Practical Platy Genetics

By Ephie Wiedermann

Table of Contents

Preface

The internet is being used as the primary source of information for many hobbies, in the 21st Century. For more advanced topics, one or two good books is not a sufficient source of information, and an important scientific paper written for a scholar is inaccessible to hobbyists. This publication was written with the intention of providing the hobbyist a good understanding of the specific genes involved in fancy platys. The author assumes the reader has an advanced understanding of mendelian genetics.

Many terms are used interchangeably to describe aquarium-type platys (as opposed to "wild type" *Xiphophorus maculatus*). I've heard the term hybrid, commercial, domestic, and fancy used the term to describe essentially the same fish. I chose to use the term "fancy platy" in this document because the word "fancy" is subjective. "Hybrid" would imply a recently hybridized fish, "commercial" would imply a fish produced for the market, and "domestic" is a term specifically used for organisms bred with a temperament useful for humans. The term "fancy" therefore seemed like the most logical option.

There are numerous .pdf's on guppy genetics changing hands between guppy fanatics, so this seemed like the most logical choice.

This document is not perfect, nor complete. It is filled with all the relevant information information I can find, with both well known information, research, theories, and my own research. I hope someone with new information will stumble across this and help fill in the blanks. Humans seem bent on simplistic and "definitive" explanations for the phenomena we observe. Although the information in this document attempts to be correct, in genetics there are exceptions to every rule, and rarely do genetics behave according to simple Mendelian inheritance. Just as with aquariums, a "pinch of salt" would be recommended. There are many unknown factors that prevent the complete expression of many traits which may be encountered when crossing two strains.

I am a student with a passion for both livebearers and genetics. I have attempted to source as much information as I can find from reputable sources, but some information is from personal correspondence and theories which I will designate in the individual entry.

I am not responsible for any errors, or misinformation in this document. If you find anything erroneous, or have any additional information, please contact me at FinsAndSales@gmail.com.

Acknowledgements

I would like to give special thanks to:

Yehuda Taha, my mentor, friend, teacher, role model, and *tzadik* for spending so much time, energy, money, and inconvenience teaching me the world of molecular biology.

Tammy Schuls, a friend of mine, who has spent countless hours talking to me, giving aquarium advice, and altogether being a great friend.

Dr. Roy Levine, for providing correspondence that help iron out a lot of the kinks in this document.

The International Xiphophorus Breeder group on Facebook (and all the members of it), which has provided more information and sources than I can keep straight, and put up with me for over a year.

Countless betta breeders, for spending the time researching fish genetics, and getting me hooked on fish genetics. (Unfortunately, I’m terrible at raising bettas)

Goliad Farms (Charles Clapsaddle), for providing great platys to the public at very reasonable prices.

The American Livebearers Association, who has been funding science and research of livebearers for nearly 50 years.

And all the amazing breeders around the world who have brought our little niche hobby to the point where it is.

Chapter 1: Genetics

Sex Chromosomes

Platys are remarkable fish beyond their vibrant colors and great temperament. While sex in humans is determined by a pair of chromosomes, X and Y, platys have 3 different sex chromosomes, W, X, and Y. This result in 5 different combinations; three different types of females; WX, WY, and XX, and with two different types of males, XY, and YY. The exact combinations are indistinguishable from each other without a pedigree or knowledge of the color genetics going into the fish. It is worth noting that although WW fish do not exist in nature, they may have been created in the lab at some point[1]. Note that these sex-determining laws are rules, but there are exceptions. However, one is unlikely to come across, and even more unlikely to identify a crossover event in a home aquarium.

Most aquarium strains of platys are WY/YY. This can be assumed because most color traits are Y-linked, and in order for females to be colored identically to males (important in a commercial strain) this would be necessary. It would be a good experiment to cross males from different aquarium strains to known XX virgin females, to see if this is true. If so, all offspring would be XY males.

