A male *Austrofundulus limnaeus* from Tucacas with well-developed red coloration and a more rounded tail fin than usual. The story of this and the other killies of Venezuela is an interesting one. Photo by J. Thomerson.

The Annual Killifishes of Venezuela

JIM THOMERSON AND DON TAPHORN

Part 1: Maracaibo Basin and Coastal Plain Species

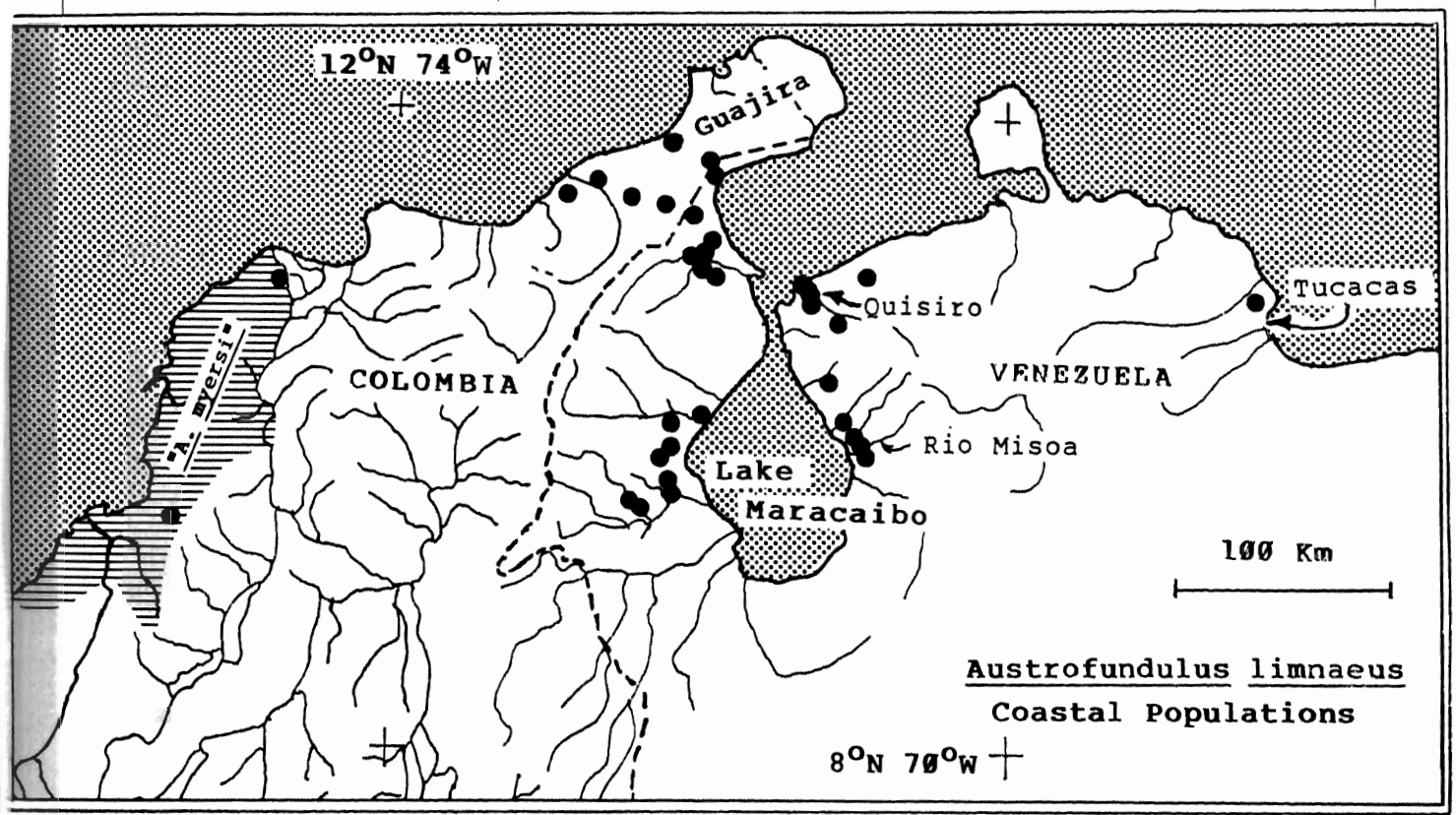
We have been studying the Venezuelan annual killifishes off and on since 1969, and appreciate this opportunity to summarize, for the broad spectrum of *TFH* readers, information about them that is scattered around in the scientific and aquarium literature. We have also dug out a few odds and ends that were hidden away in our files. The distribution maps are new, and as complete as we can presently make them. A few of the dots represent two or more localities close together. There is also a short bibliography for the benefit of our more intrepid readers.

We started writing these articles while Jim, a professor of biology from Southern Illinois University at Edwardsville, was on sabbatical leave in Guanare, Venezuela, to work with Don on killifish. Don is professor, and Director of the Zoological Museum, at UNELLEZ—University of the Llanos—in Guanare. These articles were inspired by our re-examining our past work as a basis for thinking about what we should do next with killifishes.

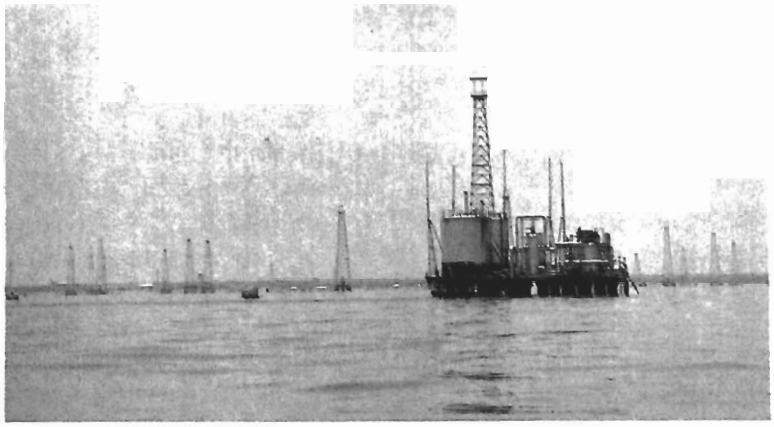
This article covers the four species, *Austrofundulus limnaeus*, *Rachovia brevis*, *R. hummelincki*, and *R. pyropunctata*, that live in the Lake Maracaibo Basin and along the Caribbean Coastal Plain. The other six species make up the Orinoco Llanos annual killifish fauna, to be discussed in Part 2. We think there are at least two more species in the country, but since we don't know very much about them right now they will have to wait for a later article.

The Maracaibo Basin is one of the long time oil-producing areas of Venezuela. It has good roads, and moving around the basin to collect annual killifishes is fairly efficient. Maracaibo, the capital of Zulia state, is a large, bustling city. Its inhabitants, called *Maracuchos*, are the Venezuelan version of Texans. They are big-hearted, boisterous, and fiercely proud of their region. They even speak Spanish with the equivalent of a southern drawl, and further distinguish themselves by use of some antique speech styles that date back to the conquistadores.

