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Guppy Longevity

by Diana Walstad (Revised May 2023)[1]

Guppies are no longer the hardy fish they once were. 1950s guppies reportedly had a 2-5 year life span [1].

Initially, I blamed premature death on the seismic shift from "basement bred" American guppies to mass-produced guppies from Southeast Asia. However, research facilities also report a surprisingly short lifespan in their established lab strains.

Granted, environmental factors (temperature, food, water quality, etc.) will affect lifespan. However, I focus here on the *genetic* causes. Many common guppy breeding practices—in the home and in research labs—inadvertently result in an inherited short lifespan.

To simplify a complex subject, I describe experiences with my own guppies. I was able to increase the lifespan of my guppies from about 6 months in 2017 to 12 months in 2022—a doubling of the generation interval. Since guppies can live two years or more, it is admittedly a modest achievement with more work ahead.

Q&A I've never been successful with guppies in spite of every aquarium article saying they're easy, so I finally gave up my serial killer ways and stopped buying the poor things. I'm now wondering if it wasn't me at all.....

Answer Don't blame yourself. No matter how good the care, many domesticated guppies have a lifespan shorter than the two years that it could be. For they are *genetically* weak. They have little disease resistance and are physiologically unfit. They may thrive in the original breeder's tanks or ponds, but they have trouble when forced to adapt to a new environment—your tank.

Many standard guppy breeding practices inadvertently produce genetically weak fish.

However, I did not select solely for longevity. For what good is a long lifespan if the resulting guppies are unattractive and don't reproduce? My goal is to have pleasing, attractive, normally reproducing guppies that also have a decent lifespan.

Short Life in a Blue Grass Strain

Longevity in guppies became an issue when I started up again with guppies in 2017. After a long hiatus with other aquarium fish (Rainbowfish, cichlids, etc.), I returned to my first love—guppies.

I purchased different fish from a variety of sources and strains. The BG (Blue Grass) strain of guppies (**Fig 1)**, two pairs purchased via the Internet, were the most pleasing. They were big, beautiful, prolific, and relatively disease-resistant. It took me almost a year to realize that these gorgeous guppies were just not living that long.

Fig 1. My Blue Grass (BG) Strain of guppies, purchased in 2017, was almost—but not quite—perfect. In my tanks, the fish did not live much longer than 6 months. (The original breeder reported a lifespan of about 8 months in his tanks.)

In 2018 I started monitoring their longevity. In July, a prized BG female produced a large batch. Raised outside in summer tubs and exposed to the elements, the offspring were uniformly vigorous. When they were 3 months old, I culled small unattractive individuals, sold some, and retained 2 males and 7 females for breeding. I then documented the lifespan of the 9 select individuals.

[1] This article complements two other articles: 'Small-Scale Guppy Breeding' and 'Breeding Guppies: Genetic Pitfalls and Successes' that are also available on my website: http://dianawalstad.com

Fig 2. Female #3 (r) at Five Months Age had grown noticeably larger than her 6 sisters. She outlived them all. Before dying at 9 months, due to a prolapsed uterus, she produced several large batches from which I selected the next generation. She was the foundation female for my longevity project.

Unsurprisingly, the males did not live long—about 4-5 months. Irreversible decline began when they rested on the bottom with swollen bellies and lost all interest in food and females. As to the females… From my 7 select females, I had expected to obtain several good breeders. Alas, I ended up with only one—Female #3. At 5 months age, her superiority became evident (**Fig 2**).

I believe that the short lifespan of my BG strain was caused by genetic "plumbing problems." The males suffered from intestinal blockage; the females, reproductive problems.

The short lifespan of this strain—and probably many other fancy domestic strains—is not unusual. It contrasts markedly with the natural lifespan of the species.

Lifespan of Guppies

In 1961, the British scientist Comfort [1] officially reported a potential lifespan of 5 years for the guppy *Poecilia reticulata.*

For his comprehensive longevity study [2], he used 4 domestically bred strains. Young guppies were sexed and placed in containers with gravel, snails, and floating plants until their death.

