# Welcome to the Mystery Snail Color Genetics Project!

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The MSCG Project is a crowdsourced effort to understand the inheritance of color polymorphism in *Pomacea diffusa*, the commercially-popular "mystery snail" common in home aquariums worldwide. The project is coordinated by Dr. Rob Dillon, a professor recently retired from the College of Charleston in South Carolina. Dr. Dillon has almost 40 years of research experience working with the genetics and evolutionary biology of mollusks.

**Would you like to join the MSCG Project?** Membership is open to everybody! All you need is:

- At least some experience in the home culture of mystery snails, or a willingness to learn.
- At least one female* mystery snail of the color form usually called, "ivory." More would be better. Ivory mystery snails can be recognized by their completely unpigmented body and shell – see the photo at right below. And notice the asterisk by that modifier, "female." See point #5 in the section entitled "Reproductive Biology" for more.
- Or newly-hatched babies from an ivory mother in your home aquarium right now. If that is the case, you're way ahead of most of us. Go directly to the section entitled, "Methods, Phase (2)."

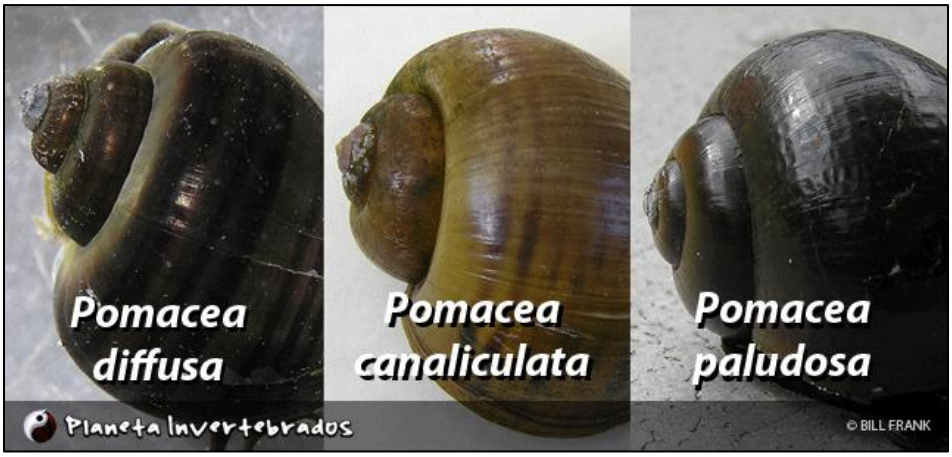
- At least one aquarium or decent-sized culture vessel dedicated to your ivory snail or snails. You can set this up according to your personal preferences – size, water quality, temperature, filtration method, and so forth. Feed your snail or snails whatever diet you prefer. The important stipulation is that only your ivory snail (or snails) are allowed in your dedicated tank. No fish or other color forms of mystery snails! Plants are OK. And (honestly) other species of snails (like *Physa*) are also OK. Not ideal, but we can live with them.
- You will need a camera or smartphone to photograph any apple snail offspring you may be able to hatch. Everybody likes baby pictures!
- I will need your name and email address. We will communicate among ourselves via email. Your intrepid coordinator does not text, twitter, tweet, instachat or snapgram. He barely understands Facebook and does not understand what "IM" means, at all. Please email DillonR@fwgna.org if you need to communicate with me or call 843-670-8002 during regular business hours. I only understand complete English sentences correctly spelled, capitalized, and punctuated.

**Ready to get started?**
Read the next six sections – Study organism, Reproductive biology, Genetics, Hypothesis, Phase (1) methods, and FAQs. Contact me. And go!

## Our Study Organism

It is important to be clear, from the very beginning, that we will be working exclusively *with Pomacea diffusa*, the snail almost-universally marketed as a "mystery snail" by aquarium shops and big-box pet stores like PetCo and PetSmart. Prior to the mid-2000s they were often identified as "*Pomacea bridgesii*" until the systematic confusion in their native South America was sorted out by our good friend Ken Hayes and his colleagues. An alternate common name for the mystery snail is the "spike-topped apple snail."

