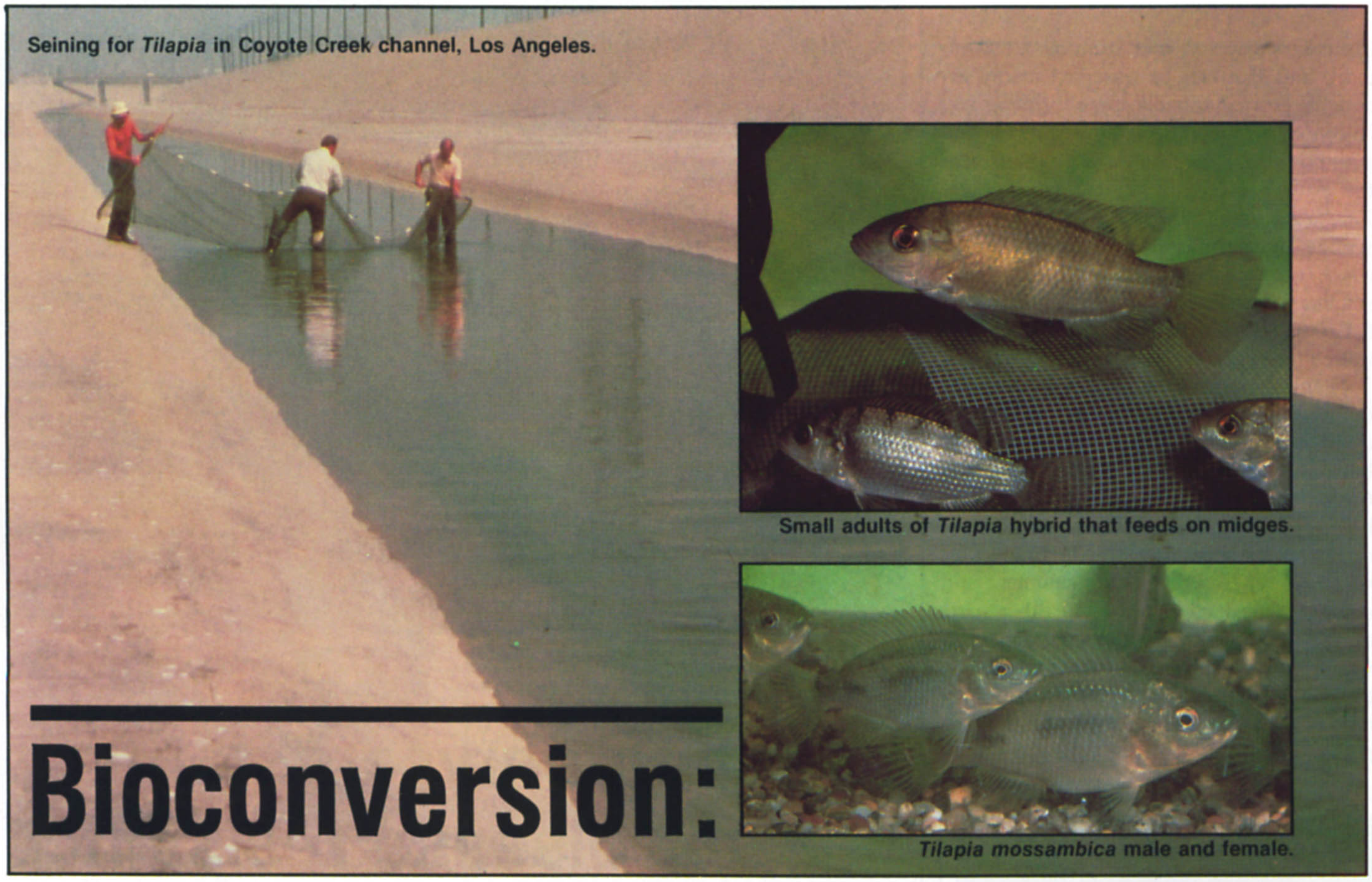


Seining for *Tilapia* in Coyote Creek channel, Los Angeles.

Small adults of *Tilapia* hybrid that feeds on midges.

Tilapia mossambica male and female.

Bioconversion:

Tilapia fish turn insects and weeds into edible protein

E. Fred Legner

Frank W. Pelsue, Jr.

One seine net catch of *Tilapia* hybrid, midge-eating fish that occur in annual population explosions in warm water.

Effective foraging on chironomid midges by an African cichlid hybrid fish, *Tilapia mossambica* × *hornorum,* in the paved Coyote Creek drainage of the Los Angeles basin has significantly suppressed the nuisance insect pest annually since 1977, eliminating the need for chemical treatments. At the same time, annual population explosions of the fish have occurred.

Another fish, *Tilapia zillii,* feeds on noxious aquatic weeds in southeastern California lower deserts. Both fish thus offer a means of converting these urban and agricultural pests into food or fertilizer with minimal investment.