Linkage & Supergenes

In platys, there are dozens of different color genes. They are organized on 24 pairs of chromosomes[2], 23 pairs of autosomes (dubbed 1, 2, 3… 23 accordingly), and one pair of sex chromosomes (see above). Most color loci are located on the X and Y chromosomes, with only a few on autosomes. Linkage refers to genes that are located closely together on the same chromosome, and are often passed on together. A supergene is where more than one loci are located on a chromosome very closely together, and almost always pass on to offspring together. In practice, instead of having to account for multiple independent genes, one just needs to account for the supergene. For example, in a particular strain the Y-chromosome has Sr and Ar linked, so that would be represented by Y^{SrAr} and could be treated as only 1 gene.

I would like to point out that when I indicate where the gene is located, it does not mean the gene is limited to that chromosome, but known to occur there. Crossover mutations are fairly common, and strains long established in the hobby may differ dramatically from what is found in this guide.

It is a bizarre occurrence that nearly all known color genes are dominant. I theorize this is due to a combination of two factors. In the wild, female platys select their mates based off of pattern[23] (phenotype), selecting for dominant traits. We can also safely assume breeders are more likely to discover novel dominant traits because dominant genes do not require inbreeding to be discovered.

Chapter 2: Xiphophorus History & Wild Platys

This chapter will cover the recent history of the genus *Xiphophorus*, talk about wild *X. maculatus*, and *Xiphophorus* hybrids. Describing the full history of Xiphophorus would be a momentous undertaking, this publication will attempt to only briefly summarize that history.

History

Like most freshwater fish, platys didn't start off the the beautiful aquatic jewels we know today. In fact, platys have been selectively bred for almost a century! Wild *Xiphophorus maculatus* is native to southern Mexico, Guatemala and Belize[17], making it the one of the most widespread Xiphophorines.

The platy's history really begins millions of years ago, when the genus *Xiphophorus* evolved. The ancestor of *Xiphophorus maculatus* diverged from the ancestor of *Xiphophorus hellerii* about 2.5 million years ago, and platys diverged from all swordtails around 1.3 million years ago. These are approximate average measurements because hybridization has been shown to be a strong factor in *Xiphophorus* evolution[20].

In 1844, Heckel described the type-species for the genus *Xiphophorus*, the swordtail *Xiphophorus hellerii*. *Platypoecilus maculata*, the Southern Platy, was first described in 1866 by Dr. Albert Gunther in "*A Catalogue of the Fishes in the British Museum*", volume 6, page 350[19]. He lists the specimens' origins only as "Mexico.", and notes the fish as being "From M(r. Auguste) Sallé's Collection." Auguste Sallé was an explorer of Southern Mexico and Central America, where he collected many different species for his personal collection and possibly for sale to exotic animal collectors. It is very reasonable to assume he was the first European collector of platys!

Fifty years later, Dr. Myron Gordon was an early researcher of platys and swordtails. Both *X. maculatus*, *X. hellerii*, and other species of *Xiphophorus* had already been on the aquarium market for some time when Gordon pioneered research in 1926 on Xiphophorus genetics. His legacy today reflects his great devotion to the science, laying the foundation for the *American Livebearers Association*, establishing the *Xiphophorus Genetic Stock Center* (which has proven critical for providing information for this document), collecting many species/strains, writing and researching numerous papers on *Xiphophorus* genetics, and most impactfully, discovered cancerous hybrids, which have been instrumental in carving out *Xiphophorus* a niche in cancer research. His students have gone on to discovering much more.[26]

Unlike in other families of aquarium fish, *Xiphophorus* hybrids are generally not considered controversial. I believe this is because *Xiphophorus* hybrids have been around for so long that it was never taboo in our lifetimes. Notwithstanding, there are a small group of people that are opposed to hybrid “freaks”. It is my belief that hybrids should not be so controversial as long as they are sold as hybrids and their parent species are maintained, unhybridized.

Platypoecilus was eventually combined with *Xiphophorus* due to the obvious similarities between the genera, and the ability to produce fertile hybrids. I have been unable to locate the paper on this subject.

There are currently 26 recognized species in the genus *Xiphophorus*, and more will probably be discovered and/or recognized in the coming decades. The 26 species are categorized into 4 “clades” (think: sub-genus), the Northern Platys, Southern Platys, Northern Swordtails, and Southern Swordtails. *X. maculatus* is a member of the Southern Platy complex.