Mystery snails reach adulthood at around 2 cm standard shell length, and very rarely reach much more than 4 cm. They will not eat your aquarium plants. They can be purchased in a variety of color forms, for about $3.00 each, last time I checked. They are active and interesting pets, easily reared in your home aquarium.




Several larger species of *Pomacea* are also occasionally available on the market, called "channeled apple snails," or "Peruvian apple snails" or "giant golden mystery snails" or something similar. These include *Pomacea maculata*, which has been introduced into ponds and drainage ditches the southeastern United States, *Pomacea canaliculata*, which has become a terrible pest in Asian rice cultivation, and the native Floridian *Pomacea paludosa*. These larger species are more challenging to keep as pets, and will eat your aquarium plants, and anything else too slow to get out of their way. They are not supposed to be sold commercially, and **we are not working on their genetics**.

The best way to recognize *P. diffusa* is by its spire angle, as shown on Bill Frank's photomontage above. If you're still worried that your pet might not be a bona fide mystery snail, *Pomacea diffusa*, visit Stijn Ghesquiere's applesnail.net website. Stijn has lots of good info on all the various species of ampullariid snails worldwide, not just *P. diffusa* but every other type of *Pomacea* you might run across, and ways to tell them apart.

## Reproductive Biology

I'm beginning with the assumption that all MSCGP volunteers are familiar with the basics of mystery snail biology, including (especially) their unique reproductive adaptations. The husbandry of egg laying

and hatching are not trivial in *Pomacea*, but the reason I have advertised this project to groups already enthusiastic about mystery snails is that, I trust, you can handle them. See Stijn Ghesquiere's applesnail.net page if you need a refresher.

Six important points to keep in mind:

(1) Sex ratios are not necessarily balanced in *Pomacea* populations. In fact, field surveys generally find wild (or naturalized) populations of *Pomacea* biased toward the females. There's been some fascinating research on introduced Asian populations of *Pomacea canaliculata* that suggests multigenic inheritance of sex, rather than the typical XY chromosomal system everybody is familiar with. So takeaway point #1 is that, although I don't know of any good study, I wouldn't be surprised if most of the mystery snails in the home aquarium today are female.

(2) Essentially all invertebrates with internal fertilization store sperm, typically for their entire lifetimes. Some model organisms, like fruit flies, are effectively inseminated just once. The situation is not well studied in gastropods, but multiple insemination is often reported. Whether the sperm of the first partner prevails, or the last partner, or some combination, is generally not known.

(3) It's a very good bet that all the mystery snails in all our home aquaria are already inseminated, possibly by multiple partners, when they arrive in the pet shops. I ran a brief FB poll that returned 14 cases of mixed-phenotype sibships, and only 2 cases of pure-phenotype sibships, from mystery snail egg clutches hatched in the home aquarium. This implies that the breeders do not keep snail stocks that they mean for the retail market segregated by color, but rather mix them sometime around maturation, perhaps in a calculated effort to block the development of pure lines by competitors. And (to be fair) it's more fun for hobbyists who might be able to hatch egg masses from females obtained at the retail level if they obtain mixed-phenotype progeny.

(4) Controlled crosses require virgin snails. So, since there is no good way to predict when maturity might be reached, we will need to isolate any snails we want to use in genetic experiments shortly after they are hatched and rear them in pairs. But let's not get ahead of ourselves. First things first, second things second, and fifth things fifth.

(5) *It is possible, although deceptively difficult, to determine the gender of adult mystery snails. The penis arises as an evagination of the mantle, at the posterior aperture edge, which you can see (sometimes) if you pull a male *Pomacea* out of the water and hold him aperture up. There are some helpful illustrations on the web to show you how to do this.


The problem is that if you can see a penis, you know your snail is a male, but if you cannot see a penis, you don't know anything. Your snail could be immature, or sick. Or the lighting might be bad, or you might be holding him wrong. That is an especially big problem in photographs, as demonstrated by the photomontage above from Ms. Roberta Rose (Snails, Snails, Snails 1Oct18).

