They entered the boat in pairs, male and female, just as God had commanded Noah.

Genesis 7:9-19

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GUIDO PEROSINO- 10th Congress of the Federation of European IWH clubs (EIWC)

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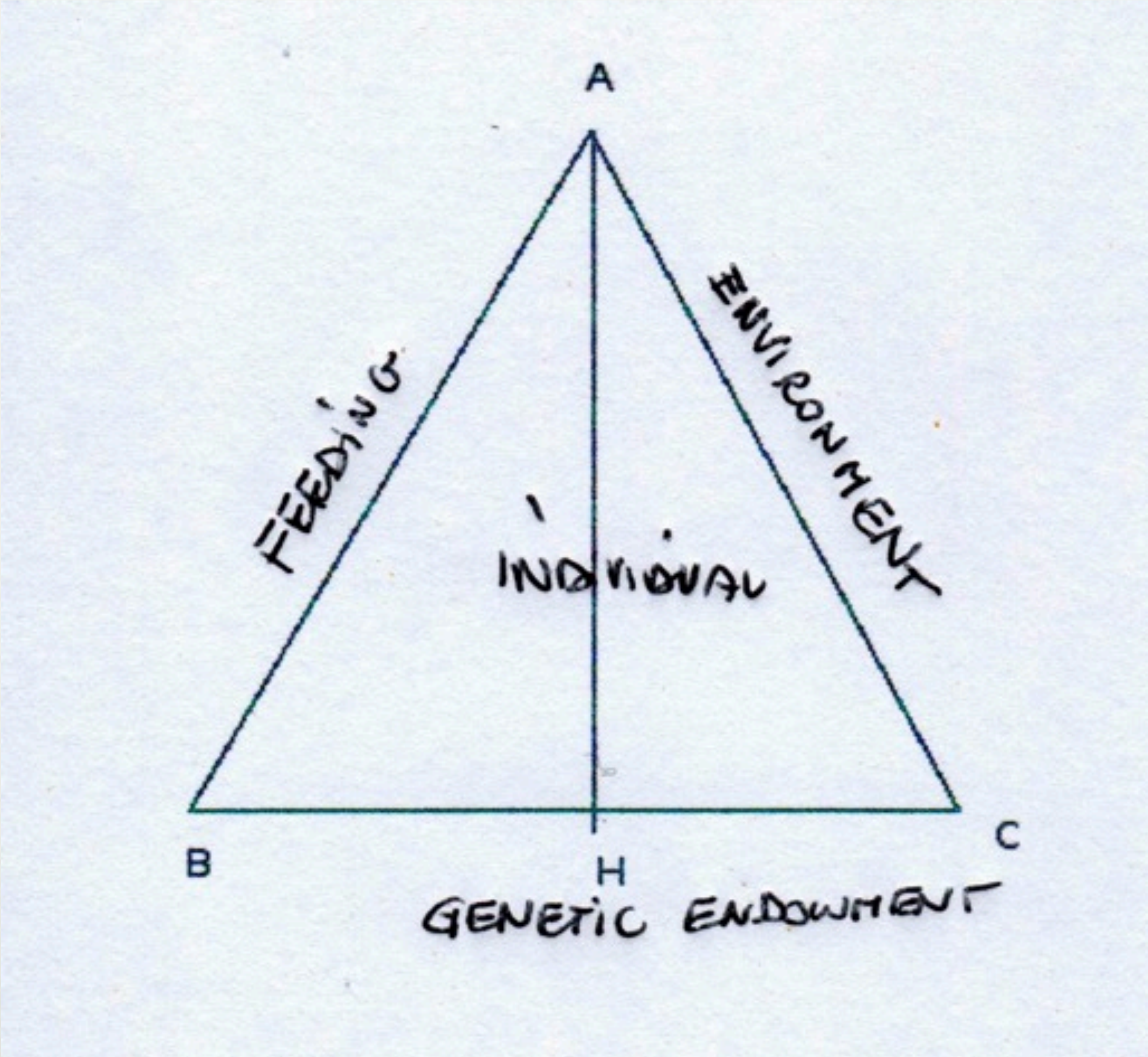
THE BREEDING PARADOX

homogeneity vs variability

THE TRIANGLE OF LIFE



THE TRIANGLE OF LIFE

- The area represents the "productivity" of the individual and this can be changed by man acting on 'feeding, breeding or changing the environment (improving the living conditions of animals). Doing so, trough the outward manifestation of the individual we can not act on genes: we can act, instead, on population genetics to improve the results in offspring with an appropriate plan: selection, crossover, consanguinity.

