# New Age Mutant

"Picasso Perculas will be the death of the three-stripe clownfish in the aquarium hobby!"

I'm sure I said that, or something very similar to it, around 2006. I certainly believed it at the time.

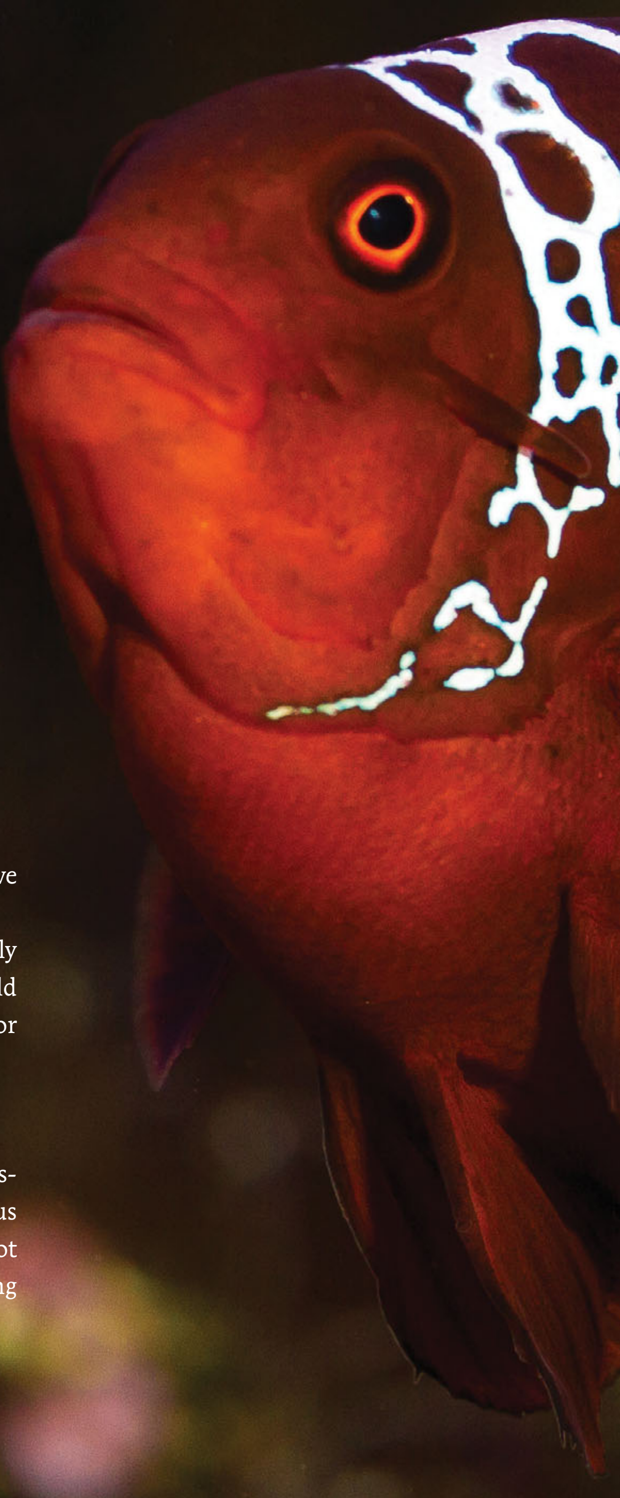
Designer clownfishes, both genetic mutations and hybrids (which we'll discuss in the next article), draw a lot of critical attention. Aquarists tend to have a love/hate relationship with these fishes.

As a marine-fish breeder, I admit to coining and branding the phrase "lazy innovation" to describe the pursuit of new and different "designer" clownfishes. My younger self was quoted as saying, "I am anti-hybrid, anti-manmade variant. Preserving natural biodiversity—rather than creating our own—should be our main focus. Ornamentalism is a shortcut—it's the lazy way to innovate and profit."

Yet in 2010, I took ownership of what is arguably one of the world's most recognized "mutant" anemonefishes—the wild-collected Lightning Maroon Clownfish from Papua New Guinea, which is pictured here and on the cover of this issue. Even so, I continued to toe a self-imposed ethical line: if the fish had been discovered in someone's aquarium and not in the wild, I would never have touched it.

I rationalized owning the Lightning Maroon because it was an example of "natural biodiversity." To me, it was akin to the naturally occurring polymorphism we see and accept in some African cichlid species I have bred; it's from the wild, so it's worth preserving.

Some might say my moral resolve was slipping, but in truth I was simply learning, and I hope I've continued to do so. With my new knowledge, I could only go one of two ways: put on the blinders and preach a stubborn mantra, or reevaluate my beliefs and bring my new understanding to the table.



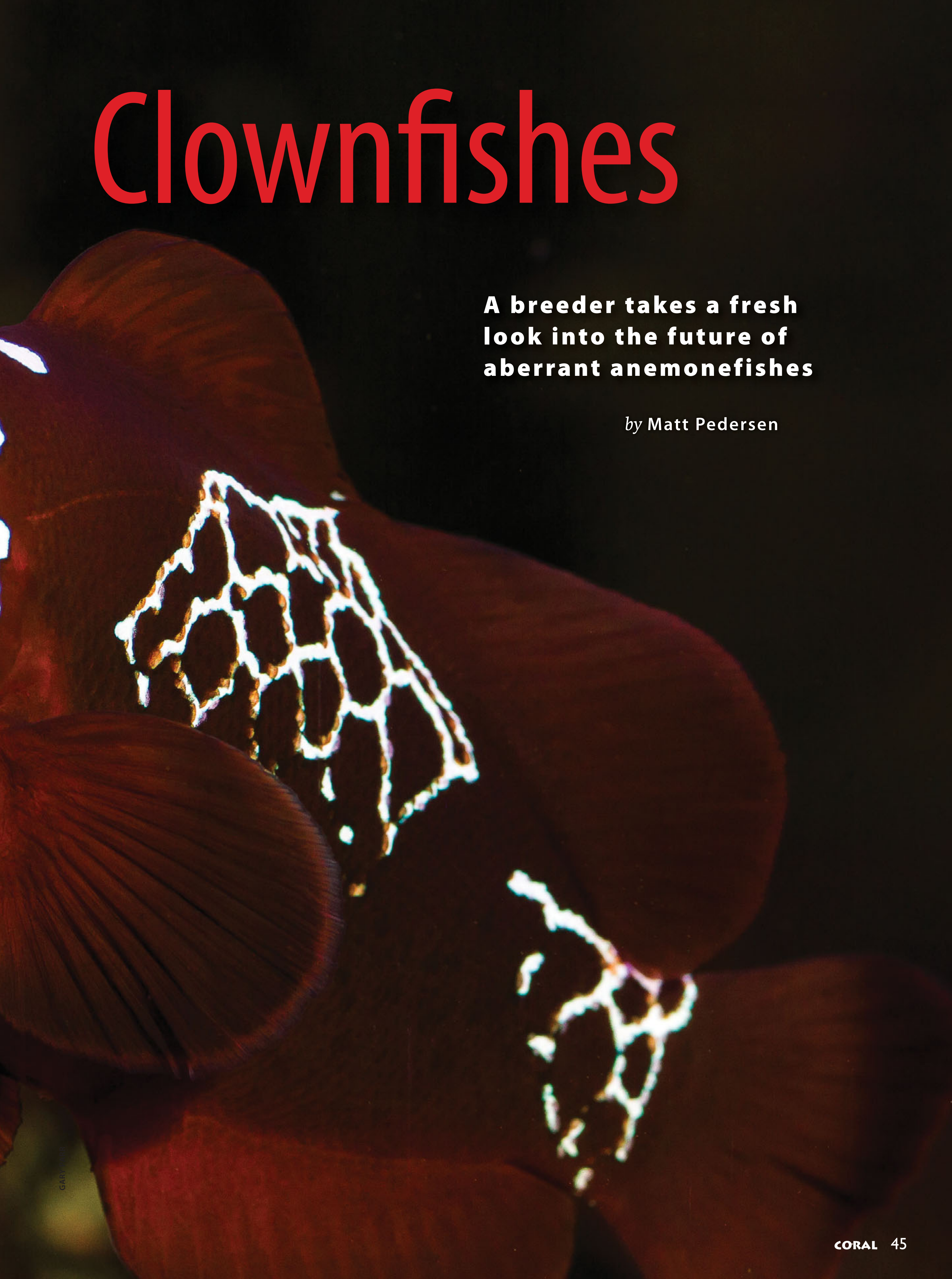
## EMBRACE THE MUTANTS!

I never thought I'd say it, but my views have fundamentally changed. In essence, I now know that "designer" genetics are natural. One of my previous objections to the new forms of captive-bred clownfishes was that they were not part of natural biodiversity and were therefore unnatural. I was flat-out wrong in this respect.

# Clownfishes

**A breeder takes a fresh look into the future of aberrant anemonefishes**

*by* Matt Pedersen



High-grade *Amphiprion percula* "Picassos" and a single "Nebula" (roughly upper center) at Bali Aquarich.