The region is also inhabited by Guajiro Indians, whose unique culture has exerted a



The distribution of *A. limnaeus* along the Caribbean coast and Lake Maracaibo Basin.



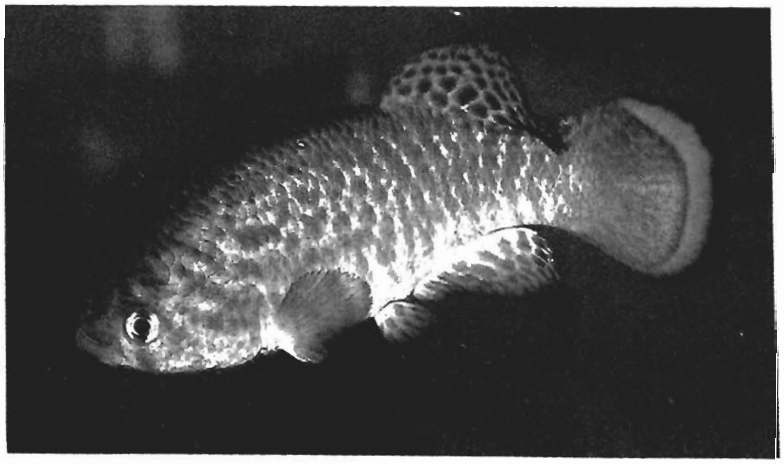
An oilfield in Lake Maracaibo. Photo by D. Taphorn.

strong influence in the area. Even after nearly 500 years of contact with the European, and now Venezuelan, cultures they maintain their identity as a people, something that few other indigenous groups have been able to manage. Their colorful woven rugs, distinctive dress code, and strong clan ties set them apart from other Venezuelans. Even those Guajiros who fit themselves into modern society retain their traditions. Many still raise goats in the desert or harvest salt by hand along the coast, and live much as they have for hundreds of years. Their sayings and folklore have deep roots. Even today, Guajiro mothers warn their children to be good, or Drake will eat them. That is Sir Francis Drake—the saying originated when pirates ravaged Guajiro coastal settlements back in colonial times. On the other hand, Guajiros have long been known as excellent merchants and are said to make good helicopter pilots!

In the northern part of the basin, around the mouth of Lake Maracaibo, the countryside is desert. Annual rainfall increases as we travel inland to the south, and on both the east and west sides of the lake there is an ecological gradient from desert to tropical wet forest around the southern end of the lake. All but one of the known Maracaibo annual killifish localities are in the northern half of the basin. We speculate that this is due to decrease in the length of dry seasons and resultant scarcity of annual fish habitat. There is a large permanent swamp bordering the southwest edge of the lake, but apparently no killifishes live there.

Rainfall peaks in May and June and to a lesser extent in November. December through March is the dry period. This varies considerably from year to year and place to place, because rainfall events in this part of the tropics are often very localized. Several times we've had the experience of finding lush vegetation and killifish pools within a kilometer or two of bone-dry desert, then going on another kilometer or two and being back in desert. Even when it is dry, fish may be present. We have collected large adults from the remnants of substantial pools in desert areas where, according to local people, it had not rained for over a year.

The Lake Maracaibo Basin annual killifish populations are as well known as any in South America. Even 40 years ago, Schultz had several collections available for use in his monumental studies of Venezuelan fishes. Between us, we made three different collecting trips into the basin to obtain additional material for our 1970 revision of *Austrofundulus* and *Rachovia*. Then, Don lived and



A young F1 *A. limnaeus* male from Guajira parents. Photo by J. Thomerson.

worked in Maracaibo for two years before accepting his present position at UNELLEZ. Part of his work in Maracaibo was a study of local fishes for potential biological control of mosquito larvae. This study (Lilyestrom and Taphorn, 1982), published in Spanish, includes considerable information on the ecology of the annual killifishes.

An annual killifish pool in the Guajira of Venezuela. Photo by J. Thomerson.

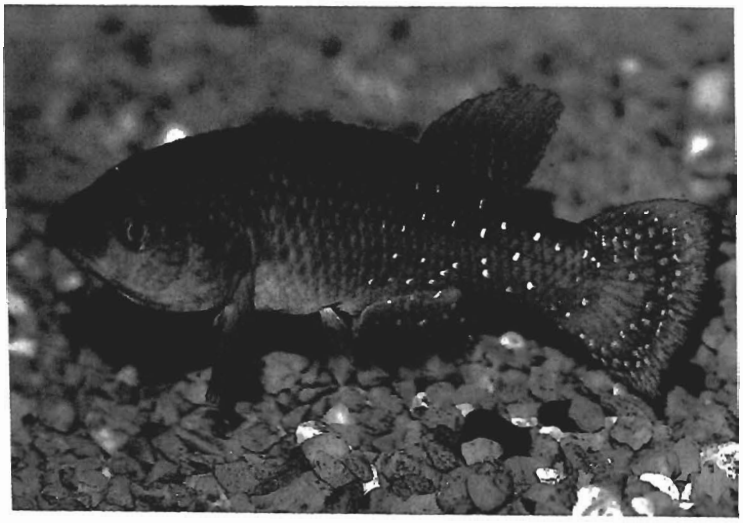
In 1949, Schultz described *Austrofundulus limnaeus* as a Maracaibo Basin subspecies of *A. transilis* Myers. In our 1978 revision we showed that *A. limnaeus* is a full species. We also included *A. stagnalis* Schultz and *A. myersi* Dahl as synonyms of *A. limnaeus*. *Austrofundulus transilis* is an Orinoco Llanos species which we will discuss in Part 2.

Sometimes we wake up in the middle of the night and wonder if that's the way it really is. One of Jim's sabbatical goals was to obtain live fishes for a study of chromosome variation to be carried out in Dr. Bruce Turner's lab at Virginia Polytechnic Institute. Maybe the chromosomes will give us a different story to tell.

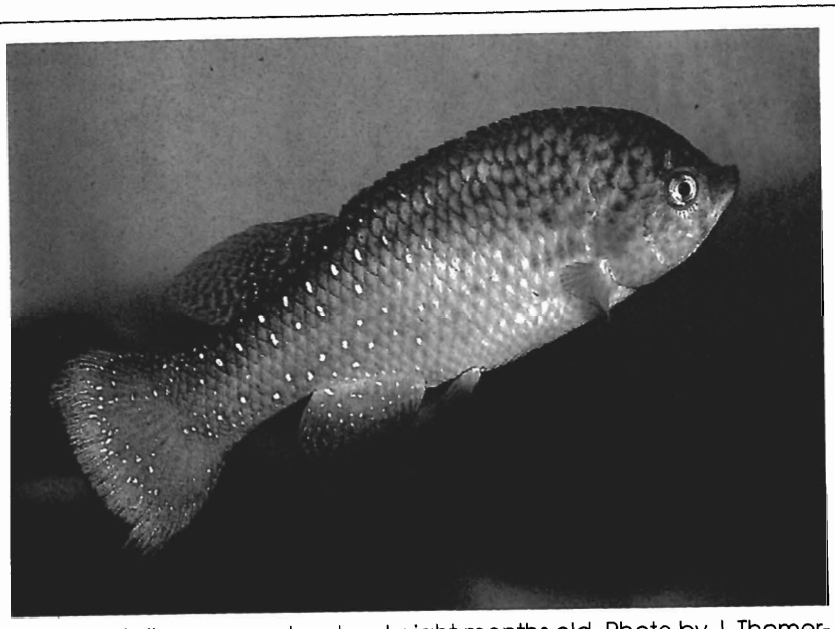
Because we don't know the limits of the range of *A. limnaeus* westward along the Caribbean coastal plain in Colombia, the map shows not only specific documented localities, but also the general range Dahl gave for his Colombian *A. myersi*.