CHARACTHERS

The characters in an individual are influenced by one or a few genes, or from all the genes (polygenic inheritance).

QUALITATIVE CHARACTERS

With the first possibility quality traits are transmitted - hair color, presence or absence of tail , presence absence of undercoat-.

In this case the variability is discontinuous, can or cannot appear, it is hardly measurable, not influenced by environmental factors or feeding.

The outward manifestation of them (phenotype) is directly and solely coming by heredity (genotype).

QUANTITATIVE CHARACTERS

- The characters depending from a large number of genes are known as quantitatives.
- They are continuously variable, strongly influenced by the environment, easily measurable, in livestock they are the characters of economic interest (weight, height, quantity of milk, quantity of meat).

QUANTITATIVE CHARACTERS

For these characters the phenotype depends not only on the genotype, but by several environmental factors (paratype) that influence the phenotype to very different degrees.

These characters are dependent on a large number of genes carried on more pairs of homologous chromosomes (complex polygenic).

QUANTITATIVE CHARACTERS

The individual genes exert their action on the development and intensity of the characters in such a way also quantitatively different, but still have the property to summate the individual effects, producing the so-called gene additive effect, which can be of dominance - recessive, between genes of the same locus, or between genes placed in different loci (epistasis).

HEREDITY AND HERITABILITY

Heredity refers to the transmission of qualitative characters (characters with a discontinuous variation, difficult to measure, influenced by a few genes, not influenced by environmental factors) from parent to offspring.
The heritability expresses the relationship between what an individual receives from their parents (additive genes), or quantitative traits, easily measurable, strongly influenced by environmental factors.
The heritability is a relative term and refers only to quantitative traits.

If we could cancel the enviromental effect - for example by making it uniform - any variation would be only due to genotype.
To this fraction of variability was given the name of heritability.

HEREDITY AND HERITABILITY

The heritability is calculated using this expression:

P = (G, E) = G + E

If we call **σ2** the variability of a character around his mean (measure of central tendency), and call **h2** the heritability, then we have:

h2 = σ2 G / P = σ2 σ2 G / G + σ2 σ2 E

Where the heritability varies from 0 to 1

HEREDITY AND HERITABILITY

- The genetic variance **σ2 G** includes the additive effect of characters (similarity between the relatives of a population) on which it is implemented the selection or a breed (population, family) genetic improvement + the variance of dominance, due to interaction between genes + the alleles epistatic variance .

The additive variance can be estimated on the relatives within a population; in the same time the enviromental variance, can be calculate (the one due to the enviromental differences among individuals); the environmental difference is not inheritable or transmissible to offspring, the factors that influence the environmental variance are climatic conditions and nutritional ones,when

$$\sigma 2\ E > \sigma 2\ G$$

the heritability decreases.

HEREDITY AND HERITABILITY

When **h2** is close to **zero** the manifestation of the character does not depend on hereditary component, vice versa if **h2** is close to **1** the character has only the genetic component.

In general, the heritability is estimated by the similarity between parents and offspring or between siblings. The concept of heritability is not appropriate to the individual animal but to a group of individuals living in the same environment.

For example, if a character is estimated **h2 = 30%** it is concluded that the superiority or inferiority of certain traits is due only for **30%** to their genetic superiority or inferiority, the remaining **70%** is due to different environmental conditions.

30% indicates the percentage of parents that may transmit the character to the offspring.

The heritability provides a measure of the genetic variability of a population, a measure of the amount of improvement achievable in the population by means of a phenotypic selection.

THE GENETIC IMPROVEMENT

- the genetic improvement of a breed is a technique that allows the increase of productive and reproductive performance of the animal population through the evaluation and subsequent choice (selection) of breeding animals;

A WHOLE HERITAGE

- Compared to others techniques this improvement generates permanent “gains in productivity”. This is true beyond the narrow particularity or a Club's interests since the whole heritage of a breed is involved (in some species almost the entire population). For this aspect, the genetic improvement is usually considered as an activity of “public interest”.

A WHOLE HERITAGE

- The characters of interest in the genetic improvement can be both functional (among which are those strictly economic or sports related) or beauty (sound) related.

BREEDING TO IMPROVE

THE **GI** TAKES PLACE IN 4 DIFFERENT STAGES:

- ☐ a) the choice of selection objectives,
- ☐ b) the study and description of the population under selection,
- ☐ c) the genetic evaluation of breeding animals;
- ☐ d) selection criteria for improving .