Apparently, he provided the most basic of care, "Aquaria looked most unsatisfactory, but the fish in them lived for 4-5 years, as against a normal aquarium life of 2 years or less." No filters or aerators. They were fed live Tubifex worms once a week and a cereal supplement. Water was changed only when the fish showed "discomfort."

Fig 3 shows results from his longevity study. Fish started out with 100% survival when they were 100 days old. At 2 years, survival of both males and females had decreased to 55% - 60% (*See* graph's vertical bar). Males began

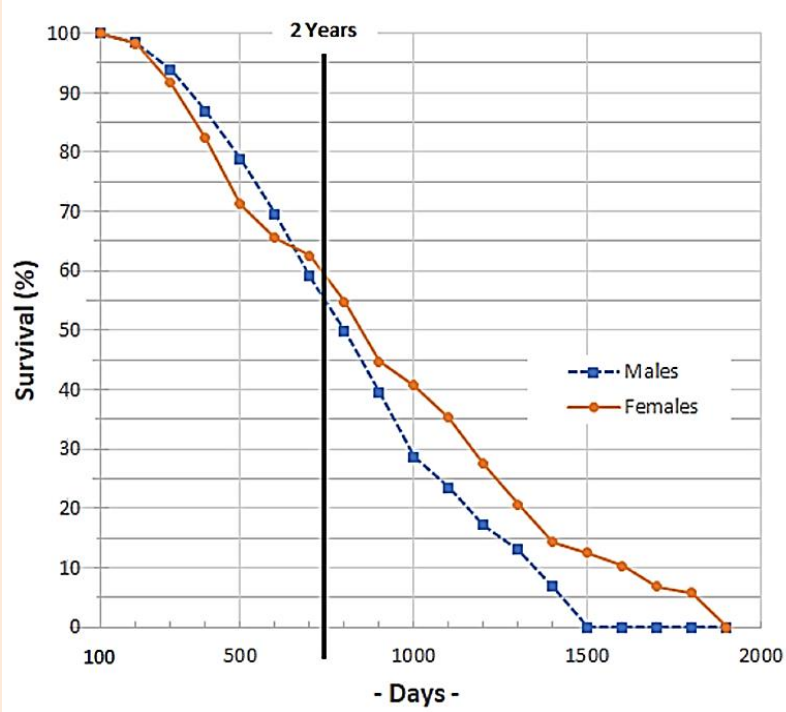

Fig 3. Survival of 1950s Guppies [2]

Results are for 312 males and 351 females kept in 50-liter (~13 gal) single-sex tanks until their death. Each tank held either 12-20 virgin females or 20-35 virgin males. Fish were counted for survival at 100-day intervals. I show here only his tank results, but survival was similar for guppies kept in jars.

{I drew graph from tabulated data in Comfort's paper.}

dying slightly sooner than females. At 1500 days (4.1 years), all males were dead, but 12% of females were still alive. The last females died at 1900 days (5.2 years) of age. The investigator noted that disease (e.g., 'Fish TB') and other pathologies increased with aging.

Comfort's survival data applies to virgin guppies, which have a longer lifespan than reproducing guppies [3]. Nevertheless, the 5-year lifespan assigned by Comfort to the species [1] is amazing compared to the brief life of today's fancy guppies.

Wild guppies also have a notably greater longevity than today's domestic guppies. In a comprehensive study, Reznick [4] documented the longevity of recent descendants of wild guppies. Average longevity for reproducing females was 2.3 years.[2]

Another investigator (Evans) [6] conducted an in-depth analysis of fecundity (or fertility) in female feral guppies. Evans' data also provided me with information on female longevity, for the fact is that only live females reproduce.