Multiple designer genes are found in wild clownfishes, most notably the Picasso Percula gene, the Lightning Maroon gene, and quite possibly the new Nebula Percula gene. (Whether one gene controls these traits or if more are involved is still unknown.) And a few known genes found in captive fishes may have since been seen in the wild as well.

Of course, a large part of the argument against designer clownfishes (or any designer aquarium fishes) is the concern that they might interfere with species preservation breeding or actually push the wild forms out of our aquariums altogether. These fears may be justified when we look at designer clownfishes as a whole, but genetics can be controlled in a conservation-minded breeding program. Once an aberration is proven to be genetic and its expression is understood, it can be controlled or even bred out of a population of captive fishes through proper mate choices.

In fact, from a breeder's perspective, wild-type fishes, which generally lack "designer genes," are a critical resource that allows us to select out designer genes if need be while also serving as an additional outcross source that can stabilize inbred lines. Even if the classic three-barred, wild-type Ocellaris Clownfish falls completely out of favor, savvy breeders will understand its importance and keep it around for their own uses.

In addition, a genetic mutation discovered in the wild whose provenance is known, or one found within a captive population with purely geographic provenance, can be allowed to persist alongside an overall species/geographically pure line because, with proper management of the overall population, that gene can be readily eliminated at any time. For example, as long as the Lightning gene is retained within PNG White Stripe Maroon Clownfish specimens and breeding groups, we will have pure PNG White Stripe Maroons, with or without that Lightning gene. In this scenario, designer goals and conservation goals both win.

I argued for years with folks like Dustin Dorton of Oceans, Reefs and Aquariums that designers were pushing out wild-type fishes. He countered that, without designers, there might be no breeding at all. But then I spent a couple of years following the money in my own fishroom, and realized that Dorton was right. Wild-type clownfishes didn't sell as well as designers do. A single Lightning Maroon probably generated more income for me than an entire year's production of wild-type clownfishes. What do I do with that designer-sourced income? Well, I still tinker like crazy with fishes that have no obvious commercial value. So when I find myself doing exactly what Dustin Dorton says a company like ORA has to do, I can only offer an apology in print: "Wow, Dustin, you were totally right."

Designer genetics do more than just generate revenue—they keep species in cultivation that otherwise might be lost. It's only a hunch, but I don't think we would have any captive-bred Bicinctus Clownfish if it weren't for the stunning Spotcinctus variety. Meanwhile, Gold Stripe Maroon Clownfish had long since displaced White Stripe Maroons in cultivation; Gold Stripes are

BALI AQUARICH

more valuable, they're less aggressive as adults and easier to pair, and the juveniles don't annihilate each other in growout; they are preferential in every way. You would've been hard pressed to find a captive-bred White Stripe Maroon a few years ago, but with the release of the first Lightning Maroon Clownfish, scores of breeders started bringing back the White Stripes. Dare I say designer genes saved these species in cultivation?

## INSIGHTS FROM ANGELS

A couple of years ago, while pursuing the propagation of the Lightning Maroon Clownfish, I also started breeding freshwater angelfishes. I took on the project to generate some extra income—as much as we love marine fishes, there is a much larger market for freshwater fishes of good quality—but also to learn how to breed and rear the domestic angelfish *Pterophyllum scalare* before moving on to the much more challenging *P. altum*. Quite surprisingly, my experiences with angelfishes illuminated the true power of genetics and gave me a deeper understanding of what might be happening with designer clownfishes in captive propagation.

What I find most compelling in the angelfish world is that through the formation of The Angelfish Society, fundamental science-based methodologies are being shared, resulting in a basic mastery of the angelfish genome. The public researches new genetic mutations, and when sufficient data has been presented a mutation is formally recognized by the society. This process results in 100 percent transparency: the genetic "formula" to make a "Platinum Angelfish" is public knowledge, and anyone can produce them with the right combination of mates. This shifts the emphasis away from using creative yet meaningless names to create the illusion of rarity and puts the focus on quality, where I believe it belongs. Breeders must compete on the basis of good health, good conformation, and good deportment; these are the things that separate poor or average commercial breeders from the truly great ones. Ultimately, this is better for the consumer, but it's also better for producers, because better fishes fetch higher prices in the marketplace.

## ESSENTIAL MUTANTS AND ABERRATIONS

In his July/August 2010 *CORAL* article *Designer Clownfish: Triumph or Travesty*, Matthew L. Wittenrich, Ph.D., stated, "The word mutation...often evokes strong negative feelings. I imagine this is simply a case of misunderstanding. Mutations are naturally occurring alterations to the genetic code and are crucial to life as we know it."

In day-to-day society, the word "mutant" carries very negative connotations, so it's perfectly understandable when that carries over into the breeding of fishes. Certainly, some genetic mutations are detrimental or even fatal to the organisms unlucky enough to suffer from them, but on the flip side, other mutations are inconsequential and some have real benefits. Most of the genetic mutations that aquarists come to understand and appreciate are those that affect the external appearance of a fish, what biologists call the phenotype. Every such variation or deviation from the normal, typical form for the species, generally called "wild-type," represents the potential for a genetic mutation that can be pursued. These unusual forms are labeled "aberrant."

Aberrations from the norm are found more often in captive-bred fishes than in the wild because captive breeders have vastly higher larval and juvenile survival rates than fishes spawning in often treacherous natural conditions. Out of a spawn of, say, 300 Tomato Clowns, the breeder may observe all 300 offspring. On the reef, it is unlikely that even one or two will survive long enough for a diver to happen upon them.

Another reason we are apt to find aberrant forms in captivity is inbreeding. This is another term with negative connotations in our society, but from a breeding perspective, inbreeding is simply descriptive of some of the pair selections a breeder of plants or animals—from

**The genetic shorthand for the Platinum Angelfish is (g/g - pb/pb); two alleles of the recessive Gold gene and two alleles of the recessive Philippine Blue gene are required to create this all-white angelfish with black eyes.**

MATT PEDERSEN

Two wild-caught aberrant Ocellaris from the Philippines, collected and exported by RVS Fishworld. The top fish shows evidence of smudgy patterning. The bottom fish is a dead ringer for the Gladiator/Da Vinci genetic; while the gene was discovered by C-Quest in captivity, could this be a random occurence of the same genetic mutation in the wild?

RVS FISHWORLD INC.

hot peppers to Pomeranians—routinely makes. While human siblings generally cannot mate and produce healthy offspring, fishes have no problem breeding with their siblings, their parents, their cousins, and their own offspring. While endless inbreeding of a small fish population will eventually cause things to go bad, the initial effects of inbreeding aren't nearly as sinister. In the first few generations of inbreeding, what generally occurs is a genetic distillation: genes are discarded and the overall genetic code, the genotype, of each subsequent generation becomes more homogeneous, or alike. This increases the odds of revealing a hidden recessive gene (one that can only be expressed when it is inherited from both the father and the mother). Again, this process cannot be sustained indefinitely; at some point a breeder must outcross to another group or line to restore the genetic diversity that has been lost through inbreeding.

## ABERRATIONS IN THE WILD

It is a fact: Mother Nature likes to tinker. Every so often, a wild fish with an unusual coloration or pattern is caught by collectors. And once in a great while, someone discovers a wild fish that rocks the aquarium world to its core.

In fact, unusual or even unique wild fishes are probably more common than most of us believe. Many in the industry have casually told me that "back in the day, no one wanted the abnormal fishes, so we threw those back and only collected the perfectly barred clownfishes." There is some data on just how common they can be. EcoAquariums PNG, the short-lived collection operation that started in Papua New Guinea when the ill-fated SEASMART program ended, truly broke the transparency barrier by publicly releasing the records for all their uniquely tagged fishes online. In 2012, I assessed the data from the first 9,723 fishes they recorded, looking specifically at Maroon Clownfish (*Premnas biaculeatus*). Within that dataset 165 Maroons had been recorded, and of those 22 were noted to be atypical or unique in some way; this is slightly over 14 percent of the total catch of Maroons. Of course, the collectors may have targeted unusual fishes more specifically than the wild-type three-striped fishes, but even so, in the time period during which they were tagging fishes, EcoAquariums' small collection crew spotted and collected an aberrant Maroon Clownfish *every 11 days*!

## GENES VS. ENVIRONMENT

Just because a fish looks outwardly different, that doesn't mean it's a new variety or has a mutant gene. There can be many other causes for unique coloration or patterning in anemonefishes. The best known example is the curious case of misbarring, the incomplete or odd formation of stripes in a clownfish. There is an overwhelming understanding among breeders that external factors are largely responsible for the incomplete formation of stripes in captive-bred clownfishes.

Physical deformities in captive-bred fishes are often treated as if they are genetic, but many common deformities are known to be environmentally induced. That isn't to say that breeders who routinely produce fishes with flared gills, bulging eyes, or twisted faces should get a pass; smart breeders don't use these fishes as broodstock, thinking, "What if this trait is genetic? Why risk it?" Of course, some of the most well-known lines of captive-bred fishes have descended from truly rough-looking fishes, and that's the point I'm making—you can't automatically call something a mutant just because it looks different.