Wild Platys

Xiphophorus maculatus is highly polymorphic species, even in the wild. Males and females alike, display a wide variety of colorful pattern, although arguably males are more colorful and subsequently rarer due to predation. Sex-skewed conditions are commonly replicated in a home aquarium by keeping two or more females for every male.

The fish has a range from Veracruz, Mexico to northern Belize. Fishbase describes the platys habitat as “warm springs, canals and ditches with typically slow-moving water, silt bottoms and weedy banks... also inhabit creeks and swamps”[21].

This fish has been the subject of much evolutionary research, which has resulted in research on the different colors and patterns found in wild platys (and many in domestic platys). This provides many sources for the information found here.

True wild platys are unfortunately rare in the aquarium trade in the United States, and are only rarely found being offered on the internet. Currently, the only strain commonly kept by aquarists in the United States is a collection of Rusty Wessel from the Rio Grijalva.

Wild platys are useful for crossing to fancy stock in order to introduce new genes, increase fertility, and correct body shape distortion caused by hybridization. From personal experience, I’ve noticed that wild platys are much more skittish than their fancy counterparts and are notorious jumpers. It is imperative to cover their tank!

Chapter 3: Background Colors

Gold (Stippled)
(St/St or G/g) Autosomal Recessive
StSt or GG - Gray
Stst or Gg - Gray
stst or gg - Gold

In most wild platys, the background coloration is a drab gray color, caused by the presence of micromelanophores and small xanthophores. But in some populations, there is a mutation called "gold" that removes the black color pigment, revealing a light yellow-peach coloration underneath.[3] This gene affects the expression of Nigra and Spot-Sided (see those entries for details)[4].

Ghost
(R/r) Autosomal Recessive
ststRR - Gold
ststRr - Gold
ststrr - Ghost

Ghost is the second mutation to occur in the background color, which eliminates the yellow xanthophores from the skin. Like Gold, this mutation is recessive. In a fish without Gold, this mutation is undetectable because micromelanophores cover over the presence of Ghost, which is characterized by the lack of xanthophores. This gene does not affect other black patterns or eye color.[3]

Albino
(P/p or I/i) Recessive
PP - Normal
Pp - Normal
pp - Albino

Albinism is common in fish, and results in a near-total neutralization of micromelanophores and macromelanophore patterns alike. The eye will take on a red color from the elimination of black pigment that masks red blood vessels in normal fish. In fish with black macromelanophore patterns, the patterns will be subdued but present.

As of this writing, Albino is currently "extinct" in platys in North America because breeders stopped breeding it. However, Albino platys can be recreated by hybridization with swordtails. One breeder in Florida is currently working on a strain.

Chapter 4: ROY Patterns

Platys and swordtails are famous for their bright reds, oranges, and yellows they add to an aquarium. This group of genes is governed by 2 main factors: "shade" genes and location genes. Listed below are several important known location genes, genes that determine where color will develop on a fish. The shade or intensity of the color is governed by many unclassified genes I've dubbed *shade genes*. Different shade gene alleles will modify the shade of location genes' expression.

Body Red
(Br/br) Y-linked Dominant[5]

In domestic platys, Red Body appears as red or orange coloration behind the gill cover and covers the body up to the caudal peduncle. It is an important component in "red platy" strains because it provides deep coverage of the body. Different shade alleles will modify the color expressed by this gene.

Dorsal Red
(Dr/dr) X-Linked (although known to cross over to the Y-Chromosome) Dominant[5]

This gene causes the expression of a red to orange dorsal fin, but can bleed through onto the body. The trait is more strongly expressed in males than in females[6]. From my personal experience I can attest that the sex-influenced expression of this trait affects domestic fish. This gene goes by several trade names. Dorsal red is linked to Spotted Dorsal on a supergene on the X-chromosome of many wild and domestic platys.

Tail Red
(Tr/tr)

Basolo[7] cites this gene as existing in wild *maculatus* platys. However, this gene is more likely to have been integrated into fancy platys via hybridizing with Variatus, where it is a common pattern. This gene colors the tail through the back half of the body red to orange depending on the modifiers.

