons of water), electric power and flood control. Prior to the construction of the dam, floods were frequent, causing log booms to break, delaying ships due to terrific currents entering the canal channel, and on at least one occasion a dam was formed by debris, etc., stacking up against the Chagres River bridge so that a seven foot head of water was impounded above it. In December, 1906, before Madden Dam was built, maximum discharge was 126,000 c.f.s. In December, 1944, after the dam was built, maximum discharge was 68,165. Before the dam was constructed, natives who sailed the Chagres River in their cayucos were at the mercy of the sudden influx of debris loaded waters that swamped their cayucos. Not only was there a great loss of produce, but many lives were lost also.

Continuing from Gamboa out into Gatun Lake to Tavernilla P. I., five miles north of Gamboa, we pass many beautiful recreational sites that are used for boating, skiing and fishing. It is a continuous problem to even partially keep the aquatic vegetation from taking over these areas.

Proceeding from Tavernilla P. I. up a lake arm, through Dumps 13½ and 13, to the little town of Laguna on the shore of the lake, is a beautiful, five mile trip in a small boat — or was until elodea and coontail infested the area so badly that it became necessary for the hyacinth control gang to work constantly to keep the channel open.

I know you wonder why we should be concerned with these lake arms that are so far removed from the canal channel. Native farmers were living in these locations on the banks of small rivers which furnished their only means of transportation prior to the time Gatun Lake was formed by the damming of the Chagres River at Gatun. When Gatun Lake was made, these same people were forced to move away from the rivers to the shore of the lake. Still, their only means of transportation was by water. As a good neighbor, it became obligatory for the U. S. government to keep access channels open to these towns so the farmers could still have ready access to the outside world. This is only one of many areas that must be kept open for small boat traffic.

As we proceed across Gatun Lake, we are continually passing areas to which access is regularly required by the Dredging Division's Navigational Aids Branch for servicing of navigation range lights. In several locations the aquatic vegetation, elodea, has recently become so rank that it is now necessary to keep boat channels open by treating the passages with copper sulphate.

Adjacent to Gatun Locks is the Gatun Hydro Power Station. Coontail has become so prevalent there that a serious problem exists in keeping the water intakes clear of this troublesome plant.

Even in 1913, while Gatun Lake was being formed by impounding the waters of the many rivers and streams behind Gatun Dam, it was evident that the water hyacinth had to be controlled. The destruction of the water hyacinth in the Canal, Gatun Lake and its tributaries was begun in March 1914.

An outfit consisting of a 30 foot steam launch, a pump boat and a quarter boat was used. The launch was used to supply steam to the pump boat and for towing and transportation of men and supplies.

The arsenic solution used was made up of arsenic, soda and water in proportions of one pound of arsenic, one pound of soda and 18 gallons of water. This mixture was most effective; killing the hyacinth and most everything else that got in the way. This mixture was used until 1935. A solution of copper sulphate and water was used as a spray from 1935 to 1952. The use of 2,4-D was started in 1948 and is still being used today.

By 1915, one year after the opening of the Canal to traffic, the hyacinth was becoming even more of a problem. The climate in the tropics is ideal for this growth, as evidenced by these four weeks old plants. It was thought at this time that the pest could be completely eradicated. The young floating and anchored hyacinths were removed by hand to completely get rid of them. It was more difficult to remove the older plants; hence they were poisoned with a solution of arsenic and soda. Later, as the seeds from these sprouted and came up, the plants were removed by hand. Naturally, this was to be an expensive and arduous way to combat the hyacinth, but since it was believed by this method that in two or three years the battle against the hyacinths would be completely won, it was well worth the effort.

All transportation was by water, and very slow. Therefore, it was necessary to have houseboats to house the hyacinth extermination gangs in their various locations. Using these houseboats as a base camp, a long and concerted effort was made to wipe out this pest, but in a few years it was given up as a hopeless task since by 1923 the number of plants being removed and destroyed each year had increased from 600,000 in 1915 to 5,000,000 in 1923.

The Panama Canal is somewhat unique in producing hyacinths. It has both kinds: the anchored and floating varieties. The floating kind is easily destroyed and with vigilance can be controlled. The anchored variety is another story. It is not easy to kill and in many cases has to be pulled up by the roots. The stem below the water, or root, is rope-like and very tough. Above water the stem is thicker, tougher and very porous, and follows along the surface of the water sending out many branches. One plant noted when eight inches out of the water, grew to be over 10 feet in length, had eleven branches and two stems of flowers in 54 days, covering an area of over 80 square feet. This species has been found growing in 16 feet of water.

The solution of arsenic and soda was used until 1935, when a change was made using copper sulphate. The copper sulphate solution was used with relative success until 1948. The change was only made then because the claim was made that 2.4-D was safer — which was so as no more livestock has been poisoned since 2,4-D only has been in use.

A continuous and successful battle has been waged against the hyacinth since 1914. It has not been eradicated, but it is under better control now than it was several years ago. In many areas, spraying and pulling of the hyacinths has been the only control used. This is especially so in inlets where there are no streams entering into Gatun Lake. Periodic spraying of designated plots have been routinely checked to prevent a reoccurrence. Exceptionally good results have been obtained in many of these sections.

