The Annual Killifishes of Venezuela

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Part 2: Species of the Orinoco Llanos

The 77,000 square miles of Orinoco Llanos in Venezuela and Colombia are vast flatlands that originate along the base of the Sierra Oriental, the branch of the Andes that forms a crescent through northern Colombia and into Venezuela. From these mountains the llanos extend more than 600 miles eastward to the delta formed at the mouth of the Orinoco River. The Orinoco River itself, as it cuts its way along the northwestern edge of the Guyana Shield, forms a natural

A young male *Rachovia maculipinnis*. Photo by J. Thomerson.

If you were in Bogota, Colombia, you might hire an Express Taxi and take a several-hour ride through the mountains to Villavicencio. The Sierra Oriental is quite rugged and landslides blocking the road are not uncommon. Presuming that you make it through, you will be confronted with a stunning vista. While still high in the mountains, suddenly you round a curve and there, far below in the distance, are the red tile roofs of Villavicencio. But you hardly

The same *R. maculipinnis* as above, as a fully developed adult. Photo by J. Thomerson.

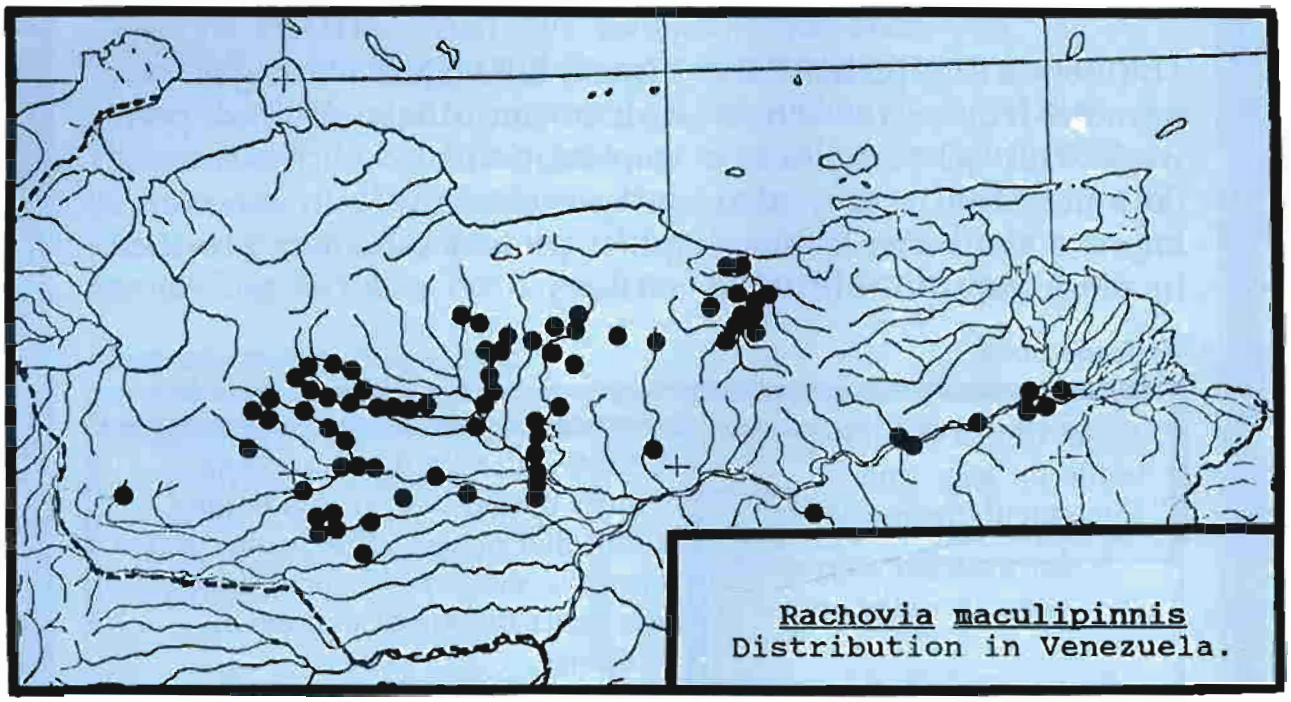
notice the city because the llanos, the utterly flat llanos, stretch as far as your eye and mind can see.

Soon after Leo came to Venezuela in 1959, he began searching the llanos for some annual fishes like those he had known as a child in Argentina. Before long he was catching strange little fishes and showing them to scientists who didn't know what they were; a category we joined in 1969.

Now, more than 20 years later, the Orinoco llanos annuals that Leo Hoigne found have been identified or described, and enough collections have been made that a picture of their distribution is emerging. We are still in the process of collecting around the edges of the Venezuelan llanos to find the limits of their distribution. As shown on the maps, we have found three of the Orinoco species in the Rio Unare drainage (Thomerson, Taphorn, and Nico, 1990) and one in the Rio Guanipa system.

Our maps do not include Colombia because the only documented Colombian llanos annual killifishes we know are *Rachovia maculipinnis* and *Pterolebias zonatus*, from localities "near Puerto Lopez," just

"In Venezuela, the llanos are home to at least six species of annual killifishes."



Black dots indicate Venezuelan localities from which *Rachovia maculipinnis* is known.

In Venezuela, the llanos are home to at least six species of annual killifishes. The *llaneros*, the cowboys of the region, call them *peces de lluvia*—"fishes of the rainy season," or *guarda aguas*—"water guardians," with the implication that the pools where they live will hold water for several months. Most of what scientists and aquarists know about them can be traced back to a fellow named Leo Hoigne.

Above: A nice *R. maculipinnis* male. **Below:** A pair of *R. maculipinnis*; the female is in the foreground. Photos by J. Thomerson.

east of the Sierra Oriental.

Orinoco annual killifishes inhabit a very large area, and all six species have overlapping ranges. Most other annual killifish faunas include only a few species, each with a fairly limited range. In fact, in the rest of the world, species of annual killi-

fishes usually are found alone, and combinations of more than two species are uncommon. In the Orinoco llanos, however, different combinations of three, four, or five species are commonplace, and we have recently found all six species living together at three places near Guanare. In July of 1988, Leo joined us in Guanare, and it was a real thrill to show him something he hadn't seen before—all six species in the same net!