BREEDING TO IMPROVE

- The choice of selection objectives is the definition, at the operational level, of the characters on which to concentrate the efforts.The definition must be as precise as possible because it must be very clear where you want to reach, and limited because the search for the improvement of many characters causes the reduction of the gain obtained for each of them (it is not possible, or at least is very difficult, to identify animals carrying the best genotypes for different characters, animals must be must be chosen with a complex genotype is good for all characters, but probably not great for both of them).

BREEDING TO IMPROVE

The second step consists in the description of the population for the chosen character. We will see how this is possible from the phenotypes (P), from the relationships among the animals, the extent of the variability of phenotypes explained by that of genotypes (measured by the coefficient of heritability: h2), the association between the statistical values of the additives characters selected and the degree to which repeated measurements of the same animal are alike (measured by repeatability r). It 'obvious that to make such a description is necessary to have a robust arsenal of statistics.

BREEDING TO IMPROVE

- The third stage is related to the use of technical coefficients, together with the phenotypic measurements and relationship among animals, to estimate the additive genetic value (the breeding value BV) of potential parents by which they may be classified with respect to each other in a scale of merit. The estimate of the BV is implemented with the calculation of the so-called genetic indexes (IG) with statistical methods sometimes very complex and with selection schemes that vary as a function of the phenotypic information used.

BREEDING TO IMPROVE

- The fourth step concerns the improvement strategy to be adopted (the so-called selection programs) that depend on the genetic progress expected E (dR), where E means espected (ie, estimated mean value), and its cost.

- In this phase will also be evaluated accessor methods such as crossing between different breeds or between different lines of the same breed or the use of inbreeding.

BREEDING TO IMPROVE

- These four stages provide an assessment of the known, <u>the phenotype</u>; the unknown, the additive genetic value of animals to select candidates in order to change the frequency of quantitative traits of the population, and its expression.

BREEDING TO IMPROVE

- The collection of all information used for the selection is made by breeders and their organizations

BREEDING TO IMPROVE

- CLUBS SHOULD BE ABLE TO DECIDE THE OBJECTIVES AND METHODS OF SELECTION, GATHERING INFORMATION FROM THE KENNELS AND THE MORPHOLOGICAL AND FUNCTIONAL EVALUATION SESSIONS, CALCULATE THE REPRODUCTIVE VALUE OF INDIVIDUALS TO SELECT CANDIDATES ACCORDING TO THE SELECTION SCHEME ADOPTED, PUBLISH THE RESULTS , DEVELOP AND UPDATE THE PARAMETERS OF THE POPULATION REGARDS THE CHARACTERISTICS OF OBJECT SELECTION (MEANS, VARIANCES, HERITABILITY, ETC..), DISCLOSE THE RESULTS.

BREEDING TO IMPROVE

Particular attention should be paid to the examination of morphological characters of the subject selection and methodology for their detection and genetic evaluation. The detection can be done in a pattern called "linear evaluation", which attempts to make objective through a classification based on morphological evaluation scores of an animal.

THE USE OF INFORMATIONS

- The selection of individuals for breeding is based on an estimate of their reproductive value, which may result from phenotypic information directly integrated or not, information collected from relatives. The selection methods are, therefore, closely linked with the methods of evaluation of individuals.

The information of relatives

If the choice of the best players were limited to individuals who have the best phenotype, we will not be here!
The estimated breeding value based only on phenotypic data of the subject in question forces us to resort to statistical analysis to obtain the parameters of the population to which the individual belongs (heritability, repeatability, etc..), But this method is not always sufficient to work the best choice, even if it is to be preferred where alternative methods do not present unique benefits of a practical and economical.
From the time of the Roman farmers had arisen the doubt that they would have chosen better players if they had been keeping an eye on their relatives.

THE USE OF INFORMATIONS

- Because we value the animals in order to achieve maximum benefit in the next generation it becomes of prime importance the estimation of their BV.

- IN GENETIC IMPROVEMENT, THE INFORMATION OBTAINED FROM RELATIVES ARE USEFUL IN TWO CASES: A) IF THE CHARACTERS ARE SUBJECT TO SELECTION FOR LOW HERITABILITY WHICH THE PHENOTYPE OF THE INDIVIDUAL IS A BAD GUIDE TO THE IDENTIFICATION OF ITS GENOTYPE; B) WHEN THE CHARACTER OBJECT OF SELECTION INVOLVES A GAIN OR A LOSS.

THE USE OF INFORMATIONS

- The use of information derived from relatives is permissible even for distant relatives, but their importance decreases, the lower the degree of relationship, may be useful in practice to differentiate those obtained as the average phenotype of a distinguished family, and those individuals within the family. In particular, it is useful to distinguish between the phenotypic information of the individual and those of his offspring.