At first we accepted *A. myersi* as a valid species, but after we became familiar with the wide range of variation in *A. limnaeus*, preserved specimens that Dahl had identified as *A. myersi* no longer seemed different. Then we collected *Austrofundulus* near Barranquilla, Colombia, within the stated range of *A. myersi*, that looked like they could have just come over from the Maracaibo Basin. Finally, in late August, 1972, Jim and the Colombian ichthyologist Dr. Plutarco Cala made collections of *Austrofundulus* across the Colombian Guajira Peninsula to fill in some of the supposed gap between the range of *A. myersi* and the Maracaibo Basin *A. limnaeus*.

From an aquarist's point of view, the Guajira *A. limnaeus* are arguably the best-looking population of the species. They are large fish—males get up to at least 4.5 inches total length, but females stay considerably smaller. They are heavily mottled, with the dark and light areas arranged into indistinct vertical bars on the rear half of the body. Something less than one-quarter of the males have a wide blood-red band, then a narrow black band, along the edge of the rounded tail fin. The red band is proportionately wider than the scarlet bar seen in some males from the Tucacas population. The red band is intensely developed in dominant



A young male Quisiro *A. limnaeus*. Photo by J. Thomerson.



A Quisiro *A. limnaeus* male, about eight months old. Photo by J. Thomerson.

males, but may be barely visible in low-rank males. All the Guajira collections were made in very turbid, muddy water, and the Guajira *A. limnaeus* become darker when kept in clear water.

Unfortunately, that part of the world is unhealthy for North Americans (and most other people) these days, so we had written off collecting live material of the Guajira fish for our chromosome studies. But on looking through our old notes for collection localities, we were reminded that the late Augustin Fernandez-Yepez, the well-known Venezuelan ichthyologist, had shown us several preserved collections which included red-tailed *A. limnaeus*. He had made these collections in the narrow strip of Venezuela that runs along the eastern edge of the Guajira—an area where we could collect.

In early July, 1987, Jim and two UNELLEZ students, Oscar Leon M. and Naboth Montilla A., made a quick trip into the Maracaibo Basin to obtain some fish for the chromosome studies. Of course, the first place they wanted to collect was the Venezuelan Guajira. Even though there is considerable official presence in that border area, car theft and other problems are not uncommon. Parking the car on the side of the road and leaving it unattended while checking out roadside ditches and borrow pits would be exactly the dumb thing to do.

The National Guard commander at Paraguaipoa was quite agreeable to their request for an armed escort, and assigned a man to go with them for the afternoon. This worked out nicely; the man knew the area very well, passed them through the numerous National Guard and police checkpoints with a wave of his hand, and got gas for them out of the emergency supplies when they ran low.

They checked about 20 pools, mostly in borrow pits (called *prestamos* in Spanish) excavated for road fill, before they found annuals in a prestamo beside the road near the frontier. There were big adult *A. limnaeus*, including beautiful red-tailed males; nice *R. hummelincki* and a few *R. brevis* were also present along with several species of tetras. By the time they finished collecting it was late afternoon, so they returned their escort to his post and headed back toward the city of Maracaibo. On the way, a few kilometers north of Puerto

Craig Lilyestrom taking the water temperature of a killifish pool near Quisiro. Photo by J. Thomerson.

A large adult Rio Misoa male *A. limnaeus* with long tail extensions. Photo by J. Thomerson.

Rosa, they checked out a hog wallow beside the road. Here they found more red-tailed *A. limnaeus* and some beautiful *R. pyropunctata*.

The Lake Maracaibo Basin *A. limnaeus* can be divided into three intergrading populations (in addition to the red-tailed Guajira populations) on the basis of differences in the usual male. Females are plain gray-brown fish and look pretty much the same everywhere, but males show a lot of variation in color, body shape, and fin development. Exactly what a male looks like reflects not only the population to which he belongs, but also his individual genetics, age, nutrition, dominance status, surroundings, and who knows what else.

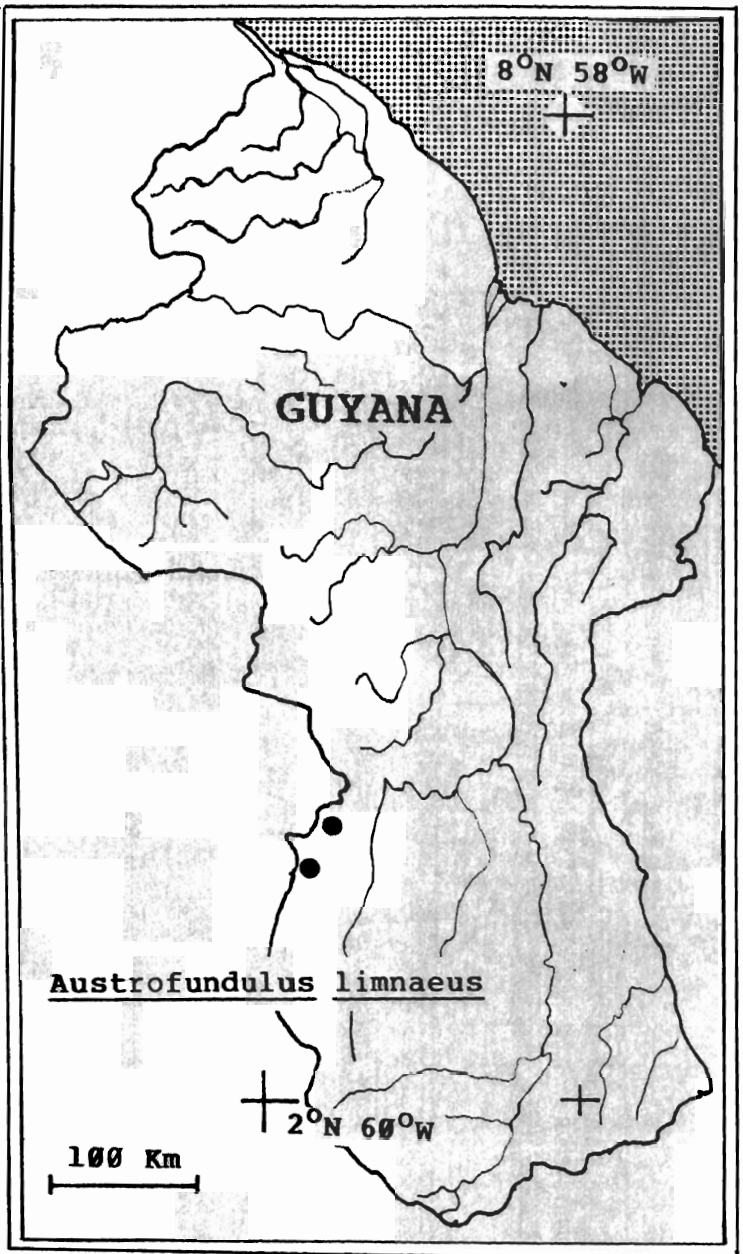
We speak of fish from the coastal desert east of the lake as "Quisiro" *A. limnaeus*. The type locality of *A. limnaeus*, 15 km (9 mi) west of San Felix, is just about at Quisiro. Fish from this area get big. Males are particularly heavy-bodied and get up to 5 inches total length. They show bright blue to yellow-green markings on the lyre-shaped tail, and numerous distinct yellow to blue spots on the body sides, particularly on the caudal peduncle. Some very large males have a light blue cast over the entire body, a characteristic shared with the Guajira population. Their background color is a light gray to gray-brown, and they are perhaps a little less mottled than the Guajira fish. The Quisiro fish are our personal favorites, and we've always enjoyed having them around in the aquarium. They are an attractive version of *A. limnaeus* and seem to have more "personality" than fish from other populations.