The most common and widespread Orinoco species is *Rachovia maculipinnis*. We recently discovered *R. maculipinnis* outside the Orinoco llanos, in the Rio Unare basin, as shown on the map. We had hoped to find annual killifishes in this basin, but expected one or more of the coastal species covered last month in Part 1. It has upset some of our ideas on annual killifish distribution to find Orinoco species in a Caribbean coastal drainage. We have records of *R. maculipinnis* out in the Orinoco delta, and, so far, it is the only member of the fauna documented from south of the Orinoco River.

Rachovia maculipinnis is usually present wherever any of the Orinoco annual species are found, and, as can be seen from the distribution maps, is often the only species present. The total population of this species is undoubtedly many times larger than that of the other five species combined.

The color patterns of male *R. maculipinnis* are extremely variable, and there seems to be almost as much variation within populations as there is between populations. It's our impression that they are as variable as wild guppies, but we haven't studied the matter in any detail. This is a species that offers considerable rewards for the aquarist who wants to do some serious selective breeding. Small males are not impressive, but overall body color and color markings in the fins increase as the fish grows. Large males can be quite spectacular, but some males are never anything but a mottled gray-

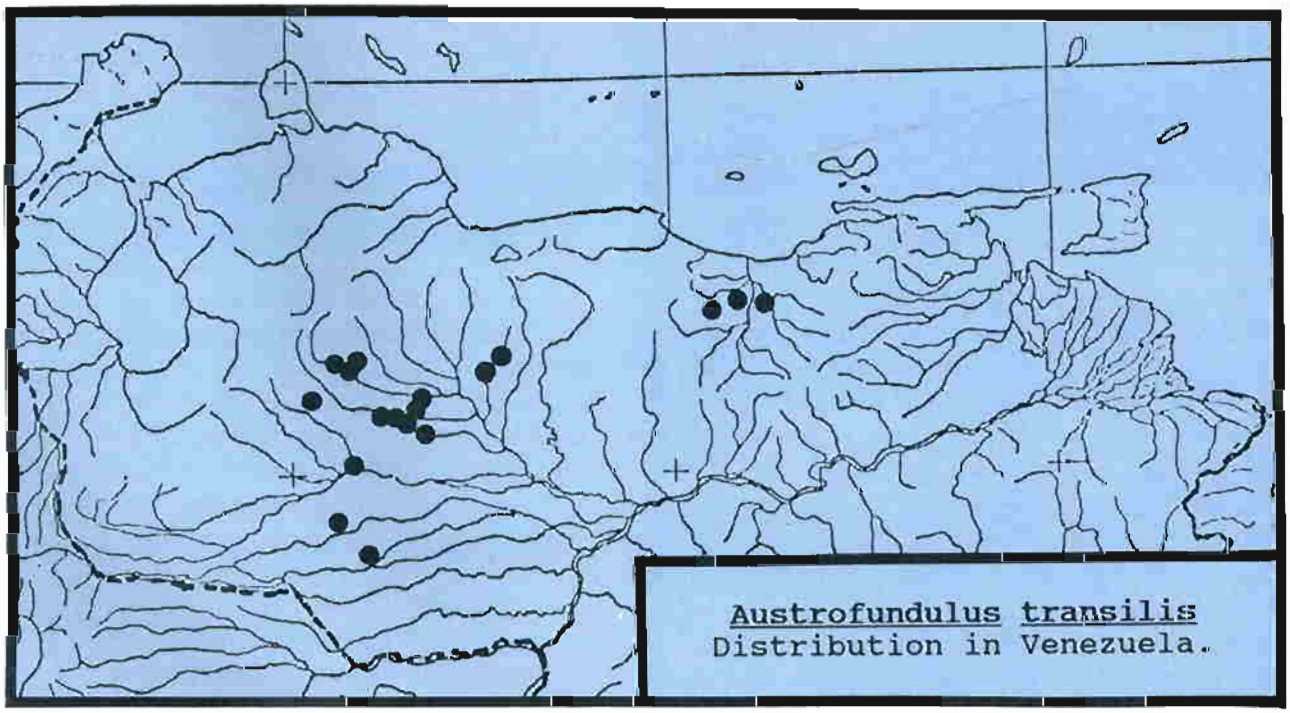
Though there is no open water here yet, this is the site of a killifish pool. Photo by J. Thomerson.

Views of *Austrofundulus transilis*, male (left) and female (right). Photos by L. Seegers.

brown. Other males have various combinations of orange, red, black, blue, yellow, or purple in their fins, and a blue iridescence over the body. Males of at least some populations show a gleaming iris and orange chin when they are breeding. The orange chin characteristic is found in some populations of all four species of *Rachovia* (see Part 1). The name *maculipinnis* refers to a black blotch often, but not always, present in the dorsal fin of males. A well-developed male caudal fin is squarish, even banner-like, with a terminal fringe of often contrastingly colored fin-ray extensions.

Rachovia maculipinnis' closest relative is probably *R. brevis* (see Part 1). Some *R. brevis* males have the dorsal fin spot, and they show a similar range of variation in color and color pattern. There is evidence that suggests (Lundberg, Machado-Allison, and Fray, 1986) that the Magdalena and Orinoco Rivers were joined and shared a common fauna some 15 million years ago. If so, they probably shared the common ancestor of *R. maculipinnis* and *R. brevis*.

The largest male *R. maculipinnis* we have seen were over 3



Map showing the distribution of *A. transilis* in Venezuela.

inches total length. Females are usually much smaller, up to perhaps 1.5 inches long. The females look much like females of the other *Rachovia* species, but show a little more scale-margin crosshatching. Both sexes have been known to live well over a year in the aquarium.

All of the Orinoco annuals need similar aquarium conditions. They generally occur in very soft water, with an acid pH between 5.5 to 6.5. Heavy clay soils with a slight salt content are common in the Orinoco llanos. These soils retain water very well and are a good place for an annual pool to form. Water in these pools will stay muddy throughout the season because the salt in the water helps keep the clay particles in suspension. So a little salt in the water, though not necessary, probably won't hurt. Other pools will have clear water, or even black water. We have kept all the Orinoco annuals in fairly hard water with good success, but they do look better and seem happier in soft acid water.

