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ANIMAL GENETIC RESOURCES INFORMATION

BULLETIN D'INFORMATION SUR LES RESSOURCES GÉNÉTIQUES ANIMALES

BOLETÍN DE INFORMACIÓN SOBRE RECURSOS GENÉTICOS ANIMALES

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FIAT PANIS

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Editorial - Tenth Regular Session of the Commission for Genetic Resources for Food and Agriculture

The Commission on Genetic Resources for Food and Agriculture (CGRFA) held its Tenth Regular Session from 8 to 12 November 2004 at FAO Headquarters in Rome. Documents can be found at: *www.fao.org/ag/cgrfa/docs10.htm.*

The Global Strategy for the Management of Farm Animal Genetic Resources

The Commission noted, with appreciation, the work undertaken by FAO's Global Focal Point in Animal Genetic Resources, in the further development of the Global Strategy, especially in regard to the preparation of the first *Report on the State of the World's Animal Genetic Resources*, and stressed the need to take immediate steps to implement concrete actions in countries, in agreement with national priorities presented in Country Reports and the draft *Report on Strategic Priorities for Action.* It stressed the need to strengthen National Focal Points for Animal Genetic Resources and recognized the positive impact of the process of preparing the Country Reports in the establishment of national structures, and encouraged countries to continue to support their national committees for animal genetic resources. The Commission emphasized the importance of Regional Focal Points in coordinating regional efforts, information-sharing and promoting technical cooperation. It encouraged FAO to continue to support the informal network of regional facilitators, until permanent regional structures to support the Global Strategy are established. The Commission endorsed the Report of the Third Session of Working Group.

First Report on the State of the World's Animal Genetic Resources

The Commission endorsed the proposed revised time schedule for the completion of the first *Report on the State of the World's Animal Genetic Resources*, which indicated that a first draft of the Report would be available for consideration by the Working Group in 2006 and by the Commission during its Eleventh Session in 2006. It recommended that FAO undertakes regional consultations in 2005, based on the updated draft *Report on Strategic Priorities for Action*. The Commission recommended the establishment of the Follow-up Mechanism, led by the Global Focal Point, based upon the proposed constituent elements: fund raising, communications and awareness raising, and technical assistance to countries to prepare projects and directed to the national and/or regional levels. Some Members of the Commission suggested the initiation of a process for preparing an international treaty on animal genetic resources, and noted the need for safeguarding the rights of indigenous livestock keepers. Other Members considered this to be premature, and stated that any discussion of a legal instrument should await the completion of the first *Report on the State of the World's Animal Genetic Resources*.

Future work of the Working Group on Animal Genetic Resources

The Commission agreed that the Working Group on Animal Genetic Resources should meet in 2006 to:

- review the first draft *Report on the State of the World's Animal Genetic Resources*;
- review, evaluate and revise, as needed, the constituent elements and operational aspects of the proposed Follow-up Mechanism;
- review the report on the results of the regional consultations;
- assist the Commission to prepare for the International Technical Conference on Animal Genetic Resources in 2007, including the preparation of the draft agenda and programme of the conference; and
- review the progress of the Global Strategy for the Management of Farm Animal Genetic Resources.

The members of the Working Group were elected. For Africa: Botswana, Cameroon, Ethiopia, Ghana, Tunisia; for Asia: Bangladesh, China, Philippines, Thailand, Viet Nam; for Europe: Denmark, France, Germany, Slovenia, Turkey; for Latin America and the Caribbean: Argentina, Chile, Colombia, Jamaica, Uruguay; for the Near East: Egypt, Iran, Yemen; for North America: Canada, United States of America; for the Southwest Pacific: Australia, Samoa.

Animal Genetic Resources Information Bulletin - 35th issue

We are proud to present the 35th issue of AGRI. A total of 82 papers have been published since 1999 (AGRI 26 to 35) with an average acceptance rate of 65%. The articles originated from countries in all six FAO regions with the following breakdown: India 18; Spain 8; Brazil, South Africa, Italy and USA 3 each; Kenya, Morocco, Nigeria, Poland, French West Indies and UK 2 each; the remaining papers one per country (Figure 1).

There is a broad and interesting distribution of the 82 papers by species. The largest number of papers concerns the main ruminant livestock species (cattle 21, sheep and goats 15 each, buffalo 3); 13 papers deal with more than one species; horses and poultry 4 articles each; pigs and turkeys 3 each; one paper referred to rabbits (Figure 2).

A review of our readership and their interests is necessary at this point. The current issue contains a questionnaire to be completed and returned to AGRI, which will be used to update our mailing list. It is also available on *http://dad.fao.org/en/refer/library/agri/AGRI_Questionnaire* in the section corresponding to AGRI, and the response can be returned by electronic mail or airmail.

The Editors

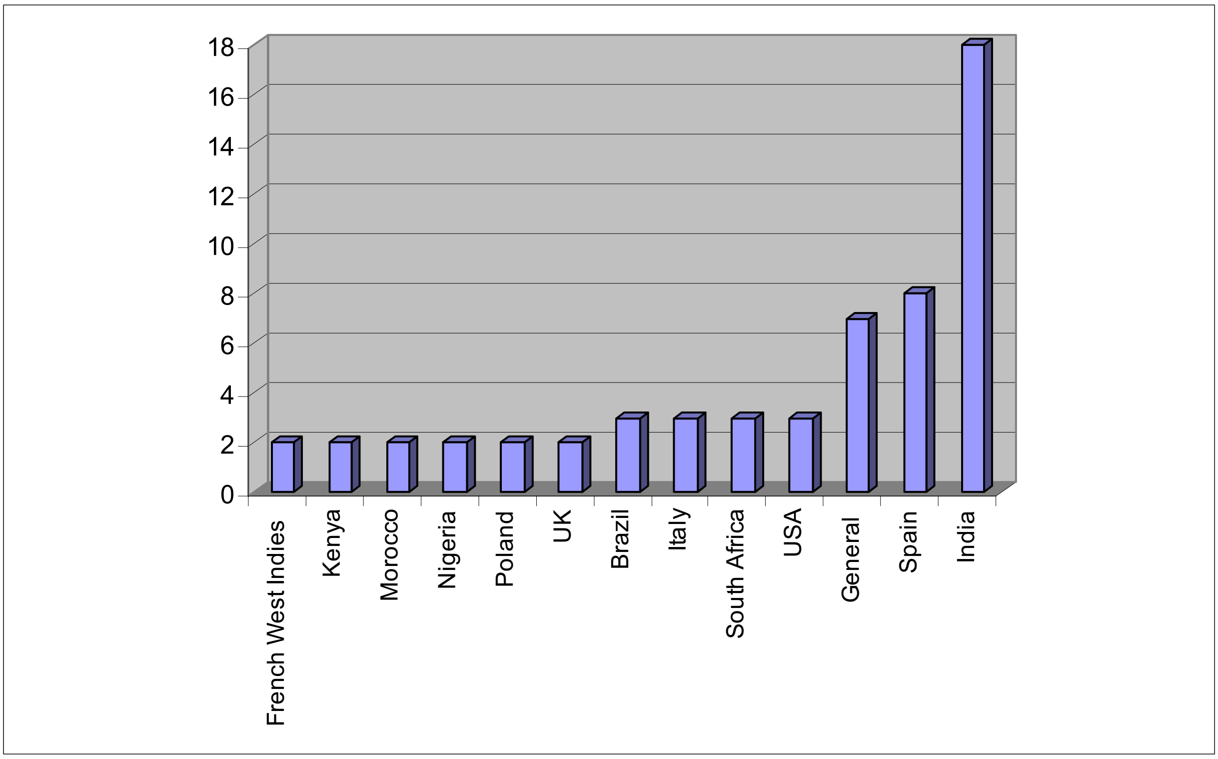

Figure 1. Number of countries with more than one paper, published in AGRI from the issue 26 to the issue 35.

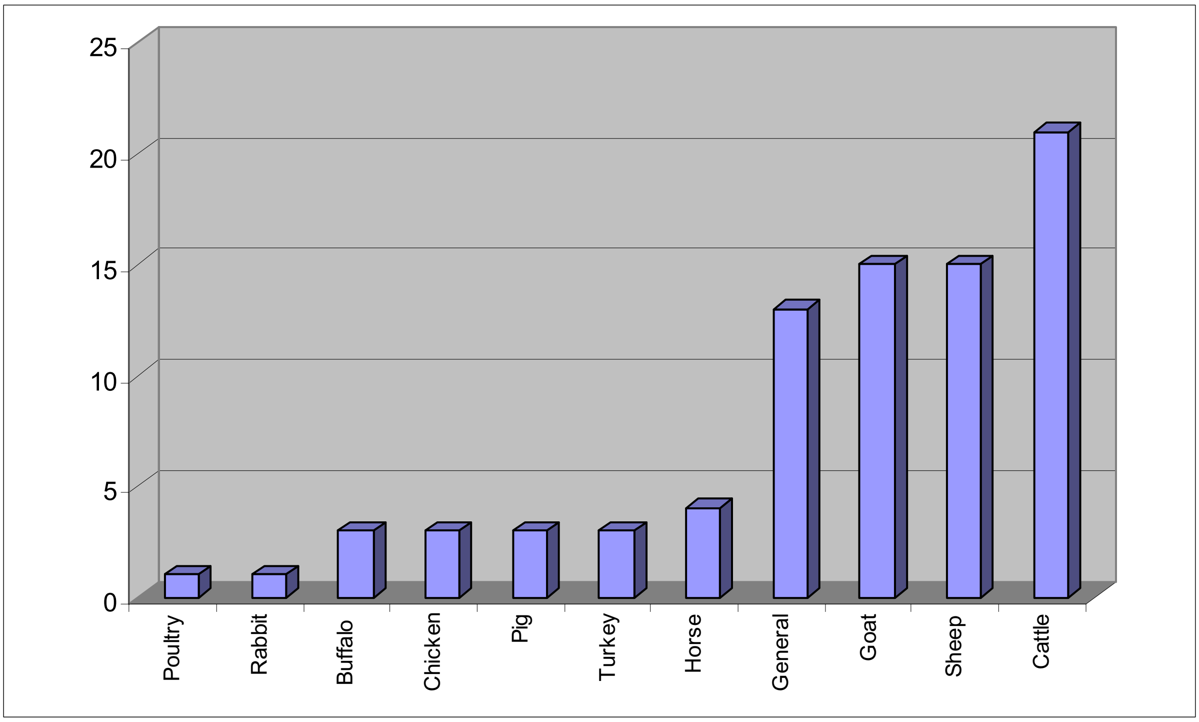

Figure 2. Number of papers per species, published in AGRI from the issue 26 to the issue 35.

Editorial AGRI 35 - Dixième session ordinaire de la Commission des ressources génétiques pour l'alimentation et l'agriculture

La Commission pour les ressources génétiques pour l'alimentation et l'agriculture (CGRFA) a tenu sa Dixième session ordinaire du 8 au 12 novembre 2004 au siège de la FAO à Rome. Les documents sont disponibles sur le site: *www.fao.org/ag/cgrfa/docs10.htm*

La Stratégie mondiale pour la gestion des ressources zoogénétiques

C'est avec appréciation que la Commission a pris note du travail réalisé par le point focal mondial des ressources zoogénétiques de la FAO à l'égard du développement de la *Stratégie mondiale pour la gestion des ressources zoogénétiques* et, en particulier, dans la préparation du premier *Rapport sur l'état des ressources zoogénétiques dans le monde*. Le besoin d'entreprendre des actions concrètes au niveau national suivant les priorités indiquées dans les Rapports nationaux, ainsi que dans le *Rapport préliminaire sur les stratégies prioritaires*, a également été souligné. La Commission a mentionné la nécessité de renforcer les points focaux nationaux pour les ressources zoogénétiques. Elle a reconnu l'impact positif du processus de préparation des Rapports nationaux dans l'établissement des structures nationales et encourage les pays à assurer leur soutien aux comités nationaux des ressources zoogénétiques. La Commission a également insisté sur l'importance des points focaux régionaux pour la coordination, l'échange d'informations et la promotion de la coopération technique. La FAO a été encouragé à poursuivre son appui envers le réseau informel d'experts régionaux, jusqu'à ce que les structures régionales de soutien à la *Stratégie mondiale* soient en place. La Commission a approuvé le Rapport de la troisième session du Groupe de travail.

Premier Rapport sur l'état des ressources zoogénétiques dans le monde

La Commission a approuvé le calendrier proposé pour la finalisation du premier *Rapport sur l'état des ressources zoogénétiques dans le monde*, selon lequel la première version préliminaire du Rapport sera soumise au Groupe de travail en 2006 et à la Commission lors de sa onzième session dans la même année. Il a été recommandé à la FAO d'entamer des consultations régionales en 2005, basées sur le *Rapport préliminaire sur les stratégies prioritaires*. La Commission a recommandé l'établissement d'un mécanisme de suivi dirigé par le point focal mondial, compte tenu des éléments suivants: mobilisation de fonds; amélioration des communications et de la sensibilisation; assistance technique aux pays pour la préparation de projets aux niveaux national et/ou régional. Certains membres de la Commission ont suggéré d'initier un processus de préparation pour un traité international sur les ressources zoogénétiques, tout en soulignant l'importance de sauvegarder les droits des éleveurs indigènes. D'autres membres ont jugé ce thème prématuré et préfèrent reporter toute discussion légale jusqu'à la finalisation du premier *Rapport sur la situation mondiale des ressources zoogénétiques*.