Tail Yellow
(Ty/ty)

Like Tail Red, Basolo[7] cites this gene as existing in wild platys, however I doubt this is the case. It is more likely to have been integrated into fancy platys via hybridizing with Variatus, where it is a common pattern. According to her, this gene colors the tail yellow, although I do not know if it can also spread onto the body like Tail Red.

Orange Caudal Peduncle
(CPo/cpo) X-linked Dominant*[7]

These genes color the caudal peduncle, the crescent shaped area conjoining the tail to the body. There are two versions of the gene, CPo-1 expressed in both sexes, and CPo-2 limited to males, although this information is probably irrelevant to a breeder. CPy is nearly identical to CPo-1, but yellow instead of orange.[7]

*CPo-1 known to be dominant and X-linked, and CPo-2 not *expressed* in females

Ruby Throat
(Rt/rt) Dominant[4]

This gene is unique in the legendary Bleeding-Heart platy. It covers the lower half of the body in red, from the mouth to behind the anal fin.

It is only expressed in males, I do not know if this is because all previous strains have been XY/XX although I find this unlikely. It is entirely possible the gene is simply only expressed in males.

Red Vertical Bars
(STr/str)[7]

This is another important gene for the Bleeding-Heart platy, and has been lost in some stains. It causes vertical red banding. In females, the expression is very light, but present.

It is possible this gene is Y-linked, which would explain why Bleeding-Heart platys have not been transferred over to a WY/YY strain. Further research must be performed to confirm this hypothesis.

Chapter 5: Black Patterns

Nigra (Tuxedo):
(N/n) X-Linked Dominant

This is an important gene in platys, as it is responsible for both full-black coloration of black platys and the tuxedo pattern. In fish that are StSt and Stst (gray) the gene manifests itself as a near solid-black fish, but in stst (gold or ghost) fish the color spread is limited to a black area on the flank of the fish.[4] There are several different modifier genes that may completely inhibit the expression of black color.

Spot-Sided (Type-A):
(Sp-A/sp-a) Known to be X-linked Dominant

Spot-Sided is a complex of a dozen known genes (probably more undiscovered) which result in black spotting on the fish's side. All the genes in this complex are very similar in expression. The Type-A group includes genes that produce larger spots[7], producing a “milk-and-ink” pattern. In fish that are StSt and Stst (gray) the gene manifests itself normally, evenly spotting the fish, but in stst (gold or ghost) fish the color pattern is limited to the back half of the fish.[4]

Spot-Sided (Type-B):
(Sp-B/sp-b) Known to be X-linked Dominant

Spot-Sided is a complex of a dozen known genes (probably more undiscovered) which result in black spotting on the fish's side. All the genes in this complex are very similar in expression. The Type-B group includes genes that produce tiny spots[7], producing a “salt-and-pepper” pattern. In fish that are StSt and Stst (gray) the gene manifests itself normally, evenly spotting the fish, but in stst (gold or ghost) fish the color pattern is limited to the back half of the fish.[4]

Spotted Dorsal Fin:
(Sd/sd) X-Linked Dominant

This trait manifests itself as a series of small, black spots on the dorsal fin. There are multiple modifier genes that can extend or suppress the expression of spots.[8]

Chapter 6: Tail Patterns

The “tail patterns” are a series of black micromelanophore traits that occur on the tail, caudal peduncle, and even the back half of the body in one case. For practicality, these genes are categorized under the umbrella term “tail pattern”. There are perhaps a dozen or more naturally occurring patterns spread throughout *X. maculatus*’ native range, and even more can be integrated into platys via hybridization with other species. However, most of these are not relevant to the average hobbyist. Like the other sections in this paper, I have omitted genes and patterns that are irrelevant to a fancy platy breeder, even though (especially in this section), there are several patterns that are quite remarkable. Furthermore, I have found it necessary to simplify much of the information for sanity’s purpose. Much more research will need to be done in order to understand this complex.

