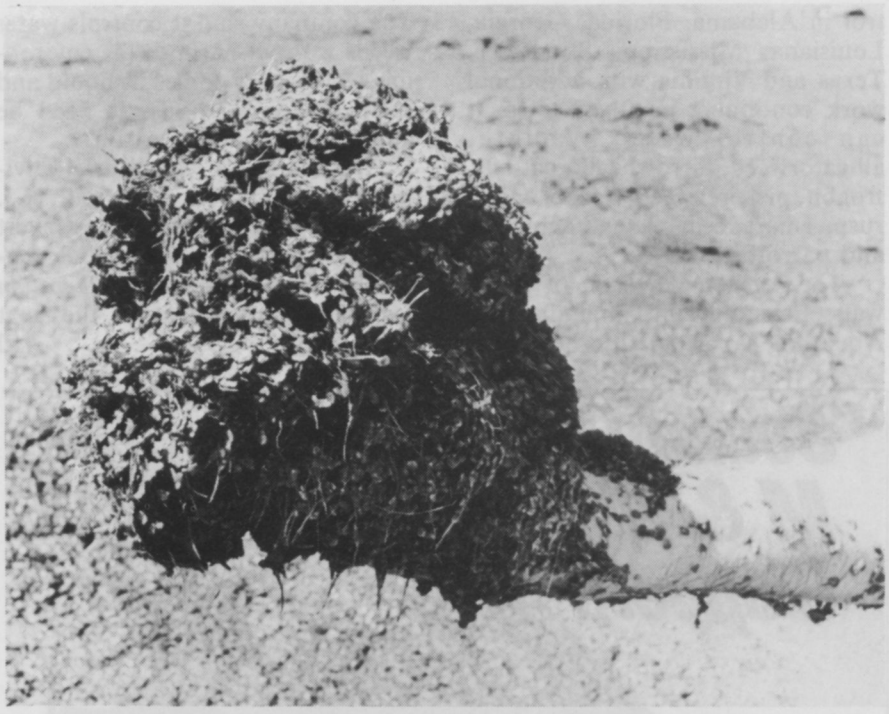

Operation Duckweed

This time last year, Alabama's Black Warrior River and boating and swimming enthusiasts among its summer cottage residents were at the mercy of duckweed — four to five feet thick in some areas. It will be different this summer.

by Charles L. Hargrove
Agricultural Division
Rhodia Inc.

For several summers the Black Warrior River in central Alabama had become increasingly choked with a pesky proliferous aquatic plant known as duckweed. But next season its waters will be clear again due to the effectiveness of an invert emulsion means of herbicidal control in "Operation Duckweed".

Until three or four years ago, the river was very popular with Birmingham-area residents for weekend and vacation fishing and boating. Many have summer cottages along the river, and fishing camps abound.

But, by the summer of 1974, the river was essentially dead. Mile after mile of its water surface was carpeted with a lush, green, "wall-to-wall" cover of duckweed, several feet deep in some places. This made it impossible to use the infested waterways for motorboating and fishing. Most of the fish camps suffered severely, and many had to close down for the season.

Although public complaints had been building over the previous few years, the explosive growth of the duckweed in 1974 finally precipitated intensive activity by state and national environmental agencies.

Apparently duckweed, which incidentally was not indigenous to the region, became established in the lagooning area, called Bayview Lake, several years ago. Until recently, however, it had not spread beyond that. But early in 1974 a spring drawdown was made and duckweed proliferated in the Black Warrior River during the summer. It reached epidemic proportions far downstream by midsummer, producing in some places a surface layer as much as four to five feet thick.

Above: Duckweed growth consists of myriad individual plants which form a choking mass, cutting off light and oxygen and endangering fish life.

Besides interfering with boating and fishing, this blanket of plant life cuts off oxygen and light to the river. Consequently, it kills the fish population and results in interruption of the natural aquatic cycle.

Government enters picture. The Alabama Water Improvement Commission (AWIC), along with the regional federal Environmental Protection Agency (EPA) office in Atlanta, had become very active in seeking a solution to this problem. Experience elsewhere suggested the solution would not be easy.

The individual duckweed plant is tiny and innocuous. An individual trefoil plant only about a quarter of an inch across, it has three hair-like roots an inch or so long. But the plant proliferates so rapidly that waterways become choked by masses of these individual plant units. Though they are separate plants and not interconnected, their population increases so fast that they create what appears to be a solid mass of plant life.

Normal types of herbicidal treatment do not function efficiently because of a tendency for the active herbicide to disperse in the water. Those solutions or conventional (oil/water) emulsions quickly become too dilute to be fully effective. Applying high enough concentrations can help counterbalance this effect, but it pushes the cost beyond economic feasibility. Also it creates unacceptably high residual levels of herbicide in the water.