Travail futur du Groupe de travail sur les ressources zoogénétiques

La Commission a approuvé que le Groupe de travail sur les ressources zoogénétiques se rencontre en 2006 pour:

- la révision de la version préliminaire du premier *Rapport sur l'état des ressources zoogénétiques dans le monde*;
- l'évaluation et, le cas échéant, la révision des éléments de base et des aspects opérationnels du mécanisme de suivi proposé;
- la révision du rapport des consultations régionales;
- assister la Commission dans la préparation de la Conférence technique internationale sur les ressources zoogénétiques de 2007, y compris la préparation de l'agenda provisoire et du programme de la conférence; et
- la révision de la situation de la Stratégie mondiale pour la gestion des ressources zoogénétiques.

Les membres du Groupe de travail ont été élus. Pour l'Afrique: Botswana, Cameroun, Ethiopie, Ghana, Tunisie; pour l'Asie: Bangladesh, Chine, Philippines, Thaïlande, Vietnam; pour l'Europe: Danemark, France, Allemagne, Slovénie, Turquie; pour l'Amérique Latine et Caraïbes: Argentine, Chili, Colombie, Jamaïque, Uruguay; pour le Proche Orient: Egypte, Iran, Yémen; pour l'Amérique du Nord: Canada, Etats-Unis; pour le Sud-Ouest Pacifique: Australie, Samoa.

Bulletin d'information sur les ressources zoogénétiques (AGRI) – numéro 35

C'est avec une certaine fierté que nous avons l'honneur de présenter cette 35ème édition de AGRI. Depuis 1999 nous avons publié 82 articles (AGRI 26 à 35). Les articles, en provenance des pays appartenants aux six régions de la FAO, sont répartis comme suit: Inde 18; Espagne 8; Brésil, Afrique du Sud, Italie et Etats-Unis, 3 chacun; Kenya, Maroc, Nigéria, Pologne, Indes Occidentales Françaises et Royaume-Uni, 2 chacun; pour le reste, un par pays (Figure 1, page II).

Au niveau des espèces, la répartition est également variée et intéressante. La plupart des articles ont pour sujet des ruminants (bovins 21, ovins et caprins 15 chacun, buffle 3); 13 articles se réfèrent à plus d'une espèce; équins et volailles, 4 chacun; porcins et dindes, 3 chacun; un article fait référence aux lapins (Figure 2, page III).

A l'heure qu'il est, nous avons considéré nécessaire la mise au point d'une enquête pour évaluer nos lecteurs et leurs intérêts. La présente édition de AGRI contient un questionnaire que nous vous prions de compléter et de renvoyer à AGRI, afin que nous puissions mettre à jour notre liste de distribution. Ce document est également disponible sur le site *http://dad.fao.org/fr/refer/library/agri/AGRI_Questionnaire* dans la section correspondant à AGRI. Nous vous invitons à envoyer vos réactions par courriel ou par poste.

Les Editeurs

Editorial AGRI 35 - Décima Sesión ordinaria de la Comisión sobre recursos genéticos para la alimentación y la agricultura

La Comisión de Recursos Genéticos para la Alimentación y la Agricultura (CGRFA) celebró su Décima Sesión ordinaria del 8 al 12 de noviembre 2004 en la sede de la FAO en Roma. Los documentos se encuentran en el siguiente sitio: *www.fao.org/ag/cgrfa/docs10.htm*

La Estrategia mundial para la gestión de los recursos zoogenéticos

La Comisión apreció el trabajo realizado por los oficiales de recursos zoogenéticos de la FAO en el desarrollo de la Estrategia Mundial y en particular en la preparación del primer Informe sobre la *Situación Mundial de los Recursos Zoogenéticos* (*Informe*). También subrayó la necesidad de establecer los próximos pasos para llevar a cabo acciones concretas a nivel de país en conformidad con las prioridades nacionales presentadas en cada uno de los Informes Nacionales y en el borrador sobre las *Prioridades Estratégicas para la Acción*. La Comisión recordó la necesidad de reforzar el papel de los Responsables Nacionales por los recursos zoogenéticos y reconoció el impacto positivo que ha tenido la preparación de los Informes Nacionales sobre estas estructuras en cada país. La Comisión animó a los países a seguir apoyando a los comités nacionales de recursos zoogenéticos. La Comisión enfatizó la importancia de los Responsables Regionales por recursos zoogenéticos en la coordinación de los esfuerzos en cada región, así como en el intercambio de la información y la promoción de la cooperación técnica. Se animó a la FAO para que siga apoyando la red informal de Responsables Regionales hasta que las estructuras regionales permanentes que apoyen la Estrategia Mundial se queden establecidas. La Comisión aprobó el Informe de la Tercera Sesión del Grupo de Trabajo.

Primer Informe sobre la situación mundial de los recursos zoogenéticos

La Comisión aprobó el calendario revisado de actividades propuesto para la finalización del primer *Informe*. En el se indica que el primer borrador del *Informe* estaría disponible para ser sometido al Grupo de Trabajo en 2006 y a la Comisión durante su Undécima Sesión en 2006. La Comisión recomendó a la FAO llevar a cabo ulteriores consultaciones regionales en 2005 en base a los borradores actualizados del *Informe sobre las Prioridades Estratégicas para la Acción*. También recomendó establecer un mecanismo de seguimiento dirigido por el responsable mundial en base a los siguientes elementos: incremento de fondos, incremento en comunicaciones y concienciación, asistencia técnica a los países en la preparación de proyectos en nivel nacional y/o regional. Algunos de los miembros de la Comisión sugirieron iniciar el proceso de preparación de un tratado internacional sobre recursos zoogenéticos y apuntó la necesidad de salvaguardar los derechos de los ganaderos indígenas. Otros miembros consideraron el tema prematuro y se decidió que cualquier discusión sobre instrumentos legales esperaría hasta la finalización del primer *Informe*.

Futura labor del Grupo de Trabajo sobre recursos zoogenéticos

La Comisión aprobó que el Grupo de trabajo para los recursos zoogenéticos se encuentre en 2006 para tratar de los siguientes temas:

- revisar el primer borrador del *Informe*;
- evaluar y revisar, en caso necesario, los elementos constitutivos y los aspectos operacionales del mecanismo de seguimiento propuesto;
- revisar el informe sobre los resultados regionales sobre las consultas;
- asistir a la Comisión en la preparación de la conferencia técnica internacional sobre recursos zoogenéticos del 2007, incluida la preparación del borrador de la agenda y del programa de la conferencia; y
- revisar la situación y progreso de la Estrategia mundial para la gestión de los recursos zoogenéticos.

Se pasó a la elección de los miembros del Grupo de trabajo. Para África: Botswana, Camerún, Etiopia, Gana, Túnez; para Asia: Bangladesh, China, Filipinas, Tailandia, Vietnam; para Europa: Dinamarca, Francia, Alemania, Eslovenia, Turquía; para América Latina y el Caribe: Argentina, Chile, Colombia, Jamaica, Uruguay; para Oriente Próximo: Egipto, Irán, Yemen; para América del Norte: Canadá, Estados Unidos; y para el Sur del Pacífico: Australia y Samoa.

Boletín de información sobre los recursos genéticos animales (AGRI) - número 35

Es nuestro placer presentar el número 35 de AGRI. Un total de 82 artículos han sido publicados desde 1999 (AGRI 26 a 35) con un promedio de aceptación del 65%. Los artículos provienen de países de las seis regiones determinadas por la FAO: India 18; España 8; Brasil, África del Sur, Italia y Estados Unidos 3 cada uno; Kenya, Marruecos, Nigeria, Polonia, Indias Occidentales francesas y Reino Unido 2 cada uno, los demás artículos fueron a razón de uno por país (Figura 1, página II).

Hay una amplia e interesante distribución de los 82 artículos por especies. La mayor parte de los artículos trata de las especies de rumiantes (bovinos 21, ovinos y caprinos 15 cada uno, búfalos 3); 13 artículos tratan de más de una especie; equinos y aves 4 artículos cada uno; porcinos y pavos 3 cada uno; un artículo sobre conejos (Figura 2, página III).

Llegados a este punto es necesario hacer una revisión sobre la satisfacción de nuestros lectores y sus intereses. El presente volumen contiene un cuestionario que rogamos que completen y que nos devuelvan ya que será utilizado para actualizar nuestra lista de distribución. El cuestionario se encuentra también en el sitio *http://dad.fao.org/es/refer/library/agri/AGRI_Questionnaire* en la sección correspondiente a AGRI y podrá ser enviado por correo electrónico o normal.

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Bulletin d'information sur les ressources génétiques animales

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Boletín de Información sobre Recursos Genéticos Animales

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Use of DNA markers to assist with product traceability and pedigree analysis and their role in breed conservation

G.L.H. Alderson[1] & G.S. Plastow[2]

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Summary

Modern pig breeds in Europe owe their origin to a mixture of Asian and European breeds and types. They evolved during the past two hundred years, and developed particular breed characteristics by the application of breed standards, which included specific reference to colour. DNA markers at two coat colour loci provide the potential for accurate breed assignation for wild boar, Berkshire and Tamworth breeds, and may also offer the potential to develop simple tools for the verification of the origin of pork products. The use of polymorphisms in genes determining coat colour is used to explore this potential in terms of breed identification for conservation of animal genetic resources, and product traceability for quality assurance.

Resumen

Las razas Europeas actuales deben su origen a la mezcla de tipos raciales tanto asiáticos como europeos. Durante los últimos doscientos años, estas razas han evolucionado y desarrollaron sus peculiaridades a consecuencia de la aplicación de los estándares raciales, entre los cuales se incluyen referencias específicas al color. Marcadores de ADN identificados en dos locus para el color de la capa nos dan el potencial para identificar con precisión al Jabalí, Berkshire, y Tamworth, y además nos ofrecerían el potencial de desarrollar herramientas simples para verificar el origen de productos porcinos. Dicho polimorfismo en genes que determinan el color de la capa nos permite explorar su potencial en términos de identificación racial con motivo de la conservación de recursos genéticos, y de la trazabilidad de productos en programas de calidad.

Keywords: Pig breeds, Colour genetics, DNA markers, Quality assurance.

Introduction

Native pig breeds in UK were developed by the mixture of indigenous European stock with imported Asian breeds and types. The proportion of European and Asian ancestry varied from breed to breed, and the line of descent and relationship between breeds is complex. Most breeds have been relatively stable since the mid-nineteenth century, but there has been some introgression. Each breed was developed to satisfy a particular market or production requirements. For example, in the UK the Large White breed was developed for bacon whilst the Berkshire was known as a "pork" pig (Davidson, 1948). As the different breeds were developed they were eventually classified by their colour or type, so that over time the

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"Standard of Excellence" was developed to define phenotype and supplement the pedigree. For example, the Tamworth Breed Standard of Excellence (as at 1947) included requirements for coat (golden red, abundant, straight and fine, and as free from black hairs as possible), head (not too long, face slightly dished, wide between ears, jowl light), ears (rather large with fine fringe, carried rigid and inclined slightly forward) and skin (flesh coloured, free from coarseness, wrinkles or black spots). Neck, chest, shoulders, legs, back, loin, tail, sides, belly, flank, hams and action are also specified. Pedigree data in Herdbooks was intended to protect the genetic integrity of a breed, but in practice a significant degree of illicit introgression occurred.

One of the main distinguishing features for breed in pigs is coat colour and pattern. In the UK this includes white (Large White, Middle White, British Lop, Welsh and Landrace), white with black markings (Gloucestershire Old Spots), black (Large Black), black with white markings (Berkshire), black with white belt (British Saddleback), and red (Tamworth). Two loci, *Extension* and *Dominant White* control much of the variation in coat colour. The genes involved have been identified *(MC1R* and *KIT* respectively), variants have been described and associations with breed and colour determined (see Kijas *et al*., 1998, Kijas *et al*., 2001, Marklund *et al*., 1998). These polymorphisms may provide the basis for a simple means of verifying the breed origin of products such as semen, pork or hams. In this way they can play an important role in Quality Assurance programmes for maintenance of brand identity. In addition, in some situations these tools may assist in setting breed standards and verifying pedigrees, thereby further assisting in the marketing of breed differentiated products, for example meat in marketing schemes such as the Traditional Breeds Meat Marketing Scheme in the UK.