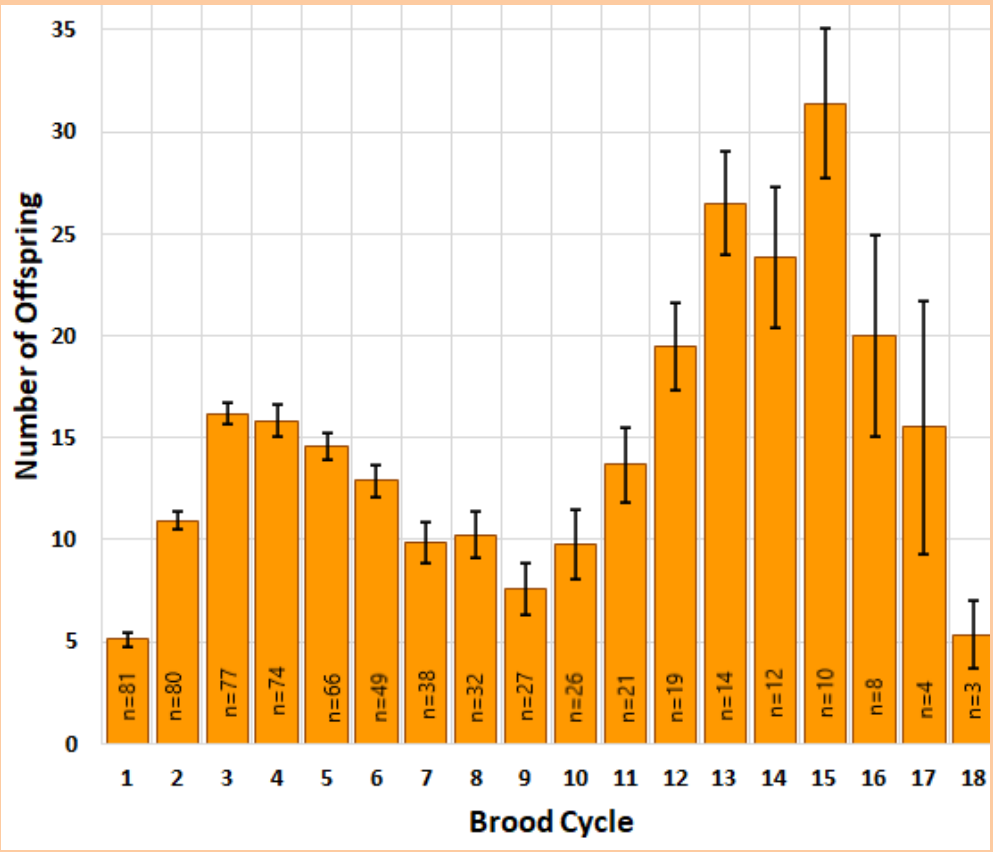

Fig 4. Longevity and Fecundity of Feral Guppies [6]

Columns shows the average brood size (± S.E.) for the study's 81 females over 18 sequential brood cycles. The number of females still producing for each cycle ('n') are shown in the columns.

{I drew graph from raw data provided by the investigator (Evans) in 2020.}

The study's 84 virgin females were mated (at age 3 months) to 1-2 males during each of their brood cycles. **Fig 4** shows the fecundity of the 81 reproducing females (3 of the 84 females produced no offspring.). First broods averaged only ~5 fry for 81 females. By the 3rd brood cycle, the average number of offspring had tripled to over 15 for 77 females. By the 15th cycle, the average reached a peak at ~31 fry for the 10 remaining females. At the final 18th cycle,

[2]Wild guppies were captured from two collection sites differing in predation level within two different river systems. F2 females produced from each of the 4 populations were maintained on either a high or a low feeding regimen to produce 8 groups (n = ~28 fish/group). The 226 females were isolated at 25 days in 7.8 liter containers. They were mated throughout their lives, first as virgins and then after each parturition [4, 5]. The average lifespan for all 8 groups (a *sampling distribution*) was 846 days (± 42 S.E.) or 2.3 years. The range for *individual* lifespan was 151 - 1,464 days.

the 3 still-reproducing females produced an average of only 5 offspring; their reduced fecundity was probably due to aging ovaries.

Interestingly, a huge surge in fecundity followed the 9th brood cycle. I think that the weaker females had died off and the remaining, more robust females had come into their own. They were older, and thus, had larger broods.

