Ecological zonation in the Aquarium

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When we look at the way in which organisms are distributed in nature, we find that it is not at all at random, but follows set, and often predictable, patterns. The occurrence of organisms is ordinarily restricted to the geographical range of the species in question, and within its range is restricted still further to the appropriate habitat. Factors which limit an organism to a particular habitat are legion, but can be grouped under one of two headings: (1) physical factors, and (2) biological factors. Either of these may prevent an organism from surviving outside the appropriate habitat or range.

Although the reader will have a general idea of what is meant by a physical limiting factor, a concrete example at this point will serve to clarify the concept. Plants of the family Orchidaceae (orchids) are found in nature growing only in the shade. Under laboratory conditions, they are found to flourish under direct sunlight, provided that they are kept cool. We conclude from this that heat is the limiting factor which prevents orchids from growing in the sunlight, not light intensity. Each of these factors is physical; however, the limiting one is the temperature, and because in nature we do not find cool conditions prevailing in direct sunlight, we do not find orchids growing in it.

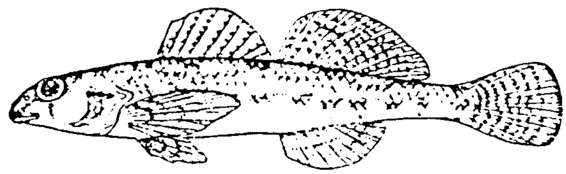
Other examples of physical factors which limit the distribution of organisms, particularly fish, include but are not limited to: pressure (depth), flow rate, bottom type, water hardness, salinity, oxygen concentration, and pH. By looking at the physical properties of the body of water from which the specimens we are attempting to culture in our aquaria came, and by duplicating these conditions exactly, we insure that no physical factor will prevent our specimens from surviving.

Unfortunately, several catches are inherent in the statement just made. The most obvious is that it ignores the existence of biological limiting factors. Secondly, it assumes that we are able to measure all the physical properties of the fish's environment. Thirdly, it assumes that we are able to duplicate it exactly (which we are not). Finally, the statement as presented here is often warped and distorted to lead the reader to believe that he must duplicate the conditions in nature exactly (i.e. do the impossible) in order to achieve success in the aquarium.

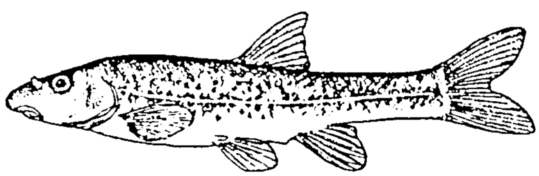
Let us examine the concept of biological limiting factors and, once understanding them, apply what we know to the art of culturing fishes in the aquarium. Such biological limiting factors are the availability of food, the intensity of predation, the presence of obligatory symbiotes, the competition provided by other species, and others more subtle. These, and physical limiting factors, are intricately tied to the concept of ecological zonation.

In nature we sometimes find that the physical properties of the environment sometimes vary abruptly as we move from one habitat to the next, or sometimes they vary gradually, or clinally. Examples of clinal variation are everywhere. A recent collecting trip vividly demonstrated one such to me. The stream in which I was netting was swift and deep in the center, somewhat less so towards one edge, and again somewhat less so at a point just downstream from this edge. Differences involved were slight, and distances involved were just a matter of feet. Here's what I found: Location 1 (center of channel) - many longnose dace, *Rhynichthys cataracte*, and nothing else. Location 2 (a little bit slower, a few inches shallower) - some blacknose dace, *Rhynichthys atratulus*, and one stray longnose dace. Location 3 (slightly slower than location 2) - some blacknose dace, quite a few common shiners, *Notropis cornutus*, and some tessellated darters, *Etheostoma olmsteadi*. I took some of each back to the Museum and put them in aquarium tanks. The tanks did not differ appreciably in depth from any of the three localities, but of course the amount of current did. The aquarium tanks had virtually none compared to their natural habitat. All four species are now thriving.

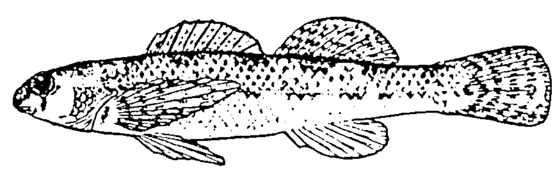
TESSELLATED DARTER, *Etheostoma olmstedi* Storer.



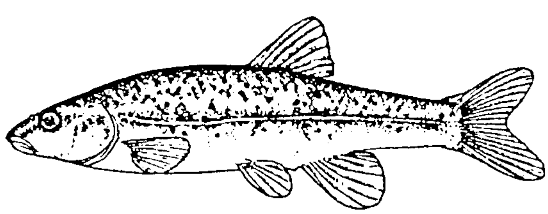
LONGNOSE DACE, *Rhinichthys cataractae* (Valenciennes).



***Etheostoma podostemone* Jordan and Jenkins**



BLACKNOSE DACE, *Rhinichthys atratulus* (Herman).