In this paper we will consider the potential of using these DNA markers with the Berkshire and Tamworth breeds. The Berkshire pig, found mainly in the Midlands and Home Counties in the first half of the nineteenth century, was a large, prick-eared animal, red with black markings and white points. Some earlier reports state that it was a black pig. It was crossed with imported pigs of Asian type, especially the black Neapolitan, to evolve the modern prick-eared black Berkshire with six white points. The colour pattern is transmitted strongly and consistently. There has been grading-up in some lines from Large White. The Tamworth also is a native of the Midlands, with records dating from the eighteenth century. It tends more to bacon type - some Large White influence being experienced in the nineteenth century. It is prick-eared, and red with occasional black hairs. The source of the red colour is variously ascribed to importations from Ireland, Barbados and India. The source of the red colour of Duroc pigs is ascribed to Africa, Spain and Portugal.

Materials and Methods

Polymorphisms were identified in the *MC1R* and *KIT* genes and associated with coat colour phenotype by analysing different native minority breeds monitored by the Rare Breeds Survival Trust in the UK or PIC in Europe and the US, and supplemented with additional small samples from Europe, Japan and the US (Kijas *et al*., 1998, Kijas *et al*., 2001, Marklund *et al*., 1998 and Pielberg *et al*., 2002). Simple PCR tests were developed for the *MC1R* and *KIT* genes and used to screen the breed samples.

DNA was prepared from tissue (e.g. meat samples) or hair samples using a simple proteinase K protocol to lyse cells and release the DNA. Alternatively DNA was prepared from blood samples using phenol choloroform extraction.

Results

DNA Markers

Four polymorphisms were analysed for the MC1R gene. These consisted of three RFLPs as well as a small insertion at the 5′ end of the coding sequence (Kijas *et al.*, 1998, Kijas *et al.*, 2001). They correspond to five alleles found in the populations tested: E^{+}, E^{D1}, E^{D2}, E^{P} and *e* (Table 1).

Several alleles of *KIT* have now been identified. The gene is duplicated in breeds such as Pietrain, Large White and Landrace and the presence of the duplication can be detected with a simple PCR test (Giuffra *et al.*, 2002). The dominant white allele found in white breeds is associated with a polymorphism at a splice site, this can also be detected using a simple PCR-RFLP (Marklund *et al.*, 1998). These two tests can only be scored dominantly for presence of the duplication and/or the splice site. An additional three intronic polymorphisms detected by sequencing from Exon 16 to Exon 19 of *KIT* were used in the development of haplotypes for the differentiation of the Berkshire breed from other pig populations in Japan (Carrion *et al.*, 2003). Association between *KIT* polymorphisms and breed are summarised in Table 2.

Our initial work with Tamworth and Berkshire identified some interesting results that suggested that it would be possible to establish breed identification tools for these breeds in the UK. Such tools might be used to support pedigree registration and management of the breed or as part of a QA scheme for the Traditional Breeds Meat Marketing Scheme (for example as used by the British Wild Boar Association) (Carrion *et al.*, 2003).

Table 1. Polymorphisms in the MC1R locus and their association with breed.

		Polymorphism				
Allele	Sequence	Nt67insCC[2]	L102P	D124N	A243T	Breed examples
$E^{+\,1}$	*MC1R*1,5*	-	L	D	A	Wild Boar
E^{D1}	*MC1R*2*	-	P	D	A	Meishan/Large Black
e	*MC1R*4*	-	L	D	T	Duroc
E^{P}	*MC1R*6*	+	L	N	A	Pietrain/LW/LR/Berkshire
E^{D2}	*MC1R*3*	-	L	N	A	Hampshire

[1]Two sequences (*MC1R*1* or **5*) have been identified for wild boar, which may differentiate Asian and European types (Giuffra *et al.*, 2002).
[2] + indicates the presence of the insertion.

Table 2. Polymorphisms in the KIT locus and their association with breed.

	KIT Polymorphism			
Allele	Duplication[1]	Splice variant[1]	Intron haplotype	Breed examples
i	-	-	1	Meishan, Large Black
i	-	-	1, 2, 3	Berkshire (Japan)
i	-	-	4	Duroc, Tamworth
i^{Be} (Belt)	-	-	4	Hampshire
I^{p} (Patch)[3]	+	-	4	Pietrain[2]
I	+	+	4	Landrace, Large White

[1]See Marklund *et al.* 1998 and Giuffra *et al.* 2002.
[2]Relatively small numbers have been tested for Large Black and Tamworth.
[3]The I^{p} allele has also been found in white breeds.

The Tamworth

During the initial work on the characterization of the *MC1R* locus we determined that the red colour in Tamworth had a different genetic basis to that seen in Duroc pigs (Kijas *et al*., 1998). This finding was based on a small sample of Tamworth from the UK. Eventually, we determined that the Tamworth breed had the same *MC1R* allele (E^P) as that found in Pietrain and Large White (Kijas *et al*., 2001). This allele is rather complex and it is associated with black spots, when the wild type *KIT* allele is present (e.g. in Pietrain). However, the two basepair insertion at nucleotide 67 results in a frameshift and inactivation of the *MC1R* protein which leads to red coat colour. We subsequently determined that black spotting is due to somatic reversion of the insertion regenerating a functional *MC1R* gene, but in this case the allele contains the dominant black mutation at amino acid 121, so that the coat colour in revertant cells is black. This finding is in line with the written description of the development of the Tamworth breed which seems to have been spotted in its early development (Porter, 1993). Interestingly when we typed a small sample of Tamworth pigs from the US we found both the E^P and *e* alleles, which we assume reflects a mixing of Tamworth and Duroc breeds at least in this sample.

We then increased the number of samples from the UK Tamworth population, by sampling 36 market pigs, to determine if this was the case. The majority of samples were found to be of the expected genotype E^P/E^P although one was heterozygous for E^P and *e*. This suggests that there may have been some introgression of the Duroc breed in the UK Tamworth population.

The Berkshire

The Berkshire breed was also found to contain E^P at the *MC1R* locus (Kijas *et al*., 2001). In this case the breed appears to have been selected to have one large black spot, although the basis for this is not understood (it may relate to an interaction with additional coat colour modifier loci). Thus it shares the same *MCIR* genotype as Pietrain, the white breeds and Tamworth, and the original description of the breed was similar to the Tamworth. However, Berkshire can be differentiated from some of these breeds using polymorphisms at the *KIT* locus. For example, animals with a duplication of *KIT*, and/or which contain the splice variant (Marklund *et al*., 1998), cannot be Berkshire. In addition, Mitsuhashi and colleagues in Japan, together with PIC, identified intronic polymorphisms in *KIT* that appear to differentiate Berkshire from the other breeds (Carrion *et al*., 2003).

In Japan the initial Berkshire samples analysed had haplotypes 1, 2 and 3 for the intronic polymorphisms of *KIT*, where haplotype 1 was found in the Chinese breeds such as Meishan. However, US Berkshire herds also contained haplotype 4, which was thought to be confined to the Western derived breeds such as Tamworth, Hampshire and Duroc. Based on the findings for Tamworth we postulated that this may have resulted by introgression of other breeds into Berkshire in the USA during the development of this breed (we have recently learnt that the RN^- mutation which had been thought to be specific to the Hampshire breed has been identified in US Berkshire animals supporting this suggestion).

Samples of Berkshire in UK were then tested to see if this conjecture could be further supported, assuming that the UK herd would be more representative of the "original" Berkshire breed (which was subsequently re-exported to Japan). Thirty-seven samples were collected from Berkshire marker pigs and genotyped for the intronic polymorphisms and none of them were found to contain haplotype 4. This was in line with the hypothesis on the origin of the Berkshire breed and fits the history of the breed in the UK and Japan.

Discussion

PIC has developed DNA based "Breed Identification" to support Quality Assurance or Pedigree schemes for wild boar (with the British Wild Boar Association, with the assistance of the Roslin Institute) and the Berkshire (for Kuro-Buta in Japan) and Hampshire breeds (in the USA) (Carrion *et al*., 2003). These test programmes make use of the polymorphisms identified to date in the *MC1R* and *KIT* genes and the associations that have been observed with colour pattern and sampling of some pig breeds.

Table 1 describes the polymorphisms and associations as they are currently understood for *MC1R*. These can be combined with the *KIT* polymorphisms to provide "breed" specific "keys" (Tables 1 and 2). For example, wild boar is the only breed that has the *MC1R* haplotype "-LDA". The situation is not as straightforward with the *KIT* locus as some of the breeds have more than one allele present. For example, the white breeds may contain I^P (patch) as well as *I* (dominant white). Even so an effective system can be provided through the use of both loci.

The Tamworth and Berkshire breed samples were used to evaluate the association between *MCIR* and *KIT* genotype and breed and colour. The results are essentially in line with expectation based on the analysis of PIC lines and other sample sets from the UK, Japan and the USA (Table 3). The results suggest that the UK Tamworth and Berkshire herds are primarily of specific genotypes for the coat colour loci and that these could be used successfully for DNA quality assurance schemes (Carrion *et al*., 2003). More recently a larger survey of European breeds was made for an EC project on Pig Biodiversity (San Cristobal *et al*. 2002). The samples collected in this project represent an excellent resource to further confirm these findings if the samples are made available (with permission of the National Coordinator according to the conditions set out in the project Material Transfer Agreement) (Cardellino 2003).

The Tamworth and Duroc breeds are both red coated. However, historical records suggest different geographical origins for the red colour (see Introduction). Analysis of the *MC1R* gene indicates that the molecular basis for the colour is different in these two breeds supporting the different recorded origins for these breeds. At least one of the UK Tamworth samples did contain a "non-Tamworth" allele that is associated with the Duroc breed suggesting that there may have been some introgression of Duroc at some stage in the UK. Unfortunately, once this has occurred it may not be possible to trace or track the mixed breeds using only DNA. For example, a backcross of a Tamworth/Duroc hybrid to Tamworth will result in 50% of the offspring scoring as Tamworth using the *MC1R* DNA test. However, the introgression would be revealed by statistical sampling of the herd or by combining the test with pedigree analysis (or by utilizing other DNA markers). If we assume that the sample is representative of the UK herd then such introgression may be a relatively small occurrence and the test could be utilized to help "clean up" the population. This could be undertaken in a

Table 3. MC1R and KIT marker haplotypes identified for breeds associated with the MC1R E^P allele.

Breed	*MC1R* Nt67insCC	*KIT* Duplication	*KIT* intron haplotype
UK Berkshire	+	-	1,2,3
UK Tamworth	+	-	4
Pietrain	+	+	4
White Breeds	+	+	4

number of different ways depending on the approach selected by the Breed Society and its members.

The importance of quality assurance applies not only to the commercial aspects of product validation, but also to identifying introgression which changes the character of a breed. The value of each breed lies in its distinctive genotype, and the specific gene interactions within its genome. Introgression disturbs these genomic interactions, and compromises the genetic integrity of the breed. At this stage, introgression in many minority native pig breeds is relatively insignificant, but is increasing cumulatively. The early application of tests for breed-specific DNA markers can be an important element in the effective conservation of animal genetic resources, and colour markers at this stage are the most valuable tool in the achievement of this objective.

In terms of utilizing the *MC1R* test to support a simple product Quality Assurance scheme one pragmatic approach would be to accept that there has been a limited introgression but to incorporate the *MC1R* test into the breed standard and use the test to verify products within the assurance scheme. That is, all "assured" Tamworth animals would need to have the *MC1R* genotype E^P/E^P. Animals that contained the Duroc allele would be culled from the population.

In the Berkshire case, the UK samples were free from the "Western" *KIT* haplotype (haplotype 4), which would mean that they would be classified as "true" Berkshire by the specification used for the Japanese market. If all UK Berkshire's are indeed free of the Western haplotype then a simple DNA standard would ensure that all Berkshire animals (and their products) contained *MC1R* E^P/E^P and combinations of *KIT* haplotypes 1, 2 or 3. This would provide a simple DNA standard to verify Berkshire meat (Table 3).

Conclusions

Introgression has occurred in many pedigree pig populations. Current interest in both conservation of animal genetic resources in the form of recognisable breeds, and the increasing market for products from traditional breeds, provide an incentive to develop methods to detect introgression. *MC1R* and *KIT* polymorphisms already provide the ability to authenticate animals and products from wild boar and Berkshire and Tamworth breeds. Further refinements are likely to allow effective breed assignment for other breeds.

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Note: The DNA tests discussed in this report are subject to patents pending or granted.

References

Cardellino, R. 2003. Legal aspects of genetic material and genetic information property. In Delgado, J.V., G. Plastow, L. Alderson, C. Chevalet & R. Cardellino (Eds) Pig Biodiversity, Archivos de Zootecnia vol. 52, number 198.

Carrion, D., A. Day, G. Evans, T. Mitsuhashi, A. Archibald, C. Haley, L. Andersson & G. Plastow. 2003. The use of MC1R and KIT genotypes for breed characterisation. In Delgado, J.V., G. Plastow, L. Alderson, C. Chevalet & R. Cardellino (Eds). Pig Biodiversity, Archivos de Zootecnia vol. 52, number 198.