THE USE OF INFORMATIONS

The phenotypic value of an individual, expressed as a deviation from the mean of the population, can be decomposed into two parts: the deviation of the average family from the average of the population (Pf); the deviation from the mean of the phenotype of the individual versus its family.

Depending on the importance accorded to each of the two information components we can classify the ways in which you can perform the selection as follows:

a) individual selection, where individuals are selected based on only the individual values for which the two components are considered with equal weights;

b) kin selection, where individuals are selected only on the basis of average family,

c) intra-family selection

THE INDIVIDUAL SELECTION

Individuals are selected only as a function of their phenotypic value and this method is the simplest and, at times, even the most economical method of genetic improvement.

FAMILY SELECTION

Individuals are selected only on the basis of the phenotypic average family to which they belong, that is to say that individual differences within the family are not taken into account. This method is based on the assumption that, in sufficiently many families, the median household phenotype is a good estimate of the genotypic value of the individuals who compose it.

INTRAFAMILIAL SELECTION

- IS THE CHOICE OF INDIVIDUALS ON THE BASIS OF THE DEVIATION FROM THE MEAN OF THE SAME CLASS, WHICH PUTS THIS METHOD TO THE ANTIPODES OF KIN SELECTION: THE BEST ARE THOSE THAT DEVIATE MORE (POSITIVE OF COURSE) WITHIN THE FAMILY.

COMBINED SELECTION

- THIS METHOD INVOLVES USING A COMBINATION OF ALL AVAILABLE INFORMATION, IT ALLOWS, IN THIS WAY, AN INCREASE IN THE RELIABILITY OF THE ESTIMATE OF GENOTYPES.

ASSESSMENT OF THE VALUE OF AN INDIVIDUAL

One of the main purposes of genetic improvement is to identify the best genotypes to be preserved for the creation of the next generation. The systems currently used for this purpose using the most amount of information available and combine within a genetic index (GI) or selection.

The GI can be defined as the best linear prediction (BLP) of the reproductive value (BV = breeding value) of an individual and it takes the form of a multiple regression of the BV of all sources of information.

RELATIONS BETWEEN ANIMALS

We are able to assess the importance of phenotypic information arising not only from the animal to the candidate selection, but also by his relatives.

RELATIONS BETWEEN ANIMALS

- The animal relatives have a similar genetic makeup, and the coupling between them (inbreeding) produces an offspring that has a higher fraction of homozygosity of the population mean. Vice versa the coupling of animals with very different chromosome pairs (outcross) give offspring with a degree of heterozygosis greater than the average of the population to which they belong.

RELATIONS BETWEEN ANIMALS

The population of animals have a fraction of genes in common, but two relatives have an additional fraction of genes identical. In common sense when two individuals are considered relatives have a common ancestor for which the fraction of additional common genes depends on the distance, in generations, which separates them from the common ancestor. The degrees of kinship express the probability that two individuals have a gene in common and it is intuitive that those whose distant relatives are likely to have common genes is lower.

RELATIONS BETWEEN ANIMALS

- The family is a group of individuals descended from common ancestors, but because the genetic asset inherited from common ancestors, with the passing of generations, the concept of family is lost rapidly.

- THE LINE IS A SET OF ANIMALS CHARACTERIZED BY HIGH CONSANGUINITY OBTAINED BY COUPLINGS BETWEEN INDIVIDUALS RELATIVES; THE CREATION OF THE PARENTAL LINES, OF WIDE USE IN THE GENETIC IMPROVEMENT OF PLANTS, IS USED IN LIVESTOCK IN SOME SPECIES SUCH AS PIGS AND RABBITS IN WHICH THEY ARE EXPLOITED TO THE JUNCTION WITH THE OBTAINMENT OF THE SO-CALLED COMMERCIAL HYBRIDS.

- THE STRAIN IS A RATHER LARGE GROUP OF ANIMALS BELONGING TO A BREED IN WHICH THE PAIRINGS WITHIN THE GROUP OCCURRED, FOR VARIOUS REASONS, WITH A FREQUENCY HIGHER THAN THE AVERAGE.

INBREEDING

An animal is said inbred when there is a kinship between the father and mother; the couplings between animal relatives are called inbreeding matchings or consanguinity. The effect of inbreeding is an increase of homozygous loci in the inbred individual than the general population.

We note immediately (and remember well) that the coefficient of inbreeding is related to an individual animal, while the relationship coefficient is related to at least two animals.