Notice something? I see two remarkable facts right away. One is that although the habitat changed gradually, the fauna changed abruptly. (A larger seine would have obscured this observation.) The second is that the lack of current in the shallow sections of the stream was not the limiting factor preventing the longnose dace from occupying these habitats. I suspect that the competition with the other species encountered was more important. Ecologists often suspect as much when such rapid changes in fauna are observed across a gradually changing habitat. Remove the competition, by placing the fishes in the (seemingly) less hostile slower current of the aquarium, feeding them, keeping their population appropriately thinned, and provide for their reproductive requirements, and the four species will exist, perhaps even coexist, indefinitely even in inappropriate habitat.

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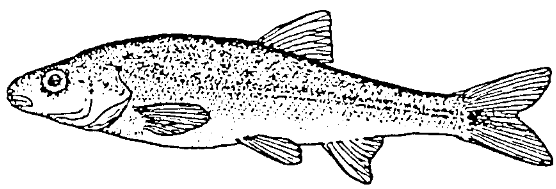
Ecological zonation such as this is nowhere more evident than it is in the intertidal zone of the seashore. Here, where invertebrate and plant populations are relatively immobile and readily observable at low tide, is the perfect place to study the phenomenon. An easily measurable cline exists, from locations at the point where only the highest of high tides reaches, to the depth where only the lowest of lows exposes. At any point in between, the surface will be exposed for a portion of time, and the higher this point, the more time it will be exposed over the course of a month. Yet the organisms here, too, are zoned abruptly, and each suddenly gives way to the next as it is unable to compete when conditions ever so slightly favor its competitor. Yet any of these are quite hardy and have proven able to colonize the whole cline when its competitors have been experimentally removed from a stretch of shoreline. Only after reintroduction of competing organisms, and sometimes this requires a protracted period, does normalcy return.

Such competition may in fact prevent the range extension of species even when physical limiting factors may appear to be doing so. The Moapa dace, *Moapa coriacea*, is an interesting species of cyprinid which is confined in distribution to a few warm springs in the Moapa River, Clark County, Nevada. The present barrier to its distribution is temperature; cold waters below would kill it. In spite of this one would expect, evolution being what it is, that a population of these would ultimately evolve the capacity to tolerate the colder waters below. Yet we find no closely related forms elsewhere. Indeed, *M. coriacea* is the only member of its genus. We suspect, then, that any population making the evolutionary move to the colder waters would find itself competing with other, temperate water, species better suited to compete under these conditions.



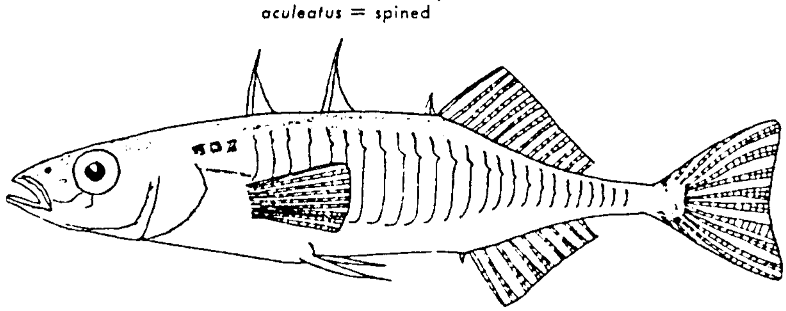
MOAPA DACE, *Moapa coriacea* Hubbs and Miller.

Members of the stickleback family, the Gasterosteidae, are commonly kept in aquaria. The most widespread and popular of these is the threespine stickleback, *Gasterosteus aculeatus*. This species occurs in coastal temperate waters of the northern hemisphere. In some parts of the globe it also occurs in freshwaters. These latter are principally encountered in Europe, though other populations exist in freshwaters elsewhere. That these populations are genetically different is evidenced by the drastic reduction in number of body plates in the freshwater forms. At least one such population, from California, has received subspecific designation, *G. a. williamsoni*.

If these fish are so readily adaptable to freshwater, why do we not have so many freshwater populations here? The answer is probably that they are being limited by competition. Freshwaters of the United States tend to be rich in perciform fishes, which group seems to be well adapted to compete in freshwater, though absent from brackish coastal waters. On the other hand, Europe has an impoverished perciform fauna, consisting chiefly of *Perca fluviatilis*, in its fresh waters. The characteristic fishes of Europe's fresh waters are the soft-rayed cyprinids. The stickleback is able to compete successfully with these.

THREESPINE STICKLEBACK
Gasterosteus aculeatus

Gasterosteus = belly bone
aculeatus = spined



What does all this have to do with our culture of fishes in the aquarium? Simply this: that the often quoted assumption that we must provide for our captives a series of physical and chemical conditions as identical to those where they were found is suspect. For example, in the case of marine fishes, experienced aquarists notice that they are more successful when the salinity of their aquaria is maintained somewhat below that of the coral reef environment. Similarly, freshwater fishes taken from an acid environment may have been there, not because they prefer an acid pH, but rather because they are better suited to tolerate it than their competitors. They may actually do better when transferred to the less hostile neutral conditions, assuming no other adverse factor is at work.

With a little more attention to the biological needs of our specimens, and less reliance on the physical ones, we will find ourselves to be better at the art of aquarium keeping.

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