Davidson, H.R. 1948. The Production and Marketing of Pigs. Longmans, Green and Co., London, pp. 535.

Giuffra, E., J.M.H. Kijas, V. Amarger, O. Carlborg, J.-T. Jeon & L. Andersson. 2000. The origin of the domestic pig: independent domestication and subsequent introgression. Genetics 154: 1785-1791.

Giuffra, E., A. Tõrnsten, S. Marklund, E. Bongcam-Rudloff, P. Chardon, J.M.H. Kijas, S. Anderson, A. Archibald & L. Andersson. 2002. A large duplication associated with dominant white color in pigs originated by homologous recombination between LINE elements flanking KIT. Mamm Genome 13: 569-577.

Kijas, J.M.H., R. Wales, A. Tõrnsten, P. Chardon, M. Moller & L. Andersson. 1998. Melanocortin receptor 1 (MC1R) mutations and coat color in pigs. Genetics 150: 1177-1185.

Kijas, J.M.H., M. Moller, G. Plastow & L. Andersson. 2001. A frameshift mutation in MC1R and a high frequency of somatic reversions cause black spotting in pigs. Genetics 158: 779-785.

Marklund, S., J. Kijas, H. Rodriquez-Martinez, L. Ronnstrand, K. Funa, M. Moller, D. Lange, I. Edfors-Lilja & L. Andersson. 1998. Molecular basis for dominant white phenotype in pigs. Genome Res. 8: 826-833.

Pielberg, G., C. Olsson, A.-C. Syvänen & L. Andersson. 2002. Unexpectedly high allelic diversity at the KIT locus causing dominant white color in the domestic pig. Genetics 160**:** 305-311.

Porter V. 1993. Pigs: A Handbook to the breeds of the world. Helm Information Ltd. Mountfield, East Sussex, UK, pp 256.

SanCristobal M., C. Chevalet, C.S. Haley, G. Russell, G. Plastow, K. Siggens, M. Bagga, M.A.M. Groenen, Y. Amigues, K. Hammond, G. Laval, M.-Y. Bosher, D. Milan, A. Law, E. Fimland, R. Davoli, V. Russo, G. Gandini, A. Archibald, J.V. Delgado, M. Ramos, C. Désautés, L. Alderson, P. Glodeck, J.N.N. Meyer, J.-L. Foulley, L. Ollivier 2002. Genetic diversity in pigs. Preliminary results on 58 European breeds and lines. World Congr. Genet. Appl. Livest. Prod., 33, 523-528.

Analyse de données de ségrégations italiennes pour la livrée des bovins

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Résumé

Des ségrégations de la livrée ont été analysées sur des données de F1 et de back-cross sur les pères de races à viande phæomélaniques (Charolaise et Limousine) et phæomélaniques à extrémités eumélaniques dites PEE (Piémontaise, Chianine, Marchienne et Romagnole) accouplés à des femelles eumélaniques noir (Holstein Frisonne Italienne).

Les ségrégations sont interprétées en termes d'allèles au locus *Extension E* avec les quatre allèles E^D,E^r ,E et E^l, au locus *Dilution Charolais DC* avec les allèles DC^D et DC^+, au locus *Albinos C* avec les allèles C^+ et C^{ch} et au locus *Spotting S* avec les allèles S^+ et $S^{s.}$

Parfois il faut faire appel à des pénétrance incomplètes.

Summary

Phenotypic segregation of coat colour of cattle has been analyzed in F1 and paternal back-crosses between French and Italian Limousin, Charolais, Piemontese, Chianina, Marchigiana and Romagnola meat breeds on one hand and Italian Holstein Frisian milk breed on the other hand. The biallelism at the *Extension* locus, *EDEr* can explain the results of pheomelanic x eumelanic black crossing being Charolais and Limousin males *ErEr* and the Italian Holstein Friesian females *EDED*. Both parental phenotypes and one intermediate have been observed in F1 and back-crosses; the incomplete penetrance explains the segregation. The triallelism at the *Extension* locus, *ED*, *E* and *E1* can explain the pheomelanic with eumelanic extremities x eumelanic black crossbreeding. Both parental phenotypes and several intermediates already described (inverted mule stripe, badger face and black and tan) or not described on cattle have been observed on F1 and back-cross.

The incomplete penetrance can explain the phenotypic variability of segregation. The biallelism at the *Dilution Charolais* locus, *DC: DCD* and *DC*+ explains the results of Charolais (white) x Italian Holstein Friesian (normal) cross for Charolais dilution. Incomplete penetrance and intermediate expressivity can explain the segregation, among the F1, of both normal and diluted no white phenotypes. The allelism at the *Albino* locus, *C: C*+ and *Cch* explains the results of Piemontese, Chianina, Marchigiana and Romagnola (chinchilla alteration) x Italian Holstein Friesian (normal) cross for the chinchilla alteration, readable on pheomelanoc basis. Incomplete penetrance can explain the segregation, among the F1 and the back-cross, of both normal and chinchilla phenotypes.

The allelism at the *Spotting* locus, *S: S*+ and *Ss* explains the results of the meat breeds (normal) x Italian Holstein Friesian (irregular spotting) cross for the irregular spotting. Incomplete penetrance can explain the segregation, among the F1 and the back-cross, of both normal and spotted phenotypes.

***Keywords**: Holstein, Limousine, Charolaise, Back-cross, Segregation, Chianina, Breeding.*

Introduction

Les études de la variation phénotypique de la livrée des Bovins (*Bos taurus* L.) et son interprétation génétique ont été résumées par divers auteurs: Lauvergne, (1966 b); Searle, (1968); Olson et Willham, (1982); Lauvergne, (1983 a) Renieri *et al*., (1990); Olson, (1999) et Lauvergne *et al.,* (2000).

Ces derniers auteurs font état de 29 loci dont l'existence a été postulée dans beaucoup de cas par homologie phénotypique et génétique, c'est à dire en comparant les phénotypes observés à ceux induits par des gènes appartenant à des séries alléliques déjà identifiées dans une ou plusieurs espèces de mammifères de laboratoire et de ferme, Searle (1968).

Des identifications au niveau moléculaire ont prolongé ces études, en particulier pour le locus *Extension (E)* dans plusieurs races scandinaves et françaises: Klungland *et al*., (1995), Rouzaud *et al*., (1996, 2000), Joerg *et al.,* (1996) et Julien, (1999) mais aussi pour les loci *Albino*, *Spotting* et *Roan*: [Foreman *et al.,* (1994); Reinsch *et al*., (1999 a,b); Charlier *et al.,*(1996)]. Il existe également des descriptions détaillées de certains phénotypes aux niveaux biochimique et microscopique (Misuraca *et al*., 1974; Renieri *et al.,* 1988, 1993).

Toutefois, comme les données de ségrégation sont relativement rares et incomplètes leur analyse est souvent délicate (Lauvergne *et al.,* 2000). De la sorte les formules génétiques des races bovines standardisées comportent encore une part d'imprécision (Lauvergne, 1983; Renieri *et al.,* 1984). L'identification correcte des produits de croisement est alors perturbée, ce qui peut nuire à la traçabilité des produits carnés (Julien, 1999).

C'est dans la perspective d'améliorer ces connaissances qu'a été conduite la présente analyse qui porte sur des données de croisements recueillies lors d'une expérience d'amélioration de la production de viande bovine dénommée «Incremento della produzione de la carne bovina attraverso l'incrocio». Cette expérimentation s'est déroulée dans les années 1980 et 1990 à l'Institut expérimental de Zootechnie de Tormancina, (Monterotondo, Rome, Italie). Elle portait sur des croisements entre races à lait et races à viande (Agricoltura e Ricerca, 1985).

Matériel et Méthodes

Des femelles de la race laitière *Holstein Frisonne Italienne* (HFI) ont été accouplées à des mâles de races à viande françaises [*Limousine* (LM) et *Charolaise* (CH)] et italiennes [*Piémontaise* (PD), *Chianine* (CN), *Marchienne* (MG) et *Romagnole* (RM)]. Il y a eu des F1 et des back-cross.

La description phénotypique des races selon la classification à 4 dimensions proposée par Lauvergne (1983) en patron pigmentaire, type d'eumélanine, altération de la pigmentation et type de panachure blanche est donnée dans le tableau 1. Cette classification a déjà été utilisée par Lauvergne (1983) et Renieri *et al.* (1984) pour décrire certaines races bovines françaises et italiennes

Les ségrégations ont été étudiées dans les croisements suivants:

- Animaux de patron phaeomélanique (*Limousin* LM et *Charolais* CH) par animaux de patron eumélanique noir *(Holstein Frisonne Italienne,* HFI);
- Animaux de patron phæomélanique à extrémités eumélaniques (PEE) des races *Piemontaise, Chianine, Marchienne* et *Romagnole* regroupées par animaux de patron eumélanique noir (*Holstein Frisonne Italienne);*
- Animaux présentant la dilution par animaux sans dilution (*Charolais x* HFI);

Tableau 1. Description phénotypique des races impliquées dans les croisements, selon 4 dimensions.

Race		Phénotype coloré			
Nom français (nom italien)	Code	Patron pigmentaire	Type d'eumélanine	Type d'altération	Type de Panachure
Charolaise (Charolais)	CH	Phæomélanique	?	Dilution charolaise	?
Chianina (Chianina)	CN	Phæomélanique à extrémités eumélaniques	Noir	Chinchilla	Aucune
Holstein Frisonne italienne (Holstein Friesian italiana)	HFI	Eumélanique	Noir	Aucune	Panachure irrégulière
Limousine Limousin)	LM	Phæomélanique	?		Aucune
Marchienne (Marchigiana)	MG	Phæomélanique à extrémités eumélaniques	Noir	Chinchilla	Aucune
Piémontaise (Piemontese)	PD	Idem	Idem	Idem	idem
Romagnole (Romagnola)	RM	Idem	Idem	Idem	idem

- Animaux présentant l'effet d'albinisme incomplet nommé chinchilla par animaux ne le présentant pas (PEE x HFI);
- Animaux présentant la panachure irrégulière par animaux ne la présentant pas, opposant la race HFI à toutes les autres races.

Le schéma expérimental des ségrégations analysées est présenté dans le tableau 2.

Tous les animaux F1 examinés étaient de sexe féminin. Les animaux issus de back-cross étaient des deux sexes mais leur sexe n'a pas été relevé.

Le schéma expérimental permettait d'identifier la race paternelle mais on ne connaissait pas exactement les pères des croisés car la monte avait été menée par groupes de taureaux de même race mélangés à des lots de femelles.

Les phénotypes des mères F1 des back-cross n'étaient pas connus car elles étaient déjà sorties de l'expérimentation lorsque les observations ont été faites.

Les animaux ont été examinés individuellement lors du pesage et une ou plusieurs photos de chaque animal ont été prises.

Résultats et Discussion

Croisements phæomélanique par eumélanique noir

Les résultats des croisements F1 et back-cross sont donnés dans le tableau 3. Ils concernent des pères *Limousins* et *Charolais* accouplés à des mères *Holstein Frisonnes Italiennes*.

Dans les croisements où le *Charolais* était impliqué la dilution charolaise n'a jamais affecté l'identification du patron pigmentaire.

Les ségrégations peuvent être interprétées par le jeu d'allèles au locus *Extension,* classiquement connu en homologie des couleurs de la robe des mammifères, Lauvergne (2000).

Tableau 2. Schéma expérimental des croisements F1 et BC.

Type génétique	Races impliquées	Nombre de descendants observés			
		F1	Total	BC	Total
F1	*LM X HFI*	29			
	CH X HFI	38			
	PD X HFI	41			
	CN X HFI	33			
	MG X HFI	37			
	RM X HFI	26			
F1 avec PEE			137		
Tous les F1			204		
BC	LM X (LM X HFI)			16	
	PD X (PD X HFI)			14	
	CN X (CN X HFI)			6	
	PD X (MG X HFI)			24	
	PD X (CN X HFI)			13	
	PD X (RM X HFI)			1	
	CN X (MG X HFI)			4	
	CN X (PD X HFI)			3	
	CN X (PD X HFI)			3	
BC sur PEE					68
Tous les BC					84

Tableau 3. Ségrégations observées en F1 et back-cross entre les patrons pigmentaires phæomélaniques et eumélaniques noir.

Type de croisement	Nombre de descendants observés			
	Eumélanique noir	Phæomélaniques	Autres	Total
LM X HFI	19	9	1	29
CH X HFI	19	19	0	38
Total F1	38	28	1	67
LM X (LM X HFI)	4	10	2	16

On sait que le locus *Extension* correspond au locus structurel pour le récepteur MC1R dont le polymorphisme a été analysé dans l'espèce bovine par Klungland *et al,* (1995), Klungland and Vage, (1999), Joerg *et al.,* (1996), Julien, (1999), Rouzaud *et al.,* (2000), Crepaldi *et al*., (2003).