As we move south along the east shore of Lake Maracaibo, we find populations in which the males look quite different. They tend to be darker, more brown than gray; the blue spots on the body become more diffuse, and they do not show the

Young male *A. limnaeus;* the one in the foreground is from southwest of Lake Maracaibo, and the other from Quisiro. Photo by J. Thomerson.

overall blue wash seen in the more coastal populations. Toward the southern end of the range on the east side of the lake, the fish are a rich golden brown, with light indistinct mottling. The anterior part of the body is yellowish brown and has scattered blue highlights rather than well-defined spots. The spots on the caudal peduncle are often well-defined, and there is a pattern of blue vermiculations covering much of the tail fin. They have well-developed upper and lower extensions on the tail fin and the fins in general are fuller than in the Quisiro males.

Schultz's *A. stagnalis* was based on a sample of these fish from 6 miles north of the Rio Misoa. The type material of *A. stagnalis* is young adults and juveniles, in contrast to the type material of *A. limnaeus*, which includes large adults. Males become deeper-bodied with increasingly rounded head profile and proportionately shorter fins as they approach maximum size. So we think some of the differences Schultz saw between his two species were only age and size differences, and the rest fall within the range of normal population variation.



Distribution of *A. limnaeus* in the Amazon drainage, Rupununi Savanna.

Males from the southern populations directly across the lake, in the western basin, look quite similar. They have a reddish cast to their fins, a lavender wash over the posterior part of the body, yellowish head and shoulder regions, and a few scattered blue spots. Their fins are perhaps even larger and more flowing than those of southern males from east-side populations.

Lilyestrom and Taphorn used data from populations at 21 sites to characterize the ecology of *A. limnaeus* in the Maracaibo Basin. Most populations were in standing water, usually in prestamos. Water temperature for the 21 sites averaged 30.3°C (86.5° F), conductivity ranged up to 3200 micromhos/cm, the bottom was invariably soft mud, and three-quarters of the sites had some aquatic vegetation. Fish were collected during May and August, 1977; April through December, 1978; and April through June, 1979. Major items of food (in 55 fish from one locality) were fishes, microcrustaceans, beetles, and bloodworms, in decreasing order of importance. Ants, snails, mosquito larvae, and caddisfly larvae were also eaten in small numbers.

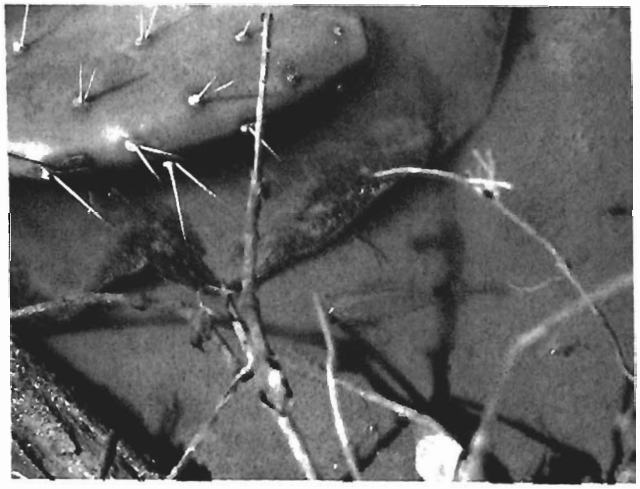
In the aquarium *A. limnaeus* will eat a wide range of foods. If food they particularly like, for example mosquito wigglers, is given in quantity, they will pig-

Male *Rachovia brevis*. Photo by B. J. Turner.

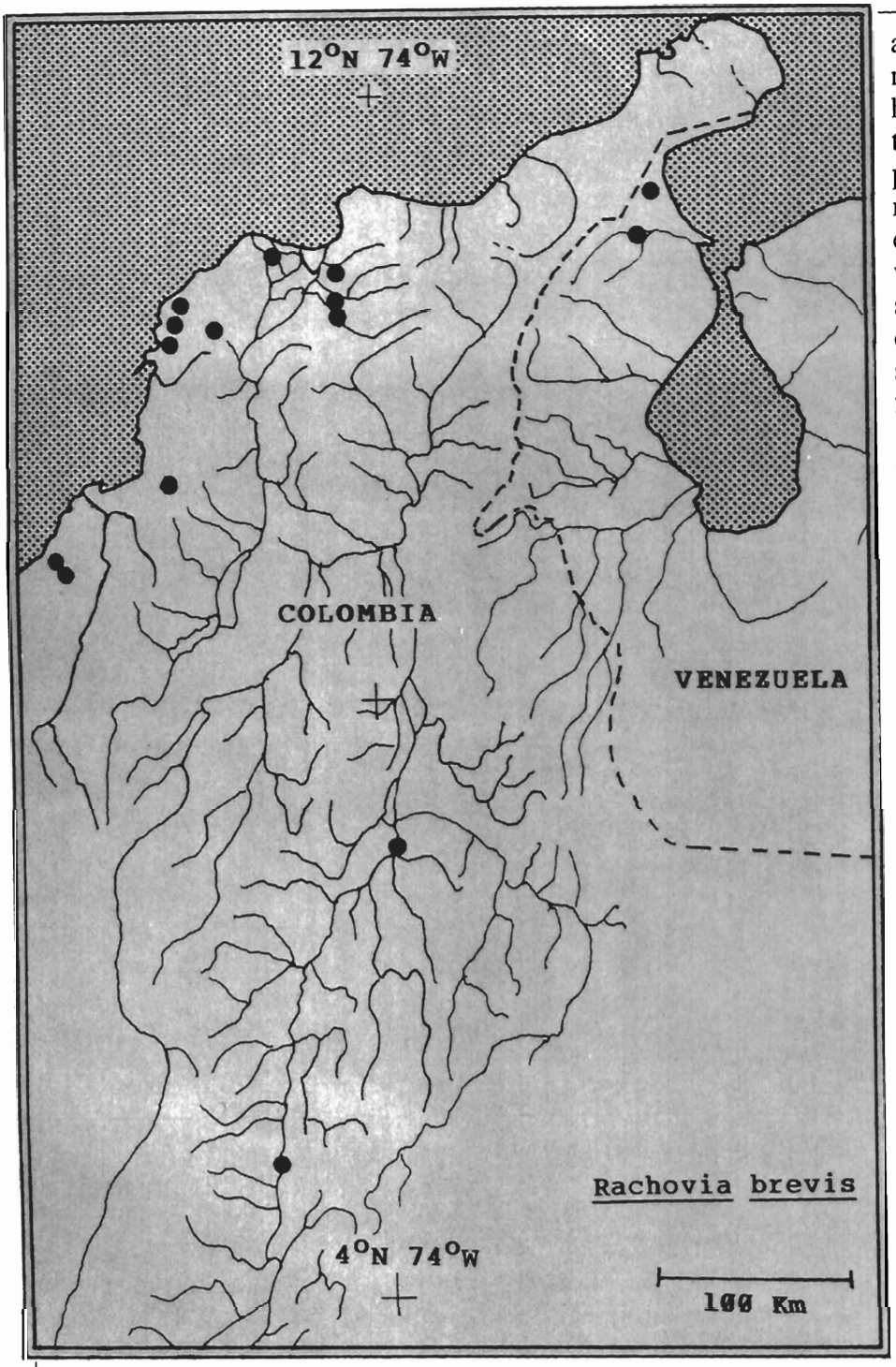
out, stuffing themselves and running the food through their gut with little digestion. The implications for the aquarist are obvious—overfeeding, even though they eat it all, can still lead to foul water problems.