INBREEDING AND OUTCROSS

The knowledge about the familiarity relations among animals is exploited in the genetic improvement not only to increase the number of phenotypic information used in estimating the genetic value of an individual, but also for the construction of proper selection schemes that use adequately the benefits of the inbreeding or those of the outcross for some traits.

Usually imbreeding causes depression effects on the character while heterozygosis will enhances the effect of hybrid vigor. The negative consequences of inbreeding for humans and animals have been known for a long time, Darwin wrote that "the consequences of the matching between relatives are the height reduction, the loss of constitutional robustness and fertility, sometimes accompanied by a tendency malformations. "

INBREEDING AND OUTCROSS

- Because inbreeding causes a rise in the proportion of homozygous loci than the general population, we do not see a difference, in the case of quantitative traits among inbred and not inbred individuals.
- Characters linked to the vitality of the individual are not usually additive (dominance, overdominance, etc. ..).In the heterozygotic individual the phenotypic expression is higher than homozygotycs.

INBREEDING AND OUTCROSS

- There are recessive genes that are responsible for malformations, some even death, which are expressed only in the homozygous state. Their research and the elimination of carriers is a practical tool in the hands of the breeder.

Since the consanguinity depresses, in particular the vitality of the individual, inbred animals show in general a depression of the productions, especially evident in the case where they are placed in difficult environmental conditions.

INBREEDING AND OUTCROSS

- The outcross is a technique that allows the increase of the degree of heterozygosity in animals usually derived froma constitutional robustness. The phenomenon of heterosis from which it derives, also known as the luxuriance of the hybrids, in animals is generally not as obvious as in plants.

INBREEDING AND OUTCROSS

- For inbreeding, there is a coefficient which measures the degree of heterosis. Such a definition would lead to the complete understanding of the genotype of the population from which are extracted the individuals to be matched. The degree of heterosis is measured then simply with the superiority of the average of phenotypes compared to that of the populations from which the parents to the offspring are chosen. This is a concrete tool to contain the spread of undesirable genes. Monitoring techniques for these genes have recourse to the matching of male candidates for selection by the females definitely carriers or with their daughters, the response of the survey is an "exception" and shows the probability that the animal tested can carrier the unwanted gene.

INBREEDING AND OUTCROSS

- Since the consanguinity depresses in particular the vitality of the individual, inbred animals have in general the depression of the productions. This is especially evident in the case where they are placed in difficult environmental conditions.

Breeding problems

There is one very interesting fact in breeding (actually there are many interesting things as we all know), that is the conflict between the theory and the practice. I know, it's more like fantasy if one thinks we could realize all the theories in the reality, but in this special matter the conflict is more like the practice, not an exception.

If a breeder wants to study breeding in books to find good hints for breeding and he/she likes to pay attention to such important things as wide gene pool, health and temperament, the breeder wants to find a partner to his/her own bitch that is as little related to his/her own stock as possible. An outcross (no same dogs in the pedigree in minimum 8 generations) brakes up the inbreeding process and makes puppies more healthy, their temperament better and of course the gene pool becomes automatically wider.

- What is the reality? Sometimes everything fit well together in outcrosses and the breeder gets usable breeding stock for the future. But the poor breeder might also stand in front of the fact that he/she has lost in one generation health (including fertility), temperament and also dog's outline. How in the earth is this possible? According to breeding books we should prefer today outcrosses in order to broaden the gene pool and save the breed. How can I save the breed when I suddenly have a bitch (out of the line I have bred for generations) in my hand that is in all quality criteria below my breeding standard: a bit shy, at most "good" in outline (the line is full of title winners) and with hormonal problems (the vet's suggestion: don't use that). This is just one example, an own one.

- There was in the Finnish Kennel Club magazine in December 2011 a long article in which the material was collected from insurance companies. Cross-bred dogs are not healthier than pure bred ones. Actually cross-bred dogs is the third (3.) biggest "breed" to get reimbursement for exactly same illnesses as pure bred dogs. The "truth" of healthy cross-bred dogs is only a myth, nothing else. This also is against all the fine breeding theories.

- I'm aware of the problems many pure bred breeds have today; I don't want to deny them. I know the basic genetic rules, and I see the difficult situation we are in: what shall we do in order to save our breeds also to the generations after us. But I'm really frustrated about the situation, when books and theories actually have nothing (or maximum very little) to do with the reality. WHY? It becomes a big problem when we have people in high positions making decisions – and their knowledge lies only on the theories.

- Why don't the theory and the practice meet in dog breeding? Or they meet so seldom. It would be nice to hear some kind of a wise explanation.

Outi Piisi-Putta

Finland