The situation is similar with behavioral cues. If your mystery snail is in an aquarium with other mystery snails, and you see him on top of a partner, attempting to copulate, you can infer that he is a male. But if you do not see that behavior, you don't know anything.

I would recommend that you do your best to determine the gender of the mystery snail or snails you a considering for use as parents. Pull them out of the water and flip them over and watch as they struggle. If you can clearly see a penis, that's a disqualification. Otherwise, keep it and we'll see.

(6) The bottom line. You'll need a teaspoon of luck or a tablespoon of persistence to participate in the MSCG Project. The more snails you start with, the more likely you are to have a healthy female. So you can certainly start this experiment with just one ivory snail, but more would be better.

## A Two-minute Refresher on Genetics

Almost everybody has been exposed to some genetics, at some point in their lives. I feel pretty sure you all remember that most organisms of all sorts, including people and snails, are **diploid,** which means that they have two sets of **chromosomes**, one from mom and one from dad. And that the genes are on the chromosomes. So that (simplifying a bit) all diploid organisms have two sets of genes.

The complete set of all the genes held by an organism is called its **genotype**. The appearance of an organism is called its **phenotype**. Some fraction of an organism's phenotype is controlled by its genotype. Trying to figure out the details of that (deceptively simple) term "some fraction" is basically what geneticists have done since 1866 and what continues to be our main job today.


But one of the more irritating things about Genetics, which I taught at the college level for 35 years, is that the meaning of the word "gene" has become confused. The term is used in several different ways, to mean several different things, even by professional geneticists. So, let's clarify.

For the sake of the remainder of this section, we will substitute the (more precise) word "locus" for the (ambiguous) word "gene." A **locus** is a place on a chromosome that encodes a trait. Then to re-state the fourth sentence in the first paragraph, all diploid organisms have two sets of loci.

And let's introduce a second (more precise) word, "allele." An **allele** is one of at least two alternative messages at a locus. I'll bet that you all remember that an organism with two matching alleles is called a **homozygote**. And an organism with two mismatched alleles is called a **heterozygote**. You probably also remember that alleles can be **recessive** (two copies required for the organism to manifest a trait) or **dominant** (only one copy required.)

So since the birth of our science, geneticists have had a problem. Suppose an organism shows the dominant phenotype. Is that organism homozygous dominant, or is it heterozygous? The way we have always answered that question is with a test cross.

A **test cross** is, simply, crossing an organism that shows a dominant phenotype to an organism that shows a recessive phenotype. If all the offspring of the dominant-phenotype parent also manifest the dominant phenotype, that parent must have been homozygous. If the parent with the dominant phenotype has babies with both the dominant and recessive phenotypes, that parent must have been heterozygous. The ratio of the dominant and recessive phenotypes in the offspring in the latter case is expected to be 1:1.

Here in the MSCG Project, we will work out the inheritance of color polymorphism in *Pomacea diffusa* using test crosses.

You'll also find little bit of additional jargon on this website, and in correspondence with me, regarding generation times. I'm calling the snail that you start with the "**mother**" snail. Her babies are called the **F1** generation. And let's call all babies born from a single egg mass an F1 **sibship**. (A sibship is a clutch

of brothers and sisters.) In Phase (2) of the MSCG Project, we're planning to rear and intercross specially-selected subsets of F1 offspring. We'll call the offspring from a pair of F1 snails the **F2** generation.

## Hypothesis

At the risk of sounding even more like your high school biology teacher than I already do, **science** is the construction of testable hypotheses about the natural world. We can't just cluelessly cross every mystery snail with every other mystery snail and hope to figure out the inheritance of shell and body pigmentation from the results. We must start with an hypothesis.

For quite a few years, hobbyists have informally suggested that color polymorphisms in mystery snails are controlled by three genetic loci, each with two alleles. I don't know who first offered this hypothesis, but it has been featured on Stijn Ghesquiere's applesnail.net for a long time. This hypothesis would lead to eight discrete color phenotypes, which jives with general (although not universal) experience.

