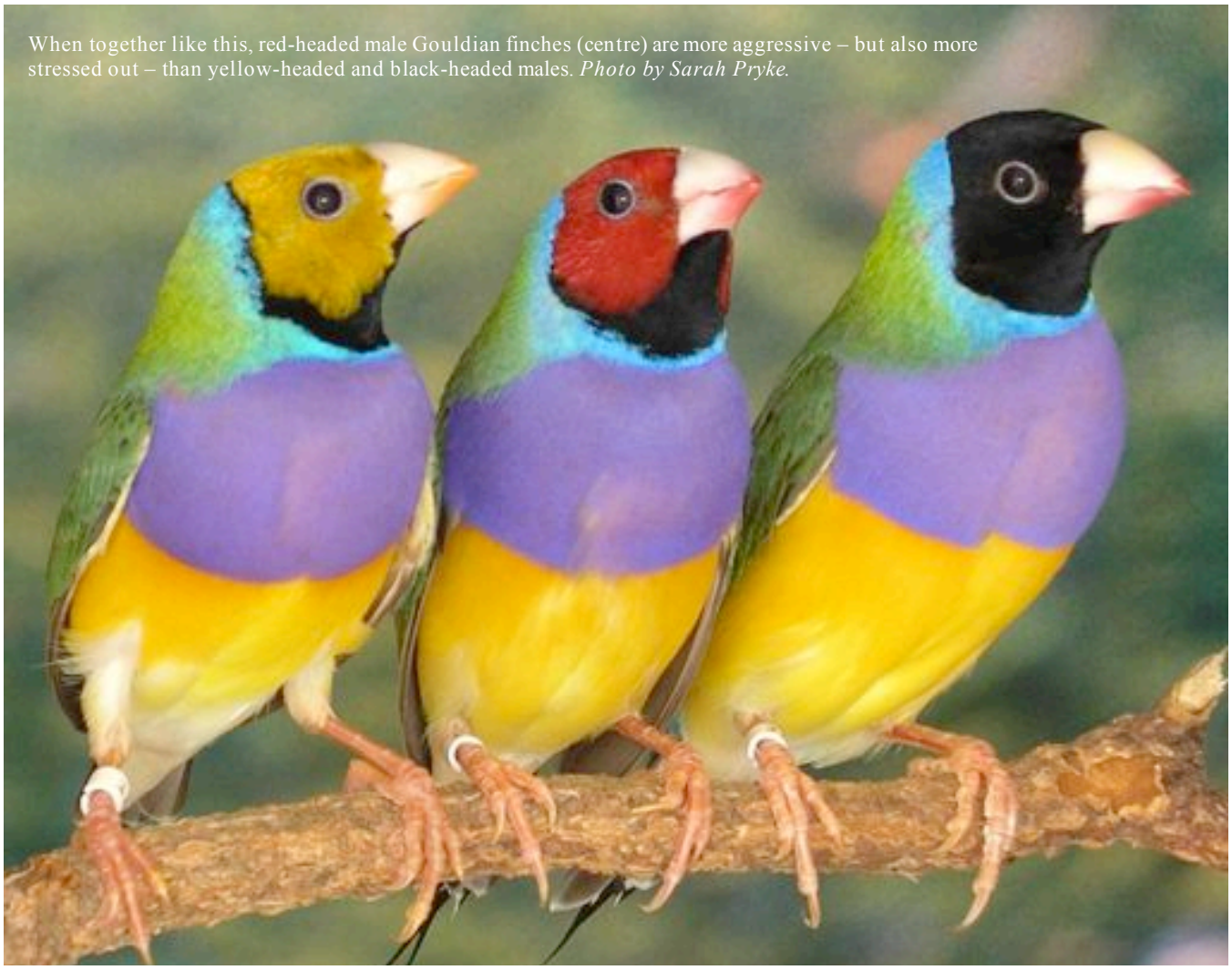

When together like this, red-headed male Gouldian finches (centre) are more aggressive – but also more stressed out – than yellow-headed and black-headed males. *Photo by Sarah Pryke.*

Fiery redheads rule the roost

Many people have shown an interest in the scientific research we are doing on the Gouldian finch. We hope that by keeping you informed we can repay some of the much appreciated support. In this first scientific newsletter, I will explore some of our recent research on the behavioural, physiological and genetic differences between the three head colour varieties (morphs) with regards to dominance. Not only does understanding how individuals compete for access to limited nest sites and food help us to understand the dynamics in wild populations, as you will see, understanding dominance is also crucial for effectively housing and breeding Gouldian finches in aviaries.