Statistical summations can be misleading. The 84 females produced an average of 7.6 broods per female, yet many individuals produced far more. For example, 21 females (or 25% of the starting population) produced at least 11 broods. The graph (Fig 4) presents a far more realistic picture of female longevity and reproductive fitness than population averages.

Predicting Longevity

Evans' study [6] also provided me with data on *individual* females so that I could answer the following question, "Could I distinguish superior females from weak females based on their reproductive performance while young?

To answer this question, I picked 8 females on each end of the longevity/reproductive fitness spectrum shown in Fig 4. My 8 "weakest" females produced only 4 broods (probably due to death) during their short reproductive lifespan. In contrast, my 8 "fittest" females produced ≥ 16 broods. Assuming a typical one-month interval between mating and broods, the 8 fittest females would have lived at least 20 months (3 + 1 + 16 = 20).

Number of Offspring	Weakest Females	Fittest Females
First Brood	**6.6** (±3.9)	**5.1** (±3.6)
Second Brood	**13** (±3.6)	**12** (±5.2)
Third Brood	**17** (±3.2)	**18** (±5.1)
Fourth Brood	**18** (±5.6)	**13** (±10)
Lifetime Production	**55** (±10)	**267** (±40)

Table 1. Fitness Extremes in a Population [6]

Numbers are the average (± S.D.) of offspring per brood. The 'Weakest Females are the 8 females that produced only 4 broods during their lifespan. The 8 'Fittest' females produced ≥ 16 broods.

{I constructed table from raw data provided by Evans in 2020.}

Did the 8 weak females signal their poor future early in life? The results in **Table 1** say, "No." Average size of the first 4 broods of the two female groups ("weakest" and 'fittest") was very similar. Indeed, the weakest females actually produced more offspring than the fittest females (18 v. 13) for their fourth and last brood. Because the fittest females continued reproducing long after their first 4 broods, their life-time output was over 4 times greater than that of the weakest females (267 v. 55 offspring). The fittest females not only lived longer but were more productive.

Results from Table 1 support my own observation that future longevity and reproductive success in young fish is difficult or well-nigh impossible to predict. Indeed, when I examine my own young guppies of 4 months age, I have no idea which ones will outlive their siblings. Only by waiting does the inherent weakness of some individuals—and the superiority of others—become apparent.

Breeding Practices that Shorten Longevity

Domestication inevitably leads to some loss of genes for longevity. Domesticated guppies are fully fed, never preyed upon, and kept in pristine water. Sometimes, the water contains prophylactics (e.g.,

salt) to prevent disease outbreaks. Should an outbreak occur, they may be treated for the disease. Over multiple generations, domestication inevitably results in lowered immunity.[3]

Many guppy breeders select primarily for color, fin shape, and strain uniformity. Longevity is rarely considered. Indeed, when my male BG guppies died at ~5 months, I simply replaced them with younger males. Only later, did I begin to contemplate the negative consequences of this practice.

For guppies, tail or caudal size seems to be another factor affecting longevity, with swordtail (short-tail) strains living longer than delta tail strains. The consensus among most guppy breeders is that delta strains have a lifespan of 1-1.5 years; swordtail strains, 1.5-2 years [8]. Because of their large heavy tails, older delta males are purportedly less able to inseminate females. In 1961, a master guppy breeder Paul Hahnel [9] recommended using younger males as breeders. No doubt, many breeders maintaining delta strains have followed his advice.

Guppy breeders and scientists [10] often cite inbreeding as a cause of reduced longevity. Perhaps, but I believe there are two other causes that get much less attention.

Short Generation Intervals

Generation interval (G) affects genetic health just as much as the size of the breeding population [11].[4] As population longevity and G (the time between each generation) increases, the rate loss of genetic variation and the accumulation of deleterious mutations automatically slow down.

When only young fish are used for breeding, longevity and G gradually erode. Ever wonder why show strains lack the longevity of wild populations? Most show breeders use only the first few batches from their females. Once the females have produced about 3-4 batches, the females are discarded or no longer used for breeding [12].