Let us call locus **A** body color. And let us hypothesize two alleles, the dominant A, which encodes dark pigment, and the recessive a, which does not. Homozygous recessive aa snails have unpigmented bodies.

Locus **Y** controls shell background color. Again we hypothesize two alleles, the dominant Y encoding the deposition of a yellow background pigment on the shell, and the recessive y not. And again, homozygous recessive yy snails have no background shell color.

Locus **S** controls shell striping. The dominant allele S encodes dark, purplish stripes on the surface of the shell, and the recessive s does not. Again, homozygous recessive ss snails have no striping.

Then using a blank underline to designate any second allele, the eight phenotypic classes will be:

Brown A_Y_S_
Jade A_Y_ss
Purple A_yyS_
Blue A_yyss
Chestnut aaY_S_
Gold aaY_ss
Magenta aayyS_
Ivory aayyss

OK, that's science. We have constructed a testable hypothesis about the natural world. Now let's test it.

## Methods, Phase (1)

Assuming the hypothesis advanced in the previous section, all the mother snails demonstrating the ivory phenotype in the pet shops and in our home aquaria are homozygous recessive at all three loci. They are also (almost certainly) already inseminated. But we probably do not know the father. So Phase (1) of the MSCG Project is simple:

**(1)** Isolate ivory snails, in dedicated tanks.

**(2)** Separate any clutches of eggs that may be laid from their mothers and hatch them. If you're using a big aquarium, it is best to remove any egg masses from the walls, or wherever they've been laid, and hatch them in a separate container. You can find plans for several different styles of mystery snail hatcheries on the web, for example the ones depicted by Ms. Beverly Laborgini below. Or if you have started with a smaller, simpler container for your mother snail, like a kritter-keeper, you might just move mom into a new container, leave the eggs attached to the wall where she laid them, and change the water.

**(3)** Count the viable F1 hatchlings immediately and separate them by any color phenotypes you are able to distinguish.

**(4)** Rear the F1 to at least pea size, count again and verify phenotype. We are trying to allay two concerns here. First, it is not clear at what size the color phenotype of a juvenile mystery snail can be reliably determined. And second, the color forms may demonstrate differential survivorship. We are trying to get a handle on both these unknowns with that (deceptively simple) term "pea size" above. We'll see.

**(5)** Report your results to me by email, with attached photograph or photographs for documentation. If all your babies look the same, you could just send one photo and say, "My ivory mother had 27 F1 babies that all looked ivory, like this." Or if your mother snail had a mixture of babies showing two phenotypes, you would send a couple photos, saying, "My ivory mother had 13 blue F1 babies that looked like photo #1 and 18 ivory F1 babies that looked like photo #2." I'm counting on you to document your results clearly and completely and report them to me.

We'll be looking for that signature 1:1 ratio of phenotypes. It is possible, depending on all the daddies of all the F1 clutches born by all the ivory mothers in the world, that we might confirm our entire model of the inheritance of color polymorphism in mystery snails at Phase (1) of the MSCG Project.

Or more likely, we'll probably go onward to Phase (2). In that case, stand by for further instructions.

## Methods, Phase (2)

If you have found your way to this page, you have a sibship of juvenile mystery snails from an ivory mother, probably from an egg mass that you hatched yourself. If you have just completed Phase (1), you have already sent me a photo (or photos) documenting what this sibship looks like. If you skipped directly here without passing through Phase (1), you'll need to send me a photo or photos of whatever babies you've got first.

In either case, the overall research concept in Phase (2) is just as simple as Phase (1), but the logistics are more difficult. We will mate our F1 mystery snails in controlled fashion, ideally by testcross.

So if, for example, your F1 sibship of mystery snails contained just ivory and gold, I'd ask you to simply set up a bunch of ivory x gold pairings, with as many pairs of juveniles as you've got. Our hypothesis will be that your golds are aaYyss, and ivories are aayyss, and we will expect a 1:1 result in their F2.

