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Artificial insemination for the propagation of CANDES: the reality!

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Abstract

Conservation is about protecting and nurturing species so that they can survive, not only now, but also into the future. Ideally this means protecting genetically diverse populations and not simply breeding a few individuals. Unfortunately, this point is often overlooked by reproductive technologists, especially if they are more accustomed to working with humans, companion animals or agricultural species, where the goals are more usually directed towards obtaining offspring from particular individuals. This approach has tended to antagonise the conservation community, who are quick to develop an unreasonable suspicion of technological solutions, partly because they are unfamiliar with the scientific principles that underpin the reproductive technology. Unfortunately, this mutual failure to recognise that all parties are actually well meaning, has led to separate cultures that barely communicate with each other and thus fail to capitalise on the potential benefits that would come from a good working relationship. Notable successes with reproductive technology have only emerged where such relationships have been forged. In this review, we highlight, mainly for the benefit of the technologist community, the need to foster good working relationships with conservation managers and to recognise that the latest hi-tech approach to animal breeding is more likely to engender suspicion than enthusiasm.

Keywords: Conservation; Endangered species; Assisted reproductive technology; Artificial insemination; Zoo and wild animals

1. Introduction

The basic techniques for assisted breeding have mostly been established for use in humans, domestic agricultural species and companion animals, and are applied routinely all over the world. For example, the global dairy industry routinely uses artificial insemination (AI) and embryo transfer for animal breeding, both at local and international levels, whereas human infertility clinics store surplus frozen embryos and semen as part of ongoing clinical treatments and support. Applications of reproductive technology to wild species have had mixed success, partly because of insufficient background data on the reproductive biology and management of the species in question. The limitations imposed by working with threatened species are rarely appreciated by specialists in technology, whose focus is mainly restricted to laboratory and agricultural animals. The application of such techniques to wild species, especially when considering advanced topics such as cloning and sex selection, requires a much wider understanding of the species in question, not simply the methodology itself. For this reason, we should be thinking about ''reproductive sciences'' rather than reproductive technologies when considering how to make a useful contribution to animal conservation. A multifaceted approach is needed; this requires understanding of many topics, including nutrition, population biology, veterinary medicine, and possibly even human social issues where they impact (as

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they usually do) on the viability of animal populations. These arguments have been expounded in detail, especially by Wildt et al. (e.g. [1]).

However, there is also a perception problem about reproductive biology—the discipline is poorly understood by colleagues in the wildlife community. Reproduction is not even listed under 'topics of interest' in major journals devoted to biodiversity conservation (see, for example, publication guidelines for the journals *Conservation Biology* and *Animal Conservation*). One reason for such benign disregard is that reproductive scientists are often seen as enamoured with using 'high-tech' assisted breeding methods. Conservation biologists traditionally have avoided technical solutions, fearing that reproductive technologies could divert funds from protecting habitats, while giving a false sense of security that species on the brink of extinction could be easily resurrected. In this article, we aim to explore this problem, with the overarching aim of encouraging greater understanding between the two groups of biologists who, with the best of intentions, seem unable to speak the same language. Similar, but not the same, arguments have been presented previously [2]; we do not apologise for this, as an ongoing process aimed at educating both the wildlife managers and the reproductive technologists is required if the two cultures are to discard their prejudices and work together.

2. What are the objectives of reproductive technology?

There is no problem understanding the rationale for applying reproductive technologies to the breeding of individuals, whether humans, cattle, sheep or indeed companion animals. The objective is to obtain offspring, possibly within the context of planned breeding programmes for domestic livestock, or alternatively to overcome infertility problems in specific situations, including human infertility. Captive breeding for zoo animals can also benefit from reproductive technologies, if specific genetic matches are desired, as these are often compromised by incompatibility between males and females. The ability to store germplasm by cryopreservation offers the additional advantage that breeding programmes can call on the use of individuals, via spermatozoa, oocytes or embryos, which are no longer alive or may be geographically separated by long distances. The establishment of genetic resource banks containing frozen germplasm has been widely proposed as a practical means of supporting genetic management programmes for captive animals and small populations [3–5].

Here we need to distinguish between sets of objectives and to specify that this article is focused on the application of reproductive technologies as a support tool for conservation. It is of course realistic to apply these technologies in agriculture and to the breeding of companion animals with considerable success, although some technical problems such as pig embryo freezing have only recently been solved. The objectives here are to obtain good conception rates and to produce offspring that meet the quality criteria of the breeders. The conservation breeding objectives are not necessarily the same; the objectives are more focused on supporting the genetic diversity of populations, with the overarching aim of maintaining a healthy and viable population that can thrive into the future. This involves attempting to avoid the well known effects of inbreeding within small populations that lead towards the so-called ''extinction vortex'' [6,7]. Here, there is less emphasis on producing numbers of offspring, but more on obtaining offspring from individuals chosen because they are perhaps least related to other members of the population. Ideally, any technique should therefore be robust and reliable to the point that its application is not noticeably different from the alternative of natural mating. With the exception of the Black-footed ferret (*Mustela nigripes*), where AI is now routinely used for genetic management and has, in fact, resulted in the production of over 130 offspring [8] (see chapter by Howard et al., in this volume), the technologies for wild species have not yet reached this level of reliability. Wildlife managers therefore do not yet regard them as viable tools for routine use.

In technological terms, there are major problems in establishing methods that actually work reliably for wild or exotic species. This has led to a culture whereby breeding successes with such species attract considerable publicity and where the one-off successes are reported in the popular press as being the breakthrough that will avert the threat of extinction for the given species. Unfortunately, it is neither valid nor reasonable to view the production of offspring as a sign that a species' conservation problems have been solved, but this is exactly what often happens. While this view of assisted reproduction may seem unduly negative, or at least muted, it is necessary to emphasise the point for the benefit of those technologists who are unfamiliar with the bigger picture of conservation. We have engaged in entertaining and sometimes frustrating discussions with biotechnologists, especially those involved with intra-cytoplasmic sperm injection (ICSI) or cloning, who often propose exotic schemes for generating embryos in rare, and usually large, species