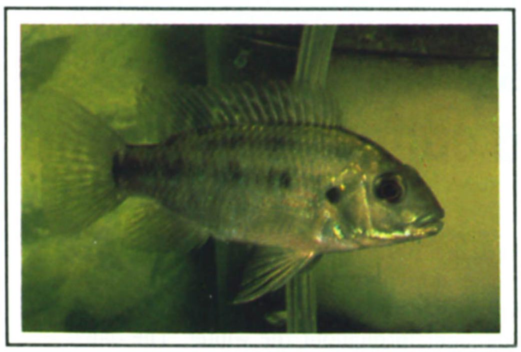
Mass migrations of *Tilapia mossambica* × *hornorum* upstream in the Coyote Creek drainage can be seen in currents of less than 1 meter per second whenever the water temperature exceeds 20° C (68° F). The fish population radiates out from thermal overwintering locations near an electrical power generating plant about 3 kilometers (1.8 miles) upstream from the Pacific Ocean, where the drainage forms an unpaved estuary in which water levels vary with the tides from 1.2 to 2.4 meters. Warm water in the 30° C range is discharged from the plant into the water there. The warm effluent creates a favorable breeding and overwintering habitat for *Tilapia,* which remains visibly abundant throughout the winter. The daily tidal washes do not adversely affect these euryhaline species (able to live in both fresh and salt water).

Migrations begin in the late spring as densities of about 20 adult fish per square meter spread out over the entire water-covered portion of the drainage. The paved channel upstream from the power plant generally averages 6 meters wide and 0.2 to 0.5 meter deep. Juvenile nonreproductive fish are usually seen accompanying the adults in various proportions. At this time the adult fish average 127 millimeters in length and 51 grams in weight (ranging from 30 to 200 grams). Thus, in 1 square meter, 75 adult fish would total about 3.8 kilograms (8.4 pounds) of fish biomass. When spread at this density over 18 kilometers (11 miles) of the drainage, the biomass can exceed 400,000 kilograms, or 440 tons, produced primarily by an insect food source!

Fish migration is in poorly defined, often overlapping schools at rates of 1 to 2 kilometers per hour against the current. By

October, starvation and stunting are common, and fish can be observed avidly examining every attainable space for algae and chironomid food. Throughout summer and autumn the angling rate on worm baits near the estuary exceeds one fish per minute. *Tilapia* migrations are also observed by midsummer in the shallow ocean waters near the coast, so that penetration of other river systems is possible. Also, this insect-eating fish population may be a significant food source for predatory marine fish.

Tilapia continue to mouth-brood their fry during the upstream migrations. The principal food for the young fish consists of bottom-dwelling arthropods, especially *Chironomus* spp., because of their larval breeding habits. Most *Tilapia* reproduction occurs in an area near the thermal overwintering site, but some summer and autumn reproduction occurs in other parts of the estuary and at upstream junctures with tributary channels where silt and debris accumulate. Studies are in progress to further characterize the behavior of the fish population in this artificial habitat.



Weed-eating species, *Tilapia zillii*.

Another related herbivorous species, *Tilapia zillii,* has been very useful in reducing aquatic weeds in the irrigation system of southeastern California. Outdoor pond culture of the species showed that an average of only 2.6 pounds of catfish pellets (largely vegetable matter) were required to produce 1 pound of fish biomass.

The *Tilapia* deserve closer attention as a source of food in this country, especially when such protein may be derived through the bioconversion of aquatic weeds and urban insect problems. Their tropical nature precludes their becoming competitors with desirable game fish, because warm water overwintering sites must be artificially provided in the western United States.

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Rust blisters form on leaf underside (left). From above, leaf looks yellow-spotted.

Testing chrysanthemums for disease resistance

Thomas G. Byrne ☐ Arthur H. McCain ☐ Thomas M. Kretchun

Verticillium wilt and black rust are two plant diseases that frequently attack chrysanthemums. The former, caused by the soilborne fungus *Verticillium dahliae*, is widespread throughout California and can persist in the soil for many years. It invades the roots and enters the vascular system, plugging the water-conducting tissues and producing toxins. Symptoms include yellowing and wilting of lower leaves with progressive "firing" (browning and drying) of the leaves from the bottom of the plant up, especially as the flowers mature and growth slows. Some cultivars have developed marginal leaf burn without wilting. The initial symptoms typically involve only one side of the plant—a characteristic that aids in diagnosis of the disease.

At one time, Verticillium wilt was perhaps the most serious problem in commercial greenhouse and field chrysanthemum plantings. However, the availability of culture-indexed propagative material and the adoption of soil fumigation practices has lessened its importance in commercial cut-flower operations.

Chrysanthemum black rust (to distinguish it from white rust caused by *Puccinia horiana*) is caused by the fungus *Puccinia chrysanthemi*, which differs from similar-appearing rusts that occur on other plants. Small blisters (uredia) form on the undersides of the leaves and on the stems. The epidermal cells rupture over these blisters, exposing a dark rust-colored mass of airborne spores. Infected leaves have a measle-like, yellow-spotted appearance when viewed from the top. Severely infected plants become defoliated, and growth slows.

Both Verticillium wilt and rust frequently attack chrysanthemums in the landscape. Although neither disease is usually fatal by itself, both often are involved in plant death when combined with other adverse growth factors. Also, diseased plantings are aesthetically unacceptable to many people. Control of Verticillium wilt by means of soil fumigation is not recommended for other than commercial flower production. Likewise, control of rust in the garden using biweekly fungicidal sprays is possible but relatively impractical and expensive for the home gardener.

Lists of major resistant chrysanthemums had previously been compiled from results of tests in which available cultivars were planted in *Verticillium*-infested soil and evaluated for symptoms, or evaluated for