Gordon[9] performed extensive experiments on wild platys evaluating tail patterns, recording data from thousands of fish, including fish from as far back as the original collection from 1866! Because no more than two different tail patterns are ever found on the same fish, he proposed these genes are in fact all different alleles on the same locus. Kallman[24] describes two males with three tail patterns (Comet, Complete Crescent, and One Spot). If Gordon’s theory is correct, it is possible this is due to a doubling mutation or an unknown “combination” pattern, such as Moon Complete. Alternatively, there may be more than one locus. In this document, we treat these patterns as if they are more than one locus.

Moon
(M/m) Autosomal Dominant[7]

Few genes can claim they name a fish, but this is one of them. Older hobbyists will recognize the now dated name for platys, “Moons”, which were named after the round, black spot found on the body in front of the caudal peduncle. In many of the specimens first imported, this pattern was found[17]. Combined with Twin Spot, it forms the well known “Mickey Mouse” pattern found on many pet store fish.

Twin Spot
(T/t) Autosomal Dominant[7]

This pattern is most easily described as being a pair of black spots on the top and bottom of the caudal peduncle that may extend into the tail or body a bit. It is the second gene responsible for the popular “Mickey Mouse” pattern. There is an autosomal modifier gene, called Guatemala Crescent (TCg), that modifies T into a crescent-type pattern (a black caudal peduncle).

Crescent
(C/c) Autosomal Dominant[7]

This is a class of similar genes that I am combining here for simplicity's sake. This trait is basically Caudal Peduncle Black. I find it shows up in "Mickey Mouse" platys occasionally, covering up most of Twin Spot, but the two spots from Twin Spot protrude slightly more.

Guatemala Crescent is a modifier gene which creates a thick, black crescent behind the caudal peduncle in the presence of Twin Spot. This could be easily confused with Twin Spot, but Cg is "broader overall"[24] in comparison. Additionally, the animal's lips become black, similar to Wag fish, which is an easy way to differentiate the two traits.

Comet
(Co/co) Autosomal Semi-Dominant[7]

Comet produces a black upper and lower line on the tail. It goes by many synonymous names. I know of a few, such as "twinbar", "rocket", as well as others. Comet is an interesting gene, because when a fish is heterozygous (has only one copy), the black bars reach from the peduncle to only the halfway point.

Extender (Wag)
(E/e) Autosomal Dominant

When comet platys were hybridized with swordtails, early Xiphophorus breeders (1936)[10] discovered an anomaly in the offspring: all the offspring possessed entirely black fins. Although the fish were subsequently bred back to platys, breeders selected for the dark fin trait and later dubbed it "Wag". This trait has proven to sell exceptionally well, and is very popular among both fancy platy breeders and LFS alike.

Upper and Lower Bar
Upper (Có/có), Lower (Cò/cò) Autosomal Dominant?

This is quite the interesting little pattern, as it presents itself as either the top (in upper) or bottom (in lower) stripe of the Comet pattern. It is not yet understood whether this is a modification of Comet, or unique alleles.[7] It is rarely found in the wild, yet I have seen pictures of a pair of examples in an aquarium.

Chapter 7: Iridescent Patterns

Unlike all previous genes I've mentioned, the genes in this sections do not result in pigment-based patterns, but produce color through a different effect entirely, the iridocytes. As a result, this complex of genes is much much complicated, but in aquarium fish we only ever see two of these genes, which will be covered here. More research is necessary in this area.

Blue Iridescence
(Bi/bi) Autosomal[5] [Conflicting sources concerning dominance[4],[13]]

This trait results in the spreading of iridocytes in the fish's scales, resulting in a metallic blue color, that can change in color and appearance when the fish moves. In wild platys, iridescence is limited to only a line of scales, but in aquarium platys most fish display blue iridescence at least on the upper flank. I know of a strain where the blue iridescence nearly reaches the caudal peduncle and gill cover! In the aquarium trade, this trait goes by a number of names, such as "mirror", "blue", "metallic", "neon", and others.

Against different backgrounds the color may be perceived differently. Most commonly, I find the color sat against a wild-type StSt background to appear blue, however I have seen it against a gold background ("neon"), and white albino with similar effects. With black and yellow the fish may appear more green.

