# BLOODTYPING OF FALLOW DEER - GENETIC MARKERS OF HYBRIDISATION

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Hybridisation of deer species is an important means of bringing new traits into the national deer herd. In the New Zealand fallow deer industry hybridisation of the common European fallow (*Dama dama*) with the larger Persian or Mesopotamian fallow (*Dama mesopotamica*) may provide valuable increases in calf growth rate and in the size of does. As well as the size and growth rate differences of Mesopotamian fallow, hybridisation introduces new genetic variation into fallow deer.

One of the unusual features of European deer is their lack of genetic variation in biochemical characters and low variation in production traits. European fallow deer are thought to have survived the last ice age only in the south east of Europe and have since been brought back to Western Europe. The population reduction in the ice age, combined with captivity and breeding by man, appears to have lessened their genetic variation with one exception - the coat colour variation that man could see and preserve.

The low level of genetic variation present in European fallow deer means the rate of progress in selecting superior strains is likely to be slower than in other, more genetically variable species such as the European red deer. Conversely, the low genetic variability of European fallow means the benefits of the heterosis produced by hybridisation may be more striking than in European red deer.

However, the benefits of hybridisation are not without cost, if valuable pure strains are lost by unwanted hybridisation. Also, after the F1 generation, hybrid animals may be variable in their production traits. This is an advantage to the breeder wishing to begin a selection programme, but to the producer consistency and predictability of production may be more important. These costs have been experienced in the hybridisation of elk (wapiti) and red deer which has occurred in New Zealand and overseas. The results of hybridisation in the wild are poorly documented and controlled hybridisation of animals in captivity leaves much doubt over the hybrid status of many animals. The cost of this uncertainty is difficult to measure but for some deer breeders, both in New Zealand and overseas, it has been considerable.

In the red deer industry blood testing is widely used by breeders to help ensure that their knowledge of hybridisation in their animals is correct. This paper describes the possible use of hybrid markers in the fallow industry as an objective means of verifying and documenting

the presence of hybridisation. The fallow industry is fortunate when compared to the red deer industry because hybridisation is at an early stage and has not occurred in the wild. However, to avoid doubt on the hybridisation status of animals it is important the issue of documenting hybridisation in the fallow industry is addressed soon.

**Hybrid markers - how they work**

The blood of all animals contains proteins which are inherited in a simple and predictable way. Blood protein type is commonly studied using a technique called electrophoresis. This technique is used widely in animal industries to provide parentage tests. At Invermay, hybridisation between deer species is using protein electrophoresis.

For fallow deer, markers which can be used to detect hybrids must have the following properties:

All Mesopotamian fallow have one protein type

All European fallow have another protein type

The protein types are inherited.

Markers such as these are inherited in a specific way - each animal inherits one type from its father and one type from its mother.

When a pure Mesopotamian buck is crossed with a pure European doe the hybrid calf (called by geneticists an F1) inherits one Mesopotamian type from the father and one European type from the mother (Figure 1). When F1 animals are blood tested they always show both the Mesopotamian and European types.

The strength of the test is that any animal containing both Mesopotamian and European types must be a hybrid.

Producing an F1 is the first step in hybridisation. From this point an F1 can be mated to another F1 (producing F2 hybrids) or backcrossed to either of the pure parent species. Backcrossing an F1 to a Mesopotamian fallow produces 3/4 Mesopotamian animals in the first generation and when these are backcrossed to a pure Mesopotamian, 7/8 and 15/16 Mesopotamian animals in later generations. Backcrossing to a European fallow produces 1/4 Mesopotamian animals in the first generation then 1/8 and 1/16 animals in later generations.

| Mesopotamian | | European | | F1 Hybrid |
|---|---|---|---|---|
| MM | X | EE | ----> | EM |

**Figure 1:** The inheritance of a hybrid marker in the mating between a pure Mesopotamian (MM type) and pure European (EE type) fallow. One type is inherited from each parent so the F1 hybrid offspring has a combination EM type which clearly identifies it as a hybrid.

| F1 Hybrid | | European | | Backcross progeny |
|---|---|---|---|---|
| EM | X | EE | ---> | 50% EE 50% EM |

**Figure 2:** The inheritance of a hybrid marker in the mating between an F1 hybrid and a pure European Fallow. One type is inherited from each parent so half the backcross progeny inherit the E type from their F1 parent and half the M type from their F1 parent.

When backcross animals are blood tested the chance that a Mesopotamian bloodtype will be detected in an animal decreases as the proportion of Mesopotamian genes decreases. Table 1 shows the probability of detecting Mesopotamian genes in F1 and backcross animals using one, two and four markers. This chance decreases in hybrids closer to a pure European fallow and increases with the number of markers used.

This is because when a hybrid is mated only one of its bloodtypes - either the Mesopotamian or European type - is passed on to its progeny. This means that in the first backcross to a European fallow (Figure 2) only half of the progeny will inherit a Mesopotamian type at a single marker. If more than one hybrid marker is used then the chance that backcrossing will contain Mesopotamian types is lessened (Table 1).

In the backcrosses to a Mesopotamian buck all the progeny will inherit one Mesopotamian type from the buck. Thus 100% of the progeny will clearly show the presence of Mesopotamian genes (Table 1).

**Table 1:** The probability of detecting Mesopotamian genes in F1 hybrid and backcross animals

| NO. OF MARKERS | Proportion of Mesopotamian genes 7/8 | 3/4 | 1/2(f1) | 1/4 | 1/8 |
|---|---|---|---|---|---|
| ONE (GPI) | 100% | 100% | 100% | 50% | 25% |
| TWO | 100% | 100% | 100% | 75% | 44% |
| FOUR | 100% | 100% | 100% | 97% | 68% |

## The GPI marker

Only one hybrid marker has been reported for fallow deer. However, it is likely that more research will reveal further markers. The marker used to detect hybridisation is one of the proteins involved in converting food into usable energy. It is called Glucose Phosphate Isomerase - GPI for short. The name and the identity of the protein are not important. What is important is that all the 11 Mesopotamian fallow typed in New Zealand and the United Kingdom have a different type to European fallow. This difference is inherited so all the F1's tested show both European and Mesopotamian fallow types.

## Discussion

Uncertainty about the hybrid status of animals, and therefore their likely performance, is one of the major costs of hybridisation for a farmer. Avoiding this cost needs good record keeping. The extent of hybridisation must be monitored so pure populations such as the rare Mesopotamian fallow and valuable strains of European fallow are not unwittingly subject to hybridisation. For hybrids it must be known whether an animal is an F1 hybrid, F2 hybrid, stabilised synthetic, or backcross and the backcross generation. All these animals and their progeny have different performance characteristics.

Bloodtyping is an important tool in avoiding the confusion of hybridisation by helping remove doubt about the genetics of hybrid animals.

Using the GPI marker all pure Mesopotamian animals, all F1 animals and all F1's backcrossed to pure Mesopotamian can be shown to contain Mesopotamian genes (Table 1).

In F1's crossed to European fallow, a proportion of animals will show Mesopotamian genes but a proportion will also show only European markers. With more hybrid markers the test will be more powerful in this area (Table 1).

Bloodtesting is most powerful when used with good records. It can then be used to maintain the accuracy of records and give more additional information about groups of animals. For example given a group of 15 animals F1, F2, 7/8, 3/4, 1/4 and 1/8 backcross animals can be distinguished by the frequency of blood types.

Hybridisation in the fallow deer industry is at a manageable stage. If an accurate recording programme can be set up at this early stage it should ensure the problems present in the red deer industry about the uncertainty of hybrid status and performance are not repeated.