When G is shortened artificially in this manner, it leads to all kinds of genetic troubles including reduced longevity.[5] Weak females get the same chance to pass on their genes as superior females. Ditto for the males. There is no selection for longevity, reproductive fitness, disease resistance, etc.

In nature, a fish's life may also be cut short abruptly, but weaker fish—whether old or young—generally succumb first allowing fitter fish to continue reproducing. Older fish still in their prime are not arbitrarily removed. Moreover, older females produce more offspring than younger females [16]. Thus, a wild population will contain a greater proportion of progeny from fitter females.

Norwegian investigators [17] documented a gradual shortening of wild guppy lifespan over the course of 10 generations of lab breeding. Each generation was started with progeny from only the female's first 1-3 broods. (Females were given three chances to produce a brood of at least 5 fry.) Thus, there was no selection for females that could produce more than 3 broods. At the start, a full 97% of the guppies survived to 12 months. After 10 generations, however, survival declined to 87%. Apparently, a decrease like this in scientific labs is not uncommon.

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[3] One investigator [7] showed that wild guppies became much more susceptible to gyrodactylid parasites (i.e., skin flukes) following just 4 generations of lab maintenance. The survival rate declined from 96% to 58% due to domestication.

[4] The rate for loss of genetic variation is $1/(2N_E)$ per generation interval (G) [11]. (N_E is the 'Effective Population Size' or the number of breeding individuals.)

[5] Similarly in Drosophila lab strains, the use of only younger flies for breeding reduces fly longevity [13]. Most Drosophila research labs maintain their strains with a strict 14-day generation interval, despite the fact that wild flies can live ~80 days [14]. One study [13] found that male life expectancy was only 60 days for lab flies compared to 83 days for wild flies. Other investigators [15] reported that the average lifespan for reproducing females from a wild population decreased from 44 to 31 days after two years of lab maintenance.

One German investigator [18] estimated that his 50-year-old strains had undergone 200 generations in captivity. That translates into an average generation interval of only 4 months (200 ÷ 50 = 4). He also reported that many of his females died before they produced their third brood.

Many scientists have observed a trade-off between early reproduction and longevity [14]. It supports a widely accepted theory for the evolution of aging.[6] Individuals that invest more in early reproduction do so at the expense of their body maintenance, resulting in a shorter lifespan. So, if you use only young guppies for breeding, you are in essence selecting for early maturity at the expense of longevity.

Virgin Guppies

Almost all serious guppy breeders and scientists work with virgin females. That way, they know exactly which male is the sire of a particular female's offspring. (While the most recent mating *generally* gets paternity precedence, one is never quite sure who is the sire when dealing with non-virgin females. Also, you may get mixed batches sired by multiple males.)

Working exclusively with virgins, though, can decrease female longevity. Virgins get little exposure to the stresses of mating and reproduction. In many show breeding setups, a female may only produce 3 litters during her entire life, whereas females that have grown up with their male siblings will reproduce continuously throughout their lives. For example, wild guppies average 22 litters per female.[7]

Thus, there is almost no selection for genes that would provide females with resistance to mating injuries and the normal stress of giving birth month after month. It is not surprising that hobbyist report a litany of problems in their female guppies.

Effect of Reproduction on Longevity

Mating and reproduction decrease longevity. Reznick [3] estimated that the "half-life" of Comfort's virgin females was ~40 months compared to only ~14 months for his (i.e., Reznick's) reproducing females.[8]

For females, the costs of mating and reproduction are particularly severe.[9] For example, the male gonopodium has a "claw" that grips inside the female's reproductive tract during copulation. This claw prolongs copulation, allowing the male to transfer more sperm during non-consensual sex [19], but it can tear female tissue [21]. This tearing allows the entry of foreign bacteria. If the female has inherited good immunity, she may be okay, if not, she could develop a widespread and deadly internal infection.

In Drosophila and many other taxa, the male ejaculate contains various seminal fluid proteins designed to increase a male's mating success. Some proteins may decrease a female's receptivity for remating. Others may disable competing sperm and increase egg production. Inadvertently, some

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[6] The association of early reproduction with a short lifespan is a classic example of antagonistic pleiotropy (AP). Some genes exert benefits to a species in early development (increased fecundity) but bad effects later in life (early senescence). The AP theory of aging explains why senescence, a deleterious condition, is not selected out during evolution.