Sometimes, a well-known genetic mutation simply shows up. The best example is albinism. Albinos, with their pink eyes and lack of melanin, appear in all forms of animal life—birds, mammals, reptiles, amphibians, humans, and fishes. I've never read about an albino gene that wasn't recessive in expression, so when a breeder discovers an albino in the aquarium, that breeder can say with a degree of certainty that the gene can be controlled and manipulated because its inheritance and expression are well understood.

More commonly, new aberrations require a fair amount of breeding effort to determine what exactly is genetically at play (if anything). I won't get into the entire step-by-step process of genetic detective work here, but I will point out that breeders don't always get lucky on the first try. It can take multiple pairings and generations to determine whether an aberration represents a heritable trait, and once that is confirmed the data collected may or may not fully explain whether there is a single mutant gene involved or not.

Finally, we do not think of geographic color variants as genetic aberrations within a species. It is probably better to think of the various geographic populations as the natural equivalent of selectively-bred captive strains. Some may, in fact, turn out to be distinctive species, but proof will have to await DNA testing..

However, a prime example of a likely genetic mutation within an established geographic variation can be seen in the Coral Sea "Stripeless Cinnamon," *Amphiprion melanopus*. This very distinct polymorphic population, which includes individuals with and without headbands, is noteworthy. Matthew Carberry of Sustainable Aquatics reports that breeding with the "stripeless" fishes can produce both stripeless and striped offspring. I suspect the chances are high that there is a gene within this population that controls whether a head stripe is present or not; further investigation with offspring counts and various test matings could reveal the presence of such a single mutation gene and probably even tell us the pattern of expression and inheritance.

## COMMON TYPES OF GENETIC MUTATIONS IN CLOWNFISHES

Several phenotypes recur in different species of anemonefishes, and some many be genetic.

**Pearl Eye** This phenotype consists of a white patch on the upper portion of the eye. It most commonly occurs in Clarkii-Complex species, having been documented in *A. clarkii*, *A. bicinctus*, and *A. chrysopterus*. It has also been documented in the Maroon Clown, *Premnas biaculeatus*. We must speculate whether this is also what creates the "Silver Eye" in certain *A. percula* specimens. Some believe this is a genetic trait, but it seems far too common and occurs far too frequently in captive-bred fishes from normally marked parents. I suspect this, like misbarring, may have an environmental cause.

**Reduced Stripes** This is different than environmentally caused misbarring. Several breeders have now documented that there is a genetic component to the Naked Ocellaris and Midnight Black Ocellaris variants. ("Naked" is shorthand for lacking bars or stripes.) Both forms produce offspring that range from heavily reduced

**Misbarring is common in clownfish larval rearing and growout and is presumed to be non-genetic. Shown are four examples of misbars from Sustainable Aquatics. Clockwise from top left; *Amphiprion ocellaris*, *A. ocellaris* "Darwin," *A. percula* "Onyx," *A. percula* "Extra Black."**

SUSTAINABLE AQUATICS

striping to none at all. Both *A. percula* and *P. biaculeatus* have been found in the wild with reduced or absent stripes, but it is not known whether these are caused by genetics, old age, or environment; the occurrence of a naked form in captivity suggests that it could also happen in the wild. It is noteworthy that the Gold Stripe Maroon Clownfish is known to lose its stripes as a function of age; this isn't a mutation.

**Over-Barring** There are many examples of fishes that have more white coloration in addition to the standard barring for the species, and this has been seen in both wild and captive-bred fishes. Examples are the Picasso Percula, Da Vinci Ocellaris, Snowflake Ocellaris, Galaxy Clarkii, Spotcinctus Bicinctus, Goldflake Maroon, and many others. I would even categorize the Lightning Maroon as a form with over-barring. In virtually all of those listed, there is documented proof that there is a heritable genetic component at play. The wild "Phantom" Tomato Clownfish and Northern Lights Chrysopterus are two more examples of over-barring seen in the wild.

**Spotting** This may be related to over-barring. Many species have shown examples of individual spots of "bar" coloration in addition to the typical stripes. It is seen in some Spotcinctus, the Meteor Chrysopterus, the Galaxy Sebae, the Morse Code Maroon, the Gold Spot Maroon, and even in wild-collected Spotted Ocellaris.

**Solid Barring** When you push the bars of a clownfish to the extreme, they will ultimately merge and cover the entire flank of the fish. We know for certain that Platinum Perculas are tied to Picasso Percula genetics, just as Wyoming White Ocellaris is part of Da Vinci genetics. We've also seen the development of the Gold Nugget Maroon, and there are a few images of the White Horse Saddleback; both are known to have a genetic basis, too. This phenotype has not been reported in the wild, and it is possible that too much white makes a clownfish a better target for predators.

**Black under White** This is a newly discussed phenotype, and the premise is simple: most clownfishes display black edging along their stripes, but sometimes black pigmentation of the skin winds up underneath white reflective scales. The net effect is that translucent scales let the skin pigmentation show through, creating various interesting effects like glowing blue edges, gray spots, mossy greenish margins, blue dots, and so forth. In some instances this appears to be a happy accident; for instance, if a Gold Stripe Maroon's bars are narrow enough, all you see is the very edges, which happen to be blue. In other fishes, particularly the Snowflake Ocellaris, this could have a genetic component. It is unclear whether a single genetic mutation or a combination of multiple genes creates these patterns; perhaps selective breeding could further push fishes to produce more black coloration that bleeds underneath the bars.

**Smudgy** This designation refers to the production of patterns outside of the stripes, with blurred edges and indistinct border coloration; picture light-colored markings that look like clouds. The Nebula Percula is a prime example of this pattern and, as stated earlier, it was found in the wild. Whether this is a new gene, another gene mixed in with over-barring genes, or some other type of interaction isn't known. What does seem to be apparent is that this trait is heritable.

**Albino** This is one of two "classic" genes seen in many fish families, not just Pomacentridae. We now have two, potentially three albinos running around: the Albino Ocellaris and Tangerine Albino Ocellaris appear to be two different forms of albino mutations in the same species, and an albino mutation that causes a melanin reduction, but not elimination, found in a pure line of Black Ocellaris, has been dubbed the Zombie Albino.

**Longfin** Think about freshwater fishes, and you'll quickly realize that the genetic mutation for extended fin length is commonplace. In recent times, we've seen this mutation arise independently in both Ocellaris and Black Ocellaris a few months apart at different hatcheries. What's even more interesting is how similar these two forms are. Without a doubt, longfin can, and probably will, arise in other species as well.

## EYE CANDY: ABERRANT CLOWNFISHES

This section is organized by morphological species-complexes/subgenera, followed by the species which have aberrations/genetic mutations. I will attempt to disambiguate between various names wherever possible. I will do a lot of speculation, and history will prove me right or wrong. We have to start somewhere.

### Skunk Complex

The Skunk complex is notable for its absence of any currently known aberrant forms or genetic mutations, captive or wild.

### Saddleback Complex

***Amphiprion polymnus* "White Horse"** The White Horse Saddleback was discovered by Ekkachai Hengarngla in Thailand among captive-bred offspring. Little is known about this solid white mutation; it's been suggested that only 2 percent of the offspring show the phenotype.

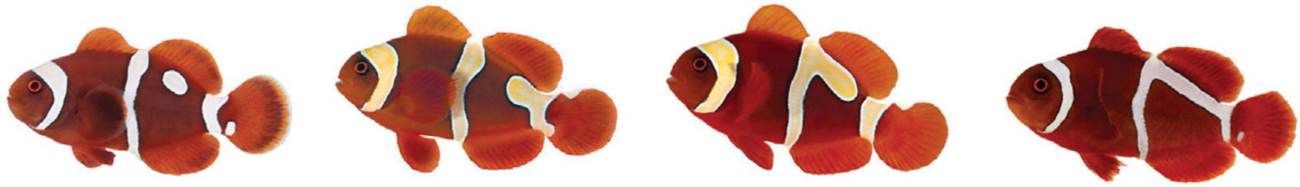
***Amphiprion sebae* "Galaxy"** The Galaxy Sebae was brought to the forefront by Bali Aquarich; we presume it is a replicable genetic trait, as it appears to mimic other spotting/over-barring mutations in other species.