The situation might be more complicated than that. If (as another example) your F1 sibship contained jade, gold, blue, and ivory, I'd (probably) ask you to pair all your ivories with jades and set aside your golds and blues for now. Our hypothesis here is that your jades are AaYyss, and (of course) your ivories are aayyss, and we are now expecting 1:1:1:1 in their F2. And we have a test for linkage. More about linkage later, as the MSCG Project unfolds.

The special case would be if your ivory mother yields all-ivory F1 offspring. In that case, we will need to send you some babies of some other color form. Stand by.

The bottom lines are that before moving forward in Phase (2), you need to contact me for specific instructions. I will be back in touch with you to suggest the preferred F2 crosses….

… and that your crosses must be done pairwise – just one pair of snails per container, nothing else.

I am leaving the Phase (2) culture details to you, just as I did in Phase (1). I feel pretty sure that you'll want to start with some sort of vessels smaller than a typical home aquarium. If you're interested in my recommendations, click on the link above entitled, "How I'd do it but my wife won't let me." But these are your snails and your space and your time and your money, and you're the boss. Select your own culture vessels, use the diet you think is best, change water according to your own schedule.

Some mortality is inevitable, and some juveniles will probably fail to thrive and grow. So if you begin, for example, with ten gold x ivory F1 pairs, some juvenile golds will die, and some juvenile ivories will die, and you will need to combine their widows. That's one of the main reasons I would not begin my

Phase (2) crosses in large aquaria, if my wife would let me. I'd want to save space and money. There's no point in purchasing and mounting ten big aquaria if you ultimately only need four.

After some months in culture, we will expect our F1 x F1 pairs to yield F2 offspring. Or perhaps not. If the sex ratio is 50:50 (which seems optimistic) at most half of your F1 pairs will yield offspring, and the other half will be matched-sex. Probably less than half will yield offspring. Maybe a lot less.

So at some point, as your snails reach maturity, it will probably be helpful to rotate partners around. In other words, leave all the snails of one phenotype in their aquaria, and move all the snails of the opposite phenotype one aquarium to the right.

But on the plus side, it will not be necessary for all your F1 paired snails to yield F2 offspring. If you started with ten gold x ivory pairs, and six died, and half of the four surviving pairs were matched-sex, the two pairs that ultimately proved viable and fertile will almost certainly yield enough F2 offspring to qualify as a success.

Treat the F2 offspring exactly as you treated the F1. Count them immediately and separate them by any color phenotypes you are able to distinguish.

Rear the F1 to at least pea size, count again and verify phenotype. Report your results to me by email, with attached photograph or photographs to document your results.

## Frequently Asked Questions

Q: Can you tell me if my mystery snail is ivory?
A: Probably. Send me a photo.

Q: Can you tell me if my mystery snail is a female?
A: No. It's just too hard to do that from photos. See Point #5 in the section on Reproductive Biology.

Q: My (Phase 1) parental- generation ivory snail is not laying eggs. What should I do?
A: My first thought is that it might be a male. I'd pull it out of the water and inspect it very closely for a penis. If I didn't see a penis, I'd re-examine my culture technique. Am I taking good care of her? Have I fed her regularly and kept her water fresh? Is she healthy, does she seem to be growing? And if my culture technique is fine, my third thought would be that she might not be inseminated. So I would pair her with another adult snail (ideally, of course, one I had reason to think is a male) for a couple days, and then isolate her again. And I would prefer that her potential suitor not be ivory, but any other color form. Brown would be nice.

Q: Do you have culture tips for mystery snails? Do you have recommendations about food, water quality, temperature, lighting, filtration, and so forth? Do you have any ideas on how to promote egg laying? Can you recommend methods to harvest egg masses and hatch babies?
A: Well, not directly. Most of you have more experience with home aquariums than I do. If I were going to do this study myself, I'd use lab culture techniques that aren't practical for the home.