Perhaps the major failing aquarists have in keeping these species is that we try to keep them too cool.

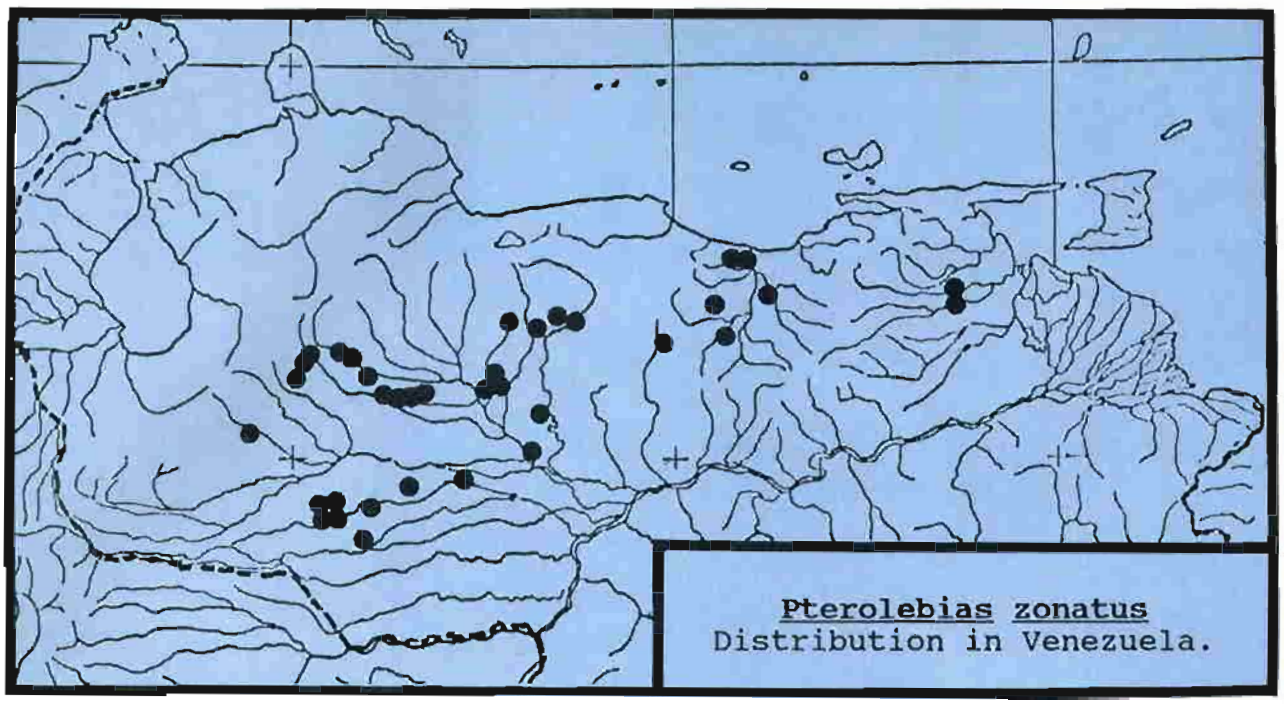
Above: Habitat of *Pterolebias zonatus* in the low llanos. **Below:** Tadpoles of the paradox frog, *Pseudis paradoxa*, are often found in killifish pools. The common name alludes to the fact that the tadpole is much bigger than the adult frog! Photo by J. Thomerson.

The largest pair of *Pterolebias zonatus* the authors ever collected. Photo by D. Taphorn.

Many of the commonly kept killifishes are quite happy in the low 70s F, but the Orinoco species live in waters that seldom fall below 80°F. You'll find that they look, behave, and breed better in the low 80s than at lower temperatures. In fact, you'll find this to be true for most, if not all, llaneran fishes.

Rachovia maculipinnis is prolific, but the eggs are small, around 1.5 mm in diameter. They prefer to dive and will do so if given peat moss. If offered a dish of sand in a bare aquarium they will readily utilize the sand as a breeding site. The eggs can

Pterolebias zonatus male in an aquarium.



The distribution of *Pterolebias zonatus* in Venezuela.

be collected each day by stirring the sand with a net handle and then decanting the eggs through a fine-meshed net. A net designed for straining out baby brine shrimp works well because the eggs are less inclined to stick than they are in a larger mesh net. The eggs can be placed individually on the surface of moist peat or stirred into a bit of peat in a jar of aquarium water. The eggs should be incubated warm, in the 80s F. Usually we store them fairly moist for a couple of weeks and then squeeze the peat as dry as we can, fluff it up again, and return it to an airtight container. The eggs may develop rapidly or they may just sit there in first or second diapause. If the eggs stay clear for a couple of months, and you get impatient, try moistening them

P. zonatus male with full fin development. Photo by S. Reid.

A *P. zonatus* male kept with other males; note the trimmed tail fin filaments. Photo by S. Reid.

and then sealing them up for another couple of weeks. This often will kick them off to complete development.

