THE "ALFORT JUMPER" RABBIT : HISTORIC, DESCRIPTION AND CHARACTERIZATION

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Abstract - Known on 1935, the 'Alfort jumper' rabbit shows a locomotion behaviour particularly acrobatic, moving on his two anterior paws. This character is due to the gene (s^{am}), a major recessive gene compared to the normal gene (character 'no-jumper'). The caryotypic analysis didn't evidence any chromosomic anomaly. Furthermore, the 'jumper' animals homozygous (s^{am}/s^{am}) were born blind and systematically develop a cataract and irreversible lesions of the retina. Some cerebellum anomalies has been observed on few individuals. This animal-model is particularly interesting for genetical, ophtalmic and neurological purposes. The 'jumper' animal is now preserved in situ by a group of agreed farmers and ex situ in form of frozen embryos that are stored in a cryobank. Now, many 'jumper' rabbits are available for persons whose research program have been agreed to a scientific committee.

INTRODUCTION

The "Alfort jumper rabbit" is an original rabbit easily recognized by its particularly acrobatic locomotion behaviour and constant ocular lesions. Recently, after a period when the "Alfort jumper rabbit" was almost forgotten, some breeders have taken interest in this rabbit. They have created a group to preserve these animals and to study this specific character in collaboration with researchers. Now, the "Alfort jumper rabbit" is preserved on less than 10 approved farms (BOUCHER, 1991). These animals seems to be an original model that can be used to learn more about different scopes of science as ethology, genetic, ophtalmology, neurology. The aim of this paper is to summarize the different data evidenced in the work of the last years on this specific "jumper" character.

HISTORIC

Four different populations have already been registered: one was raised in England, but this population seems to be definitively lost (ROBINSON, 1958). Two other populations, one from the hospice of Marseille (France) and one from a natural park in Italy, have been reported previously (ARNOLD, 1991) but at the moment there is no more information about them. The population that we are studying today is originated from a single female of the breed "Normande" which was first observed in 1935 at the veterinary clinic of Maisons-Alfort (France) and mated to be multiplied (LETARD, 1935). Nevertheless, E. LETARD professor of zootechnic at the Veterinary School of Alfort had to abandon his rabbit rearing during the second world war. When he came back, there was only one male left from which he again constituted a strain that he classified as "very prosperous" (LETARD, 1943). The descendents of this male are today registered in 3 strains: a dwarf strain to decrease the cost of in situ preservation, a medium size strain originated from various breed crosses and a homogenous strain derived from an absorption cross on the synthetic line INRA 1077. Nowadays, animals from the first and third category are mainly multiplied to provide young rabbits with the same base population to be studied.

DESCRIPTION OF THE "JUMPER" CHARACTER

The specific feature of this rabbit is an irregularity in its way of moving. This abnormality of locomotion behaviour is not always visible especially not when the rabbit is at rest, he adopts a normal attitude on its four paws. Even when passing over a short distance, less than a few meters, it moves on its four paws as its congeners or in a way slightly different, which is hardly visible to a viewer who is not aware of the problem. When the rabbit jumps, the two hind paws don't move simultaneously, but have a tendency to place themselves alternatively as the common walk observed on the majority of other mammals. On the other hand, if the rabbit wants to run on a longer distance in a faster pace or if someone try to catch him, the hind legs will lift, lose contact with the ground and the animal moves in an upright position, hind paws and tail above the head as a

human acrobat would do when walking on the hands. An animal can walk like this around its cage, then the hind paws lightly touches the ground and then the animal again gets up on its front paws.(Figure 1).

Figure 1 : The particular locomotion behaviour of the "Alfort jumper" rabbit

Actually, S. RENOUS (Museum National d'Histoire Naturelle, Paris, France) and I. AUDIGIER (Ecole Nationale Vétérinaire d'Alfort) describe this particular way of moving by using the technic of cineradiography. Animals are placed on a moving walkway which speed can be adjusted. Like this, the movement of articular chains of limbs can be filmed and radiographied which permit to compare normal rabbits with 'jumper' rabbits of the same delivering. An anatomic study of these animals complete the data in order to understand the mechanism of this particular way of moving.

Moreover, ocular lesions are always associated with the "jumper" character (THERET, 1961). The macroscopic analysis of eyes are normal from the eyelid-opening of young rabbits and up to about one year. Later, a cataract unilateral or bilateral is systematically developed on all "jumper" animals.

