

G.I.S. - G.P.S. - OPTIMUM CROWDING
A POSSIBLE SYNTHESIS?

by Harry Abrams

Those hobbyists who have delved into the literature relevant to the hobby cannot have helped running across the concept of G.I.S. - Growth Inhibiting Secretion. Particularly those that follow developments in the exchange magazines.

The purpose of this article is to bring to the attention of hobbyists at least two other concepts pertaining to the growth of fishes. These concepts are based on valid scientific studies but, to my knowledge, have never been acknowledged when article are published purporting to support the G.I.S. theory. I will also offer a nebulous theory or two and some tentative conclusions.

First of all, let me make it clear that I am not attempting to refute the fact that G.I.S. exists, although it can be said that I am refuting G.I.S. theory. While I had never personally been convinced that G.I.S. was the full explanation for variances in growth rate of fishes in aquaria, I cannot deny that there is a substance contained in the secretions of fish which will inhibit growth to a greater or lesser degree. I have always questioned however, the postulation of the G.I.S. theorists that it (G.I.S.) was the sole determinant of variances in growth.

My main reason for so questioning G.I.S. theory was that it appeared to me, of all the experiments I had read about, none had taken into consideration the tremendous number of variables involved and their possible affects on the problem, and the complex physiology and bio-chemistry of a highly organized animal were not considered. Let me give just one example of a variable that just possibly might have an affect. Most hobbyists are, at least slightly, aware of what the nitrogen cycle is, and a few of them are aware that this cycle is not completed to any great extent in aquaria. Thus, regardless of type of filtration, there is a continuous build-up of the concentration of nitrates in aquaria. This is one thing that periodic water changes are meant to alleviate. Now, most hobbyists know that a high nitrite content is detrimental to the lives of fishes, but they tend to think that nitrates are safe, and they are - relatively speaking. However an extremely high concentration of nitrates is also detrimental. Now, my question is this; what, if any, is the effect of nitrate concentration on the physiological processes of fish, and, if there is an effect or effects, are they as great on one individual of a population as another? This is only one question (actually two) that has been ignored, it seems to me.

To continue; it also appeared to me that all of these experiments were designed exclusively to prove the existence of G.I.S. rather than to determine what factors are involved in determining growth rate variances. There is nothing wrong with this type of experiment of course, but there is something wrong with saying "such and such causes so and so" without knowing what other factors are involved and what their effects are. To use an example I will refer to again later; to say, "Insulin determines blood sugar level in humans", is wrong because blood sugar level is determined by Insulin, Glucagon, Insulinase and, depending on circumstances, several other factors.

I think I've voiced enough objections, so let me bring in the two other concepts I previously referred to. In 1940, Allee et al postulated that fish condition their water by secreting a Growth Promoting Substance - G.P.S. Does that surprise you? Well, it really shouldn't. As I have been intimating, but haven't actually stated, when experiments are not properly controlled, the same results can be interpreted in many ways. However, in this case, Allee et al proceeded to isolate this substance. Their findings were reported in the 'Journal of Experimental Zoology'. They isolated G.P.S.; concentrated it; diluted it and found it effective in low concentrations, with this exception - when tanks were overcrowded. They then theorized that the high concentration of waste products and the mechanical disturbances of overcrowding overrode the effects of G.P.S.

The emphasis I have put on the last two sentences is not frivolous since those theories are in accordance with my own views.

Let us go on to Margaret Brown and the year 1946. In one experiment, Brown found that the growth rate of trout fry in a 7 liter aquarium was greatest when the number of fry was 80, and growth rate was less when the number of fry was 25, 50 100 or 150.

In another experiment, Brown found that fry kept in aquaria where the amount of water per fish was 3 liters or 50 liters did not grow as well as when there were 12, 24 or 35 liters per fish. She found that those in crowded conditions (3 liters per fish), ate less, used food less efficiently and disturbed each other more. Those kept in uncrowded conditions (50 liters per fish), fed and grew erratically.

As a result of her experiments, Brown came up with the theory of Optimum Crowding. This theory postulates that a certain amount of social stimulation is conducive to rapid growth, but, by the same token, extremely crowded or uncrowded conditions are not conducive to good growth. The former for essentially the same reasons as theorized by Allee, and the latter because of the lack of social stimulation.

Now, where are we? We have essentially the same phenomena explained in three different ways; G.I.S. - G.P.S. - Optimum Crowding. Is one of these three right and the others wrong? No! They are all right in a sense; i.e. each one is a factor to be considered in determining causes of growth variances, but all three are also wrong because the proponents of each have fallen into the trap of oversimplification. Life is just not so simple that a complicated physiological process like growth can be fully explained by one simple factor.

I believe that not only the above three factors, but many others interact to determine growth variances. As for two substances being isolated, whose effects are diametrically opposed, I believe there are three possible explanations for their existance:

- 1. Growth determination is not their primary function but only a secondary effect.
- 2. These two substances act as counterbalancing agents, much as Insulin and Glucagon do in humans, in controlling blood sugar level.
- 3. Fish secrete both substances according to unknown stimuli.

However, I am a theorist, not an experimentalist. Consequently, the truth will have to be determined by others.

As a final note; there are three difficult problems in relation to this question in particular and others like it. The first has been implied; i.e. stating conclusions as gospel that are based on incomplete experimentation or on experimentation that ignores too many relevant factors. The second is the extreme difficulty of working with animals whose environment is so different from our own. And the third, of course, is the extreme inaccessability of relevant literature. However, in spite of these difficulties, the question is so interesting that the search will go on and someday the full truth will be known and when it is, I am sure the answer will be much, much more complicated than the proponents of the above three theories would have us believe.

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