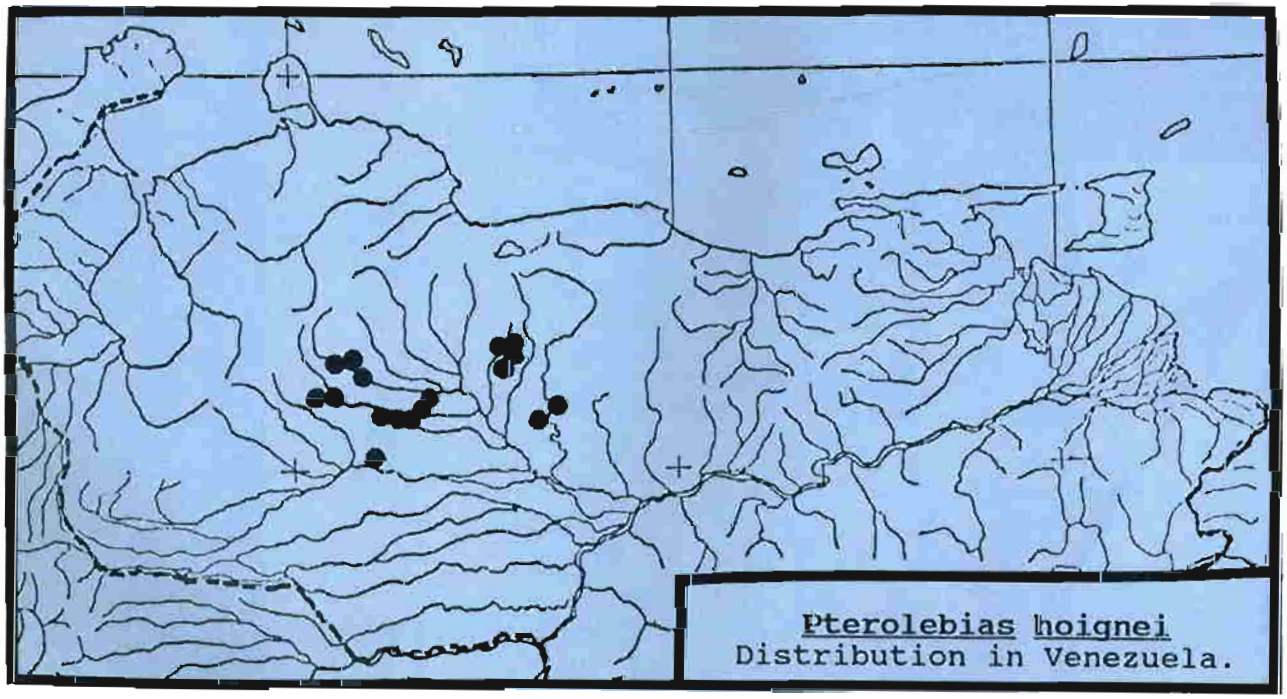
Aquarists will often ask us, "How long should I incubate the eggs of species X?" We always reply, "Until they are ready to hatch"—the correct answer, but

P. zonatus male with orange anal fin border. Photo by J. Thomerson.

generally received with a frown. We have had eggs of several of the annual species which developed without any hint of diapause, but other eggs of the same species, or even the same pair, sat in diapause for a year or more. The fact is, our track record on predicting incubation times is so bad that we have given it up, at least for the moment. We deal with the problem by periodically looking at the eggs to see what they are doing. Factual knowledge is a great help to good decision making!

The annual killifish egg that should concern you the most is one that contains a fully formed embryo with little eyes looking back at you. If the embryo is in third diapause—with very slow heartbeat and little fin movement, you can wait a while before hatching it if you want. If, on the other hand, the embryo's heart is beating steadily and its fins are actively moving, it's probably doing "delayed hatching," just sitting in the eggshell slowly

A *Pterolebias hoignei* male kept with other males: note the trimmed caudal filaments. Photo by S. Reid.



Venezuelan distribution of *Pterolebias hoignei*.

starving to death. If not hatched soon it will come out weak and probably a belly-slider.

Rachovia maculipinnis generally lives around the shallow margins of pools, although individuals will occur throughout the pool. It sometimes lives in floodwaters along the margins of creeks and rivers (all the locality dots south of the Orinoco River mark this sort of habitat). We once found newly hatched *R. maculipinnis* fry in tiny puddles of water standing in shallow footprints on a jungle trail. They obviously hatch out in very shallow water in nature, and we would recommend hatching them in an inch or less of distilled or rain water in the

Top: A male *P. hoignei* raised alone: note the extensive caudal filaments. **Bottom:** Female *P. hoignei*. Photos by J. Thomerson.

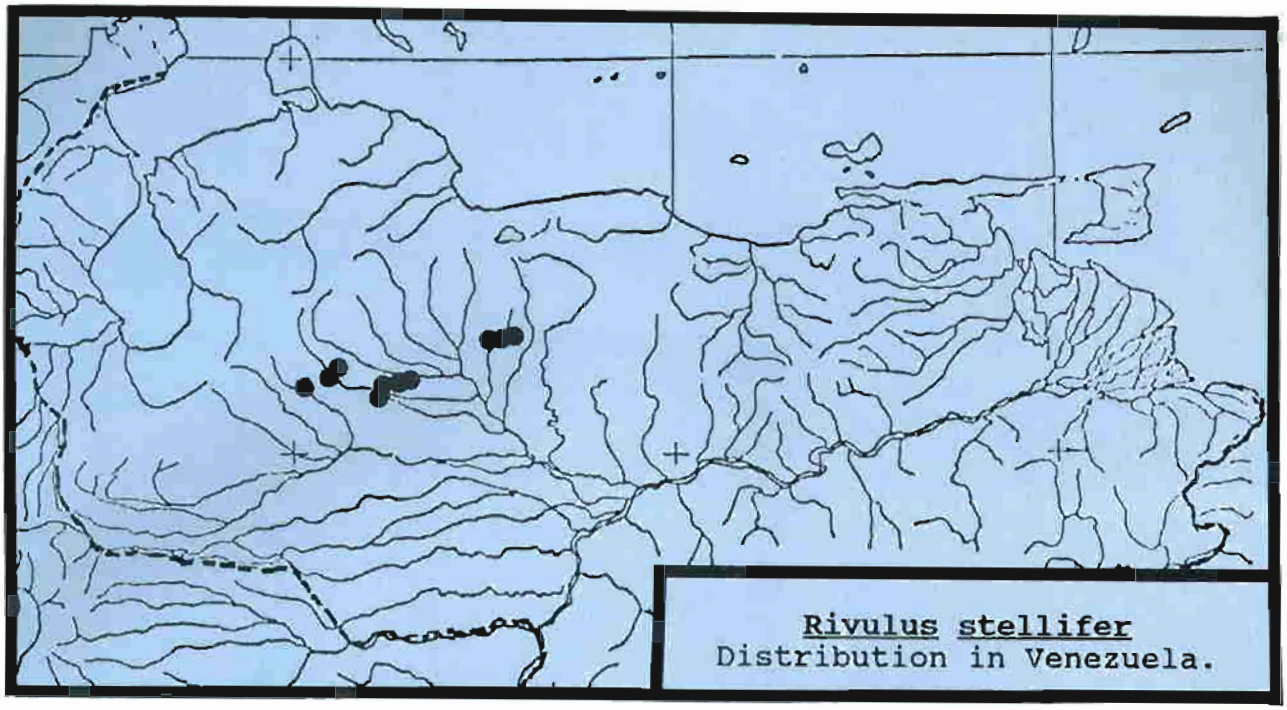
Top: *Rivulus stellifer* female; note the "*Rivulus* spot" on the upper caudal peduncle. **Bottom:** *R. stellifer*, male. Photos by L. Nico.

high 70s F. If nothing hatches in 24 hours, re-dry the peat and try again in a couple of weeks.