That stipulated, if you go to the section entitled, "How I'd do it but my wife won't let me," you'll find lots of recommendations imbedded, including indirect answers to many of the questions posed above. See if you can adapt some of those recommendations to your home situation.

Q: Why did you start the MSCG Project?
A: I'm a recently-retired college professor who is bored. And I'm intellectually fascinated by the ecology, evolution, and genetics of mollusks.

Q: What do you hope to get out of it?
A: Our results will certainly be published. We're aiming for a paper in the peer-reviewed scientific literature. But the quality of the publication depends on the quality of the data we ultimately generate.

Q: When it is published, can I be a coauthor?
A: I will certainly acknowledge all contributors by name, with their permission. But it's too early to talk about coauthorship at this point.

Q: How long will the project take?
A: That's difficult to estimate. Maybe a couple years? I used to walk into the lab and ask my students, "How's the snail research going?" And they would answer, "Slow."

Q: Years, are you kidding? Can I get results sooner?
A: Yes, absolutely. We're all working together. I will collect all your email addresses and send periodic updates on our progress, including all interim results may have been sent to me. I'll also post periodic updates on the MSCG Project "News and Announcements" page.

Q: Can I remain anonymous?
A: No and Yes. I must have (at minimum) your full name and email address, and I would also be interested to hear anything else about yourself that you'd like to share, including your actual physical address, background, interests, and so forth. We're colleagues. That's called "collegiality." But if you don't want me to share your info with anybody else, I'll respect your privacy.

Q: Why email?
A: I do not understand social media, probably because I am not social. I would actually feel most comfortable conducting this entire study by old-fashioned snail-mail, with stamps. Email is as far as I can go.

And I hate gadgets of all sorts. I still have a flip phone, which I use to talk to people, and a digital camera, which I use to take photos, and a computer, which I use to connect with the internet. If I want to listen to music, I have a CD player, and if I want to watch movies, I go to the theater. And I have no desire to google-up random factoids to contradict my spouse, whatsoever. I cannot for the life of me understand why anybody would want to do all of those things, worse, with an expensive, fragile, awkward little box that pinches in the pocket.

Q: Why must I correspond in complete English sentences, with correct spelling, grammar, and punctuation?
A: My friends tell me that I can be a nice guy, sometimes. But when it comes to science, I am an arrogant jerk. I am demanding, and I am critical, and one of the (many) things I will not tolerate is sloppiness.

So, the way you express yourself tells me a lot about you. If you are so careless and inattentive to detail that you cannot communicate in complete, correct English sentences, I will not trust any scientific data you might be able to gather. And there's no point in your participating in this project.

Q: Why is the MSCG Project website so ugly?
A: Ouch, that's harsh, man. First, this is a research project. And form must follow function. But second, any volunteers out there with web skills are invited to contact me!

## How I'd do it … but my wife won't let me.

(1) I'd cover every square inch of surface in this house with those inexpensive plastic aquaria usually called "Kritter Keepers," size medium. Just room temperature, no aeration, nothing fancy.Kritter Keeper

(2) I'd add no more than one inch of aquarium gravel. Maybe less.


(3) I'd ask my local aquarium shop for recommendations on water. I'd use whatever they use to fill each kritter keeper maybe 60 – 70%, leaving (of course!) enough dry space above the surface for egg laying.

(4) I'd put one ivory snail in each kritter keeper. I'd prefer smaller, younger snails. Not babies, but not big old adults, either. Healthy young snails, right around maturity. And I'd hold them out the water, aperture-up, disqualifying any with penis.

(5) I'd feed them Romaine lettuce. The heads of lettuce you see on the grocery shelves worry me at bit, because they might have pesticides on them. I think I'd probably have a big bucket of old snail water on the floor and rip off a bunch of fresh Romaine leaves and throw them in the bucket to wash them, maybe 24 hours before I fed them to my snails.

(6) I'd watch my snails every day and try to keep Romaine lettuce available at all times. I'd also supplement with an occasional pinch of flake fish food, for protein.