### Tomato Complex

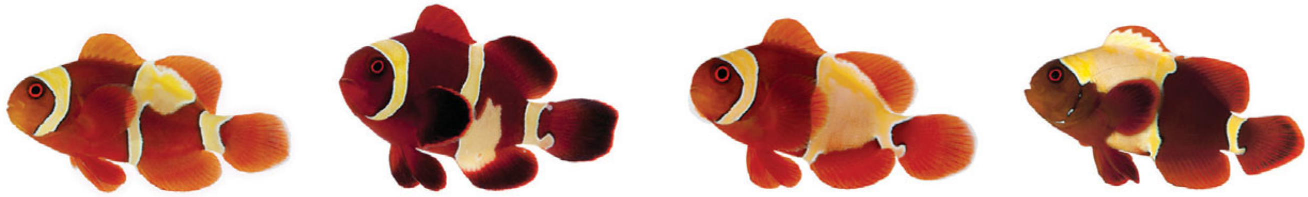
***Amphiprion frenatus*, Wild Aberrations** Multiple subtle wild aberrations of this species have been documented by RVS Fishworld, most all centering around the shape of the head stripe. Occasionally fishes are found with a head bar with a dark spot at the top; others simply have oddly shaped stripes. One example has bright blue lips.

***Amphiprion frenatus* "Phantom/Picasso/Galaxy"** There

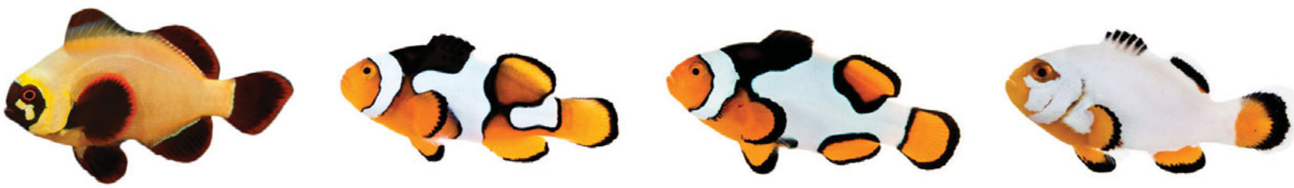
## A sampling of genetic mutations in clownfishes produced by ORA



Gold Dot Maroon | Gold Flake Maroon | Gold Flake Maroon | Gold Flake Maroon



Gold Flake Maroon | Gold Flake Maroon | Gold Flake Maroon | Gold Flake Maroon



Gold Nugget Maroon | Picasso Percula | Picasso Percula—"Premium" Grade | Platinum Percula

Caramel Black Ocellaris | Midnight Black Ocellaris—"Extreme Misbar" Grade | Midnight Black Ocellaris—"Domino" Grade | Midnight Black Ocellaris

Naked Ocellaris | Snowflake Ocellaris | Snowflake Ocellaris—"Premium" Grade | Pearl Eye Clarkii

Spotcinctus Bicinctus | Spotcinctus Bicinctus | Spotcinctus Bicinctus | Spotcinctus Bicinctus

CIURTESY OF ORA

have been multiple examples of Tomato Clownfish showing over-barring type patterns on the head stripe and body, often in conjunction with smudgy markings. This has occurred in both captive-bred and wild fishes. It is unknown whether there is a genetic basis for this or not.

***Amphiprion frenatus* "Rotten Tomato"** Discovered by Fisheye Aquaculture in captive-bred offspring, a single black and white offspring earned the name Rotten Tomato; all its siblings were a normal red. We might have assumed this fish was expressing an anerythristic (red-lacking) mutation, but Fisheye reports that after a growout phase, the black and white fish turned red. Interestingly, Brazilian anemonefish enthusiast Yuri Barros has documented wild adult fishes with strikingly similar coloration.

***Amphiprion ephippium*, melanistic** Along the exact lines of the "Rotten Tomato," Bali Aquarich at one time shared an image of a juvenile Fire Clown that seemed to be black, lacking any red pigmentation. Was this fish a melanistic form? An anerythristic form? Or did it ulti-

Brandon Mehlhoff's female Blue Dot Maroon failed to produce any blue-spotted offspring with her Blue Dot mate. Both fish were wild-collected.

mately turn red, just like Fisheye's "Rotten Tomato"?

### Maroon Complex

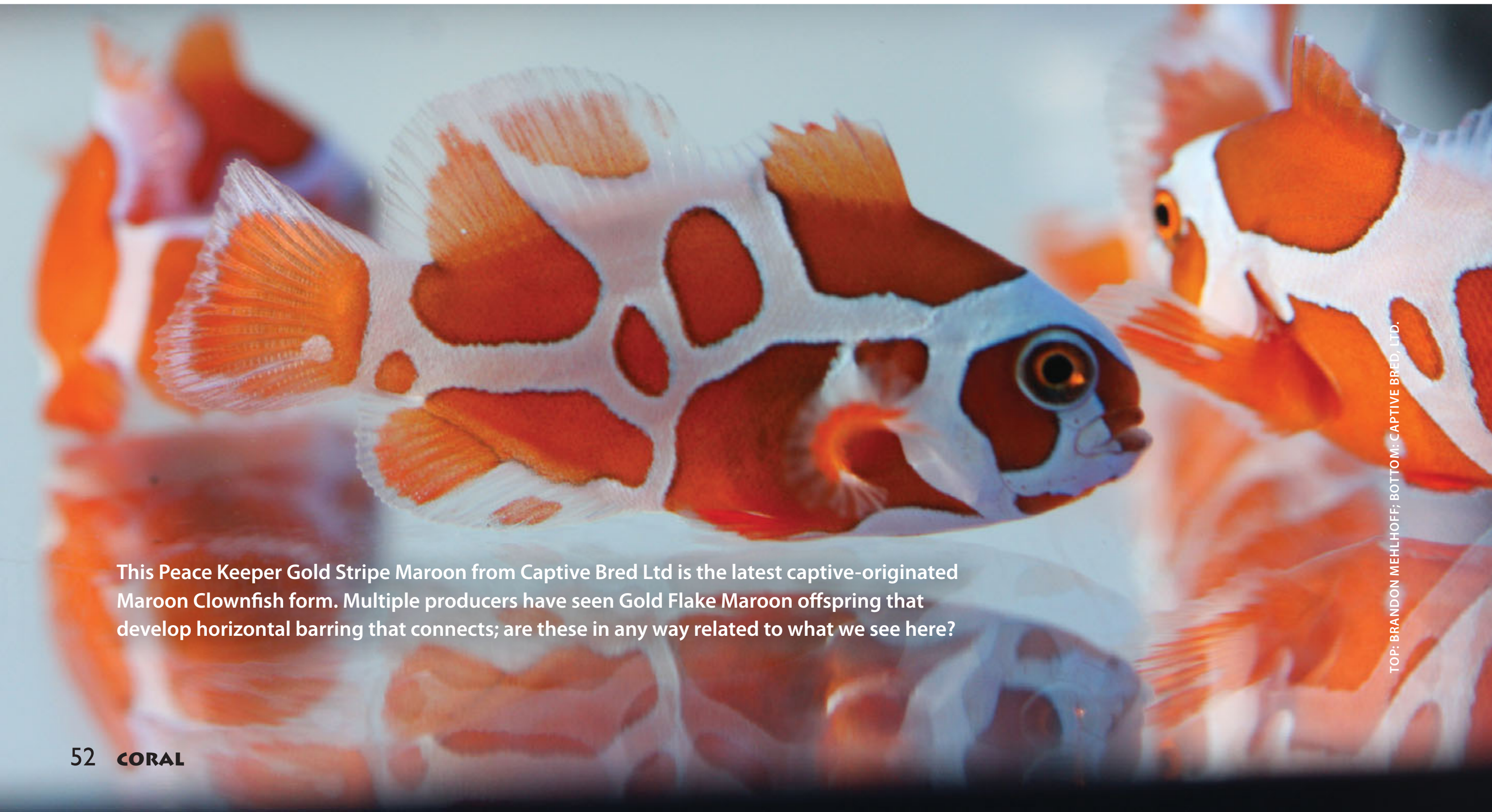
***Premnas* sp. *epigrammata* "Goldflake/Goldspot"** This seems to be a genetic variant in which the Goldstripe Maroon has extensions or spots outside the bounds of the normal bands. "Epigrammatica" is an unofficial species name used by some for the Goldstripe Maroon. Sustainable Aquatics first created this strain, but ORA was the breeder that really dug in, and they are now producing these fish on a commercial scale.

***Premnas* sp. *epigrammata* "Gold Nugget"** The Gold Nugget Maroon is a solid-barred form that likely derived from the Goldflake breeding program at ORA. This solid white fish with maroon fins and face turns a striking yellow color upon maturity. ORA's website states that this "is the result of a genetic mutation that manifests in a similar way to the mutation that produces the Platinum Percula."

***Premnas* sp. *epigrammata* "Blue Dot"** Several wild examples of "Blue Dot Maroons" were reportedly collected and imported by Internet retailer iBlueWater.com. Brandon Mehlhoff received and bred a pair of the wild Blue Dots and reports that every last offspring was a fully barred fish. This result leads us to speculate that the wild fishes may simply be very old Gold Stripe Maroons that have lost all their stripes, resulting in very tiny blue dots that may ultimately disappear completely.