The fry are relatively small but can still handle newly hatched brine shrimp from the smaller strains. They also eat microworms well. Initial growth is not as fast as some of the other annuals, so be prepared to feed them baby brine for a while. In a couple of weeks' time you will notice size differences, with some of the males beginning to show color. They should be completely sexable in four to six weeks. In nature, they are quite generalized feeders (Nico and Thomerson, 1989) eating protozoans and microcrustaceans while small and an increasing percentage of insects and insect larvae as they get larger.

Males will fight and the dominant male will take over the spawning container. They are generally not too rough on each other and several pairs or trios can be kept together provided there are several spawning sites and some cover in the tank. As with most of the annuals, show-quality males are best produced by having one male per tank.

Austrofundulus transilis Myers, 1932, was the first of the Orinoco annuals to be described. Coincidentally, it was also the first annual Leo Hoign caught in Venezuela. For many years only the single type specimen was known to science. Then Myers himself identified *Austrofundulus* from the Maracaibo basin as *A. transilis*, and the name was applied to the Maracaibo and



Venezuelan distribution of *Rivulus stellifer*.

Tucacas populations (Part 1). Finally, with specimens and information supplied by Leo Hoign, we identified the Orinoco species as Myers's *A. transilis*, and the mottled coastal forms as a separate species, *A. limnaeus* (Taphorn and Thomerson, 1978).

Austrofundulus transilis is one of the three annual species that gets into the Rio Unare basin. We are now finding *A. transilis* to be common in areas where they used to be absent: for example, at Leo Hoign's collecting sites on the Cano Benito road (Thomerson, 1974). This area has undergone considerable development in the past 20 years and many of Leo's sites have been destroyed or heavily modified. Even so, in 1988, we were able to find five of the six species in the area. At some of the sites around Guanare *A. transilis* is the dominant species, but we don't know what those sites were like 20 years ago.

The males lack dark markings, except that some will show a black margin on the tail, and some have a dark *maculipinnis*-like spot in the dorsal fin. In life this spot is overlaid with a green iridescence. There may also be some green iridescence along the body sides. In the wild, male *A. transilis* often have reddish dorsal, anal, and caudal fins. This can range from pink through a dull wine color to a burnt orange. They seem to lose color and become uniform grey in our aquariums. This color loss may be caused by a diet with insufficient red pigments. In the wild, they are largely midwater plankton feeders, specializing in cladocerans (such as daphnia) that, (like shrimp) are usually high in carotenoids. The females are typical small grey *Austrofundulus* females.

Although they seem to be prolific, we haven't made much effort to propagate *A. transilis*. They have some interesting breeding behavior that seems different from what we have seen in other annuals, so we are going to look into them a bit more. A big male is about 2 inches overall, and a big female about an inch long. They are active fish and feed well in the aquarium. They certainly do a slick job on daphnia.

Pterolebias zonatus Myers, 1935, was the second of the Orinoco annuals to be described. It also occurs in the lower Rio Unare Basin, and we have collected *P. zonatus* at two sites,

along the highway that goes south from Maturin, in the lower Rio Guanipa basin. The Rio Guanipa flows west to east parallel to the lower Orinoco, and empties into the Gulf of Paria at the northern corner of the Orinoco delta. We expected to collect more annuals as we went south from Maturin into the Orinoco llanos, but we found instead the non-annual *Rivulus delaphilus* in the pools and prestamos where we looked for annuals. The llanos in the lower Orinoco basin have sandy soils which don't seem to provide good annual fish habitat; all of the annual killifish records from that region are from lagoons or backwaters near the main river where silt and clay have been deposited.

P. zonatus is about as widely distributed as *R. maculipinnis*, and is said to be imported commercially from Colombia on occasion. In 1972, a Colombian aquarium fisherman took us to a "near Puerto Lopez" site where he had previously collected annual fishes. He shook his head in disgust when we found a sterile rice field instead. In the early '70s we tried, on several occasions, to find annuals in the Colombian Orinoco llanos, but without success.

Pterolebias zonatus is fairly familiar to killifish fans. It is a colorful and graceful fish that has been available to aquarists off and on over the years. Both males and females have well marked vertical bars, and are attractive fish even at a young age. Males are somewhat variable in coloration. The photos show two forms that occur together around Guanare, one with an orange, the other with a black, anal fin margin. The body has an overall bluish or greenish sheen. Part of the attractiveness of *P. zonatus* is due to the males' large flowing fins, a characteristic which leads Venezuelan aquarists to call them *pez peleador de los llanos*—the Venezuelan version of the Siamese fighting fish. Males do fight; lost tail and pelvic fin filaments, and split and nibbled anal fins, are the usual result. In the aquarium, dominant males seem to inhibit the growth of subordinate males.

The eggs of *P. zonatus* are over 2 mm in diameter, and the newly hatched fry are several times as large as *R. maculipinnis* fry of the same age. In nature, this size difference often continues throughout life, and may help cut down on food competition between the two species (Nico and Thomerson, 1989). In the aquarium, a 5-inch male is easy to grow, and they sometimes get this large in the wild. Two to 2.5 inches is a very large female.

Food in nature includes insects caught at the water surface. Their habit of swimming at the surface has earned them the name *mira cielo*—"sky watcher," among the llaneros. They occur in a wide range of habitats, but seem to be most common in pools that are unshaded, a foot or two deep, with scattered emergent or floating plants.