After the 1974 crisis, the Awic and EPA called upon Dr. Robert D. Blackburn, a plant biologist, to find a practical solution. Formerly research leader for the U. S. Department of Agriculture's Aquatic Plant Management Laboratory (Ft. Lauderdale, Fla.), Dr. Blackburn had recently joined his wife (Candy Joyce Blackburn) in a specialized consulting firm, Joyce Environmental Consultants, Inc. (Casselberry, Fla.), to handle weed-control problems such as this.

Invert emulsion recommended. From his years of experience with similar aquatic infestations, Dr. Blackburn proposed to use a special combination of herbicides in an invert emulsion as the most productive way to

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achieve aquatic weed control. Unlike conventional water emulsions, which disperse readily in water, invert (water-in-oil) emulsions possess a consistency somewhat like mayonnaise and do not readily disperse and disappear.

He determined the optimum combination which would most effectively control the duckweed infestation was a mixture of Chevron Chemical Co.'s Diquat aquatic herbicide and Cutrine-Plus a copper-based algaecide from Applied Biochemists, Inc., Mequon, Wis. Chevron is based in San Francisco. It was applied through the Visko-Rhap spray system, incorporating Visko-Rhap inverting oil, to produce the invert emulsion. Rhodia Inc.'s Agricultural Division, Monmouth Junction, N.J. manufactures the oil.

Dr. Blackburn normally recommends a dosage of one gallon of Diquat (two pounds of cation) and one gallon of Cutrine-Plus (0.9 pounds copper content) for this type of control. This amounts to equal volumes of the commercial formulations in the invert spray. In May of last year, he evaluated the use of the spray technique on a closed lagoon off the river several miles downstream from the steel plant's lake. This five-acre lagoon was almost completely choked with duckweed and served as a good test area. Being outside the river itself, it could not affect conditions downstream.

How system works. Depending upon the application, he employs either a truck-mounted spraying system (for work on irrigation canals) or, as in this case, an air-boat (for jobs on open water). The latter is a flat-bottom vessel powered by an aircraft engine mounted on the transom at the stern. A two-bladed airplane propeller pushes the shallow-draft boat across the surface of the water. Consequently, the presence of duckweed or floating debris does not impede its progress. ("All it needs is damp grass," Dr. Blackburn said.)

His air-boat utilizes the latest

version of a gasoline-powered invert homogenizer (KW-MC-IOE-AAL Mechanical Invert Pump Pack) designed for aquatic spraying. Manufactured by the Minnesota Wanner Co., Inc. Minneapolis, Minn., it is capable of spraying 25 to 30 acres per day, at a rate of three or four acres per hour. Installed amidships, the unit accurately meters water, herbicides and inverting oil into the system by vacuum. The metering is done by orifice plates or discs, each with a strainer before it to prevent clogging. The water/oil ratio and the amount of herbicide to be used is all pre-calculated, to determine the proper size of orifice disc to use.

No further adjustments or measurements are required. The boat is equipped with a tank to hold the inverting oil, but the herbicides are kept in their original containers and are manifolded into the system through an orifice tube placed in each container. This eliminates the need for handling the herbicides, thereby saving time and adding a valuable safety factor to the operation.

The mixture then travels into the piston pump, which has a loop bypass, and then into the mechanical inverter. This is the main component of the system, and produces a consistent, thick water-in-oil emulsion. The invert then travels to the nozzle where it sprays out in the form of a thick strand, about the consistency of mayonnaise. This breaks up into smaller droplets as it approaches the target.

Bayview Lake, its lower half almost completely blanketed by duckweed growth, regained its pristine appearance less than a week after being sprayed with the invert herbicide emulsion.

As the mayonnaise-like emulsion impinges on the duckweed at the surface, it sticks to individual plants and does not wash off in the water. The invert transfers from plant to plant as water movement brushes them together. Any globules of emulsion that don't touch a plant initially will float on the surface, without breaking up, until they do make contact. This assures full utilization of the herbicide. Within two or three days a complete kill is observed in areas properly sprayed with the system.

The test spraying proceeded with textbook effectiveness. Results were outstanding, and Dr. Blackburn quickly got the go-ahead decision to begin "Operation Duckweed".

Killed at the source. After the success of his test run in the lagoon, Dr. Blackburn went up-river to the major source of the Black Warrior River problem — 500-acre Bayview Lake near the steel mill. While the duckweed did not extend in a solid carpet all across the surface of the lake, it was particularly dense for a considerable distance out from the shore and in large floating islands in the center of the lake.