This characteristic can also get them into trouble in the wild when they overeat their food supply. Jim, along with Leo Hoigne (Thomerson, 1971) found large adult *A. limnaeus* starving to death in a prestamo with knee-deep water and abundant aquatic vegetation. There were hundreds of emaciated bodies floating on the surface. They collected some of the fish that were still alive, even though they were little more than skin and bones. Upon being put in an aquarium and offered beef heart, these fish ate voraciously. Many recovered and fleshed out in a matter of only a few days. Several of these fish lived for over a year after they were collected, breeding away the whole time.

Aquarists are most familiar with the Tucacas population of *A. limnaeus*. Leo Hoigne discovered these fish in the early '60s, and deserves most of the credit for making them available to killifish enthusiasts. Soon after their discovery, the Tucacas fish were identified as *A. transilis*. They traveled under that name in the aquarium and scientific literature until 1978, when we recognized *A. limnaeus* and *A. transilis* as separate species, and identified the Tucacas fish as *A. limnaeus*.



Left: How many *Rachovia hummelincki* can you count in their natural habitat? Photo by D. Taphorn. **Right:** The type locality of *R. hummelincki* as it was seen in August of 1969. Photo by J. Thomerson.

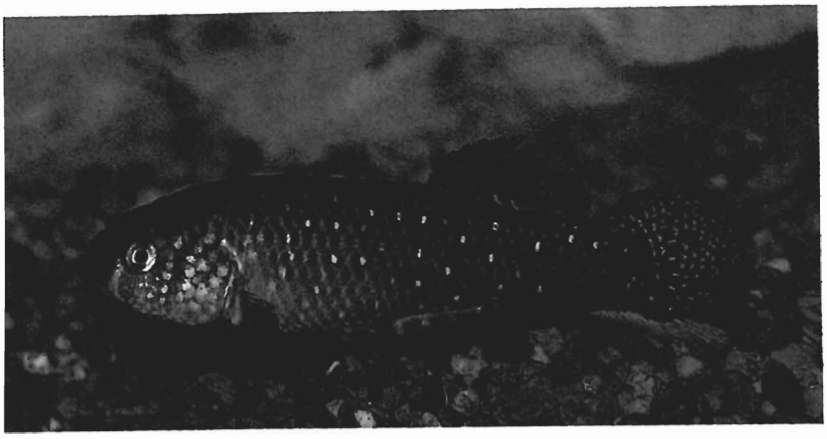


Distribution of *Rachovia brevis*.

The Tucacas fishes are the darkest population of *A. limnaeus*, and run smaller than some of the other populations. A large male would be about 2.5 inches total length. We have found them to be easy to breed and rear but not as prolific as the other populations. They do well at temperatures of 80°F or even a few degrees higher, but we have collected them from water as cool as 76°F. In nature, a minority of the Tucacas males have a blazing scarlet bar near the end of the tail fin. Our experience with aquarium-reared fish has been that several males in each hatch would show traces of the scarlet bar, but only the dominant male (if he had the scarlet bar) would develop it fully. If subordinate males with traces of red were removed from the presence of the dominant male, they would also develop a full-scale red bar. We raised some at temperatures in the low 70s and they developed yellow rather than red bars.

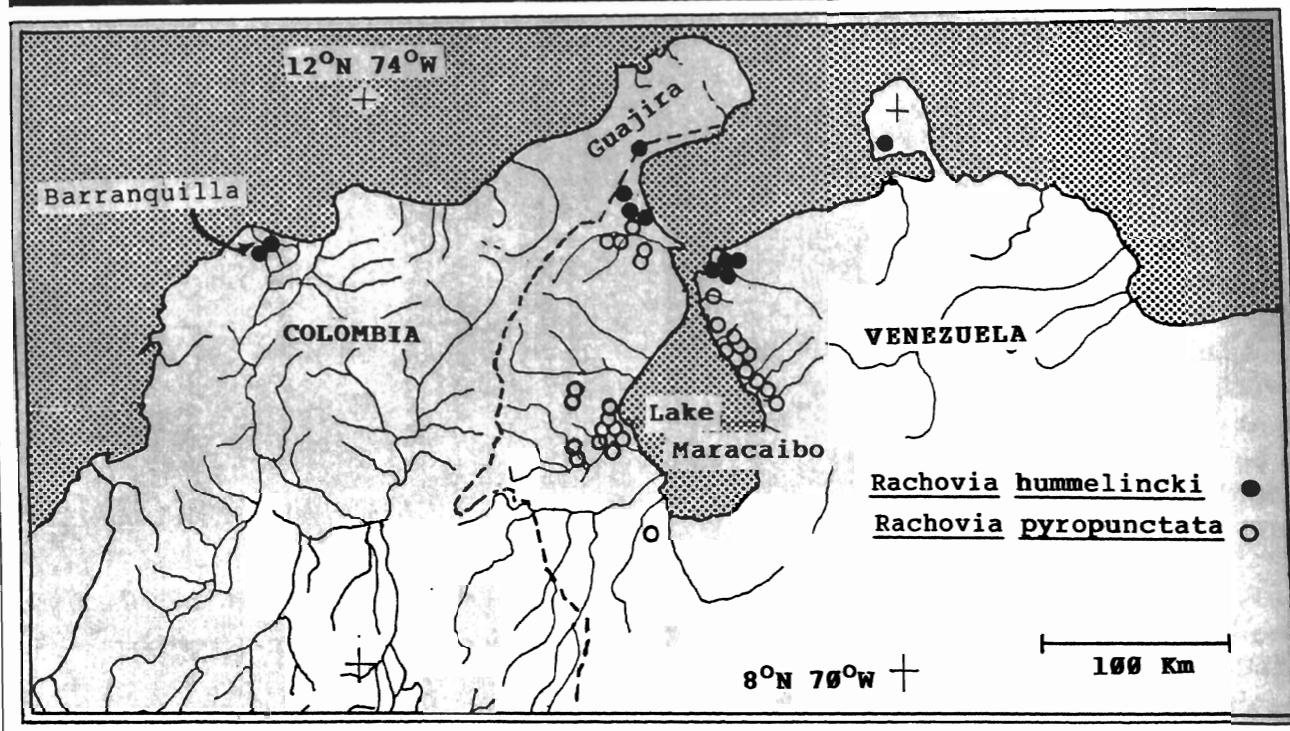
Annual rainfall in the Tucacas area averages approximately 50 inches a year, but we are not completely clear on how the seasons are supposed to run. The collections plotted on the map were made in late January, August, and September, of different years. Pools in the Tucacas area have generally had some vegetation, if only grasses, growing around the edges, and the water has been clear and tea-colored. Most of the sites are in fairly open areas, but the 76°F temperature reading was taken from a duckweed-covered shallow prestamo that was old enough that it had a forest of 6- to 8-inch diameter trees growing in and around it.