In the aquarium they will readily accept a wide range of foods, including good quality

A killifish pool? You never know! Photo by D. Taphorn.

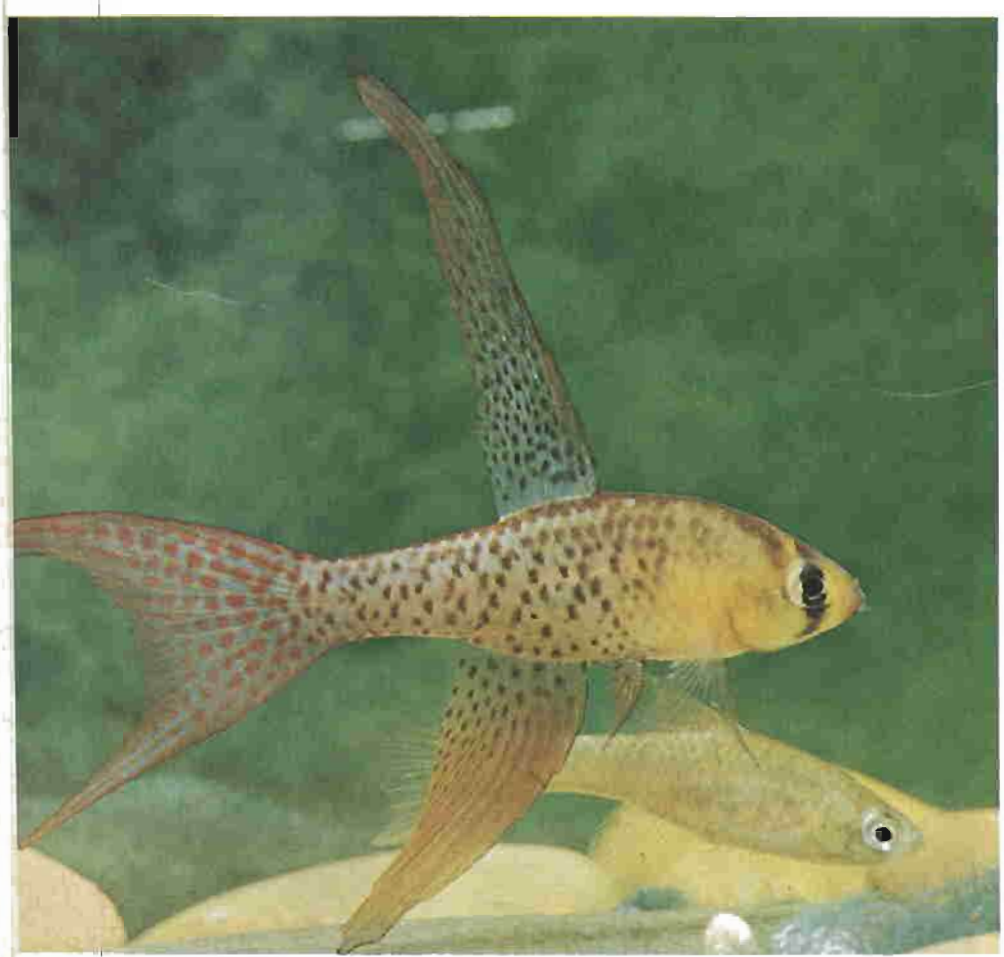
flake foods. We don't have figures on fecundity at hand, but it's not as high as for some of the other annuals. They will spawn in sand. One problem with this is that the male's anal fin and the lower part of his caudal fin will become worn or frayed by the sand. It doesn't appear to bother them, but they don't look as nice. They really prefer to dive into peat, a process that is neat to watch. We have had good success using about 3 inches of peat in a gallon jar, set in a bare aquarium that is deep enough to provide 2 or 3 inches of water above the jar. We generally use a male and several females, although the males are not rough on females and a pair will do fine. In nature, we generally find more females than males in a population. It may be that fishing birds see and catch the males easier than they do the females, as Dick Haas showed for the African annual *Nothobranchius guenheri*. Several of our aquarist friends have complained of hatches with skewed sex ratios, very heavy on males.

To process the eggs, after a week or so take out the gallon jar, put an airstone in it, and let it sit for another week or so. We think that this practice cuts down on contamination of the peat by uneaten food and feces. We then squeeze all the water we can out of the peat, fluff it up, and check for eggs. Usually we can find two or three pretty quickly. Then we put the peat in a glass jar and place an egg or two where they can be seen through the glass or by opening the top. This gives us a clue to what's happening to the eggs in the jar. Our experience with *P. zonatus* has been that eggs handled this way usually take three or four months, or longer, to get ready to hatch.

Even if you can't find any eggs, try hatching the peat several times before you add it to your earthworm culture. We have had success with hatching the peat in a gallon jar with 6 or 7 inches of distilled or rain water added. *Pterolebias zonatus* grows moderately fast and should be sexable in a month or so, but will take several months to reach full size.

A second species of *Pterolebias*, *P. hoignei*, has a somewhat more restricted distribution. It is usually found in deeper pools in forested areas, or at least where there is some overhead cover in the form of bankside trees or brush. This species (and the next two as well) was discovered by Hoigne. It was, of course, named in his honor (Thomerson, 1974), in recognition of the contributions he has made to our knowledge of these fishes.

The two llaneran species of *Pterolebias* are quite similar in general form and coloration, and one could wonder if they were maybe just ecophenotypes—the same fish responding differently to different habitats. The arguments given by Thomerson (1974) for regarding them as



The striking saberfin killie, *Cynolebias dolichopterus*. Photo by H. J. Richter.

separate species are reinforced by our finding them *syntopic* at several places around Guanare. Syntopic means they live together in close association, and could try to interbreed or hybridize if they felt like it.

Finding places where *P. zonatus* and *P. hoignei* have lived together without interbreeding and mixing their genes in hybrids (continued syntopic genetic isolation, for you jargon lovers) is fine evidence that they are in fact two different biological species.