[7] The 22 (± 1.7 S.E.) litters/female represents a sampling distribution for 8 diverse groups of wild guppies. The range for *individuals* across the groups was 2-43 litters/female [4]. (See Footnote #2 for a more complete description of the groups studied.)

[8] Drosophila studies have consistently shown that mating reduces the fruit fly's lifespan, particularly in females [14]. Zwaan [19] reported 28% and 44% mating-related decreases for males and females, respectively.

[9] Males pay less of a price for reproduction. Continuous courting and competition between males exert a toll, but the cost (in terms of lifespan) is much less than for females.

proteins have side effects that are known to decrease female longevity [22]. If a female in a given population has resistance to these proteins, she may be okay; if not, her life may be cut short.

No doubt there are many other reproductive factors that can shorten a female's lifespan. In 2017 after I restarted with guppies, I witnessed the distress and death of several females shortly after they gave birth [**Fig 5**].

Females have developed a range of protective mechanisms that counter male strategies to increase paternity [22]. Those mechanisms inevitably involve inheritance, evolution, and selection for genes that enhance a female's reproductive fitness. But when there is little selection for females that can handle the natural stresses of reproduction, those genes can be lost.

Fig 5 Reproduction is Stressful

Female #3 (*See* Fig 2) had out-lived all her siblings. But she became morbid at 9 months, a few days after parturition. Note swelling at vent area, possibly due to a prolapsed uterus. I blame this on a weak uterus.

Longevity v. Reproduction

In breeding guppies for increased longevity, reproductive lifespan may be just as important as longevity. In breeding my own guppies for longevity, I came across males and females that lived longer but had stopped reproducing months earlier. **Fig 6** shows a 15-month-old male that I was unable to get any progeny from. When he was a year old, I put him with females for 3 months. The females produced progeny, but the batches were all sired by earlier males.

Guppy breeders should be aware that there is a known trade-off between reproduction and longevity. If one focuses solely on longevity, the result may be long-living guppies that cannot reproduce.

Wild female guppies were found [4] to have an average lifespan of 2.3 years and a reproductive lifespan of 2.0 years representing 87% of their total lifespan. However, these population averages encompass enormous individual differences.[10]

Indeed, Reznick [5] reported that reproduction was highly variable in his females. Some females produced a new litter every month for years and then died promptly after their last litter; others skipped litters for months before getting back on track; some lived many months after their last litter.

There are no similar comprehensive guppy studies on males. Based on work with Drosophila, however, I suspect that male guppies have a longer reproductive lifespan than females. Male fruit flies are fertile throughout their lives, while female flies may live long after they have stopped reproducing [14].

Fig 6 Long-living but Infertile

Unfortunately, I was unable to get any progeny from this beautiful male as an older adult (~12 months). Photo shows him at 15 months.

[10] The average reproductive lifespan (i.e., 'age of last reproduction') for the 8 groups (*See* Footnote #2) was 727 days (± 43 S.E.) or 2.0 years. The range for *individuals* across the groups was 109 - 1,294 days [4].

Breeding Older Fish

Older guppies are valuable as breeders simply because they have proven their ability to survive. Moreover, older females produce much larger broods. A female's first brood might number less than 10 fry, but a large older female (7-12 months) can produce more than 60. That gives the guppy breeder more progeny to choose from, increasing the odds of finding individuals that are both attractive, sturdy, reproduce normally, and that have longevity.

Fig 7 The "Fin Rot" shown in this otherwise healthy male only became apparent at an older age (7 months).

I select ~4-month-old individuals that I find personally pleasing and put them in a separate tank. I want females with good size, nice shape, and big dorsals. For males, I want big spotted dorsals, short backs, energy, lots of color, etc.

After this initial selection, I may do some miscellaneous culling. As the guppies approach 8 months age, markers for longevity and fitness become increasingly apparent. By then some individuals have died out; some have gained size on the others. Some males have lost their energy and enthusiasm for courting females; not a good sign.