Selon ces auteurs la couleur eumélanique noire de la *Holstein Frisonne Italienne* (HFI) serait due à la présence de l'allèle dominant E^D, le patron phæomélanique de la *Limousine* et de la *Charolaise* étant, quant à lui, dû à un gène récessif nommé *e (*Klungland et al, 1995; Klungland et Vage, 1999; Joerg *et al.*, 1996; Julien, 1999; Rouzaud *et al.*, 2000; Crepaldi *et al*., 2003).

MIC 2000 retient la terminologie E^D pour l'allèle dominant et nomme E^r le récessif (Lauvergne *et al.*, 2000). L'apparition de phénotypes phæomélaniques en F1 (HFI x LM ou CH) peut alors être expliquée par l'existence d'hétérozygotes E^DE^r parmi les parents HFI. Le même allèle récessif serait présent chez les animaux phæomélaniques qui ségrèguent en *Holstein Friesian* (Joerg *et al.*,1996).

Croisements phæomélanique à extrémités eumélaniques par eumélanique noir

Le tableau 4 présente les résultats des croisements F1 entre la *Holstein Frisonne Italienne* et des races à patron phæomélanique à extrémités eumélaniques (PEE): *Piémontaise, Chianine, Marchienne* ou *Romagnole*.

Le tableau 5 donne les résultats du back-cross sur la race paternelle ou sur une race de même phénotype (PEE).

Le tableau 6 présente les différentes expressivités observées en F1 et le tableau 7 celles observées dans les back cross.

D'après le tableau 5 en F1 le patron eumélanique noir (60%) semble incomplètement dominant sur le patron PEE (7%) mais plusieurs phénotypes intermédiaires apparaissent (33%). Dans le tableau 6 qui donnent les BC la plupart de ces intermédiaires sont identifiés En back cross sur les races PEE (tableau 6 et 7) 38 animaux sont PEE (56%), 3 sont eumélaniques noirs (4%) et le reste, 27, sont intermédiaires (40%) dont raie de mulet inversée (5%), noir et feu (5%) et blaireau (20%).

Ces résultats sont tout d'abord explicables par la présence en race HFI de nombreux hétérozygotes pour les l'allèle E^D, un

Tableau 4. Ségrégations observées en F1 PEE par eumélaniques noir.

	Nombres de descendants observés			
Races parentales	Eumélanique noir	PEE	Autres	Total
PD X IHF	24	6	11	41
CN X IHF	17	2	14	33
MG X IHF	23	1	13	37
RM X IHF	18	1	7	26
Total noir x PEE	82	10	45	137

Tableau 5. Ségrégations observées en back-cross sur des races de phénotype PEE.

	Nombre de descendants observés			
Type de croisement	Eumélanique noir	PEE	Autres	Total
PD X (PD X HFI)	0	6	8	14
CN X (CN X HFI)	0	2	4	6
PD X (MG X HFI)	1	14	9	24
PD X (CN X HFI)	2	7	4	13
PD X (RM XHFI)	0	0	1	1
CN X (RM X HFI)	0	3	0	3
CN X (MG X HFI)	0	3	1	4
CN X (PD X HFI)	0	3	0	3
Total des back-cross	3	38	27	68

Tableau 6. Différentes expressivités observées dans les F1 entre les patrons PEE et eumélanique noir.

	Nombre de descendants				
Races parentales	Raie de mulet inversée	Blaireau	Noir et feu	Autres	Total
PD X HFI	1	6	4	0	11
CN X HFI	1	13	0	0	14
MG X HFI	5	5	1	2	13
RM X HFI	1	3	2	1	07
Total	8	27	7	3	45

Tableau 7. Ségrégations observées dans les back-cross sur patrons PEE.

	Nombre de descendants				
Type de back-cross	Raie de mulet inversée	Blaireau	Noir et feu	Autres	Total
PD X (PD X HFI)	2	0	0	6	8
CN X (CN X HFI	3	0	0	1	4
PD X (MG X HFI)	7	0	0	2	9
PD X (CN X HFI)	3	0	0	0	3
PD X (RM X HFI)	1	0	0	0	1
CN X (RM X HFI)	0	0	0	0	0
CN X (MG X HFI)	1	0	0	0	1
CN X (PD X HFI)	0	0	0	0	0
Total	17	0	0	9	26

phénomène déjà observé dans les croisements du tableau 3. Au total il pourrait y avoir un tri voir un quadri allélisme au locus *Extension* (*E*, $E^{l,}$ E^D,*e*). Les races italiennes PEE présenteraient les 3 génotypes: E^1E^1, E^1E ou *EE* déjà mis en évidence par Julien (1999), Rouzaud *et al.* (2000) et Crepaldi *et al.,* (2003) cependant que la race *Frisonne italienne* serait porteuse de E^D à l'état homozygote (E^D E^D) ou hétérozygote (E^D *E* ou E^{D-}-).

Dans ces conditions l'apparition de phénotypes non parentaux pourrait résulter du fait qu'en HFI la présence de E^D à la fois dominant et épistatique empêche l'expressivité d'une série d'allèles en *Agouti,* qui ségrèguent d'une manière silencieuse et qui, lorsque la formule en *E* ne comporte plus l'allèle épistatique E^D, peuvent se manifester et s'exprimer dans des formules en *Agouti* où ils se combinent avec l'allèle donnant le fauve à extrémités noires apparemment homozygote dans les race italienne PEE. Ces allèles sont A^i *(inverted mule stripe)* et A^t *(black and tan)* que MIC 2000 propose comme appartenant à la série *Agouti* dans certaines races bovines.

Ségrégation de la dilution charolaise

Les résultats de F1 sont donnés dans le tableau 8

Tableau 8. Ségrégations pour la dilution observées en F1 Charolais par non Charolais.

Type	Sur fond eumélanique	Sur fond phaeomélanique	Total
Dilution charolaise	18	10	28
Non dilué	1	9	10
Total	19	19	38

Sur fond eumélanique noir la dilution donnait des animaux bleus ou gris, tandis que, sur fond phæomélanique les animaux dilués apparaissaient jaune ou crème.

Par le passé la dilution charolaise a été étudiée dans des croisements entre les races *Charolaise* et *Brune des Alpes* par Lauvergne *et al.* (1989). En F1 on observait deux phénotypes: le tout blanc charolais et une forme de dilution dite dilution charolaise. Cette dilution provenait du fait que, sur fond phæomélanique, il y a une réduction de la quantité de mélanosomes qui arrivent à maturité et de la densité des mélanocytes folliculaires (Renieri *et al*., 1993). Ainsi, même si on a coutume de définir la couleur de la robe *Charolaise* comme étant le blanc (Quittet, 1946; Babo, 1998), il ne s'agit pas d'un blanc provenant d'une absence totale de la production de mélanine comme on l'observe au niveau des tâches blanches de la *Frisonne*.

Dans les données F1 du tableau 8 on n'observe pas chez les hétérozygotes des sujets ayant l'expressivité "tout blanc" de la race *Charolaise*, seulement des non dilués et des dilués sur fond phæomélanique (rose ou crème) et sur fond eumélanique noir (gris ou bleus).

Apparemment le gène DC^{D} (*dilution*) au locus *Dilution Charolais* (Lauvergne *et al.*, 2000) que l'on peut invoqué ici a un comportement dominant avec pénétrance incomplète sur l'allèle DC^{+} *(standard).*

Ségrégation de l'altération chinchilla

Les résultats des ségrégations en F1 sont donnés dans le tableau 9. Ceux du back cross sont donnés dans le tableau 10.

L'altération pigmentaire chinchilla n'affecte que les zones phæomélaniques, en conséquience de quoi sa présence est indétectable sur les animaux de patron pigmentaire eumélanique. De tels animaux ont été classés dans la colonne "illisibles".

Le terme d'altération chinchilla a été suggéré par Lauvergne (1966 b) pour expliquer que, dans certaines races phaeomélaniques à extrémités eumélaniques comme en France la *Gasconne* et en Italie les

Tableau 9. Ségrégations observées en F1 dilué chinchilla (races PEE) par pigmentation non altérée (ici IHF).

Type de croisement	Nombre de descendants			
	Chinchilla	Normaux	Phénotype illisible	Total
PD X HFI	4	13	24	41
CN X HFI	3	13	17	33
MG X HFI	3	11	23	37
RM X HFI	2	6	18	26
Total	12	43	82	137

Tableau 10. Ségrégations de l'altération chinchilla observées dans les back-cross PEE x F1.

Type de croisement	Nombre de descendants			
	Chinchilla	Normaux	Phénotype illisible	Total
PD X (PD X HFI)	2	12	0	14
CN X (CN X HFI	5	1	0	6
PD X (MG X HFI)	11	13	0	24
PD X (CN X HFI)	6	7	0	13
PD X (RM X HFI)	0	1	0	1
CN X (RM X HFI)	1	2	0	3
CN X (MG X HFI)	2	2	0	4
CN X (PD X HFI)	2	1	0	3
Total PEE x F1	29	39	0	68

races dites podoliques qui présentent ici le phénotype PEE comme on l'a vu plus haut, il y avait disparition précoce des zones phæomélaniques dans la livrée.

Cette appellation chinchilla provient de l'homologie phénotypique avec le mutant *chinchilla* au locus *C* de la souris, Silvers (1979). L'appellation C^{ch} a été retenu dans MIC 2000 (Lauvergne *et al.*, 2000 c). Cette appartenance n'a pas été vérifiée.

Dans le tableau 9 on observe 60% de F1 (82) qui sont eumélaniques noir et sur lesquels il n'est pas possible de déceler l'altération car celle-ci n'affecte que les parties phæomélaniques de la livrée. Les hétérozygotes restant sont pour 78% (43) non altérés et pour 22% porteurs de l'altération chinchilla.

Cette fréquence des F1 avec altération chinchilla ne peut pas être justifiée par la présence d'hétérozygotes dans les races maternelles car, à notre connaissance, le gène de type chinchilla n'a jamais été décrit en ségrégation dans la race *Holstein* (Lauvergne, 1983); Lauvergne *et al.*, 2000).

Ici aussi est-il donc nécessaire de faire appel au phénomène de pénétrance incomplète.

Tableau 11. Ségrégations observées en F1 uniformes par panachés.

Races en croisement	Nombre de descendants		
	Panachés	Uniformes	Total
LM X HFI	11	18	29
CH X HFI	16	22	38
PD X HFI	7	34	41
CN X HFI	8	25	33
MG X HFI	11	26	37
RM X HFI	9	17	26
Total	62	142	204

Tableau 12. Ségrégations observées en back cross sur animaux uniformes.

Type de croisement	Nombre de descendants		
	Panachés	Uniformes	Total
LM X (LM X HFI)	0	16	16
PD X (PD X HFI)	1	13	14
CN X (CN X HFI	0	6	6
PD X (MG X HFI)	0	24	24
PD X (CN X HFI)	0	13	13
PD X (RM X HFI)	0	1	1
CN X (PD X HFI)	0	3	3
CN X (MG X HFI)	0	4	4
CN X (PD X HFI)	0	3	3
Total	1	83	84

Ségrégation de la panachure

Les résultats des ségrégations en F1 sont donnés dans le tableau 11. Les résultats des back-cross sont donnés dans le tableau 12.

Les données du tableau 11 montrent qu'en F1 30% (62 sur 204) des animaux sont panachés avec des tâches blanches toujours petites et localisées aux parties déclives. Cette fréquence de panachures en F1 ne peut pas être justifiée par la présence d'hétérozygotes dans les races paternelles car, à notre connaissance, aucun gène de panachure n'a jamais été observé en ségrégation dans les races maternelles utilisées ici (*Limousin* et races PEE italiennes) (Lauvergne, 1966, a; Lauvergne *et al.*, 2000).

Il est donc nécessaire d'invoquer en F1 un phénomène de dominance avec pénétrance incomplète de l'allèle muté pour la panachure sur l'allèle standard conditionnant la couleur uniforme.

En back cross sur les races uniforme (tableau 12) on remarque que la pénétrance de cette dominance de l'allèle pour la panachure s'atténue considérablement: on n'observe qu'un animal panaché sur 84. Cette quasi disparition de la dominance est due sans doute à la présence des 75% de gènes modificateurs en provenance des races de pères qui sont uniformes

En retenant la nomenclature de MIC 2000 (Lauvergne *et al.,* 2000) on aurait l'allèle S^+ *(standard)* au locus *Spotting,* dominé avec une pénétrance de 30% par l'allèle S^s (*spotting*), lequel retrouve une situation de dominance à peu près totale en back cross.

Conclusions

Dans les croisements phæomélanique x eumélanique noir les ségrégations observées ont été interprétées par un bi allélisme au locus *Extension*, *E*: les pères Charolais et Limousins étant E^rE^r et les mères HFI E^DE^D *ou* E^DE^r. En F1 et en back-cross on observe les deux phénotypes parentaux et des phénotypes intermédiaires. Cette situation a été interprétée en terme de dominance incomplète de la phase eumélanique noir.