But why were the species recognized as separate in 1974, when they had not been found syntopic? Another aspect of the "Biological Species Concept" is the idea that each species is unique and has a unique ecological niche. The two forms had been found consistently in contrasting kinds of places—open sunlit pools vs. shaded forest pools. This could be explained by competition theory: the prediction that if two species are similar enough, they will compete for resources to the extent that one will win and the other will lose in a given set of circumstances. So Thomerson (1974) saw two species: *P. hoignei*, which wins in the shade, and *P. zonatus*, which wins in the sun. Judith Pinero, a Venezuelan graduate student, has recently finished her Master's thesis on the two species. She compared food habits, distribution within the pool, population structure, sex ratios, etc., of the two species when they are together versus when they are alone.

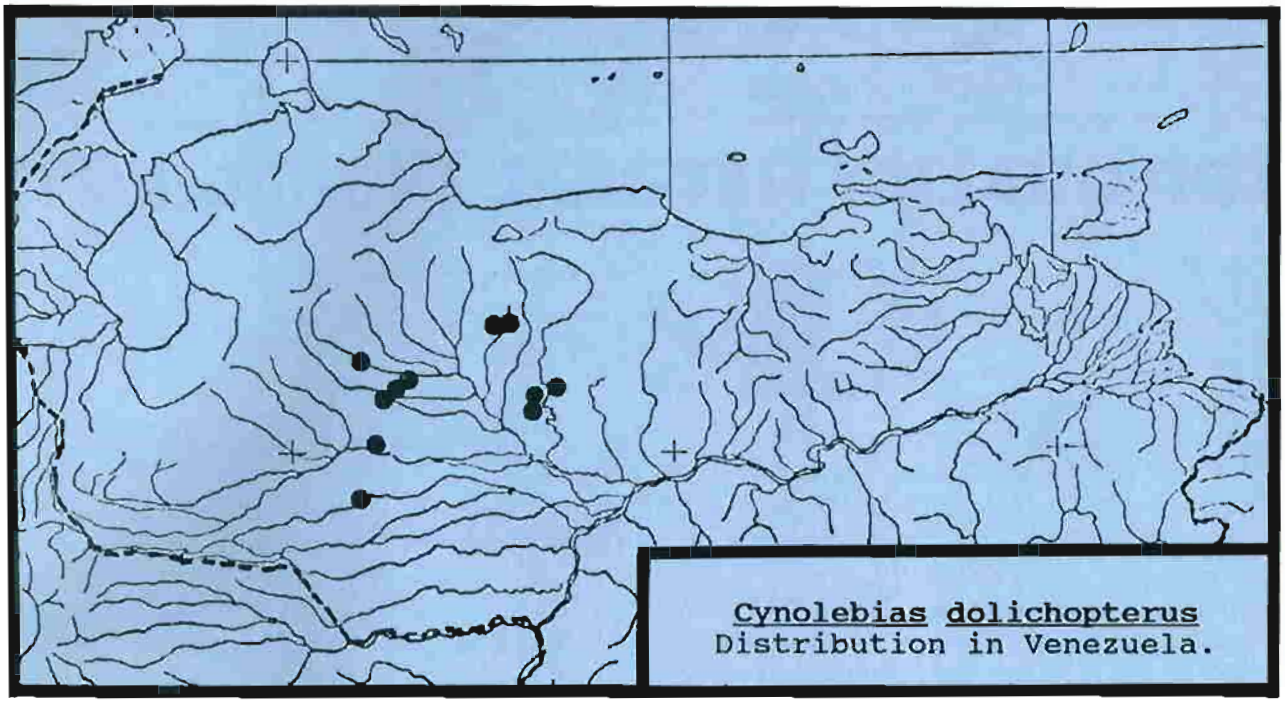
"...*P. zonatus* and *P. hoignei* have chromosome differences...it's doubtful they are closely related..."

In Part 1, we mentioned a study of Venezuelan annual killifish chromosomes. This turned into a Master's thesis for John Elder. Among other things, he found that *P. zonatus* and *P. hoignei* have chromosome differences such that it's doubtful they are very closely related, or could produce hybrids if they wanted to.

Pterolebias hoignei gets a little bigger than *P. zonatus*, and there is usually less size difference between the males and females. Of the two, *P. zonatus* is a little more colorful, but *P. hoignei* shows more fin development. A well developed male *P. hoignei* will have uniformly developed long black filaments all along the rear border of the tail fin, but a similar male *P. zonatus* will have only two or three at the top of the tail fin. If some one sends you a young pair of *P. hoignei*, don't be disappointed to receive a couple of little brown fish. They don't look like much when they are young, but there are not many fishes that look better than a fully developed *P. hoignei* male!

We breed *P. hoignei* just as we breed *P. zonatus*, but we keep them in a darker tank to entice them to spawn. They will sometimes refuse to breed in bright light. Also, they look better against a dark background with subdued light, and deserve to be set up to look their best. In nature the sex ratio runs about one to one, but we often set them up as trios to spawn. Males will fight but are not vicious about it. The tail filaments do suffer, so by all means keep your show males one male per tank. They are greedy eaters and grow fairly quickly. Small *P. hoignei* are not easy to sex, so plan on raising them for six weeks or so before you will know for sure what you have.

Rivulus stellifer has the most restricted distribution of the six species. It's sort of a strange fish, probably the most primitive of the New World annuals. When Thomerson and Turner (1973) described it, they waffled around a bit before placing it in *Rivulus*. For one thing, *R. stellifer* has less sexual dimorphism than most annuals. Both males and females are bluespotted, and the females are attractive in their own right. For another, it's the



The distribution of *Cynolebias dolichopterus* in Venezuela.

only *Rivulus* species that is unquestionably an annual fish (although there is circumstantial evidence for a couple of others).

Ruud Wildekamp (1981) suggested moving *Rivulus stellifer* into the genus *Rachovia*, but we can't agree with him. The males do look sort of *Rachovia*-like, but the females do not. All the *Rachovia* species have 44 chromosomes, but *R. stellifer* has 48 chromosomes.