BY DR SARAH R. PRYKE

Alexander the Great, Billy the Kid, Eric the Red, Napoleon, Winston Churchill and even Vladimir Lenin was rumoured to be one before he went bald – all red-heads infamous for their fiery tempers. Recent work has revealed a similar pattern among Gouldian finches where, in the bird world at least, red-heads have an evolutionary advantage allowing them to rule the pecking order. Wild-type Gouldians (which form the basis of our study) have either a red, black or yellow head, and our studies on hundreds of birds have shown that red-heads are dominant to both the black- and yellow-heads.

Similar to hair colour in humans, head colour in Gouldian finches is genetically-inherited (from parents), but unlike us, the head colour of Gouldians is discreet, with no variation in between. This occurrence of different head colour varieties (morphs) in wild populations of a bird, or indeed any animal species, is very rare. This is because selection (e.g. from mates, predators) tends to

produce only the single-best colour form for each species – as we see in pretty much every other animal species. From an evolutionarily perspective, this makes the Gouldian finch a very unique and interesting species, and one of our major aims is to understand how and why these three head colour morphs coexist together.

To do this, we started by looking at behavioural differences between the different colour morphs. Since different genes control the expression of the different head colours (red, yellow and black), theoretically, it seems likely that these different genes could also control (or be linked to) other genes which determine different behaviours. To test this theory, we looked at how dominance behaviours differed between the birds, because competition for access to food, nest sites and mates is a crucial component of a bird's fitness (reproductive success) – without any of these, birds are unable to successfully breed.

To begin with we staged unfamiliar males in competition over access to limited food, and watched to see who claimed control of the food. Red-heads won. Matched with either black- or yellow-heads, the red-heads strongly dominated, while black-heads outcompeted yellow-heads.

We then gave the birds a colour make-over by temporarily dying them red or black to determine whether head colour was a communication 'signal' between birds. The birds definitely paid attention to head colour as they were reluctant to compete with opponents that had red-dyed heads. For example, although yellow-heads are at the bottom of the pecking order, when yellow-heads are temporarily dyed red they gain the top spot –because none of the other birds will attack or fight them. This demonstrates that these birds do pay very close attention to the colour signal and use it to avoid getting into fights with red-heads.


Photo by Sarah Pryke.

Other birds avoid conflicts with red-heads for a very good reason – red-heads are highly aggressive. Even when the red-heads had their heads blackened (i.e. red dominance status removed), they still managed to dominate the other birds, and they did this by initiating and sustaining more physical fights. This is because red-heads are truly very aggressive and therefore it pays black- and yellow-headed birds to avoid fighting with them – because they will lose.

Why are red-heads so aggressive?

Some recent work carried out this year aimed to answer this question by investigating individual responses in different aggressive situations. For this experiment, males were placed in a range of different social environments, which varied only in the ratios of red-heads to black-heads, and we measured a range of behavioural, hormonal and health (immune function) parameters. What we found was rather surprising, because although male birds in a number of species are predisposed to aggression through their genetic make-up, in Gouldian finches it is their social situation that actually influences the amount of aggression they display.

When birds were kept in complete isolation (i.e. single bird per cage), there were no differences in hormones and immune performance between red- and black-heads. However, in socially competitive environments (i.e. when the frequencies of aggressive red-heads increase), red-heads responded aggressively, elevating their testosterone levels to over five times their baseline, whereas black-heads reduced their testosterone levels in response to higher frequencies of red-heads. In other words, this means that as the frequencies of red-heads increase within a cage, red-heads become very aggressive, while black-heads become very submissive. The high aggression (i.e. high testosterone levels) of red-head males gives them a huge advantage over black- and yellow-heads during competition for food, nest sites and mates.

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However, this high aggression in red-headed birds is not without cost. In these competitive environments, when there are high frequencies of red-heads, red-head males have a highly elevated stress response (this is indicated by the stress hormone corticosterone), and they also suffer severe health risks because they cannot maintain normal levels of immune function. This contrasts with the submissive black-head males that show little or no stress response or reduced immune function to socially competitive environments. Therefore, red-heads and black-heads respond very differently to aggressive environments. This is a very exciting find for us because this is the first study to show that aggression is socially mediated and not simply linked to genes.

What does this mean for breeders?

These findings have a number of important implications, which will hopefully be useful for owners and breeders of Gouldian finches.

First, to maintain healthy, stress-free populations (i.e. multiple birds in a single cage), red-heads should be kept at lower densities than either black-heads or yellow-heads. It is important to note that variation in 'stress' is not an easily measurable index (without specific blood and hormone assays), but ultimately, stressed birds are more susceptible to pathogens, parasites and disease, and therefore are more likely to get sick. When breeding birds in large populations it is particularly important to keep red-heads at lower densities, because breeding increases the normal stress load placed on birds – and this effect is exaggerated in red-heads.