CHARACTERIZATION OF THE "JUMPER" CHARACTER

Genetics

Even though LETARD only had about fourty rabbits in 1943, he figured that the "jumper" character was the expression of a typical recessive major gene. Classical experiments of crossbreeding and adoption have confirmed that the anomaly has nothing to do with learning by experiments (LETARD, 1943; BOUCHER, 1994). In 1958, ROBINSON described a British strain with a locomotion behaviour very similar to that of the "Alfort jumper" rabbit and indicated that the recessive gene was referenced 'a^k' (BOUCHER and NOUAILLE, 1996). Different crossbreeding experiments were designed to be definitively fixed on the genetic determinism of this character. The results analysed by chi square are shown in table 1.

These results on a total number of 384 offsprings confirms that the 'jumper' character is the expression of a major gene (s^{am}) recessive in comparison with the gene (+) which heredity transmission is in accord with the Mendelian distribution. In addition, it was supposed that the gene (s^{am}) was partially lethal because the survival rate is lower for the "jumper" than for normal young rabbits in the same litter. The higher mortality can be explained by the fact that the 'jumper' offsprings are weaker than their siblings at the moment when they open their eyes and therefore have difficulties in competing for the access of mammaries. Such a situation was not observed in the litter composing only by "jumper" homozygous (s^{am}/s^{am}) animals.

The caryotype analysis of the 'jumper' rabbits was performed in 1992 by BERLAND (Ecole Nationale Vétérinaire de Toulouse, France). The strip chromosome coloration technic was used and didn't shown any major anomalies on the chromosomes of these animals.

The expression of gene (s^{am}) was more particularly observed on the strains of medium size. The gene (s^{am}) appears in the same way whatever the genes of fur colour may be: locus A (A^+,a,a^t,a^{ct}), locus B (B^+), locus C (C^+,c,c^h,c^m), locus D (D^+,d), locus E (E^+,E^d), locus Du and locus en. No genetic interactions were evidenced between these genes previously referenced (SEARLE, 1968 ; BOUCHER,1993) and the gene s^{am}.

At least, it must be notified that the mitochondrial DNA (mDNA) of the "jumper" rabbit is being studied by MONNEROT (CNRS, Gif/Yvette, France). The results on the different type of mDNA are still unknown.

Table 1 : Phenotypic evaluation of offsprings originate from different types of crossbreeding

Breeders	[jumper]	[normal]	
[phenotype]/(genotype)	(s^{am}/s^{am})	(+ /s^{am})	(+ /+)
[jumper]	[jumper]		[normal]
(s^{am}/s^{am})	n= 87 (100%)		n=99 (100%)
[normal]	[jumper] n=54 (40%)[a]	[jumper] n=14 (26%)[b]	[normal]
(+ /s^{am})	[normal] n=74 (60%)[a]	[normal] n=40 (74%)[b]	n=16 (100%)

(s^{am}) = Gene jumper (Sauteur Alfort Moderne)
(+) = Gene normal, no jumper
[a] non significant difference according the ½ -½ distribution of MENDEL
[b] non significant difference according the ¼ - ¾ distribution of MENDEL

Ophtalmology

In 1961, THERET was the first researcher to emphasize the interest of the "jumper" rabbit in order to study the hereditary anomalies of eyes (cataract) that was slightly binded with the "jumper" character. Thus, this rabbit was used in the veterinary school of Alfort as model animal in order to study the evolution of cataract and to implement the technics of ocular microsurgery usable on pets.

Since 1991, different types of ocular malformations have been observed: abnormal retina with bilateral papillary coloboms and a reduction of pupillary reflex only on the "jumper" homozygous (s^{am}/s^{am}) animals; a bilateral cataract with luxation of crystalline lens, glaucoms, entropions and ectropions as well on homozygous and heterozygous (+ /s^{am}) animals. The present selection of the "jumper" rabbit strains shows a clear regression in the number of eyelids malformations and it has raised the age when the cataract occurs even though it develops when animal is 2 or 2,5 years old (SCHMIDT MORAND,1992).

Pathological anatomy

The examination of histological cuts was performed on the brain and the eye of the 'jumper' rabbit by PLASSIART (Laboratoire d'Anatomie Pathologique Vétérinaire, Metz, France) and BRETON (Ecole Nationale Vétérinaire de Nantes). They have observed dysplasic or non differenciated retina and cataracts with luxation on the eyes of the animals at different ages. In some cases, a procidence of the optic nerve and a hypertrophy of pigmentary epithelium of retina were evidenced on animals. The observations of brain have shown few lesions on the brains of very young rabbits but a severe hypoplasia and an immature aspect of the cerebellum. The locomotion behaviour specific for the 'jumper' rabbit could be explained by an attack of the cerebellum and/or of the vestibule.