When we visited the Rupununi Savanna in southern Guyana during August, 1975, we didn't know that Fred Cichocki had found some *Austrofundulus* near Good Hope.

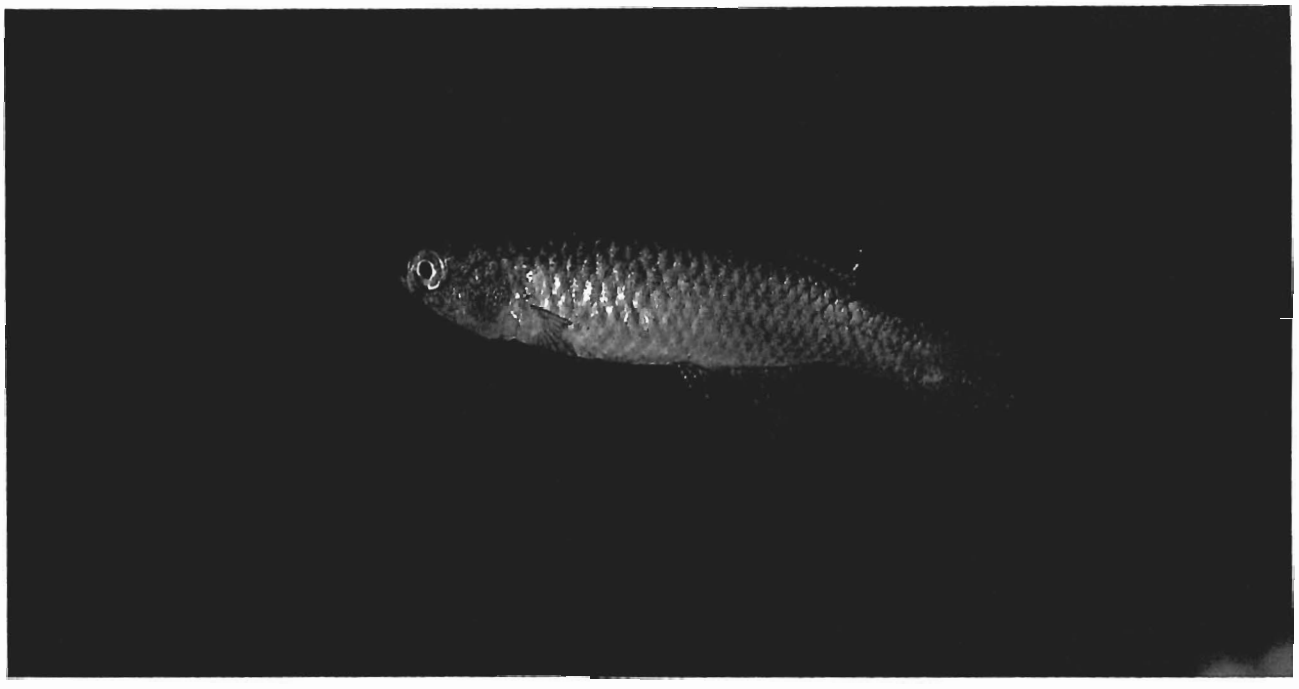


We were there to study the environmental impacts of the aquarium fish collecting industry. Still, we couldn't help noticing that the Rupununi is a likely place to look for annual fishes.

We stayed at Manare Ranch, a working cattle ranch with limited accommodations for guests. When we arrived, the manager, Louis Orella, was not feeling well, so we were greeted by his sister, who had come over to help out. During the conversation she asked Don what he was studying. In the course of describing his Master's thesis work, Don drew her an *Austrofundulus* male and asked if she had ever seen one. Both she and an Indian girl helper recognized the fish. The Indian girl said they were called *enacku*. (There is a town named Enacu in the Rupununi. Wouldn't it be interesting to go there and look



Top: A Venezuelan male *R. hummelincki*. Photo by D. Taphorn. **Center:** *R. hummelincki* males have an orange chin. Photo by J. Themerson. **Bottom:** Distribution of *R. hummelincki* and *R. pyropunctata*.



A female *R. pyropunctata*. All female *Rachovia* look very similar. Photo by J. Thomerson.

around?)

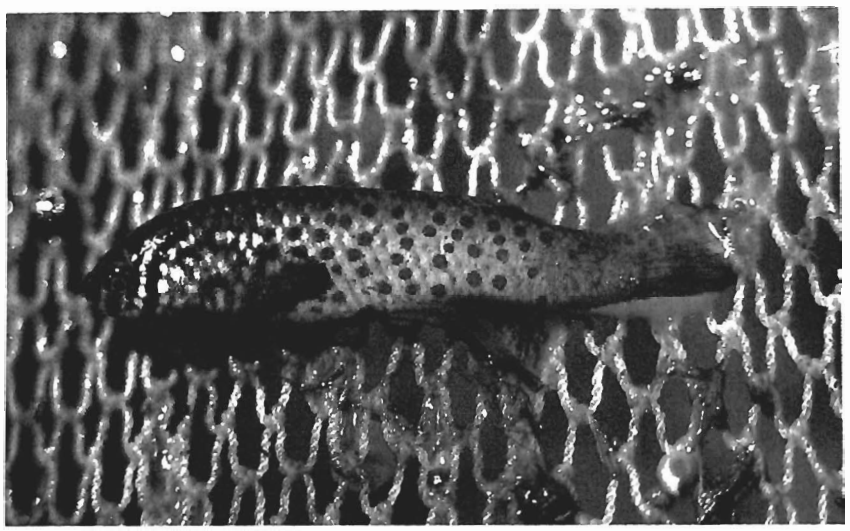
About this time, a recovered Mr. Orella joined the conversation. He was not familiar with *Austrofundulus*. His sister explained to him that she had seen them. Around here? No, in the pond behind so-and-so's house near Good Hope. Well, he knew a place like that on the ranch and would take us there tomorrow.