In areas where there is a continuous stream flow entering the Canal channel and Gatun Lake area the problem becomes more difficult and spraying alone is not the answer. I believe one of the reasons we have been able to keep it under such good control is through the use of log booms. Log booms are on all of the streams emptying anywher near the Canal channel. In many instances there will be several booms on one river. In most cases, collected aquatic weeds and debris are removed mechanically. The largest one in operation is on the Chagres River near Gamboa. This boom funnels many millions of plants into the lagoon where it is removed by the Sauerman, as mentioned above. (This method was in use as early as 1935.)

At times, so much material is washed down by the continuous rains that it is necessary to operate this plant on an 8 hour, 7 day/week basis. The use of these log booms greatly reduces the time, labor and cost of controlling the hyacinth and collecting the many cords of driftwood.

These same booms have miserably failed as far as the submersed weeds are concerned. They slide under the booms and move with the currents to infest other areas.

A few years after the use of copper sulphate was discontinued, patches of foreign aquatic weeds were observed growing along the edges of the banks in the Chagres River from Gamba to a point five or six miles up river. This did not seem to alarm anyone, since it was assumed that these plants would only grow in water a few feet deep. In the next year or two it was beginning to appear in other places, and in deep water also. The swift waters were tearing these aquatic weeds loose from the banks and spreading them in all directions.

I am an avid fisherman and even though it was still thought by most that we had no problem confronting us, I was very concerned for more reasons than one, but especially so because it looked as though it would take over all the good recreational areas in Gatun Lake.

In 1963, when I was given command of the problem, we started an all out effort to get rid of the elodea and coontail. Our first effort to control it was with the use of large rakes or drags operated by a large derrick barge and an excavator mounted on a barge. The submersed weeds were collected in the rakes and loaded into dump scows and later dumped at sea, or loaded on flat decked barges and transferred to the bank of the river.

It appeared, for a while, that our labors were really successful, until it seemed like overnight the aquatic weeds were back ten times thicker than ever.

I had previously been to the States to see if I could find some chemical that would kill this pest. I did find out about the use of Acrolein and felt it would be of great help; but the Canal Zone health authorities would not allow it to be used.

We seemed to be getting nowhere until it was remembered that we did not have the submersed weed problem until several years after the use of copper sulphate was discontinued.

An experiment was started with copper sulphate. The Dredging Divisision still had a few hundred pounds left over from previous years. The crystals were quite large and when applied in crystal form most of it reached the bottom before it had dissolved. The results were astounding. In a few days all of the elodea and coontail had disappeared.

In the first experimental area, no sign of regrowth was noted for ten months. At this time some plants were found so another application was made. January 1966 was two years since the first application was made, and 18 months since the last. Still, no sign of regrowth.

In one small area Diquat was applied to elodea. Two weeks later it appeared healthier than ever. Copper sulphate crystals were then applied and within a week no sign of elodea remained. Now, 24 months later, there is still no sign of regrowth.

Boating and skiing are wonderful sports, but the carelessness of the boat operators in not keeping their boats, trailers and motors free of aquatic plants, has spread these pests to all parts of Gatun Lake and the rivers. In many places where there never had been any hyacinth, the area is now completely infested with elodea and coontail. As fast as one area is brought under control, another one will break out.

Relative success has been had with the use of copper sulphate. Vital areas have been freed of the aquatic weeds, which, prior to its use, were being completely choked out. Boat ramps, dock areas, recreational areas and water intakes for both electric power and domestic water supply were clogged but are now easily kept clear.

It was felt that if copper sulphate was applied when the level of the lake was low and the water clear, that better results would be obtained. Experiments were carried out all during the recent dry season, when the lake level was low and the water clear, using copper sulphate on elodea and coontail. The results were very disappointing. Twice as much material had to be used and applied more often. It has since been determined that when the water is muddy and deeper, much better results are obtained.

The copper sulphate has been applied by using a mechanical sprayer and by hand. Where the submersed weeds were thick, the mechanical sprayer threw the crystals on top of the plants where a lot of it stayed until dissolved — the tops of the plants were burned but the roots were not affected. In applying the material by hand, it is placed in the open spots and around the edges. After a few days, as the plants die, more copper sulphate is applied, gradually working the infested area back.

Some of the large weed infested areas were first cleared by use of the rake — then copper sulphate was applied with the mechanical sprayer. Results obtained were very good, as the crystals immediately settled to the bottom and attacked the roots.

Only moderate success was obtained when copper sulphate was applied in the rivers on a sandy, gravelly bottom. An experiment was tried by placing copper sulphate crystals in burlap bags and placing them in checkered patterns across the river channel. After a few days the area was checked. Unfortunately, crystals had dissolved and washed away with no apparent damage to the elodea.

While in the process of our experimenting, the governor of the Canal Zone decided we needed some technical advice on the control of submersed aquatic weeds. We asked Dr. Weldon to come to the Canal to study the problem and make any suggestions that he thought might fit our needs. Dr. Weldon arrived on the Canal Zone in July, 1965. Several days were spent observing and studying the area and its problem.