Opal
(Op/op) Recessive[23]

Because of the sheer number of fish raised, new mutations are found rather frequently. Charles Clappsaddle[23] describes his discovery of a white iridescent gene among an F_2 cross of Blue Iridescent Golds to Hifin Golds from another farm. In the F_2, a handful of fish were discovered with pearly pastel blue Iridescence he dubbed "Opal", where the fish would normally be blue. It is likely that Opal was carried into the gene pool through the foreign males, which did not express the trait because they lacked Blue Iridescence.

From this information, we can conclude a few things. First, the trait is a modifier of Bi. The trait is only apparent when in the presence of Blue Iridescence. Second, the trait is recessive. Opal fish only appeared in a cross where both parents carried opal. Third, the trait is not W-linked. It must have been carried in the males, and all fish with a W-chromosome are female.

Further research is need to determine if the trait is X-linked, Y-linked, or Autosomal, as well as what effect the gene has on the cellular level. I hypothesize the gene modifies the iridocytes (hence why I included this gene under this section), either by increasing the number of them, the amount of guanine in each cell, or the structure of the guanine ("granular" instead of crystalline).

Other Patterns:

In this paper I attempted to cover every pattern a breeder will probably see. However, I recognize this list is not a complete profile of *X. maculatus* patterns, as there are dozens. A few, such a Dot, I chose to exclude because of how minor they are. Others have an unknown genetic basis (see Chapter 10). While I was writing this, I got an email from a platy enthusiast, like myself, who asked me if a yellow-eyed blue platy was “unusual”. This gene is commonly found in wild *X. maculatus*, but it is quite an unusual find!

Carefully examination of seemly uniform petstore platys will uncover a whole plethora of unnoticed genes. I am certain amazing strains could be developed from the most “average” strains will the right eye.

It is not unheard of for new patterns to emerge and be described. Most of the genes found in platys are from their wild heritage, but not all of them. Keep a lookout for anything truly unusual. You never really know when the next ‘big thing’ will emerge!

Chapter 8: Fin & Body Modifications

Platys are well known for their bright colors, but there are a few select breeders out there who also breed for fancy finnage. Two of these have been integrated via hybridization with swordtails, but with a short period required until sexual maturation (relative to swordtails), there is tremendous potential for developing lines of fancy-finned platys. Most of the sources used in this next section are from hobbyists, not scientists (although the two are not mutually exclusive). I believe this does not render the content unreputable. In fact, sometimes your fellow hobbyists have more practical information than scientists!

Hifin
(H/h) Autosomal Dominant*

Originally, Hifins were discovered on swordtails, and introduced to the hobby in the early ’60s, sold under the name “Simpson Swordtail”, named after its developers. Only a few years afterwards, it was bred into platys. Because platys lacks a swordtail, the name “Simpson Swordtail” was dropped in favor of the more descriptive name “Hifin” (alternatively spelled “Hi-Fin”)[11]. “Sailfin” is another market term that emerged recently, but these are merely Hifins with slightly different modifiers[25], while “topsail” platys are similarly just another synonym.

The Hifin gene results in a fish with an extra-long dorsal fin that grows as the fish ages. Although the gene is dominant, a fish cannot be homozygous for Hifin (HH), as two doses of the gene are lethal. In order to produce Hifins, a breeder would need to cross a Hifin (Hh) to another Hifin (Hh), yielding 66% Hifins, or a Hifin (Hh) to a normal fin (hh) yielding 50% Hifins.[4] This implies a true-breeding hifin strain is impossible. However, several strains have been described that yield nearly 100% Hifin offspring![12]

Plumetail
(P/p) Autosomal Dominant

This mutation is best defined by Charles Clapsaddle's definition of the trait as "a plume of elongated fin rays in the middle of the caudal or tail fin of the fish". Males also possess a small “sword” extension on the bottom of the tail, like a swordtail. I hypothesize that the mutation emerged on a swordtail-platy hybrid, and the Plumetail allele is linked to a sword-producing allele. Alternatively, the sword may be a secondary effect of the gene. Like Hifin, the length of the fin extension increases as the fish ages, however unlike other the other known *Xiphophorus* fin mutations, fish are born with the extension prevalent, while in hifins and lyretails it takes time for the extension to develop. Even though newborn fry can have a plumetail, I wait until the fry are 1 week old and the plume is more apparent to separate fry. It is unfortunate that plumetails are no longer widely kept in the North America.