The next day he drove us past several really good-looking pools to park his Jeep hub-deep in a flooded area near the river. Jim hopped out of the Jeep and was utterly dumbfounded when the first sweep of a hand net brought up a male *A. limnaeus*. All the *Austrofundulus* we caught came from within 30 feet of the parked Jeep, even though we collected all around there and spent parts of another two days investigating other likely-looking spots.

This story shows how much luck and circumstance have to do with finding annual killifishes. Any ichthyologist or aquarist who sets out to collect annuals should make up his mind to accept getting hot, wet, dirty, bug-bit, and tired for nothing, pool after pool, and still go on to check the next pool with undiminished enthusiasm. Our usual strategy is to start from someplace where annuals are known to occur and work out from there, but even so, we do a lot of looking for every killifish pool we find.

"Any ichthyologist or aquarist who sets out to collect annuals should make up his mind to accept getting hot, wet, dirty, bug-bit, and tired for nothing, pool after pool, and still go on to check the next pool with undiminished enthusiasm."

The Guyanan population in the upper reaches of Amazon tributaries is an exception to our characterization of *A. limnaeus* as a coastal fish. This population is probably more widespread than our map suggests. The fish we collected looked to be young adults. They were not as dark as the Tucacas fish, but were noticeably darker than the usual. Males showed some blue on the tail and series of blue dots arranged in a chevron pattern on the caudal peduncle and rear body. We took a few of these fish alive to see what they



Rachovia pyropunctata male. Photo by J. Thomerson.

would look like when they got older, but they contracted some dread disease and died off on us. This population lives in an area where aquarium fishes have regularly been collected for export, and perhaps they will show up in the trade. The Rupununi *A. limnaeus* raise an interesting, as yet unanswered, scientific question. How did they get there, considering that all other known populations of the species live at least 1500 miles away along the coast? They also make us wonder what other unexpected places will turn out to harbor *A. limnaeus*.

By now you may have some real doubts about our decision to lump all these diverse killies into one species. For one thing, our short descriptions and the few photographs can't help but give you an exaggerated impression of how different the populations are. At first we were just as impressed with the differences between local populations of *A. limnaeus* as you are, and talked about several undescribed species.

Now, we do enjoy describing new species of killifishes, so what stopped us? We collected large samples at a number of different localities, and we found that males show a lot of individual variation in color, size, and body form—more than we had expected from work on other killifishes. (Females all look pretty similar.) When we did ichthyological counts and measurements on these beauties after they had hit the formaldehyde (sorry, aquarist friends) they looked even more similar to us.

We regard a taxonomic diagnosis as a necessary part of any new species description. A taxonomic diagnosis does not tell you what disease your pet fish has, but rather is a statement of how to tell the new species from similar related species. As we looked at more and more fish, our new species diagnoses got fuzzier and fuzzier and eventually vanished. In the end, we had to accept the fact that we could separate only the most different fish when comparing two populations; many were in between and indistinguishable.

Austrofundulus limnaeus, in its various manifestations, is an interesting and rewarding aquarium fish. Breeding and rearing should pose no problem to anyone who has had experience with annual killifishes. They do need warmer water (in the 80s F) than most tropicals. They are real pigs and you must pay at-

This pool, containing *R. pyropunctata* and *A. limnaeus*, is at the corner of two busy highways. It stays red and turbid because of salt in the water, which helps keep the clay particles suspended. Photo by J. Thomerson.

tention to keeping their tank from going foul with partially digested food. It's our impression that they can grow to sexual maturity more rapidly than any of the other annual killifishes, but we don't have hard data. (Dr. Dick Haas has reported that *Nothobranchius guentheri* can grow to sexual maturity in 24 days from hatching.) On the other hand, they seem to tolerate going hungry while you are gone on vacation better than many of the other annuals. The males are somewhat aggressive, and it's easy to raise one big dominant male and a bunch of little subordinates.

They breed incessantly and are very prolific. If they can, they will dive into the substrate (remember, they live over soft mud bottoms in nature). If not, they will breed as best they can, in sand, gravel, or on a bare bottom. We usually breed them in a bare aquarium using a plastic refrigerator dish holding a half inch of fine sand. They will lay eggs in the sand in preference to the bare bottom. The eggs are about 2 mm in diameter. We pour the sand, water, and eggs through a net with mesh that stops the eggs and lets the sand pass through. The eggs can then be individually placed on the surface of moist peat moss to incubate.

Although this method is the most time-consuming, it allows us to count the eggs, observe their development, remove bad eggs, etc. If this is too much trouble for you, just collect the eggs as described, and dump them into a small jar of peat moss and water until you think you have enough. Then squeeze all the water you can out of the peat, and store it in a sealed plastic bag at 80°F. You probably will be able to find eggs in the peat. If so, check them periodically, and when they look back at you with their little eyeballs, have a go at hatching them.

If that's still too much trouble, just spawn your *A. limnaeus* directly in peat moss. Collect the peat moss whenever you

have the inclination, squeeze it dry, and store it in a plastic bag. Let it incubate a couple of months at 80°F and then throw it in water and see what happens.

For hatching, we use soft water, in the upper 70s F; deep or shallow doesn't seem to make much difference. It will help the hatching process if you blow your CO_2 laden breath into the water through a piece of airline. If nothing happens in 24 hours, re-dry the peat and try again in a couple of weeks. Even if you get a good hatch, there are probably still eggs in the peat that have been developing at a slower rate. In nature these eggs are insurance for the population. Sometimes it rains a little, and some water collects and forms a pool. But the pool does not last long enough, and the fry that hatched out simply die when the water dries up before they can grow up and reproduce. You may have to re-dry a bag of peat several times before you get a successful hatch. That's why we like to be able to find the eggs so we can follow their development and hatch them when they are ready.

The fry are on the large side for killifishes and can easily take newly hatched brine shrimp, first instar mosquito larvae, microworms, and other standard large fry food. They grow rapidly, and you can start feeding them some of whatever you feed your adults within the first week. The males and females start showing differential growth rates very early, and, given that they will eat fishes, you may want to do some separation by size to prevent possible cannibalism.

Three of the four recognized species of *Rachovia* are discussed here; the fourth, *R. maculipinnis*, is an Orinoco Llanos species. *Rachovia brevis* was described by C. Tate Regan, in 1912, from an individual imported into Germany as an aquarium fish, so it has had a long history in the hobby. It has also been imported several times as *Rachovia splendens* Dahl, a

name that still pops up in the aquarium literature. Thomerson, *et al.* (1976) showed that *R. splendens* is a junior synonym of *R. brevis*.