***Premnas* sp. *epigrammata* "Peace Keeper"** This striking variety of Gold Stripe Maroon was introduced by the Israeli progagation company Captive Bred Ltd in 2014. The bizarre patterns suggest war paint to some, masks or "giraffe markings" to others. Currently only one pair produces these fish, and the number of individual offspring that show this phenotype is very low. It is presumed genetic, but a lot more breeding must be done to be sure.

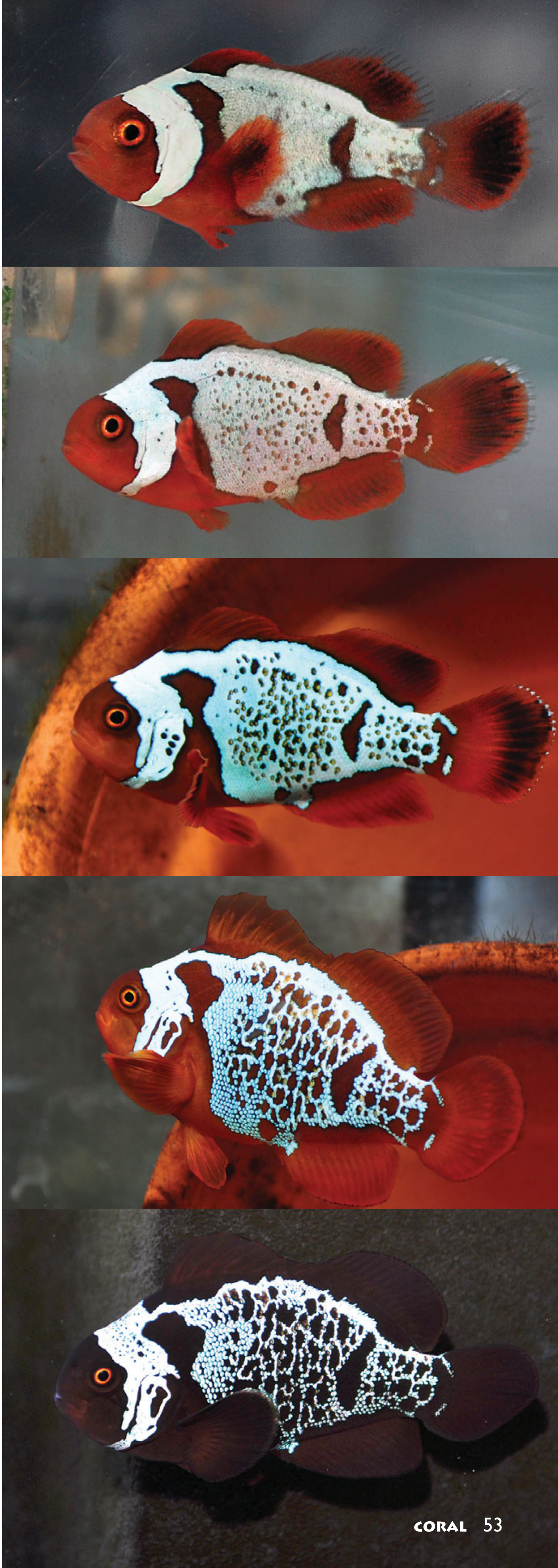
***Premnas biaculeatus*, Wild Aberrations** In the Philip-



This Peace Keeper Gold Stripe Maroon from Captive Bred Ltd is the latest captive-originated Maroon Clownfish form. Multiple producers have seen Gold Flake Maroon offspring that develop horizontal barring that connects; are these in any way related to what we see here?

TOP: BRANDON MEHLHOFF; BOTTOM: CAPTIVE BRED, LTD.

Right: This series of images illustrates the change in patterning in an individual F1 Lightning Maroon Clownfish over the first two years of life.  From top to bottom: 6 weeks, 11 weeks, 8 months, 17 months, and roughly 2 years post hatch.



MATT PEDERSEN

pines, RVS Fishworld has shown several examples of odd striping and incomplete bars. A fully naked (stripeless) Maroon was found in Papua New Guinea, but does this represent a genetic stripe reduction, extremely advanced age, or some other influencing factor?

***Premnas biaculeatus* "Morse Code"** I actually came up with this name for an individual PNG Maroon that was sent to me, and the name stuck and got applied to all fishes sharing similar phenotypes. Sea & Reef's breeding appears to have shown a genetic basis for this trait, potentially not related to the Lightning genetic. This phenotype is very similar to *P.* sp. *epigrammata* "Gold Flake."

***Premnas biaculeatus* "Lightning"** Some early speculators said that the extremely unusual lace patterning of the wild-caught Lightning Maroon from Papua New Guinea may have been caused by disease or poor environment. It is now unquestionable that the Lightning trait is genetic and can be passed along to subsequent generations; based on current observations and data, it appears this is most likely a partially dominant or straight dominant gene. Offspring carrying the gene start off with solid white over-barring and, as the years progress, the pattern continues to break up, becoming lacier. Eventually, I presume, the offspring will show patterning comparable to their mother's.

## Clarkii Complex

***Amphiprion bicinctus* "Pearl Eye"** It is unclear who first produced a Pearl Eye Bicinctus, and a genetic basis for the Pearl Eye appearance is up for debate.

***Amphiprion bicinctus* "Spotcinctus"** This was the first major designer clownfish in the Clarkii complex and was introduced by ORA in 2009. A recent report by Lee Davis on the Marine Breeding Initiative's website says that when two Spotcinctus mated, 100 percent of the resulting offspring expressed the Spotcinctus phenotype as well. Interestingly, Davis reports that only about 50 percent had the Pearl Eye trait.

***Amphiprion clarkii* "Pearl Eye"** We don't know who first discovered this form and, as with all Pearl Eyes, the question of a genetic basis is open for debate.

***Amphiprion clarkii* "Galaxy" & "Meteor"** This appears to be a Bali Aquarich introduction and outwardly looks identical to the "Spotcinctus" on many levels. Some observers identify it as a "Picasso," but currently the producers at Bali Aquarich apply the name "Meteor" to fishes that are spotted and reserve "Galaxy" for heavily marked fishes whose spots merge with other spots or with stripes. Due to the number of fishes being produced, it is safe to assume this is genetic, so the only remaining unknown is the expression type. The fact that

Cameron Bee photographed this stunning wild-caught aberrant Fijian Blue Stripe Clownfish for Walt Smith International. The purchasers dubbed this form "Northern Lights."

CAMERON BEE/WALT SMITH INTERNATIONAL

there are two clearly distinct phenotypes might suggest a partial dominance scenario, with a spotted fish having inherited one copy of the gene from only one parent and the heavily patterned fish having inherited two copies of the gene, one from each parent.

***Amphiprion clarkii* "Blue Dot"** Blue Dot Clark's Clownfish is an interesting spotted variety—perhaps a mild form of the Galaxy form. The size of the blue dots suggests that this is an example of "black under blue" overlapping. Retailer iBlueWater introduced the name and fish from an undisclosed source in August 2011 in *Advanced Aquarist*. It was reported that "Blue Dot Clarkii" were the F1 offspring of two wild fishes that showed somewhat similar markings. Via Archive.org, I was able to find Blue Spotted Clarkii on Bali Aquarich's website in 2011, so it is likely that Bali Aquarich was the undisclosed source and that the Blue Dot is just another Galaxy/Meteor/Picasso Clark's that happens to have very small spots, resulting in a tiny blue speck.

***Amphiprion clarkii* "Smudgy"** A single photo shared by Bali Aquarich documents an Indian Ocean Clark's Clown with a large white patch connecting the head stripe and mid-stripe along the back. The patch lacks the crisp, defined look of most over-barring/spotting mutations, instead having a blurred edge that is referred to as "smudgy." This could be the start of something new.

***Amphiprion chrysopterus* "Meteor"** A single Blue Stripe Clownfish, presumably from Bali Aquarich's Irian Jaya line, has been shown and labeled "Meteor." Given that this is the name used for spotted *A. clarkii*, could this represent a new genetic mutation in captive-bred *A. chrysopterus*?

***Amphiprion chrysopterus* "White Eyebrow"** Bali Aquarich has applied this name to Pearl Eye specimens from their *A. chrysopterus* Irian Jaya breeding.

***Amphiprion chrysopterus* "King Kong"** This trade label was applied by Bali Aquarich to an *A. Chrysopterus* specimen that only had a head bar. Is this simply a misbar, semi-naked, genetic or not? Time will tell.

***Amphiprion chrysopterus* "Northern Lights"** A very interesting aberrant Blue Stripe Clownfish was collected in Fiji by Walt Smith International in 2014. The markings are reminiscent of the Lightning pattern in Maroon Clownfish, but there is also still solid white striping in places as well. Initially we could only speculate about the genetics, but recently I came across two photos of what are clearly two more unique specimens, both photographed in Fiji, one dated 2001. While multiple occurrences do not automatically prove a solid genetic base (see the Blue Dot Maroon Clownfish), it is a strong positive indicator that genetics may be responsible.