Second, for breeders keeping mixed populations of Gouldian finches, it is important to get the balance between red-heads and black-heads right. We know that red-heads and black-heads respond very differently to aggressive environments: red-heads are very sensitive and become highly stressed at high densities, whereas black-heads are more passive and appear to be buffered against these social stressors. As a guide, mixed populations should contain no more than 30% red-heads. In fact, this is the frequency of red-head birds observed in wild populations (with black-heads making up 70% and the rare yellow-heads less than 1%) and is by the far the most successful breeding frequency across our large population-based studies.

In addition to the specific dominance effects between the colour morphs, there are also a number of general management tools which can help to reduce negative dominance effects in caged birds.

Simply by looking at the head colour of birds we are now able to predict how they will respond to stressful and competitive environments


Photo by Sarah Pryke.

First, it is important to provide 'unlimited' resources to avoid creating highly competitive environments when housing or breeding birds in populations. This means providing multiple food dishes to prevent one or a few birds dominating the food (and preventing subordinates from feeding), and also providing an excess of nesting sites (e.g. nest boxes) to avoid dominant birds disrupting other breeding pairs. As a rough guide, for every 5 birds there should be an extra food bowl, and during breeding, provide 20-50% more nest boxes than the number of breeding pairs.

Second, it is important to provide a number of 'safe houses' within a cage or aviary, so that subordinate individuals are able to escape from aggressive birds. In aviaries, this can be done by placing a number of vegetation thickets within the cage, creating sub-areas (e.g. joining multiple cages) and also by increasing the number of available nest boxes (as above). Specifically designed perches with safe compartments to perch and roost, such as those provided by the 'de-stress perches' (see the photo above; all details on these perches are provided in Evans & Fidler 2005, The Gouldian Finch) are very effective for reducing stress in Gouldians.

Lastly, although this may initially appear counter-intuitive, it is important to allow birds to successfully establish dominance hierarchies. Dominance is an important natural behaviour in all animals, used to resolve conflicts over access to limited resources. Birds have evolved a variety of methods to passively 'signal' their relative dominance status, without having to continuously fight with every individual (and hence wasting energy and risking injury). They may use signals such as a colour display (e.g. red head used to signal aggression), or more subtle behavioural cue, such as dominant (e.g. raised body) or submissive (i.e. crouched body) posturing. Such behavioural signals provide us with very important insight into how birds communicate.

For example, Gouldian finches (and probably a number of other birds) characteristically attack from above and will not aggressively displace their opponents from a vertically lower position. As a consequence, dominant males typically occupy and defend the highest perch, nest box or position in an aviary. This means by simply looking at which bird spends most of their time on the top perch or breeds in the highest nest box, you will be able to identify the dominant birds. There are ways to aid birds in establishing a stable dominance rank by helping them to quickly and effectively establish a dominance hierarchy – contrary to expectations, this will actually reduce (rather than increase) aggression within a population. For example, individuals who can simply signal their relative dominance status by where they perch or nest within a cage will substantially reduce the number of aggressive conflicts and fights needed to establish their dominance status. In contrast, bird's which perch or nest in a uniform environment (i.e. where all resources are the same height) are unable to passively signal their dominance status and will therefore have to engage in more aggressive conflicts or fights to determine the relative fighting ability of their opponents (i.e. this results in increased aggression and fighting). As a management tool, it is easy to create opportunities for birds to occupy their relative dominance position in an aviary by simply providing a range of perches and nest boxes along a vertical gradient, from very low to very high in the cage (see photo above).

Overall, by using some of these simple guidelines, you should be able to reduce aggression within populations and in doing so provide a stress-free and optimal environment for housing and breeding birds.

Photos by Sarah Pryke.

Reduce aggression by helping birds establish dominance hierarchies, using perches and nest boxes positioned along a vertical gradient

Future research plans

This newsletter outlines some of our findings regarding dominance, and in the next few issues, we will report on other behavioural research, such as mate choice, imprinting and parental care, as well as aspects of nutrition and diet. Our work on the wild populations in the Kimberley is also continuing (with great success) and over the next year we will report on the threats and current management plans for these endangered populations. We also have big plans for the next few years (in some new and very exciting areas) and they will no doubt be of interest to all Gouldian finch supporters and breeders – we will continue to keep you up to date with our research on this amazing little finch.

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Relevant Publications

Pryke, S. R. , Astheimer, L. B., Buttemer, W. A. & Griffith, S. C. 2007. Frequency-dependent physiological tradeoffs between competing colour morphs. *Biology Letters* 3: 494-497.

Pryke, S. R. 2007. Fiery red heads: female dominance among head color morphs in the Gouldian finch. *Behavioral Ecology* 18: 621-627.

Pryke, S. R. & Griffith, S. C. 2006. Red dominates black: agonistic signalling among head morphs in the colour polymorphic Gouldian finch. *Proceedings of the Royal Society of London B* 273: 949-957.

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