Recommendation was made that we employ a botanist to carry on experiments and direct the operation of the hyacinth control section. He would also do some research work in collaboration with the Fort Lauderdale District, as well as conduct minor research studies in the Canal Zone.

On May 2, this year, we acquired our aquatic weed technician. With his inauguration we have expanded our experimental work in aquatic weed control. The first experiments were started in Miraflores Lake, May 18th. The first photographs show the areas before any chemicals were applied. The second photographs, taken May 27th, show the areas, Nos. 1, 2 and 3, respectively, where Diquat, Copper Sulphate and Hydrothol 191 were applied. You can note the copper sulphate appears to give the best results, but upon close examination of the plants themselves it appears that Diquat may give a more lasting action. The copper sulphate was applied in five parts per million; Diquat in one part per million; and Hydrothol 191 in 0.3 parts per million. From past experience we know that copper sulphate applied in 60 parts per million is very effective and it has given exceptionally good control in many areas, lasting up to 12 months duration. Of course, this is very expensive and we are making studies, hoping to come up with a substance or a combination of chemicals that will give better results with cheaper costs. These experiments will be carried out in conjunction with the Agricultural Department working out of Fort Lauderdale, Florida.

Due to the lack of an aquatic weed control technician, some of the experiments that we have been planning for several months have not materialized as yet. They will be started in the near future and our results will be communicated to the various people through or in collaboration with Dr. Lyle Weldon and Mr. Bob Blackburn of Fort Lauderdale, Florida. We hope that plans can be worked out so that we will be able to invite some teams from Fort Lauderdale to come to the Canal Zone to assist our aquatic weed technician in setting up an experimental program. Our technician will be assisting and studying, from time to time, with the Department of Agriculture under the direction of Dr. Lyle Weldon in Fort Lauderdale.

We have an ideal location in the Canal Zone for experimental work. The climate is especially suited for growth of various aquatic weeds and our tanks are on location, needing only mother nature to give vigorous and healthy plants. Hence, I hope it will be possible for Dr. Weldon and Mr. Blackburn to work closely with us in the Canal Zone in carrying out these various experiments over the next two years.

Since the procurement of 10 manatees, the last one entered the manatee lagoon on the Chagres River in December 1964, these mammals have been under observation as a possible naturalistic biological control method, not only for the removal of the vegetation which floats into the Canal but primarily for the removal of the Mansonia mosquito which develops on the submerged roots. A seven and one-half acre lagoon on the river near the Gamba townsite has been the site of activity for 5 manatees including one baby manatee born in the lagoon to the only female of the group, during the past year and a half. The lagoon has all the species of aquatic vegetation native to the Chagres River area. The floating vegetation masses cover approximatey two-thirds of the water surface. There has been no noticeable evidence of exactly what the manatees are eating with the exception of the cut tops of the water hyacinths. If the manatees have been eating the underroot systems, this is not evident. However, general conclusions have arisen from the manatee observations: (1) Manatees are selective in eating habits where there is abundant vegetation; (2) Manatees will not remove offending vegetation, which supports Mansonia breedings, or remove submersed plants as masses of elodea which supports Anophene mosquito breedings; and (3) Aquatic vegetation as evident in the Chagres River and in certain areas of Gatun Lake will require more than a large herd of manatees for effective control. Although manatees have been effective in the narrow canals in New Guinea by a rotating pasture operation, the problem in the Zone waters does not compare to expect similar results. The size and scope of Canal Zone waters will not be effectively controlled by the use of manatees for removal of aquatic vegetation with further control of mosquitoes.

Future observations in the 7.5 acre manatee lagoon may indicate that the manatees have removed the aquatic vegetation as reported by their eating 100 lbs. per day individually The study will be continued to observe if this will be accomplished.

We are proceeding with the assumption that each separate area in the Canal Zone will have its special set of characteristics. Therefore, it is probable that one chemical might work well in one area and not in another. Also, we have to keep in mind that only a limited number of chemicals will be allowed in Gatun Lake due to the water being used for drinking, swimming, cooking and fishing.

On May 19, 1915, about two cubic feet of mud was taken from an area where old hyacinths had been growing and deposited in a tank under twelve inches of water. On June 30, forty-two days later, thirty-two young hyacinths had sprouted and were growing, some of which were seven inches long.

We are planning to take underwater earth samples from the bottom of various areas and place them in test containers to observe regrowth. The results will be published.

Experiments are to be conducted in an attempt to find a product which will deter regrowth for longer periods. Raw copper is one of these substances.

Present control measures are primarily aimed at vital areas, since costs for controlling elodea, niad and coontail with copper sulphate alone is much too expensive. It is imperative that a cheaper means be found.

In the event that the foregoing fails to accomplish the desired results, studies are now being made of possible routes for a sea level canal, so that when all our efforts are exhausted, say in about 15 years, we will abandon this canal to the aquatic weeds and start with a new, salt water canal.