## Percula Complex

***Amphiprion percula* "Onyx"** This is a black-flanked Percula phenotype that results from the expression of one or more genes, but that is all we know. Current understanding suggests we should treat this as a strain, and not a single-gene mutation. Captive-cultured lines have been selectively bred to darken faster and more consistently than wild-originated lines. They also stripe up faster, but there has been speculation that Ocellaris blood may be in the mix of some of these lines. (Ocellaris parentage has been demonstrated to improve stripe formation and pacing in other hybrid examples.)

***Amphiprion percula* "Picasso"** Developed by ORA from a wild-caught Solomon Islands fish, the Picasso Percula is the best-understood genetic mutation we have in the clownfish world. It appears that mating any two Picasso Perculas will yield approximately 25 percent Wild Type Percula, 50 percent Picasso Percula, and 25 percent Platinum Percula. A Picasso Percula carries a single dose of the partially dominant Picasso gene (P/+). Numerous other examples of Picasso-type *A. percula* have been seen in the wild from both the Solomon Islands and Papua New Guinea.

***Amphiprion percula* "Platinum"** A clownfish with Platinum Percula traits is simply what happens when there is a double dose of the Picasso gene (P/P), so it was inevitable that multiple breeders working with ORA's initial Picasso releases at the same time would start producing Platinum Perculas and scrambling to stake their claim with a name (which is why we also have Maine Blizzards). Based on the genetics at hand, matings of Platinum X wild-type should yield 100 percent Picasso offspring, and a Platinum X Picasso pairing would produce 50 percent Platinums, 50 percent Picassos.

That said, some clownfish breeders suggest that fishes like the Platinum Percula may have some reproductive handicaps. Jonathan Foster of Fisheye Aquaculture reports that a pair of Platinum X Platinum Percula are unusually unproductive breeders: their largest successful spawn yielded 10 viable offspring, all Platinums. It seems that Platinums are slow to mature, reluctant to spawn, and have reproductive issues. This might be true for Wyoming Whites in Ocellaris as well. The related forms, Picassos and Da Vincis, respectively, do not have these breeding problems.

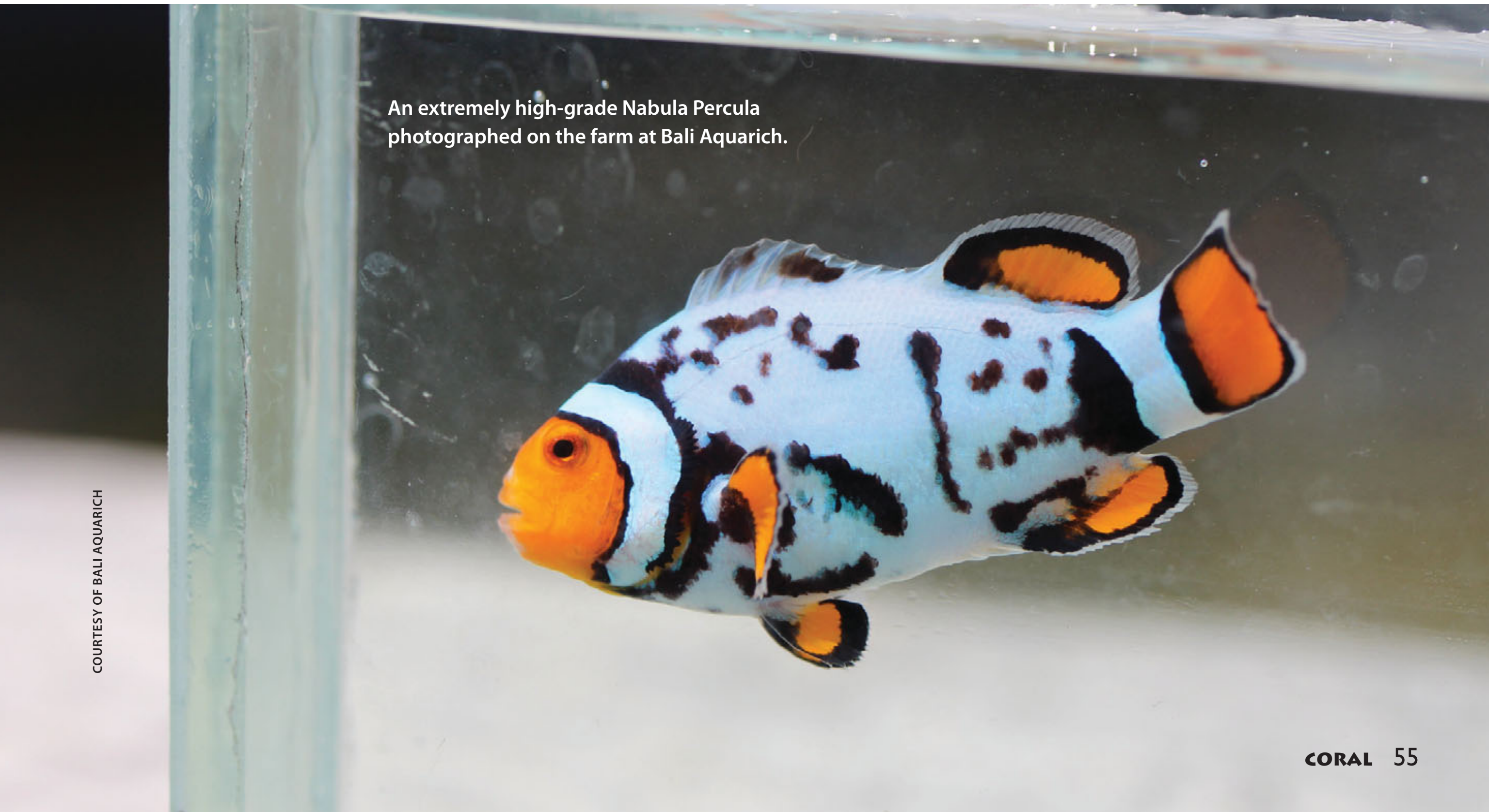
***Amphiprion percula* "Nebula"** This stunning introduction from Bali Aquarich started with a wild-caught fish. The best way to describe a Nebula Percula is to say that on the surface, it looks like a white-dominated biocubist-style Picasso, with the addition of hazy clouds. There is clearly a genetic component, as this fish is being produced in commercial numbers; we don't know whether this represents the combination of the Picasso gene or genes with some sort of Smudgy gene(s) or an entirely new gene.

***Amphiprion ocellaris* "Naked"** Introduced by ORA years ago, this variety has a known genetic basis, but the exact mechanisms of the gene(s) are not fully understood. We do know that Nearly Naked fishes, sometimes with only a white cheek spot, are part of the range of possible offspring, but these fishes are very rare. This Naked Ocellaris has appeared under the name "Tequila Sunrise."

***Amphiprion ocellaris* "Snowflake"** Introduced by Tropical Marine Centre (TMC) in the UK, this popular form was discovered among captive-bred fishes. Its markings have irregular, sometimes jagged edges to their markings and, like snowflakes, no two are alike. The mechanism of the genetics is unclear, but the Snowflake Ocellaris is one of the most interesting designer clownfishes yet produced.

Outwardly, a dominant gene appears to be at work—any fish inheriting the gene from a parent shows the unmistakable snowflake-overbearing phenotype. We know that the mating of a Snowflake to a wild-type Ocellaris yields 50 percent Snowflakes and 50 percent wild-type Ocellaris.

Whether we assume partial dominance or full domi-



An extremely high-grade Nabula Percula photographed on the farm at Bali Aquarich.

COURTESY OF BALI AQUARICH

**A sampling of genetic mutations in clownfishes produced by Sustainable Aquatics**


Snowflake Ocellaris


Snowflake Ocellaris—"Special" Grade


Snowflake Ocellaris—"Extreme" Grade


Fancy Snowflake Ocellaris


Fancy Snowflake Ocellaris—"Special" Grade


Fancy Snowflake Ocellaris—"Extreme" Grade


Fancy Ocellaris—"Super" Grade


Fancy Ocellaris


Vivid Fancy Ocellaris


Fancy White Ocellaris—"Semi" Grade


Fancy White Ocellaris


Fancy White Ocellaris—"Extreme" Grade


Fancy White Ocellaris—"Smudgy"


White Ocellaris


Frostbite Ocellaris—"Flurry" Grade


Frostbite Ocellaris—"Chilled" Grade

nance, there are limited outcomes, depending on parental genetics. Hypothetically, two Snowflake parents that each only carry one Snowflake gene (SF/+) would produce only 25 percent normally striped fish, the rest being some sort of Snowflake, 50 percent with one gene (SF/+) and 25 percent with two (SF/SF). The spread changes again if one parent has two Snowflake genes (SF/SF) and the other only one (SF/+); the offspring will all get one Snowflake gene from one parent, and the other parent has a 50 percent chance of contributing. The net result should be a 50/50 split between (SF/+) and (SF/SF). Of course, if both parents have two Snowflake genes (SF/SF) X (SF/SF), 100 percent of the offspring should too.