En F1 et en back-cross des croisements phæomélanique à extrémités eumélaniques x eumélanique noir outre les phénotypes parentaux on observait des phénotypes déjà décrits chez les Bovins (raie de mulet inversée, blaireau, noir et feu) et des phénotypes non encore décrits. Cette situation a été interprétée par un tri allélisme au locus *Extension*: E^D, *E* et E^1.

Deux phénotypes ont été observés en F1 Charolais x normal: dilué et normal. Cette situation a été interprétée par un bi allélisme au locus *Dilution Charolais*, *DC*: DC^D et DC^+ avec, à l'état hétérozygote, une' expressivité intermédiaire entre le deux phénotypes parentaux. Une pénétrance incomplète existe.

La détection de l'altération chinchilla n'était pas possible sur les animaux à fond eumélanique. Parmi les animaux pheomelaniques, en F1 et en back-cross on observe l'apparition des deux phénotypes parentaux. Cette situation a été interprétée par un bi allélisme au locus *Albino*, *C*, C^+ et C^{ch} avec pénétrance incomplète.

En F1 et en back-cross entre panachure irrégulière et uniformément coloré on observe les deux phénotypes parentaux. Cette situation a été interprétée par un bi allélisme au locus *Spotting*, *S*, S^+ et S^s, avec une expressivité variable et pénétrance incomplète en F1 et en back-cross.

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Références

Agricoltura e Ricerca. 1985.: Introduzione. Agric. Ric., Roma, 45/45, 7-13.

Babo D. 1998. Races bovines françaises. Editions France Agricole, Paris.

Charlier C., B. Denys, J.I. Belanche, W. Coppieters, L. Grobet, M. Mni, J. Womack, R. Hanset & M. George. 1996. Microsatellite mapping of the bovine roan locus: a major determinant of white heifer disease. Mammalian Genome, 7, 138-142.

Crepaldi P., M. Marilli, C. Gorni, D. Meggiolaro, M. Cicogna, C. Renieri. 2003. Preliminary study on MC1R polymorphisms in some cattle breeds raised in Italy. Proc. ASPA, Bologna, submitted.

Foreman M.E., M.L. Lamoreux, B. Kwon & J.E. Womack. 1994. Mapping the bovine albino locus. J. Hered., 4, 318-320.

Joerg H., H.R. Fries, E. Meijerink & G.F. Stranzinger. 1996. Red coat color in Holstein cattle is associated with a deletion in MSHR gene. Mamm. Genome 7, 317-318.

Julien R. 1999. Utilisation de marqueurs génétiques pour la traçabilité, Séminaire du Dpt de Génétique animale de l'INRA, Cap d'Agde, 27 sept-1er oct. 1999, Département de Génétique animale de l'INRA, Toulouse, 1999, pp 279-282.

Klungland H. & D. Vage. 1999. Presence of the dominant extention allele E^D in red and mosaic cattle. Pig. Cell Res., 12, 391-393.

Klungland H., D. Vage, L. Gomez-Raya & S. Adalsteinsson. 1995. The role of melanocyte-stimulating hormone (MSH) receptor in bovine coat color determination. Mammal. Genome, 6, 636-639.

Lauvergne J.J. 1966 a. Contribution à l'étude de la couleur du pelage chez les Bovins domestiques, Thèse 3ème cycle Fac. Sci. Univ. Paris.

Lauvergne J.J. 1966 b. Génétique de la couleur du pelage des Bovins domestiques (*Bos taurus* L.). Bibliogr. Genetica 20, 1-68.

Lauvergne J.J. 1983. Les robes du Boeuf domestique (*Bos taurus* L.) et leur formule génétique. Ethnozootechnie 32, 70-90.

Lauvergne J.J., C. Renieri, M. Silvestrelli & F. Valfrè. 1989. Genetic analysis of cattle coat color from crossbreds with Swiss Brown. J. Anim. Breed. Genet., 106, 389-397.

Lauvergne J.J., C.H.S. Dolling, A.L. Rae, C. Renieri, D.P. Sponenberg & B. Denis. 2000. Coat Colour Loci (Category 1). In: Millar P., Lauvergne J.J., Dolling C. (Eds), Mendelian Inheritance in cattle 2000, EAAP Publ. No 101, Wageningen Pers, Wageningen, pp. 37-105.

Misuraca G., G. Prota & J.J. Lauvergne. 1974. Nature des pigments mélaniques du pelage des Bovins domestiques (*Bos taurus* L.). Ann. génét. sél. anim. 6, 399 404.

Olson T.A. 1999. Genetics of colour variation. In: Fries R., Ruvinsky A. (Eds), The Genetics of Cattle, CAB International, Oxford, U.K., pp 33-53.

Olson T.A. & R.L. Willham. 1982. Inheritance of Coat Colour in Cattle: a review. Iowa Agr. Home. Ec. Exp. Sta. Res. Bull. 595, Ames, Iowa, pp. 149-176.

Quittet E. 1946. :Les races bovines françaises. Ministère de l'Agriculture, Paris,.

Reinsch N., H. Thomsen, N. Xu, C. Looft, E. Kalm, G.A. Brockmann, S. Grupe, C. Kühn, M. Schwerin, B. Leyhe, S. Hiendleder, G. Erhardt, I. Medjugorac, I. Russ, Föster B. Brenig, J.M. Blümel, R. Reents, G. Averdunk & J. Duda. 1999. Mapping loci for the degree of spotting, color dilution, and circumocular pigmentation in the ADR granddaughter-design, 50th Ann. Meet. EAAP, pp. 1-16.

Reinsch N., H. Thomsen, N. Xu, M. Brink, C. Looft, E. Kalm, G.A. Brockmann, S. Grupe, C. Kühn, M. Schwerin, B. Leyhe, S. Hiendleder, G. Erhardt, I. Medjugorac, I. Russ, M. Föster, R. Reents, G. Averdunk. 1999. A QTL for the Degree of Spotting in Cattle Shows Synteny with the KIT Locus on Chromosome 6. J. Hered, 90, 629-634.

Renieri C., J.J. Lauvergne & F. Valfrè. 1984. La formula genetica della colorazione delle razze bovine a standard italiane [Genetic formula of standardized Italian cattle breeds]. Riv. Zoot. Vet. 12, 310 317.

Renieri C., T.A. Olson, D.P. Sponenberg. 1990. Present state of genetic nomenclature of coat colour loci in cattle. IV World Congr. Genet. appl. Livestock Produc., Genetic nomenclature of cattle, 14, pp. 529-532.

Renieri C., G. Martino, J.J. Lauvergne, M. Trabalza Marinucci. 1988. Quantitative analysis of eumelanins and phaeomelanins in hair of cattle with different pigmentation genotypes. In: XX Int. Conf. Anim. Blood Groups Biochem. Polymorphisms, Turin, p. 76 (abstract).

Renieri C., J.J.Lauvergne, S.Gigli & F. Valfrè. 1989. Analisi genetica della colorazione de bovini. Dati di incroccio e backcross tra le razze Bruna, Limousine, Chianina e Piemontese. Ann. Ist. Speriment. Zootecnia, 3, 107-124.

Renieri C., P. Ceccarelli, A.M. Gargiulo, J.J. Lauvergne & G. Monacelli. 1993. Chemical and Electron Microscopic Studies of Cattle (*Bos taurus*) with Four Types of Phenotypic Pigmentation. Pigment Cell Res. 6, 165-170.

Rouzaud F., A. Oulmouden, J.M. Petit, H. Levéziel & R. Julien. 1996. Gènes de la coloration des races bovines allaitantes françaises. Perspectives d'application à l'identification des produits, Rencontres Rech. Ruminants 3, 317-320.

Rouzaud F., J. Martin, P.F. Gallet, D. Delourme, V. Goulemot-Leger, Y.Amigues, F. Ménissier, H. Levéziel, R. Julien & A. Oulmouden. 2000. A first genotyping assay of French cattle breeds based on a new allele of the extention gene encoding the melanocortin-1 receptor (Mc1r), Genet. Sel. Evol., 32, 511-520.

Searle A.G. 1968. Comparative Genetics of Coat Colour in Mammals, Logos Press/Academic Press, London.

Silvers W.K. 1979. The Coat Colors of Mice, Springer-Verlag, New York, 1979.

Polish Red Cattle breeding: past and present

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Summary

The aim of this study was to characterise the Polish Red cattle breed, the only existing native breed in Poland. The origin and conformation of this breed and its historical development, distribution and performance were described. Moreover, the attention was paid to the attempts to improve the breed milk performance by crossbreeding with Jersey, Danish Red and Angler and beef performance by crossbreeding with Black-and-White, Red-and-White, Simmental and beef bulls.

Before the Second World War the Polish Red held the rank of an international breed, and since the middle of the previous century had been found almost throughout Poland. In the 1950s it still constituted 22% of the whole cattle population in Poland. Indeed in 1954 the Polish Red cattle population amounted to over 1.5 million head. Currently, Polish Red cattle are in danger of extinction. Only 300 cows are included in the Program of Genetic Resources Conservation and scarcely several hundred embryos and semen doses are stored in the Semen Bank of the National Research Institute of Animal Production in Balice.

In 2001 the number of recorded Polish Red milking cows was 1 201. Their average performance amounted to 3 786 kg of milk with 4.26% of fat and 3.39% of protein. However, milk yield of the cows at the best farms exceeded 5 500 kg.

Resumen

El objetivo de este estudio es la caracterización de la raza bovina Polish Red, única raza bovina nativa en Polonia. Se describe el origen y la conformación de esta raza así como su desarrollo histórico, distribución y rendimiento. Además, el estudio se centró en la mejora del rendimiento en leche de la raza a través del cruce con las razas Jersey, Danish Red y Angler, y del rendimiento en carne con los cruces con toros de carne de las razas Black-and-White, Rend-and-White, Simmental.

Hasta la Segunda Guerra Mundial, la raza Polish Red se encontraba a los mismos niveles de las demás razas internacionales y desde mediados del siglo pasado se podía encontrar en casi todo el territorio de Polonia. Hacia los años 1950 representaba el 22% de la población total de bovinos en Polonia. De hecho, en 1954 la población total ascendía a más de 1,5 millones de cabezas. Actualmente la raza se encuentra en peligro de extinción. Sólo 300 animales están incluidos en el programa de conservación de recursos genéticos y a penas algunos centenares de embriones y dosis de semen están conservados en el Banco de Semen del Instituto Nacional de Investigación de Producción Animal de Balice.

En el 2001 el número de animales en control de esta raza era de 1.201. Su media de rendimiento ascendía a 3 786 kg de leche con 4,26% de grasa y 3,39% de proteina. Sin embargo, el rendimiento en leche de las vacas en las mejores explotaciones superaba los 5 500 kg.

***Keywords**: Polish Red cattle, Breeding, Conservation, Characteristics, Production performances.*

Introduction

Of all the Polish breeds of cattle, only Polish Red cattle, named so by F. Holdefleiss (1897) [acc. to Szumowski (1936)] and L. Adametz (1901): "Das Polnische Rotvieh", had international significance and were acknowledged as the only indigenous breed raised in Poland. The breed's international importance was due to the fact that prior to 1939 it constituted 25% of the Polish cattle population, represented one of the oldest pedigree breeding programs in Europe, established in the 1880s, and was exported from Poland to Europe and South America. Other indigenous Polish breeds (e.g. Zulawki and White-backed) were of little economic importance in Polish history (Konopinski, 1949).

The outline of Polish Red (PR) cattle breeding history confirms the great importance of this breed in Poland in the past (Table 1).

The Origin of Polish Red Cattle

Although the PR cattle population in Poland, as throughout Europe, was not uniform, it shared the autochthonic and brachyceric origin. The original cattle had a uniform red colour (and initially also dark brown and even black) and were short-horned. According to Pajak (1968), PR cattle have been associated with Slavonic tribes from very old times and distinguished themselves with excellent hardiness and adaptation to adverse environmental conditions. Different climatic and soil conditions gave rise to local types of red cattle, although generally this was a dual-purpose breed of the intermediate type (Szumowski, 1936).

Varieties of Polish Red Cattle

Differences in the conformation, colour, performance, growth rate and development of PR cattle observed according to the regions of Poland, served as a basis for distinguishing several varieties of the breed. Historically, the first classification was made by Baranski (1887) [acc. to Szumowski (1936)] who distinguished the varieties; Mountain (Old Polish, Old German), Lowland (Forest, Majdan, Field), Steppe Grey (Hutsul, Podolian) and Mixed (Vistula River and Werchowno). This classification was extended by Adametz (1901) who distinguished additional two varieties of PR cattle in the Malopolska region; original mountain cattle with dark brown ("wild") colour found in the Central Carpathians (up to 900 m above sea-level) and farmed red cattle, located north of the Carpathians in the Malopolska Upland (250-600 m above sea-level). Pajak (1968), citing after Branski, distinguished Mountain and Lowland cattle, a classification similar to that of Rostafinski (1920), into the Mountain (Malopolska region) and Lowland (from the area of the former Congress Kingdom of Poland) varieties. However, the classification of PR cattle made by Konopinski and Borman (1931) was used in the interwar period and adopted by the then Ministry of Agriculture and breeders. The above authors distinguished four varieties of PR cattle: Submontane, Valley, Silesian and Poznan. Even after the end of World War II, Konopinski (1949) mentioned three varieties of PR cattle: Valley (previously known as Lomza, Podlasie, Bug River, western Mazovian), Upland (Swietokrzyskie, Malopolska and submontane) and Silesian (old Silesian and southern Poznan or Rawicz).