Interestingly, in 1934 a male platy was discovered that expressed a mutation similar to plumetail.[14] The male in the picture lacks a small sword like those found on modern plumetail males. Unfortunately, the trait disappeared until it re-emerged in the early 70's in Germany. Unlike Hifin and Lyretail, this gene originally emerged in platys, and not swordtails. The original name of this trait was "brushtail", but "plumetail", and "pintail" are used interchangeably as well. It has been suggested that pintails are thinner extensions that taper to a point, but I find the differentiation unnecessary.

Lyretail
(L/l) Autosomal Dominant*

The Lyretail mutation causes all fins to "sword" (have a sword-like extension attached to them). The fish develops a sword, similar to those found on swordtail males, on the bottom and top of the tail. There are also a filaments that grow on the front edge of the dorsal fin, on both ventral fins, and on females, the anal fin.

As a result of the anal fin enlarging, the male's gonopodium becomes useless for inseminating females because of its increased length[15]. Breeders have cut off most of the gonopodium in hopes the male will then be able to fertilize females, but the males are missing the necessary "hook" used to anchor to the female[27]. A better solution would be to use artificial insemination, or resort to the traditional method of producing lyretails, using a "normal" male and a lyretail females.

Because lyretail males are rendered useless by their long gonopodium, it is difficult to create a homozygous fish (LL). Fortunately, Lyretail is a dominant gene, so most breeders cross a normal male (ll) to a lyretail female (Ll) to produce about 50% lyretails in the offspring[15].

Since the discovery of lyretail swordtails in the late '60s, the gene has been bred into platys numerous times, all over the world[16]. As of this writing, all known lyretail platy strains are "extinct" in the US, because breeders stopped breeding it. However, lyretail platys can be recreated by hybridization with swordtails.

Balloon (Coral)
(B/b) Semi-Dominant*

This gene reduces the number of vertebrate in the fish's spine, subsequently resulting in a more compact body. The information regarding the origin of this trait, as well as the development may never be known.

I hypothesize the name "coral" is because this gene occurs almost exclusively on red platys (I attribute this to the 'Founder's Effect'). "Coral Red Platy" was probably a market name, and people began to associate the "coral" part of the name with the "balloon" trait.

I am under the impression that the general consensus in Europe considers the balloon platy ‘deformed’, and find it immoral to breed fish with a ‘deformity’ that inhibits the fish’s ability to swim correctly. To the contrary, Asian breeders (at least Chinese breeders) enjoy “nice, cute and auspicious”-looking fish which “may generate profits”, as fish are a “big business” there. American breeders are split down the middle, with strongly opinionated people on both sides.

*Personal correspondence with a breeder overseas reveals that Balloon may be influenced by modifier genes and is more apparent homozygously (BB) than heterozygously (Bb).

Variations

Obviously, different tail types can be combined. A plumetail lyretail platy was once dubbed a “crowntail” platy, and in extreme examples the lyre and plume filaments are fused together into a “veiltail”. There are a potentially unlimited number of fin types, however like the ones I just mentioned, these are not caused by new genes, but difficult to identify modifiers.

Chapter 9: Further Research & The Future

Fancy platys are severely under-appreciated and subsequently poorly studied by hobbyists. The genetic basis of strains such as *red* is virtually unknown, while the knowledge of the linkage and inheritance of genes such as Tail Red is very weak. The upside to this situation is it provides an ample opportunity for hobbyists to make discoveries by carefully experimenting with and studying common strains. There are also outlets such as the American Livebearer Association's *LIVEBEARERS* that would be happy to publish the results of the experiment.

I know there are numerous problems in this publication, mostly regarding the dominance and even existence of several genes. There is no literature regarding the "blackhead" pattern of the bumblebee platy, nor the "back black" pattern of the panda platy. The exact genetic makeup of the "red" platy is similarly unknown.

Opal and bleeding-heart platys are kept in only a few tanks in the US, and should be distributed among as many hobbyists as possible. I implore hobbyists to send Opal fish to Europe and Asia to insure the trait is not lost like others before it.

