That Reciprocal Cross — Is It a Mule or Hinny?

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A mule is a hybrid between a donkey and a horse. So is a hinny. The difference is that a mule has a donkey as a father, and a hinny has a horse as a father. The two are reciprocal crosses, the outcome of which is quite different. A hinny, unlike a mule, has a much bushier tail, gentler disposition, and much shorter legs. Why can reciprocal crosses lead to different results? The answer lies in the cellular location of the genes.

In plant cells, there are tree structures that contain genes. Most of the genetic material in an organism is structured into chromosomes. Chromosomes contain the genetic material DNA arranged as a very long, highly twisted, and knotted string of genes. Most of an organism's characteristics are encoded by genes that are found in chromosomes. The chromosomes are found within the cell nucleus.

Another cellular structure, the mitochondrion, also contains genetic material. In mitochondria, the DNA is arranged as several small circular molecules. The mitochondria are responsible for cellular respiration, and several key respiratory genes are located on mitochondrial DNA.

The other cellular structure that contains genes is the plastid. Plastid DNA also is arranged as small circular molecules. The plastids have multiple functions. One type of plastid, the chloroplast, is responsible for photosynthesis. Another plastid, the chromoplast, contains the deep yellow-gold ddarotenoid pigments found in flowers. Many key genes for photosynthesis and carotenoid production are encoded on plastid DNA.

These three different types of DNA are each inherited in a different manner. Nuclear DNA is inherited in the most complex way. A process called meiosis assures that each pollen cell and egg cell contains one and only one copy of every gene found within the nucleus. When a pollen cell then fertilizes an egg cell, the resulting zygote contains an equal number of nuclear genes from each parent. The maternal and paternal parents have an equal contribution. Therefore, reciprocal crosses will not produce progeny that differ in their nuclear genes. This is not the case for plastid and mitochondrial genes.

Pollen grains are small cells that contain few plastids, while egg cells are quite large and contain about 50 plastids. When the pollen cell fertilizes the egg cell, only the nucleus plus a few mitochondria enter the egg cell. No plastids from the pollen cell enter the egg cell; thus plastid genes are maternally inherited. It makes a considerable difference which parent is the mother.

A typical egg cell contains several hundred mitochondria. When fertilization occurs, the pollen cell releases one or two mitochondria into the egg. Less than 0.5% of the mitochondria in the zygote are derived from the paternal parent. This small fraction is insignificant in inheritance. Mitochondrial genes also are inherited maternally.

In every instance, reciprocal crosses will produce different progeny. If, however, one is not interested in the plastid and mitochondrial genes, then these differences are unimportant. Several traits that are inherited maternally are some types of leaf variegation (e.g., *Neofinetia falcata* 'variegated form' and not *Paphiopedilum* Maudiae), plant growth characteristics related to photosynthesis or respiration (e.g. resistance to temperature extremes), pollen sterility, and aspects of yellow/gold flower colors (e.g., carotenoid

pigmentation). In the orchid family, very few true reciprocal crosses have been made. A true reciprocal cross must involve identical clones. For example, *Phalaenopsis* Meadow Lark 'Flecked' x *Phalaenopsis* Rio's Sundial 'Spotted' is the reciprocal cross of *Phalaenopsis* Rio's Sundial 'Spotted' x *Phalaenopsis* Meadow Lark 'Flecked'. On the other hand, *Phalaenopsis* Meadow Lark 'Golden Eagle' x *Phalaenopsis* Rio's Sundial 'Spotted' is not the reciprocal cross of *Phalaenopsis* Rio's Sundial 'Spotted' x *Phalaenopsis* Meadow Lark 'Flecked'.

When you review the Royal Horticultural Society registrations or the current American Orchid Society awards, you cannot determine which crosses are true reciprocals because clonal epithets have been omitted. In addition to this lack of information, many commercial and amateur breeders do not feel that reciprocal crosses produce different results. Thus, they do not keep accurate records on which parent in a cross was used as either the male or female. When you make a cross, keep accurate records and be sure you do not create a hinny when you want a mule.