As a result of wars which took place in Polish lands, the intensive exchange of breeding animals between varieties, and the introduction of insemination, PR cattle became gradually uniform throughout

Table 1. History of Polish Red cattle breeding.

Year	Event
1869, 1891	The first PR herds established by in Wójcza, Brańszczyk and Czernichów (near Kraków)
1893	Creation of the first PR herd in Jodłownik, which became the first PR cattle breeding centre.
1895	The Union of Polish Red Cattle Breeders was set up by the Kraków Agricultural Society, marking the beginning of systematic breeding work.
1906	Official evaluation of milk yield was introduced to the Małopolska region.
1909	Polish Red Cattle Breeders Association was established in Warsaw with a branch in Białystok.
1913, 1929	Three volumes of cow and bull Herd Books were published by the Polish Red Cattle Breeding Association for the period 1896-1911, 1921-1928.
1914	Polish Red Cattle Breeding Inspectorate was set up in Poznań.
1929	Silesian Red Cattle Breeders Union was set up.
1929	At the National Animal Exhibition in Poznań, PR cattle farm from Małopolska won the Grand Prix, a number of state awards of the first degree and other awards.
1934	At the Małopolska Jubilee Animal Show in Lvov, 550 PR animals from 155 breeders were exhibited to mark 50 years of systematic pedigree breeding. They were awarded 440 distinctions, including 248 state awards and three congratulatory diplomas from the Minister of Agriculture. The bull Juras III (G.10 Lw./11870), representing the main male line in Małopolska breeding, raised by Stanisław Słonecki from Jurowce, won the championship title.
1937	PR cattle were exported to Brazil and Argentina (16-18 animals were sent from the area of the Cracow Association).
27. August 1955	Decree of the Ministry of Agriculture to establish 7 PR cattle breeding centres in Podhale, Beskidy, Mazovia, Rawicz, Lublin, Cieszyn, Lubliniec, and the Świętokrzyski regions (created at the request of breeders).
2. December 1960	Law on Farm Animal Breeding regionalized 4 principal breeds of cattle in Poland (Black-and-White Lowland, Polish Red, Red-and-White Lowland, Simmental).
20. December 1973	Decree of the Minister of Agriculture to confine the regions of PR cattle breeding to the provinces of Katowice (Bielsko and Cieszyn districts), Kraków (Nowy Targ, Nowy Sącz and Limanowa districts), and Rzeszów (Kolbuszowa district).
1975	Station estimation of PR bull breeding value was introduced due to a gradual decline of the PR cattle population; A conservation breeding region was created for 55 000 PR cows in the Nowy Sącz province (district of Nowy Targ and commune of Jodłownik) – subsidies equivalent to 1000 kg of milk per cow per year, free insemination and performance testing were offered to breeders.

(To be continued ...)

(...to be continued).

Year	Event
1982	The Małopolska Cattle Breeders Association was established in Kraków. Among others, it exported 6 groups of in-calf PR heifers to Germany as the so-called ecological cows.
1997	Advisory Group on Genetic Resources of Farm Animals was set up at the Central Animal Breeding Station in Warsaw – a Working Group on Cattle Genetic Resources was established as its part.
1999	National Breeding Program for Genetic Resources of Farm Animals and the Polish Red Cattle preservation project were developed. In the year 2000, the Minister of Agriculture and Rural Development approved them for implementation.
2001	Growing interest in PR cattle in the Białystok province (by 2003, it is planned to buy from the herd in Popielno 100 cows as part of a program implemented by the North Podlasie Bird Protection Society within the framework of the project "Restitution of Polish Red Cattle in the Upper Narew River Valley").

Poland (Figure 1). By the 1970s, the division of PR cattle into varieties was no longer relevant.

The Prevalence of Polish Red Cattle

From the 18th century to the period between the wars, PR cattle were found in almost every part of Poland, but their early breeding was marked by the occurrence of motley colours. Initially, PR cattle were bred mainly by peasants and farmers, while in manors preference was given to imported breeds (Simmentals, Dutch cattle, etc). It is important to note that the 19th century studies on native cattle were initiated by foreigners: Holdefleiss, Wilckens and Adametz (Konopinski, 1949).

After World War II, the Submontane variety of PR cattle was found in the provinces of Kraków, Rzeszów and Kielce, the Silesian variety in the provinces of Katowice and Poznan, and the Valley variety in the Lódz, Bialystok, Lublin and Warsaw provinces (Felenczak, 1997).

In 1954 the population of PR cattle stood at 2 103 419 animals (1 552 320 cows), which constituted 22% of the cattle stock in Poland (Pajak, 1968). The distribution of PR cattle in Poland was uneven – 50% of the population was concentrated in the Kraków province (with about 90% of the population in the districts of Limanowa and Bochnia and about 80% of the cattle population in the districts of Biala, Myslenice and Zywiec). Of this relatively large stock of cattle, just over 13 000 milking cows were recorded. Although in 1955 the active population of PR cattle was 22 000 cows, this constituted just about 1% of all PR cows. In addition, pedigree books of PR cattle contained only a small number of animals – about 2 400 bulls and over 10 000 cows.

Until now, this 1% of recorded cows has been maintained with a rapid decline in the population of PR cattle. This was and is one of the main hindrances limiting the efficient breeding work with the PR breed.

The population of PR cattle in Poland peaked in the 1950s but was increasingly replaced by Black-and-White Lowland and Red-and-White Lowland breeds in the years

Figure 1. Pure-bred polish red cow.

that followed. In the end, as a result of another regionalisation of cattle breeding, the Ministry of Agriculture limited the occurrence of PR cattle to the region of Nowy Sacz, where a conservation breeding centre was established in 1975 to maintain a pure PR cattle breeding program. It was planned to gather a population of 55 000 cows mainly in the area of the Nowy Targ district and commune to make breeding work possible. However, the area of Nowy Targ had no tradition of breeding and it was doubtful whether the advantageous attributes of PR cattle would be retained. When in 1982 the Minister of Agriculture resolved to abandon cattle regionalisation in Poland, the breeding of PR cattle was limited to four farms at the Experimental Station Baranowo, at the State Pedigree Breeding Centre Elk, in Hanczowa and Popielno. The purpose was to retain a reserve of genes that represented the valuable traits of PR cattle. Finally, however, the population of PR cattle, which forms about 1% of the national cattle stock, was first crossed with Red Danish and later with Angler breeds. To protect the breed from complete extinction, a breeding program was developed as part of the National Program for the Conservation of Genetic Resources of Farm Animals to recreate and preserve the population of old PR cattle (first 300 animals with a target number of 750 cows). The majority of these animals are found in the area of the Kraków Inspectorate (over 210 cows), followed by the Olsztyn Inspectorate (60 cows, farm of the Polish Academy of Sciences Station in Popielno) and the Bialystok Inspectorate (24 cows) (Program hodowlany zasobów genetycznych bydla polskiego czerwonego, 2000). The authors of the program estimate the size of the purebred PR cattle population to be about 1 000 cows, of which 150 cows are bred in performance tested conservation herds. In mid-2002, 42 farms took part in the breeding program protecting the genetic resources of PR cattle, the largest belonging to the Cistercian Fathers in Szczyrzyc (30 cows) (Kowol, 2002).

Characteristics of Polish Red Cattle

PR animals are characterized by high degree of viability and excellent adaptation to harsh living conditions probably as a result of the poverty of peasant families who kept them over centuries and the areas of their occurrence (the region of south Poland). PR cattle are characterised by resistance to disease (particularly tuberculosis), excellent fertility and longevity. Another major advantage of the breed has been its consistent ability to use farm-produced fodders efficiently (this particularly concerns bulky feeds in winter and pasture grass in summer). This, however, has for many years been misinterpreted as a sign that PR cattle do not require intensive feeding (Pajak, 1968). It is the authors' opinion that this was one of the reasons why PR cattle breeding ended in a failure.

In addition to the above characteristics, the PR breed is distinguished by unique conformation, which in the case of the Submontane variety (the most numerous at present) has not changed much over 70 years, as evidenced by the data in Table 2.

During the interwar period, PR cattle were considered a medium-sized breed. Younger cows were most often characterised by a small frame size, while older, well fed animals reached larger sizes. The characteristic sexual dimorphism was easily noticeable – bulls were stocky with aurochs - like conformation, while cows had roe deer-like conformation with a delicately shaped head, neck and legs. The trunk was cylindrical and narrow, the front of cows fairly deep, rump usually roof-shaped, base of the tail high. The udder was small and round with vulval suspension. Unlike cows, bulls were characterized by much greater frame size, the front trunk being better built than the rump area, as well as a wider and heavier head. Conformation of PR cattle was highly harmonious, the body weight averaging 450-500 kg for adult cows and 700-900 kg for bulls. Birth weights were 25-35 kg for heifers and 28 45 kg for bulls. Year-old heifers reached a weight of 280 kg, which is 20 kg less than bulls of the same age. PR cattle were an early maturing breed, mainly bred for meat and milk. The average milk yield of cows was 3 000 3 500 kg milk which contained 4.0-4.5% fat (Twardzicki, 1937).

The current Breeding Program specifies the following characteristics of the PR cattle standard:

- coat colour ranging from red to dark red, dark nostrils and hooves;
- conformation traits: strong legs, hard and strong hooves, properly formed udder;
- height at sacrum of adult animals: bulls 140 cm, cows 130 cm;
- utility type: meat-and-milk;
- milk yield per cow averaging 3 200 kg per lactation, fat content of milk 4.2-4.5%, protein content 3.3-3.6%.

As can be seen from the above, the current standard adopted for the recreation of PR cattle in Poland is similar to the characteristics of this breed in the interwar period (1919-1939). It is worth noting that in

Table 2. Zoometric measurements of PR cows.

Measurements	Konopiński and Bormann (1931)	Feleńczak (1997)
Height at withers (cm)	123	124
Chest depth (cm)	64	67
Pelvic width (cm)	43	46

the meantime the breed standard was formulated several times (in the 1950s by Szostakowski (1959) and in the 1990s by "Program hodowli bydla i produkcji bydlecej do roku 2000" (1996).

Milk performance

Officially controlled recording of the milk yield of PR cattle was first introduced in the area of the Malopolska Association of Polish Red Cattle Breeders (MZHBCP) in 1906, but results of milk testing on superior farms were given by Szumowski (1936) for the year 1895. For example, in the Przyborów farm in 1896 the mean yield of PR cows was 1 400 kg of milk with 4.80% fat, while in 1928 the cows produced 2 552 kg of milk with 3.85% fat. The same author provides data on the milk performance of PR cows in 1902-1933 grouped into individual Associations of Polish Red Cattle Breeders in Poland, with the earliest data given for 1902 for the Malopolska Association. In that year cows produced an average of 1884 kg of milk with 4.40% fat, while in 1933 their milk yield achieved as much as 2 516 kg with a fat content of 3.94%. The highest milk yield of cows was noted by Szumowski for the Poznan Association (where in 1929 PR cows produced an average of 3 423 kg of milk containing 3.83% fat).

In 1960-1965, controlled milk performance recording involved the greatest number of PR cows (23 000-24 000, including over 10 000 cows registered in pedigree herd books).

Analysis of the results of controlled milk recording over decades shows a very slow increase in the milk yield and in the fat content of milk. Until 1985 cows produced an average of 3 000 kg of milk containing about 4.0% fat. During the following decades (probably as a result of crossing PR cattle with Anglers and improved feeding) the milk yield was shown to increase considerably to 3 663 kg with 4.36% fat content and high protein content of 3.42%. Unfortunately, the improvement of milk performance traits was accompanied by a decrease in the number of tested PR cows to about 1 000 animals[1].

It should be noted that despite their low milk yield, an important advantage of PR cattle is the favourable composition of milk which makes it particularly suitable for cheese-making purposes – this milk gives a higher yield of casein clot of better quality (especially a high proportion of kappa-casein B) in relation to the Black-and-White and Red-and-White breeds (Leonhard-Kluz, 1976; Szarek *et al*., 1980a; Felenczak, 1997).

Without doubt, the advantages of PR cows' milk did not compensate for the relatively low milk yield, which in cows reared on individual farms in the former Nowy Sacz province was due to poor nutrition (Felenczak *et al*., 1990). While further attempts were made to enhance PR cattle by crossing, not enough efforts were made to improve the conditions in which cattle were bred, especially the rationalisation of cow and heifer nutrition.

