



Hybridisation:

an exciting prospect or a moral dilemma?

The concept of species hybridisation is one of the most controversial and hotly-debated topics in herpetoculture today. It seems to divide opinion straight down the middle. But is there more to it than the traditional "it's not natural" argument? In the first of a two part article, geneticist Andy Tedder argues that there is, and explains more about the background to this debate.

Species concepts : when is a 'population' no longer a 'population'?

In order to appreciate the concept of hybridisation, we first need to understand what constitutes a species. Strangely enough, this definition is perhaps not as simple as you may think. Science is currently unable to delimit accurately what constitutes a species, and this poses a real issue if we then want to consider the consequences of breeding between species.

The biological species concept, which is one of the simpler, currently 'accepted' theories, suggests that for a 'population' to warrant specific species status, it must be reproductively isolated from other 'populations'. Reproductive isolation can take many forms, the simplest of which is sexual incompatibility. One species for example has significantly different reproductive organs, which in turn present a physical barrier to reproduction between the two 'populations'.

In situations where this is the case, hybridisation would be almost impossible, and for the sake of this discussion can be considered unimportant. Other commonly accepted forms of reproductive

isolation include spatial, temporal and other ecological and behavioural isolation characteristics, each of which has been tested by taxonomists for hundreds of years.

Spatial isolation: Sometimes referred to as geographical isolation, this refers to populations which are prevented from breeding together because they never come into contact. Speciation (the process by which a single species may diverge into multiple species) mediated by mutations may have changed the appearance (morphology) of the two 'populations'. But if put together for mating purposes, individuals would still be able to create viable offspring.

Temporal isolation: This character generally relates to breeding season, or the time at which a 'population' is reproductively active. If these seasons do not coincide with each other, then reproductive activity between the 'populations' will not occur. Again speciation may have occurred between the two, but if individuals from both populations were to breed together at the appropriate time, they could still produce fertile offspring.

Behavioural isolation: This is perhaps the most interesting type of ecological

isolation, and relates to differences in behavioural traits such as courtship behaviour which prevent breeding between two 'populations'. Perhaps the best example here would be mating calls in amphibians. Females from one location will be induced into spawning by a specific male call. If the male's call is not accepted however, then breeding will not occur, even if the males are capable of reproducing successfully.

What becomes clear from this simple demonstration is that there are many ways in which reproductive isolation can arise in wild populations. Furthermore, this is one of the simplest forms of the species concept, and as you begin to get into more complex definitions, the way you identify reproductive isolation also changes, and adds a further layer of complexity to the whole topic. At this point, it is probably worth pointing out that there are currently 55 accepted species concepts in biological literature, and this figure is still growing! Most of these are not only very complicated, but also clearly incorrect, based on some of the assumptions you are forced to make when applying them.

OK, so what does this really all mean? Well if we cannot define exactly

A croaking frog. Vocalisations of this type help frogs and toads to recognise members of their own species at spawning time.



what constitutes a species, then how can we consider breeding between two 'populations' hybridisation? This is a real problem, not only for popular herpetoculture, but also science in general, and we shall come back to this later.

Morphological taxonomy : can we trust it or is molecular evidence just as confusing?

Traditional morphological taxonomy suggests that differences in terms of physical appearance can constitute enough variation to separate 'populations' into species. Undeniably this can be the case, especially when this morphological variation is linked to reproductive isolation. But are taxonomists too quick to grant specific species status before tests for population level variation have been carried out?

I think this is a very telling question, and to a certain extent, it can be tested when we consider the power of molecular studies to corroborate or contest them. Interestingly the results vary greatly. For certain genera, both molecular and taxonomic studies agree, and it would superficially appear that correct assignment of species has been achieved. However, there are also genera where there is no similarity between the two methods, and species which are considered closely-related by morphological taxonomy are considered far less closely-related by molecular methods.

So what does this mean in terms of species delimitation? Are either of these methods really appropriate for defining species when there is no suggestion of reproductive isolation?

The point I am attempting to make here is that if we cannot accurately say

what exactly a species IS, then accurately classifying breeding between species as hybridisation becomes really difficult, if not truly impossible.

The problem becomes far more complicated when you remove an animal from its natural environment, and thus alter its patterns of behaviour. By removing the barrier of isolation for example, so this then makes reproduction more likely. Does this mean that species can return to being 'populations' by altering their ecology? It is certainly an intriguing suggestion, and perhaps goes some way to explaining some of the common reptile hybridisation taking place in captivity.

Hybridisation at different taxonomic levels.

It seems quite logical that species that are closely-related will have more chance of being physically able to reproduce together than more distantly related taxa. The reasoning behind this is that as they are closely-related, so the period of separation between the species, and their subsequent evolution is much less than in more distantly-related species, and so fewer mutations are likely to have occurred, which may adversely affect their ability to reproduce together.

With this in mind then, it seems strange that many hybrids present in modern herpetoculture represent mating between taxa that are very distant in both evolutionary and geographical terms. In fact, there are numerous examples of successful hybridisation between species in different, distantly-related genera. The

same logical argument should lead us to conclude that the chances of successful pairings like this happening are low, because of the amount of evolutionary time which has passed since the 'populations' became separated. This suggests the chances of mutations occurring in one or both of the species, thereby creating a reproductive barrier, are high. It is clear that this can be the case, although it is also evident that this does not apply in many instances.

What does this mean though? Have we got our phylogenetic tree wrong? Are species, which are capable of producing fertile offspring, actually more similar than molecular and morphological taxonomy characteristics suggest? We obviously need to take into account the difficulties of defining a species. Or is something else happening here? While I think it is very unlikely that our current best methods of phylogenetics (the science of tracking evolutionary relationships) are so far out as to place closely-related species in different genera, it could be that we are witnessing speciation that is not linked with reproductive characters.

Perhaps what we are seeing instead are species that have been separated by distance for a very large amount of time, but have never become reproductively isolated. To all intents and purposes therefore, although they are physically and genetically distinct, they do not fulfil the basic criteria of the concept of being two separate biological species.

While defining a species is a pivotal requirement in biology, we are actually unable to do it in every case, which is a pretty hard concept to grasp. This also has to have a major impact on how we react to the idea of hybridisation. ■

Next month

In next month's issue, Andy addresses the practical implications surrounding the breeding of hybrid reptiles.

Strawberry poison dart frogs (*Dendrobates pumilio*) can have a very different appearance, reflecting the fact that distinctly-different local populations are common in this group of amphibians.