(7) I would completely change the water at least weekly, maybe even more frequently, depending on what the water looked like. Lettuce fouls the water. My guess would be that **water change will be the most important key to success in mystery snail culture.**

(8) When one of my snails laid an egg mass, I would remove the momma, and all her aquarium gravel, to a fresh kritter keeper. And I would add fresh water to the kritter keeper in which the eggs were laid, without gravel, back to the same level, or maybe even lower. And I would wait for hatch.

(9) At hatch I would count all my babies and note their color phenotypes. I might split them into a couple kritter keepers, depending on how many there were.

(10) I would not add aquarium gravel to containers of babies. I would add fresh water, of course. And a leaf of lettuce, maybe ripped up, and a pinch of flake fish food, ground fine.

(11) Melanin production – any sort of pigmentation, really – is typically later-developing, in snails no different from human beings. So I'd be interested to watch over the following days (a week? two?) as color phenotype became scorable.

(12) I'd watch for mortality, and water fouling, and change the water often. I'd monitor the food supply, adding as necessary.

(13) Maybe a couple weeks posthatch, I would make a final entry into my notebook on the yield of each egg mass. And photograph results.

(14) And (assuming that I was in Phase I of the project) I would pair babies according to phenotype and begin to rear a second generation.

(15) To culture my second generation, I would purchase a 50-pack of 20 oz clear cups, with lids. Looks like maybe $15 from Amazon.com. I would add maybe 3/4 inch of aquarium gravel, and fill with water to maybe an inch from the top. Just put them on the table top – no temp control, no aeration, nothing fancy. Add one pair of F1 snails, and a piece of a Romaine leaf. And maybe a pinch of flake fish food, ground fine.

(16) I would check my F1 cups every day, making sure to keep lettuce available, and water fresh. I'd remove the mortalities, and re-pair snails as necessary.

(17) At a shell sizes of maybe 10 - 15 mm, I would graduate my F1 pairs to kritter-keepers. And culture just as I did with my parental snails.

(18) As my F1 snails approached 25 – 30 mm, I would expect to see at least some egg laying activity. If the eggs appeared fertile, I would remove the pair of F1 snails (and their gravel) to two, separate kritter keepers, change the water in the keeper with the eggs, and wait for hatch.

(19) And count and classify the F2 offspring by their color just as I did for the F1, rearing to pea size, to make sure color phenotype was scorable.

(20) For any F1 pairs that had not yielded viable F2 at this point, I would perform a partner rotation. I would leave all the F1 snails of one phenotype in their keeper, and move all the F1 snails of the other phenotype one aquarium to the right. I might wait a week or so, and then try a second mate rotation, depending on results.

(21) I'd be very happy with 100 F2 offspring scored, in total, for all F1 pairs. I'd quit entirely if I got 300.

## An Open Letter to the breeders and suppliers of mystery snails worldwide:

**First**, I must confess that I'm a big fan. I would love to know how you initially developed all your keen Pomacea color variants, and how you currently cultivate them and bring them to market at such large scales.

**Second**, it seems likely to me that you already have enough data for a good peer-reviewed publication, or (in any case) could easily gather it. Much more easily than I.

But **third**, I understand why you might be reluctant to share details regarding the genetics of color polymorphism in your valuable product. You consider this information proprietary. It is one of your "trade secrets."

**Fourth**, I mean you no harm. I have no plans to start my own mystery snail business. Nor do I have any grant support, nor am I struggling to get tenure at some big-time research university. If I was, this would be a terrible way to get it. I'm just a retired college professor who is intellectually fascinated by the genetics of freshwater snails. And I would like to see this information available to the larger scientific community. And, in all honesty, it doesn't look as though it will be terribly hard to figure out.

So **fifth**, the bottom line. Please contact me. If you've got immediate plans to publish, I don't want to scoop you. I will, of course, be interested to see your manuscript, or in any case, your data. If you've been considering a publication, but have not moved forward for some reason (experimental design? data analysis? English composition?) I would be happy to collaborate.