Until now, I've avoided talking about genetics at this level of detail for one simple reason: in most cases we've only reached the point where we can say "it's genetic." The Snowflake presents a true conundrum, because in all the test matings I've outlined above, the results don't meet expectations. No one has claimed to have a pair of Snowflake Ocellaris that produce 100 percent Snowflake offspring. Invariably, the pairing of two Snowflakes produces some normally striped offspring. We need more data; so far, only Matt Carberry of Sustainable Aquatics has approached me with a hard number. He states that at best, he gets 50 percent Snowflakes, 50 percent wild-type from a mating of two Snowflake parents.

Such a spread doesn't match up with any of our proposed outcomes at first glance, but that's where this gets very interesting. I've proposed two possible solutions to this mystery; we have to rethink our expectation of what a "double dose" Snowflake (SF/SF) would be. It could be that receiving a Snowflake gene from both your mother and father is a death sentence. This actually works very well with my models, because it means that every Snowflake Ocellaris is (SF/+); there can be no (SF/SF) to contend with. Where this hypothesis falls apart is that the mating of two single-gene Snowflakes would leave a different spread if we eliminated all the offspring that got two genes; the result would then be 66 percent Snowflake (SF/+), 33 percent wild type (+/+). The distribu-

Frostbite Ocellaris—"Frozen" Grade

Longfin Ocellaris

Color-Changing Ocellaris—(In Transition)

Color-Changing Ocellaris—(Transitioned)

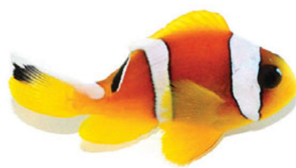
Chocolate Black Ocellaris

Naked Ocellaris—"Nearly Naked" Grade

Naked Ocellaris

Naked Black Ocellaris

Pearl Eye Clarkii



Pearl Eye Bicinctus

Spotcinctus Bicinctus

Onyx Percula

Picasso Percula—"Semi" Grade

Picasso Percula

Platinum Percula

Silver Eye Platinum Percula

COURTESY OF SUSTAINABLE AQUATICS

tion appears this way because the portion of double-dose Snowflakes is dead and is therefore not counted. Still, this hypothetical offspring count does not match Carberry's 50/50.

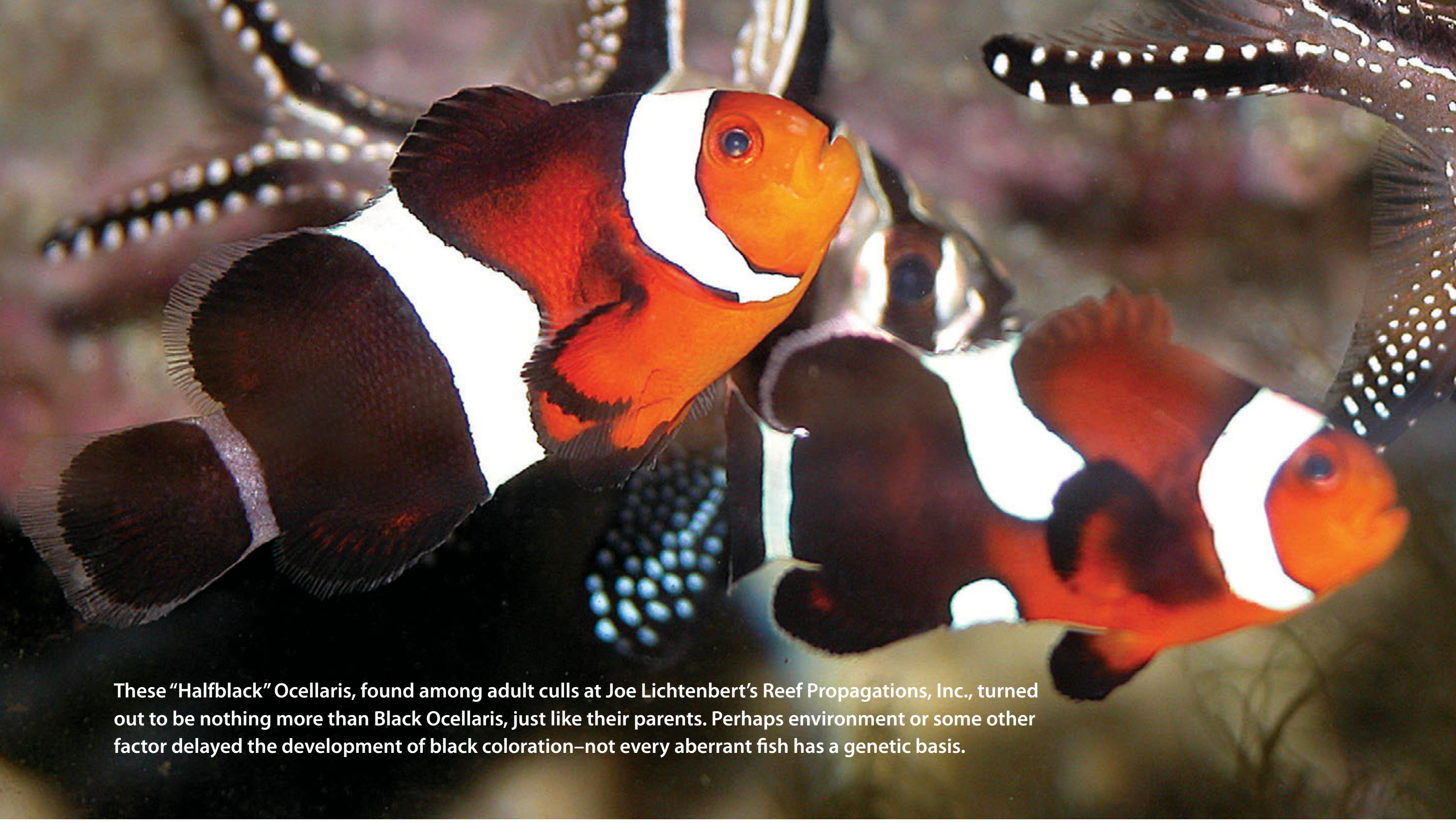
The second hypothesis is this: two Snowflake genes cancel each other out, causing a reversion to wild type appearance. This actually fits better with the possible offspring genotypes compared to Carberry's 50/50 consistent result. The beauty is that no Snowflake X Snowflake pairing will ever produce more than 50 percent outwardly Snowflake offspring, because any double-dose Snowflake (SF/SF) would appear to be wild type (+/+). To discover whether this is true would require a lot of breeding with the outwardly normal offspring of a Snowflake X Snowflake pairing, trying to hit the right combination of two outwardly normal-looking fishes that suddenly produce 50 percent Snowflakes. Consider this footnote from the ORA online catalog:

"This popular clownfish was originally produced by Tropical Marine Centre in the UK around 1999. At that time extra white patterning was considered an undesirable trait. TMC had two completely normal-looking pairs of Ocellaris that produced two or three Snowflakes once every couple of spawns. These pairs are still alive and reproducing today but they no longer produce Snowflakes. Only around 100 of these fish were ever exported to the United States, making F1 broodstock direct from TMC extremely rare."

It is obvious that the Snowflake is a mystery begging for detectives.

***Amphiprion ocellaris* "Fancy"** This is not a genetic mutation, at least not a single gene, but rather a strain developed through selective breeding by Sustainable Aquatics that has heavier black margins on the fins and bars, akin to some forms of natural *A. percula*.

***Amphiprion ocellaris* "Da Vinci"** In short, we owe this gene to C-Quest, the legendary hatchery built by Bill Addison with Joyce Wilkerson, two pioneering clownfish breeders who are no longer with us. While it was discovered in C-Quest tanks, multiple wild fishes that



These "Halfblack" Ocellaris, found among adult culls at Joe Lichtenbert's Reef Propagations, Inc., turned out to be nothing more than Black Ocellaris, just like their parents. Perhaps environment or some other factor delayed the development of black coloration–not every aberrant fish has a genetic basis.

MATT PEDERSEN

look exactly the same have since been documented. For the most part, the gene in question appears to function as a partially dominant gene; all fish with a single copy fall into this group. The original name, "Gladiator," has been tied to so many other forms that is has become useless and confusing. Many of us think of this fish as Fancy White, Sustainable Aquatics' name for it; it is worth noting that SA's Fancy White contains this gene on top of their Fancy Strain, which is where the name comes from. Sea & Reef has really brought forward Da Vinci as a potentially viable name. This fish has the same gene, but not on top of the Fancy Strain.

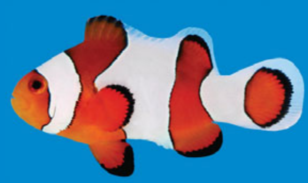
***Amphiprion ocellaris* "Wyoming White"** This show-stopping clownfish has a double dose of the gene responsible for Fancy Whites, Da Vincis, and Gladiators. When you mate two Da Vincis, you get 25 percent Wyoming Whites (along with 50 percent Da Vincis and 25 percent wild-type offspring). If you were to mate a Wyoming White with a wild-type Ocellaris, you should get 100 percent Da Vincis, and it goes on from there. C-Quest initially called this fish the Cotton Candy Clownfish before settling on Wyoming White. (Wyoming was Bill Addison's home state and where the C-Quest hatchery moved after it left Puerto Rico.) Occasionally, this form is simply called the "White" Ocellaris. Our understanding of the genes involved are just about perfect—maybe too perfect.