INTEREST OF THE "JUMPER" CHARACTER

The characteristics expressed by the "Alfort jumper" rabbit are original. Only few cases in other species were reported on animals with similar troubles: locomotion troubles in canine species (FÜHRER, 1995) and ocular lesions in mice.

For ophtalmic studies, this rabbit characterized by constant cataracts and retinopathies constitutes an excellent model animal more interesting than the murine model. In fact, the size of the rabbit eyes is well adapted to ophtalmic equipments currently used in veterinary practice and it is more easy to observe the eye bottom on rabbit species than on mice.

Moreover, the comparison of the way of moving between "jumper" and "normal" animals give a better understanding of the particular mechanism of this pathological locomotion.

Moreover, this character can be considered as an efficient genetic marker to reveal precociously animals that will develop ocular lesions or other characters.

Recently, DEI-CAZ (INSERM, Lille, France) has observed that the 'jumper' rabbit was a healthy carrier of Pneumocystis carinii. This pathogen agent develops rapidly on humans suffering from AIDS. If these preliminary results are confirmed, this rabbit could be a model to study the mechanism of HMC induced by this agent.

PRESERVATION EX SITU OF THE GENE S^{AM}

The embryos freezing at low temperature permit to store in liquid nitrogen (-196°C) for a long time the biological material with any decrease of the cellular viability (JOLY and RENARD, 1994). Homozygous (s^{am}/s^{am}) and heterozygous (+/s^{am}) does (n=10) were sampled and treated by superovulation methods used routinely to enhance the production of freezable embryos per female. Then, does were mated with homozygous

buck (s^{am}/s^{am}). After females slaughtering, embryos were collected at compacted morulae-blastocyst stage (65-72 hours post coitum) by perfusing of genital tract. Classical slow-freezing procedure was carried out in a programmable freezer. The results show that 90% of treated females produce embryos of good quality (in average, 30.4 frozen embryos/ donor females). These values are the higher for the 'jumper' rabbit than for all other populations already treated (JOLY et al., 1994). The viability of these stored embryos were evaluated in vivo after thawing and transfer of 10 embryos in a presynchronized recipient. One month later, 3 offsprings (1 with a genotype s^{am}/s^{am} and 2 with a genotype $+/s^{am}$) were born alive in normal condition

Nowadays, more than 270 frozen embryos are stored in the cryobank that is located in 2 different places (INRA, Jouy en Josas, France).The persons that are interested in the gene (S^{am}) have to submit their program research to a scientific committee. After an agreement by the commission, they can easily have access to the frozen embryos stored in cryobank.

CONCLUSION

After a period when it was almost lost, the "Alfort jumper" rabbit is now preserved in situ by agreed farmers and ex situ in the form of frozen embryos stored in the cryobank of INRA. Thus, more studies must be initiated to specify the genetic determinism of the gene s^{am} and to understand the reasons of a such locomotion behaviour which is rare in animal species.

Now, the 3 strains of different size are available for research purposes after an agreement has been reached with an official scientific committee. For ethical reasons, a deontological charter must be signed before each exchange of the gene s^{am} to protect these animals from any abusive use of the character "jumper".

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Le lapin "Sauteur d'Alfort Moderne" : historique, description et caractéristiques - Connu depuis 1935, le lapin "Sauteur d'Alfort Moderne" présente un comportement locomoteur acrobatique: il marche sur les pattes avant. Ce caractère particulier est dû au gène (s^{am}), gène majeur récessif par rapport au caractère normal. L'analyse du caryotype ne présente pas d'anomalies chromosomiques spécifiques. Parallèlement, les animaux homozygotes (s^{am}/s^{am}) naissent aveugles et développent systématiquement une cataracte et des lésions irréversibles de la rétine. Certains sujets présentent des anomalies cerebelleuses. Ce modèle d'étude est particulièrement intéressant en génétique, ophtalmologie et neurologie. Le lapin "Sauteur d'Alfort Moderne" est actuellement préservé *in situ* par un groupe d'éleveurs et *ex situ* sous forme d'embryons congelés et stockés dans une cryobanque. Désormais, ces animaux sont à la disposition de toutes personnes dont le programme de recherche a été agréé par un comité scientifique.