Sources

[1] Gordon, Myron. "Genetics of Platypoecilus maculatus. IV. The sex determining mechanism in two wild populations of the Mexican platyfish." Genetics 32.1 (1947): 8.
[2] Schartl, Manfred et al. "The genome of the platyfish, Xiphophorus maculatus, provides insights into evolutionary adaptation and several complex traits." *Nature genetics* 45.5 (2013): 567-572.
[3] Copeia, 1983(1), pp. 170-181. Genetic Basis of Three Mutant Color Varieties of Xiphophorus maculatus: The Gray,. Gold and Ghost Platyfish. KLAUS D.
[4] Fancy Platies Joanne Norton
[5] http://www.xiphophorus.txstate.edu/publications-data/stockcentermanual.html
[6] http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=1753956
[7] Basolo, Alexandra L. "Genetic linkage and color polymorphism in the southern platyfish (Xiphophorus maculatus): a model system for studies of color pattern evolution." Zebrafish 3.1 (2006): 65-83.
[8] http://www.jstor.org/discover/10.2307/1442275?sid=21105885724693&uid=3739256&uid=3&uid=70&uid=2&uid=2482031213&uid=60&uid=2134&uid=2482031203
[9] https://books.google.com/books?id=DRD5ueZKWIMC&pg=PA95&lpg=PA95&dq=Distribution+in+time+and+space+of+seven+dominant+multiple+alleles+in+Platypoecilus+maculatus&source=bl&ots=_VkSTmszDo&sig=mXMff1S6UvrgbcLoGGKkDJOfOkI&hl=en&sa=X&ei=covjVNPSOcOgNp_rgYgC&ved=0CCsQ6AEwAg#v=onepage&q=Distribution%20in%20time%20and%20space%20of%20seven%20dominant%20multiple%20alleles%20in%20Platypoecilus%20maculatus&f=false
[10] http://www.platys.net/modules.php?name=Content&pa=showpage&pid=80
[11] http://www.international-xiphophorus-breeder.net/modules.php?name=News&file=article&sid=14
[12] http://www.tfhdigital.com/tfh/november_2013?sub_id=PmcuL8OZWNn0#pg29
[13] http://www.tfhdigital.com/tfh/april_2014?sub_id=PmcuL8OZWNn0#pg31
[14] October, 1934 issue of “The Home Aquarium Bulletin”
[15] http://www.tfhdigital.com/tfh/200802/#pg104
[16] http://www.afae.it/pages/tematica/articolipoecilidi/the_lyretal_platy.htm
[17] Exotic Aquarium Fishes, 1979
[18] http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=872
[19] https://books.google.com/books?id=sAJRAAAAYAAJ&printsec=frontcover#v=onepage&q&f=false
[20] http://www.evolutionsbiologie.uni-konstanz.de/files/resourcesmodule/@random5161ca2624207/1365363436_mec12269.pdf

[21] http://www.fishbase.org/summary/3232
[22] http://www.tfhdigital.com/tfh/june_2014?sub_id=PmcuL8OZWNn0#pg33
[23]
http://www.jstor.org/discover/10.2307/2407810?sid=21106143776693&uid=3&uid=3739256&uid=60&uid=2482031203&uid=2
[24]
https://books.google.com/books?id=Q0rTBwAAQBAJ&pg=PR3&lpg=PR3&dq=Handbook+of+Genetics:+Volume+4+Vertebrates+of+Genetic+Interest&source=bl&ots=4wqpjFaBWt&sig=YnG1ZaGtdz1zsb_ooBiBp-5KL_Q&hl=en&sa=X&ei=Xr8mVaCKCYvFsAXI_oE4&ved=0CC4Q6AEwAg#v=onepage&q=Handbook%20of%20Genetics%3A%20Volume%204%20Vertebrates%20of%20Genetic%20Interest&f=false
[25]
http://www.international-xiphophorus-breeder.net/modules.php?name=News&file=article&sid=14
[26] How the Xiphophorus Problem Arrived in San Marcos, Texas
[27] Clark, Aronson, Gordon 1954