Rachovia brevis is an extremely variable and often strikingly pretty fish. Large males develop fairly deep bodies, and could pass for an *Austrofundulus* at first glance. It seems to be the most common annual on the Colombian Caribbean Coastal Plain, and ranges far up the Rio Magdalena Valley. In Colombia, it is often the only annual species present in a pool, but it has been collected with *A. limnaeus* and *R. hummelincki* (see Turner, 1967). In Venezuela, it's known from three localities in the desert at the base of the Guajira Peninsula. Here it occurs with *A. limnaeus* and either *R. hummelincki* or *R. pyropunctatus*.

The Venezuelan *R. brevis* are attractive fish, and we have seen males from various Colombian populations that were spectacular killifish. Some of the Colombian populations even have males showing a scarlet tail bar similar to that of the Tucacas *A. limnaeus* males. Back in the '60s, Jim had some of these. He tried selective breeding to fix the character in his stock. In just 5 generations he succeeded in losing the character completely, and gave up in disgust. Surely some of you master breeders can do better than that!

Lilyestrom and Taphorn describe *R. brevis* as coming from a pool of fairly clear brown water with a temperature of 80 to 82°F. They found them there (with *R. pyropunctata*) in August, '77, April through December, '78, and April through June, '79. Major food items of 50 fish, in order of descending importance, were beetles, true bugs, bloodworms, and mosquito wigglers. They also ate occasional microcrustaceans, scorpion flies, caddisflies, snails, and mayflies.

Rachovia hummelincki and *R. pyropunctata* are variations on a theme. The males have basically the same color pattern, but painted in different colors. The major difference is that *R. hummelincki* males have small blue, green, or even whitish dots on a brown to purple body, and *R. pyropunctata* males have larger brown to scarlet dots on a blue body. Both have a distinctive, sharply contrasting stripe along the bottom margin of the tail fin. This stripe is usually orange but may be yellow or white. Body shape and scale and fin ray numbers are similar. Preserved specimens with their colors bleached out are not easy to tell apart.

The type locality of *R. hummelincki* is out on the Paraguana Peninsula, east of the Lake Maracaibo Basin. It is a small reservoir formed by a dirt dam across an arroyo out in the desert. This was built as a drinking water supply for the people of the region. When Leo Hoigne and Jim visited the site in 1969, it was a dried-up shallow ex-mudhole. Local people told them it had filled in and now no longer held water for more than a month or so. It's a pretty safe bet that *R. hummelincki* is extinct at its type locality. One of our future projects is a collecting trip to the

Paraguana Peninsula after one of the infrequent rains. We would like to see some live *R. hummelincki* from near the type locality, and also find out what else is out there in the way of annual fishes. All the known localities for *R. hummelincki* are out in desert areas near the coast, and there aren't that many of them.

According to Lilyestrom and Taphorn, *R. hummelincki* occurs in turbid waters with up to 2000 micromhos/cm conductivity. They give an average water temperature of 88°F for this species. Fish were present in July and August, '77, October through December, '78, and April through June, '79. Seventeen fish from Quisiro had eaten beetles, bloodworms, dragonfly and damselfly larvae, and caddisfly larvae. There was a minor amount of microcrustaceans, true bugs, and ants. Lilyestrom and Taphorn didn't find any mosquito wigglers in the diet of *R. hummelincki*, but they found them abundantly in nearby pools without fish. They reported that an adult male ate 135 fourth-stage *Aedes aegypti* (the mosquito that carries yellow fever) wigglers in 15 minutes.

Pyropunctata is a strong contender for the title of gaudiest of the South American annuals. A good red-spotted male can hold his own, colorwise, with most of the African killifishes. If you are a red and blue fanatic, here is a South American killifish for you! Redness and size of the spots varies from population to population in an apparently random manner. As far as we know, *R. pyropunctata* is confined to the Lake Maracaibo Basin. It lives on both sides of the basin, and is known from one locality south of the lake. It also gets out into some pretty dry areas, but seems to be replaced by *R. hummelincki* in the really dry coastal desert. We have found the two species within a couple of kilometers of each other, but have not found them together.

Here the taxonomic story is reversed—we started out thinking we had one variable species, but more collecting made us realize that we were seeing two consistently distinctive fishes. The populations of *R. pyropunctata* close to *R. hummelincki* populations were just as different from them as were the fish from the south end of the lake. Years ago we had both species at SIUE and tried to set up a

Rachovia pyropunctata males also display an orange chin. Photo by J. Thomerson.

hybridization experiment, but the *R. hummelincki* died off on us before we could get anywhere.

Rachovia pyropunctata vies with *A. limnaeus* for the title of most common annual killifish in the Maracaibo Basin. Lilyestrom and Taphorn found it at 20 sites. It was generally found in quite shallow water, at temperatures from 81°F to 103°F. The average was 86.7°F. The bottom was soft mud or organic detritus, there were generally aquatic plants, and part or all of the pool was usually shaded. Food of 32 specimens included microcrustaceans, beetles, bloodworms, moths, and mosquito wigglers, in decreasing order of importance. They also had eaten a few true bugs, caddisflies, mayflies, and snails. They were found from April through December, '78, and April through June, '79. Lilyestrom and Taphorn regarded *R. pyropunctata* as an effective and efficient predator on mosquito wigglers.

We haven't said much about females because there is not much to say. Female *Rachovia* are fairly plain fish, and females of all four species are quite similar. So, if you keep more than one species of *Rachovia* at a time, be very careful to keep the females straight. It's not easy separating the females when you catch two species together in the wild. You may wonder how the males keep the females straight when there are two species out in a muddy pool. A likely answer is: they don't—it's the female who selects the male. This is what Dr. Dick Haas found when he studied *Nothobranchius guentheri*.

With very slight modification, the directions for keeping and breeding *A. limnaeus* apply to the coastal *Rachovia* species. The *Rachovia* do not grow as rapidly as the *Austrofundulus*. They also start out from a smaller egg, about 1.5 mm in diameter, and consequently the fry are smaller. They can handle newly hatched brine shrimp immediately, and will start sexing out in a month or so. Sometimes males will get along fairly well together, and other times they will fight viciously. It's a good idea to provide some cover if more than one male is in the tank. Java moss works well. If possible, provide a spawning site for each male and also plenty of females. Males have been known to kill females who were not receptive to their advances, so keep your females well fed and provide them some cover also.

Rachovia are hearty eaters, but not as piggy as *Austrofundulus*. They like dry flake foods more than some of the killies do. They seem to be fairly long-lived for an annual fish, and males will eventually grow into the 3-inch range. Water hardness, pH, etc., are not critical, but they do appreciate clean water and occasional water changes. They seem happiest at temperatures they are adapted to in nature: low 80s for *R. brevis*, and even mid to high 80s for *R. hummelincki* and *R. pyropunctata*.

Rachovia are good jumpers, and *Austrofundulus* are fair-to-middling. So keep them covered or pick them up off the floor! A cover on the aquarium will raise the humidity over the water and cut down on cooling by evaporation. You'll find that just putting a glass or plastic cover on an aquarium will raise the water temperature a couple of degrees F, compared to an identical aquarium without cover. This is particularly true if the aquariums are well aerated. If you have to use heaters to keep tanks in the 80s, that couple of free degrees will not show up on your electric bill.

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