Increasing the generation interval allows for the removal of genetically inferior individuals. For example, one male, which I had planned to use for breeding, looked normal at 6 months. At 7 months, however, he developed "fin rot" (**Fig 7**). The slow tail erosion suggested early senescence, poor circulation, and diminished immunity to bacteria—all genetic weaknesses. I no longer considered him for breeding. Instead, I used his equally attractive brother who kept his tail intact throughout his life. By simply waiting a couple months before using the males for breeding, I could select out a tendency towards "fin rot" in my male guppies.

Fig 8 One Year Plus Survival
This big beauty was my first female that survived past one year. She grew to an impressive 4.5 cm body length. Big females like this can easily produce 60 or more fry.

In early 2020, I had narrowed a batch down to one single female who even when young was noticeably bigger and more vigorous than her sisters. When she was 7 months, I started saving her progeny hoping that she would make the 8-month cut-off. She did and then some (**Fig 8**). Fortunately, I managed to get three big litters from her, all sired by different males. She represents the 3rd generation of females that I have selected for longevity. This female was a major improvement on the fish that I started out with in 2017.

As to the males, they are currently a "work in progress." Their longevity has increased from the 4-5 months that I started out with in 2017 with my BG strain, but monitoring their reproductive success is more difficult than with the females. It requires mating them to virgins and seeing whether the females actually reproduce.

Setting a minimum threshold for the generation interval is critical. Currently, mine is 8 months. Breeders must live at least 8 months before I will keep their progeny. If they die beforehand, I discard their progeny. This threshold is based on the current situation in my guppies. In the future, I may be able to increase it.

In keeping older guppies until they run out their internal clocks, two cautions:

First, as a fish ages, it becomes increasingly vulnerable to endemic, potential pathogens and disease. If an older fish—or any fish for that matter—becomes a disease reservoir, it can endanger tankmates. Thus, I monitor the health of older fish a little more closely than younger ones. Should one develop disease symptoms or become incapacitated, I euthanize it in a timely manner.

Q. If I use older females for breeders (select for greater female longevity), will that also increase male longevity?

A. It could, especially if your guppies are dying at a very young age (5-6 months). Some strains of fancy guppies are so genetically weak that almost any counter-measure would probably help. Increasing immunity to bacterial infections certainly would benefit both sexes.

Beyond a certain point, though, achieving greater longevity in one sex does not guarantee longevity in the opposite sex.

Second, animals are known to acquire deleterious mutations in the germline as they age.[11] (They become increasingly less able to repair the precious DNA within their reproductive organs.) Thus, when a very old female guppy is no longer reproducing normally with her usual large batches, I would not save progeny from her last small batches. Reduced fecundity due to ageing correlates with deleterious mutations in the fry's own germline DNA. Those mutations will be inherited by the next generation.

Readers should understand that my experience with guppy longevity to date (2022) is limited. Breeding guppies for longevity is a step-wise process that takes time. However, I enjoy having beautiful guppies that stick around a little longer than a few months.

Recommendations for Increasing Longevity

- Save progeny from older—but not too old! —guppies. (Older individuals have proved their superiority by outliving their siblings.)
- Recognize that increasing longevity may require selection over multiple generations.
- Keep in mind that older reproducing females have much larger litters than young females. This increases your opportunities for finding superior individuals.
- Consider outcrossing to strains that are recognized for greater longevity.
- Avoid severe inbreeding (e.g., mating full-siblings) over multiple generations. Instead, plan matings between less related guppies (e.g., cousins and half-siblings).
- Be judicious in treating guppies for disease. Concentrate more on breeding disease-resistant fish. Use disease outbreaks (e.g., flukes and Costia) to cull susceptible individuals lacking genes for normal immunity and select out more resistant individuals.

[11] The 'Lansing Effect' is a well-known problem in human fertility clinics. For example, children born to aged parents have an increased risk for inheriting genetic disorders (e.g., autism and schizophrenia).

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