***Amphiprion ocellaris* "Wide Bar Gladiator"** and ***A. ocellaris* "Vivid Fancy"** These two fishes have very different stories, but might be the same thing. The Wide Bar Gladiator was offered by C-Quest and then all but lost. Sea & Reef has brought it back in large numbers. The name Wide Bar Gladiator suggests a relationship to the Gladiator genetic. The outwardly similar Vivid Fancy is the wild-type Ocellaris offspring that Sustainable Aquatics generates when breeding Fancy Whites; ordinarily these fish, presumably lacking the mutant gene, would just be Fancy strain Ocellaris. But here's where things get interesting: Sustainable Aquatics reports that the mating of two Vivid Fancy clownfish occasionally produces Fancy Whites; thus, the separate name to differentiate the origin. While this sounds puzzling,

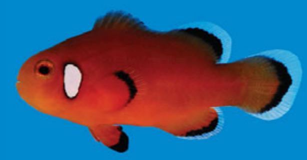
***Amphiprion ocellaris* "Frostbite"** This is possibly our first "double genetic" designer clownfish: a Snowflake and a Fancy White are paired to create an Ocellaris with two designer genetic traits put together. Based on our current genetic understanding, the Snowflake X Fancy White scenario would likely yield 25 percent wild type, 25 percent Snowflake, 25 percent Fancy White, and 25 percent Frostbite offspring. Snowflake X Wyoming White ought to yield 50 percent Fancy White and 50 percent Frostbites. Sustainable Aquatics currently offers three grades of Frostbite Clownfish, based on the amount of black spotting on the mainly white flanks; Flurry have the fewest markings, Chilled a few more, and Frozen the most. These grades are useful for marketing, but not genetics.

***Amphiprion ocellaris* "Golden"** A single wild, solid-yellow (xanthic) Ocellaris/Percula-type clownfish has been documented and brought into captivity. One source suggests the fish was harvested in the Philippines, which would definitively make it *A. ocellaris*. Most forms of xanthism (seen in many fish families) seem to be recessive, so this fish's genetics might be easily decoded with a few years of dedicated breeding effort.

## A sampling of genetic mutations in clownfishes produced by Sea & Reef Aquaculture



Wide Bar Gladiator Ocellaris



Naked Ocellaris—“Nearly Naked” Grade

Naked Ocellaris

Longfin Black Ocellaris

Da Vinci Ocellaris —“A” Grade

Da Vinci Ocellaris —“B” Grade

Da Vinci Ocellaris —“Extreme” Grade

Wyoming White Ocellaris

Snowflake Ocellaris

Snowflake Ocellaris—“Premium” Grade

Snowflake Ocellaris —“Ultra” Grade

Frostbite Ocellaris

Onyx Percula

Picasso Percula—“Premium” Grade

Maine Blizzard Percula

Morse Code Maroon

COURTESY OF SEA& REEF AQUACULTURE

## A sampling of genetic mutations in clownfishes produced by Proaquatix

Picasso Percula—“Premium” Grade

Picasso Percula—“Premium Helmet” Grade

Picasso Percula—“Helmet” Grade

Frostbite Ocellaris—“Flurry” Grade

Onyx Percula

Onyx Picasso Percula

Wyoming White Ocellaris

Wyoming WhiteOcellaris

COURTESY OF PROAQUATIX

***Amphiprion ocellaris* "Color Changing"** One of our hobby's most unusual fishes, this introduction from Sustainable Aquatics could be thought of as the reverse of Fisheye's "Rotten Tomato" Clownfish. SA Color Changing Ocellaris start life looking like normal orange Ocellaris, but at some point they rapidly change to a shade of black. The genetics responsible for this are not publicly known, but we do know that not all offspring from the original parental pair became "Color Changing," forcing Sustainable to wait until the color change had started to sell these fish.

***Amphiprion ocellaris* "Albino"** Discovered by Marcel Triessl in South Africa, these were classic albinos. Unfortunately, Tressl's strain seems to have been lost due to legal issues surrounding the breeding of non-native marine fishes in South Africa.

***Amphiprion ocellaris* "Tangerine Albino"** This albino form of Ocellaris was introduced by Proaquatix. This one appears to allow some melanin production in the fins. Whether or not this is genetically different from Triessl's may never be known.

***Amphiprion ocellaris* "Longfin"** Some will hate it, some will think it's phenomenal. Either way, this is the first longfin mutation bred into a species of marine aquarium fish; Sustainable Aquatics in Tennessee is the breeder. In most fishes, longfin mutations are dominant or partially dominant genes.

***Amphiprion* ocellaris Darwin "Halfblack"** I mention this fish to emphasize the point that not every aberration we discover in the aquarium is a genetic mutation that can be passed down through the generations. The Half-Black Ocellaris were two part-orange/part-black fishes I spotted in the cull tanks of Joe Lichtenbert's Reef Propagations in Chicago, and were the offspring of normal Black Ocellaris. Joe suggested I take the pair home and see what came of them. Within a month of living in a reef aquarium, the pair started to darken, and within five months they were solid black.

***Amphiprion* ocellaris Darwin "Chocolate/Caramel"** ORA's Caramel and Sustainable Aquatics' Chocolate are both brown forms that come out of Black Ocellaris breeding. Based on the information at hand, neither of these likely represent any genetic mutation in Black Ocellaris; they are fish that have been graded out due to a lack of solid black coloration. Both sources say the fish should turn black with maturity, although ORA says that the occasional fish retains the rich brown color.

***Amphiprion* ocellaris Darwin "Longfin"** The Longfin mutation showed up in Sea & Reef Aquaculture's Black Ocellaris breeding lines only a few months after the announcement from Sustainable Aquatics of the same mutation in *A. ocellaris*. Again, we presume that this mu-

**A sampling of genetic mutations in clownfishes produced by Proaquatix**

Naked Black Ocellaris—
"Extreme Misbar" Grade

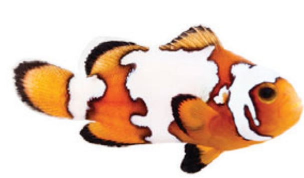
Naked Black Ocellaris—
"Domino" Grade

Naked Black Ocellaris—
"Domino" Grade

Midnight Ocellaris

Tangerine Albino Ocellaris

Da Vinci/Gladiator Ocellaris



Snowflake Ocellaris

Platinum Percula

Picasso Percula

Picasso Percula—
"Cheekspot" Grade

Picasso Percula—
"Helmet" Grade

Picasso Percula—
"Extreme Helmet" Grade

COURTESY OF PROAQUATIX

tation, like most longfin mutations in fishes, is either partially dominant or dominant.

***Amphiprion* ocellaris Darwin "Zombie Albino"** This albino form, presumed to be a recessive trait, arose in captive-bred Black Ocellaris broodstock purchased in the early 2000s. It was discovered by Robert King and Tom Lamb. It is interesting how much black coloration develops. One normally expects about 25 percent albinos when the parents are both normally colored fish with a hidden gene; King and Lamb reported that there were roughly 70 albino and 40 normally colored siblings. This is more like 63 percent albinos. King hypothesized that the use of a larval trap pulled in mainly weaker larvae like the albinos, and this skewed the numbers.

### Mystery Clown Complex

**S'More, Black Ice, Black Snowflake** See the following chapter covering hybrid crosses between species of clownfish for discussion of these and other "designer" fishes.

## ENDNOTE: BOTTLE OPEN, GENIE NEVER TO RETURN

Designer genes in aquarium anemonefishes are here to stay. Past fears of these dramatically different clowns largely stemmed from the fact that they were unfamiliar. Some of us feared they would overrun the marine aquarium hobby and wipe out the naturally beautiful and alluring wild-type *Amphiprion* and *Premnas* species. This now appears less likely to happen, although the popularity of designer strains can't be denied and the genetic challenges involved in breeding ever more interesting clowns is a new hobby in itself. This can be a positive pursuit if we continue to embrace an ethic of transparency, sharing our observations and data. When breeders are open about both successes and failures, we can change our hobby and industry for the better.

More important, a solid understanding of the genetic mutations in our designer fishes is a game changer in terms of preserving natural biodiversity. These goals need not be at odds. We are still in the early stages of the genetic mutation game. Very few, if any, genes have crossed hybrid lines; most are well confined within a single species group. Some currently known genes are still isolated right down to the geographical group, and if breeders start demanding that all fishes arrive with known provenance, all future designer genes could arise within fishes linked to exact geographic data. With a basic understanding of how to keep lines of wild-type fishes natural, there is no reason why the conservation breeder can't bring designer genetics into his fishroom and vice versa.