Lynne Parenti (1981) did a broad-brush phylogenetic study of all the killifishes, including the livebearers. She agreed with us that *Rachovia* as it stands (*R. maculipinnis*, *R. brevis*, *R. hummelincki*, and *R. pyropunctata*) is a natural group. She also concluded, based in part on bone characters, that *Rachovia* is not as closely related to *Rivulus* as we had all thought (see Taphorn and Thomerson, 1978; Thomerson and Turner, 1973; Weitzman and Wourms, 1967).

Even though Lynne examined only 5 of the 70-odd nominal *Rivulus* species, she argued that *Rivulus* ought to be split into two genera, with *Rivulus hartii* and *R. stellifer* in a new genus of their own. So *R. stellifer* will likely have a different generic name some day, but it probably won't be *Rachovia*.

In nature, *R. stellifer* is most commonly found in very shallow water in forested areas, but we do find them in deeper water and in more open areas from time to time. They seem to be territorial in nature, and can be quite scrappy with each other in the aquarium. Females square off with each other almost as readily as males do. We have been able to keep several pairs together in a well-planted aquarium, and they seem to settle down after they have been together for a while. They will spawn in sand, but prefer peat. Unlike most *Rivulus*, they show no interest in a floating mop. They grow to almost 4 inches, and females get almost as large as males. As they get bigger they become less and less active and finally spend most of their time, when not eating or breeding, just sitting around. Their eggs can be handled like the other annuals, and are quite resistant to drying. The eggs are about 2 mm in diameter and the fry are easily able to handle newly hatched brine shrimp.

Last, and least, and perhaps most spectacular, is the little (males grow to about one inch body length) saberfin killifish,

described as *Austrofundulus dolichopterus* by Weitzman and Wourms (1967). In 1978, we created a new genus, *Terranatos*, for it, and, in 1981, Lynne Parenti moved it to *Cynolebias*. It's the only known killifish in which both sexes have both elongate dorsal and anal fins, and long upper and lower tail fin extensions. Males do have much more fin development than females, and may even have spectacular long filaments extending from the tips of the anal and dorsal fins.

Coloration is variable. In nature, males often have the front half of the body covered with a yellow wash, and there is considerable red, orange, blue, black, or purple in the fins. Saberfins are not easy to get home alive after you collect them, but once they are acclimated to the aquarium they are not so touchy. They are shy fish, and need to be exhibited over a peat bottom to show their color best. They tend to stay near the bottom, but up in the water a little. If frightened, they will dive into the peat. Males will square off at each other, but no real damage seems to be done.

We have not been able to get them to eat anything but live food. Baby brine shrimp seems to be an adequate diet for them throughout life, but we do like to feed them other small live foods when we have it available. In nature they eat a lot of copepods, some cladocerans, and a few worms and insect larvae.

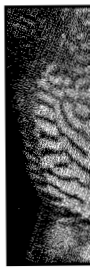
We have bred them only over peat. The eggs are tiny, about 1.1 mm in diameter, but the fry have huge mouths and can immediately begin to consume newly hatched brine shrimp.

A downside to the Orinoco annual killifish story is that they often have very heavy body-cavity parasite loads. Several different roundworms and flukes are involved, and quite often these worms will have destroyed the testes or ovaries of externally healthy-looking fish. So, if you are given the choice, you may be better off to take aquarium-raised fishes in preference to wild stock.

And so we end our chronicle of the known annual killifishes of Venezuela. We have seen that in general, all are inhabitants of lowlands, but that conditions in nature can vary greatly in annual killifish pools. *Rachovia hummelincki*, *R. brevis*, and *Austrofundulus limnaeus* are known from coastal deserts where rain pools probably don't last more than two to three months, and water temperatures may reach the 90s. *Rachovia pyropunctata* lives further inland in the Maracaibo basin, and has a bit more time to complete its life cycle. The Orinoco Basin killies covered in Part 2 also have it a bit easier, as their wet season lasts much longer, up to seven months in most years, and in some particularly rainy years their pools may not dry out at all. But they always run the risk of having their pools invaded by stream fishes riding the rising tide of floodwaters.

All, however, must cope with the uncertainty inherent in the ephemeral rain pool. This fact has established certain limits for the successful life history strategy of killifishes. Biologists often seek patterns or repeating themes common to different animals to guide them in their quest for answers to the question "Why?" We start off collecting and cataloging the rich diversity of the natural world, but sooner or later we want to know more than just how many species are here or there; we want to know why they are where they are, or why they do what they do. These questions are tougher to answer, but more rewarding in the long run. Killifish observers will see a pattern common to most killifishes, whether they be Orinoco species or African *Nothobran-*

"Males will square off at each other, but no real damage seems to be done."



chius. For example, besides the obvious adaptation of the drought-resistant eggs, these little fishes have other tricks up their pectoral fins. They are indeed small. A fifteen-pound *Rachovia* might have trouble waiting for enough food to fall into his pool, and he would have to grow incredibly fast to get that big in just the few months his pool will be around before drying out. Smallness, then, is an adaptation to the limited resources and time available to killies. Killifishes do grow to maturity very quickly, and will eat just about anything small enough to fit in their mouths that comes their way (although some feeding specializations are apparent) This lets them start packing eggs into the peat as soon as possible. You probably stash money in the bank for a "rainy day;" killifishes bank on their embryos. The individuals that manage to get more viable eggs into the peat have a better chance of passing their genes on to the following generations.

"The individuals that manage to get more viable eggs into the peat have a better chance of passing their genes on to the following generations."

And that is what the big genetic lottery (okay, so it's fixed!), evolution, is all about. Killifishes tend to shift the attention of predators to the gaudy colors of the more expendable males (one male could fertilize the eggs of most of the females in the pool, but one female could never lay enough eggs to satisfy a whole pool full of males). Thus, only males have bright and risky colors used in courtship to attract the drab, well-camouflaged females. This costs the males their lives sometimes, but in the long run, aids the species on the whole by keeping a breeding population functioning in the pool for as long as possible. There are many other patterns in the lives of killifishes, and we hope that we have helped you better understand those that you may have already observed, and will pique your curiosity enough to lead you on to many more hours of killie-watching.

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