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Letter to the Editor

Species concepts for conservation – Reply to Russello and Amato

There are two critical steps required in assessing the taxonomic identity of populations (especially fragmented ones) for conservation purposes. The first is to define the criteria for distinguishing species and the second is to implement the delineation. Russello and Amato (2014) and other proponents of the phylogenetic species concept (PSC) concentrate on the delineation stage and consider that any markers can be used as a basis of delineation. Frankham et al. (2012) demonstrated that the choice of markers is crucial to delineations for conservation purposes. If small inbred populations with allopatric distributions are to be saved from extinction (and there are huge numbers of them), then species must be delineated on the basis of reproduction isolation (in the broad sense), as used in the differential fitness and biological species concepts (DFSC and BSC). If this is done, crosses of populations within species will have beneficial (genetic rescue) or benign effects on reproductive fitness, while those between species will be deleterious (outbreeding depression). This conclusion is based on genetic theory, simulations and empirical examples. A similar conclusion regarding delineation of species for conservation purposes was reached by Crandall et al. (2000) based on arguments about conserving adaptive genetic variation.

Russello and Amato (2014) consider use of reproductive isolation to be non-operational, as at the most stringent level it requires data on crosses between populations. However, it can be implemented practically as we now recognise that reproductive isolation arises overwhelmingly from adaptation to different environments (as proposed by Darwin) and/or the existence of fixed chromosomal differences (that cause outbreeding depression in crosses) (Frankham et al., 2012). Chromosomal differences can be readily distinguished by karyotyping and those due to ploidy differences by measuring DNA content. Many adaptive differences are readily delineated, such as day length adaptation from changes in clock genes, altitudinal adaptation from changes in haemoglobin loci in animals, diet from changes in digestive enzyme loci, flowering time in plants from changes in flowering time loci, etc. In fact, Russello and Amato (2014) accepted our suggestion for the use of ITS2 as a predictor of reproductive isolation as diagnosable. They also point to the feasibility of diagnosing adaptive genetic differences in their final sentence where they say 'our increasing ability to detect genome-wide variation in natural populations holds promise for directly integrating adaptive genetic variation...'

The issue of over-splitting of small inbred populations with low genetic diversity for allopatric populations when using PSC does not disappear with adequate sampling, as it is an inherent problem created by genetic drift in small isolated populations. Conversely, use of PSC is not a problem with sympatric or parapatric distributions of populations, as diagnosability indicates reproductive isolation. Inadequate sampling is a serious problem in conservation contexts, as densities of individuals are often low, populations may have been extirpated, capture of animals for sampling may stress animals, permits may deny access to any but a few individuals, the source of individuals in captivity may be unknown and there are often very limited funds for sampling and analysis, especially for non-charismatic species.

Thus, there are multiple reasons for avoiding the use of PSC in delineating species for conservation purposes, especially for populations with allopatric distributions. Conversely, the use of DFSC or BSC is operational via the causal associations between reproductive isolation and adaptive differences and/or fixed chromosomal differences.

In conclusion, rapid loss of within-population diversity and development of divergence among local populations due to random genetic drift is a potential threat to many populations. Divergence should be protected when it reflects adaptive differences, but countered when it threatens populations. For conservation, we need to address this tension rather than rely on species concepts that – while operational – always preserve and amplify population isolation regardless of its value or cost to the species. Finally, it is critical that species delineations explicitly state which species concept is being employed, so that the suitability for conservation or other purposes can be evaluated.

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