Using a single air-boat, Dr. Blackburn sprayed over 200 acres of infested surface in 7 days. The invert-spray technique proved as effective there as its trial run had promised, and within a few days the duckweed infestation was eliminated.

He followed this by a day's spraying of a heavily infested 25-acre section of the river at Locust Fork, 12 miles downstream from Bayview Lake. As the duckweed in the river died out, the thick blanket of dead plants broke up and the re-

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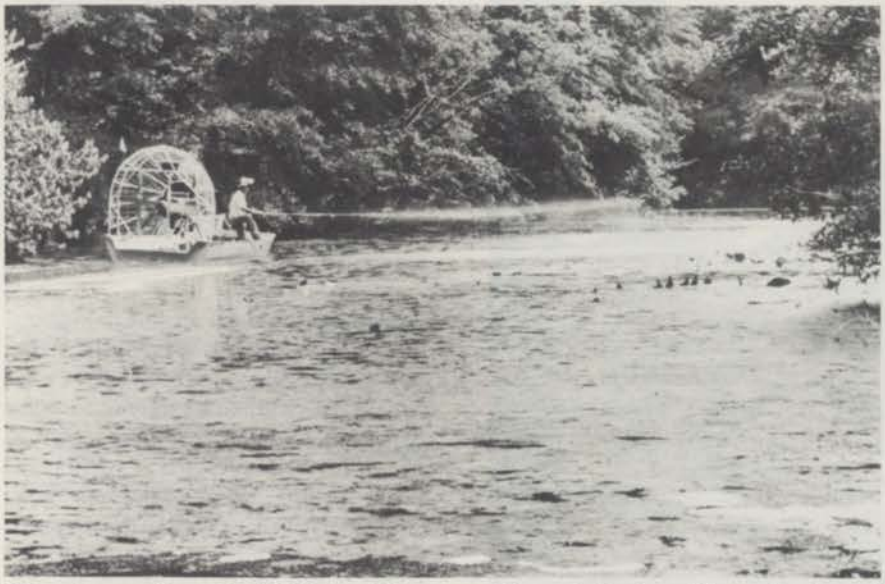

Thin stream of invert herbicide emulsion sprayed from air boat readily reaches beneath overhanging trees to reach duckweed colonies close to shoreline.

Duckweed *continued*

mains drifted downriver. The river quickly regained its usual clarity.

Vacationing fishers returned to their Black Warrior River camps in the summer of 1975. And, happily, so did the fish. As Dr. Blackburn explains, "The results of this spray project clearly demonstrated that aquatic weed control by the invert-spray technique is effective, and economical, for this type of problem. In addition, our ability to place the herbicide in direct contact with the plant — without having it disperse in the water — reduces residue levels."

Low-cost effectiveness. The cost/performance relationship becomes increasingly important these days as environmental needs interface with economic reality. With conventional spray systems, Dr. Blackburn says it would take at least a gallon of each emulsion per acre (two pounds of water-soluble Diquat cation plus 0.9 pound of complexed copper) to destroy duckweed as thick as it was on Bayview Lake and on parts of the Black Warrior River. But the invert emulsion requires, at most, only half as much active herbicide (1 pound of Diquat and 0.45 pound of copper per acre) to do the same job thoroughly. This reduces herbicide costs by 50 percent right at the start.

From his preliminary run in the small lagoon, Dr. Blackburn found that the increased effectiveness of his invert-spraying technique would permit a further significant reduction in active concentration. He used a level of 0.75 pounds of Diquat (with a proportionate reduction in Cutrine-Plus) per acre to give complete duckweed kill. This represents an overall reduction in herbicide use of more than 60 percent, compared with requirements for o/w emulsion systems employing the same active ingredient for the same application.

To control amount of herbicide used, Dr. Blackburn changes orifice discs. The two herbicides he used in this job, Diquat and Cutrine-Plus, were metered directly from their shipping containers through the orifice tubes into the system. This avoided the dangers of pouring and mixing these herbicidal solutions. (Dr. Blackburn feels the safety factor can't be emphasized strongly enough. He finds that most accidents associated with aquatic herbicides occur during the mixing procedure.)

Where necessary, he can feed one or two more solutions into the pump simultaneously, making it possible to homogenize as many as six input streams (up to four active solutions, plus invert oil and water) to form a stable invert emulsion.

Other applications. Besides similar duckweed projects elsewhere in the South, Dr. Blackburn employs a variety of emulsion systems to control such aquatic plants as water hyacinth, water lettuce, hydrilla, naiad, cattail, brush, and ditch-bank grasses. In most irrigation-canal situations, he uses a truck-mounted invert pump. With this setup, he can spray over 50 acres per day. □