Tables 2 and 3 illustrate selected traits of milk performance of Polish Red cows under milk recording in 2001. The number of milk recorded cows was 1201. Their average performance amounted to 3 786 kg of milk with 4.26% of fat and 3.39% of protein (Table 4). However, the milk yield of cows at the best farms exceeded 5 500 kg (milk performance of the best cow called Malina with regard to fat and protein yield was the following: milk yield: 6 924 kg, fat content: 4.68%, protein content: 3.36%, during 6th 305-days lactation).

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[1] The results of milk recording of PR cattle for 1934-1984, with classification into cows in herd books, are given by Juszczak and Zalewski (1986), for 1955-1997 by Central Pedigree Breeding Station, quoted after Kuczaj (2001), for 1993-1999 by Szarek *et al*. (2000), and for 2000 and 2001 based on data of Central Pedigree Breeding Station and National Animal Breeding Centre in Warsaw (Ocena wartosci uzytkowej krów..., 2001, 2002).

Table 3. Milk performance of Polish Red cows in Poland in 2001[1].

Cows	No. of cows	Milk yield (kg)	Fat		Protein	
			(kg)	(%)	(kg)	(%)
Total	1 201	3 786	161	4.26	128	3.39
Registered in the herd-books	311	3 755	163	4.34	126	3.35
Not registered in the herd-books	651	3 675	153	4.16	122	3.31
Cow heifers	239	3 177	134	4.22	105	3.30

[1]94.6% of the cows are kept in private farms; 5.4% – in state farms
Source: Ocena wartości użytkowej krów oraz ocena i selekcja buhajów – wyniki za 2001 rok. 2002. KCHZ w Warszawie, 19-65

Table 4. The yield obtained in the best cow sheds for Polish Red cows in 2001.

Breeders	Average no. of cows	Average calving interval (days)	Milk yield (kg)	Fat		Protein	
				(kg)	(%)	(kg)	(%)
Wojciech Zdebski, Kobylec [1]	4.5	463	5 664	275	4.85	186	3.29
Mariusz Sotola, Kobylec [1]	3.2	362	5 557	265	4.77	192	3.46
Sbreihzz Pan w Polpielnie [2]	56.1	382	3 398	146	4.30	113	3.33
Klasztor oo. Cystersów, Szczyrzyc [2]	55.4	415	3 046	123	4.04	102	3.35

[1]Among breeders kept not more than 20 cows, [2]Among breeders kept more than 20 cows
Source: Ocena wartości użytkowej krów oraz ocena i selekcja buhajów – wyniki za 2001 rok. 2002. KCHZ w Warszawie, 19-65

Beef performance

Studies carried out at the National Research Institute of Animal Production in Balice demonstrated that in terms of suitability for fattening and slaughter, the PR breed is the worst of the four breeds found in Poland (Romer, 1973). However, according to Bujwid (1971) , the meat of PR cattle is characterised by high degree of tenderness, delicateness, marbling and water holding capacity, parameters that are very important from the point of view of meat processing. The results were confirmed also by Szarek *et al.* (1980a). In addition, the studies of Szarek *et al.* (1980c) showed that as well as good conversion of bulky feeds by PR fattening cattle, they are also characterised by high slaughter yield and their carcasses by favourable tissue composition.

These favourable meat characteristics of the PR cattle did not compensate for lower weight gains during intensive fattening and the resulting higher intake of feed per 1 kg weight gain compared to other breeds of cattle in Poland. Although better results were noted with semi-intensive and extensive fattening of PR cattle (mean daily weight gains of 750-900 g, slaughter yield 55-60% (Juszczak and Zalewski, 1986), this must have been associated with the earlier termination of fattening (at about 360 kg of body weight), while lowland breeds could be fattened to 450-600 kg without the risk of excessive carcass fatness. Under these circumstances, Italian traders did not want to buy PR slaughter cattle, while the then classification of slaughter animals retained Class I only for fattening cattle with a weight exceeding 450 kg.

In order to improve the efficiency of fattening PR cattle, commercial crossing with beef breeds and other breeds raised in Poland was applied.

Improvement of Polish Red cattle

According to Adametz, quoted after Szumowski (1936), Polish Red cattle were an intermediate breed (between primitive and refined breed) and remained so despite the 120 years of breeding work. The results of these efforts were often wasted by the results of wars (World War I and II, the Bolshevik War), by changes in the political system (1989) and by poor breeding decisions (unimproved environmental conditions, inadequate choice of breed components for improvement crossing, etc.). During 1884-1934, the PR breed was not only established but also improved to the extent that it could rival other breeds of cattle (e.g. Black-and-White or Simmental), and in some regions of Poland, PR cattle supplanted other breeds almost completely (e.g. in the Kraków region). This resulted from professional breeding work and the love of breeders for PR cattle. That period was marked specifically by patriotism and aspirations to create a native breed of cattle. It is worth mentioning that the PR breed was used to advantage during the Versailles Congress (28 June 1919) to encourage the US President Wilson to support Poland's aspirations for national independence. Himself a devoted breeder, Wilson was shown an album of PR cattle as one of important arguments in favour of establishing independent Poland (Bujwid, 1971). Another fact worthy of note was the export of PR cattle to Germany (more specifically to the Institute of Plant Science in Wroclaw and Bavaria), to Czechoslovakia, Greece, Romania and, most spectacularly to Brazil (state of Parana) (Twardzicki, 1937).

In 1934-1984 breeding work on PR cattle was carried out by 11 PR Breeders Associations in different regions of Poland. This activity involved 400 farms owned by large farmers and 15 000-20 000 cattle licensed in farms owned by small farmers. During that time, purebred breeding for superior male lines [e.g. the lines Topór Rzezbiony (Figure 2), Starosta, Juras III] and family selection (Szumowski, 1936) were applied.

Regrettably, this period was also characterised by "breeding formalism", a sort of emphasis on conformation traits and colour of hair coat more than performance characteristics. PR cattle, as a less demanding breed, were allocated to areas with poor soils where extensive farming was carried out. Furthermore, when evaluating and selecting animals, too much emphasis was placed on the conformation and coat colour while neglecting milk and beef performance which, as was commonly believed during that time, were specific to the breed and did not require any improvement. As a result, milk performance has remained unchanged for 70 years (Juszczak and Zalewski, 1986).

PR cattle breeding suffered huge losses during World War II but only because of war damage. During that time, an extreme form of "breeding formalism" was employed by the Nazi occupiers. All cows that were not 100% single-colour were delivered to the army. Even a small bright spot near the udder or legs disqualified the cow, and it was usually the case that such animals had generally superior milk performance.

Another important cause of losses suffered by PR cattle breeding in Poland was mishandling of breeding records and selling of breeding bulls of false origin from Malopolska to other regions of Poland. These dishonest practices were revealed in the Kraków province when Prof. J. Rapacz began to test the pedigree of cattle based on blood typing (Piestrak, 1961). It became apparent that out of 10 000 calves born from cows registered in herd books, there were as many as 8 000 bulls and only 2 000 heifers.

The present authors heard of a case where 9 breeding bulls from a superior PR cow were sold over a period of just 1 year! This was during the period when no embryo transplantation or multiple ovulation procedures were used. There was astonishment when daughters of the bull Elwir – regarded as the preferred representative of the breed – showed an average milk yield of just 1 500 kg at the Bull Testing Station of the Institute of Genetics and Animal Breeding of the Polish Academy of Sciences in Jastrzebiec (Jasiorowski *et al.*, 1988).

These obvious errors resulted in breeding progress failing to reflect breeders' efforts and as a consequence, PR cattle lost out to lowland breeds in Poland. This also gave credence to the arguments of breeders who favoured the improvement of PR cattle by crossbreeding. At this point it should be noted that advocates of both concepts (pure breeding and crossbreeding) have since the beginning of PR cattle breeding argued over the final direction of improvement of these animals.

After World War II, due to the large-scale fragmentation of PR cattle farms, breeding work was carried out in 8 Polish Red Cattle Breeding Centres (Podhale, Beskidy, Swietokrzyski – with the Submontane variety; Mazowsze and Lublin – with the Valley variety; Cieszyn and Lubliniec – with the Silesian variety and in Rawicz with the Rawicz variety) (Pajak, 1968).

In the 1950s, the desired type of PR cow had the following parameters: beef-milk type, body weight 500 kg, annual yield of 3 500-4 000 kg milk containing 4.0% fat, strong constitution, good resistance to

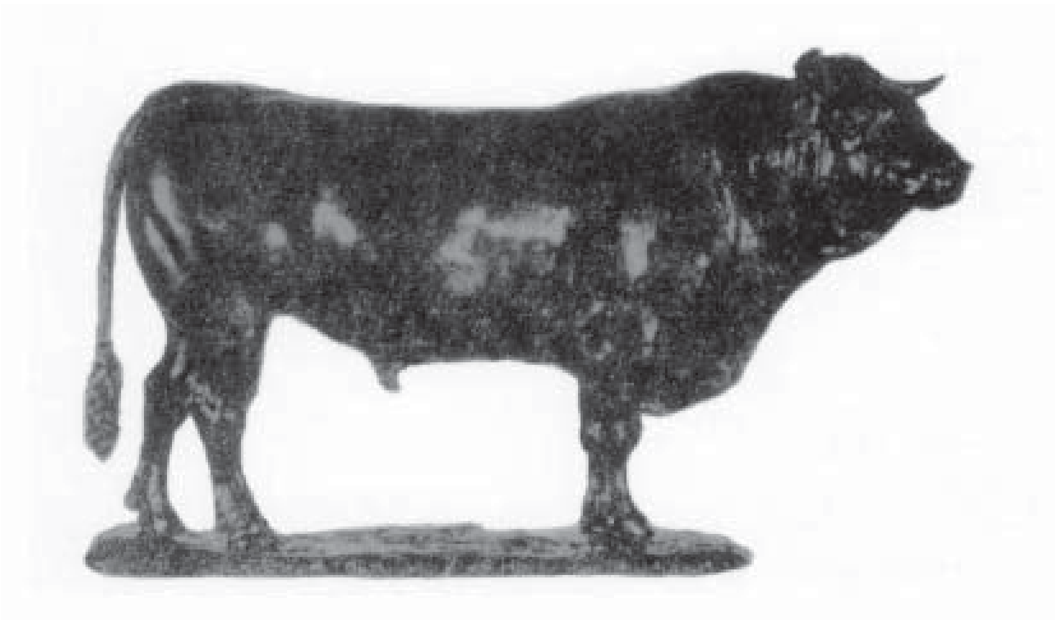

Figure 2. Topór Rzezbiony bull (Polish Red cattle), which received the First Prize on the Livestock Exhibition in Vienna in 1913.
Author of sculpture: Kazimierz Chodzinski; Graphic designer: Krzysztof Adamczyk.

disease and longevity (Szostakowski, 1959). According to these authors, the above breed standard was achievable by improving breeding conditions (mainly nutrition), selection and adequate choice of the bulls for mating.

However, the beliefs of breeders favouring PR cattle crossing predominated despite the fact that Prof. Konopinski warned in his handbook, as early as 1949, that "*neither Red Friesians (...) nor even Red Danish, despite their obvious advantages, are suitable for crossing with Polish Red cattle*."

Similar views were later held by Glus (1987) who stated that the Angler breed should not be crossed with PR cattle either, because neither Red Danish nor Angler cattle are suitable for breeding in Polish conditions, for they originated from seaside areas with milder climate that abounded in feeds. Moreover, both breeds were used only for milk production. The same disadvantages concerned Jersey cattle, which were experimentally crossed with PR cattle in the 1960s in state farms in the Warsaw province and in the area of the Siemiatycze district. It was easy to predict that this would produce animals with superior parameters of milk performance (milk yield and composition, udder conformation) but poorer beef performance (weight of calves at birth, rate of daily weight gains, musculature and slaughter yield). During the inter-war period and just after World War II, Prof. Marchlewski carried out experiments into the crossing of PR and Jersey cattle, stating conclusively that such crossbreeding fails to give positive results because breeders prefer dual-purpose cows. Attempts were made to improve beef performance by crossing with Belgian Red cattle. However, this project has never left the experimental stage (Jasiorowski *et al*., 1988).

In 1976 efforts were begun to improve PR cattle by crossing with Angler cattle (Felenczak, 1997). This was a success in terms of milk performance as the animals were kept in superior environmental conditions. However, no improvements in frame size or musculature were obtained.

Also in the 1970s the replacement of PR cattle with lowland breeds (Black-and-White Lowland and Red-and-White Lowland) and replacement crossing with the Red-and-White Lowland breed were initiated. PR cattle were crossed with Red-and-White cattle in western and eastern Malopolska and in the district of Lubliniec, thanks to which both dairy and beef traits were improved in the crossbreds. Also, heterosis for milk performance was achieved (Romer *et al*., 1976; Szarek *et al*., 1980a, 1981).

On a smaller scale and quite unintentionally, mainly in border areas, PR cows were crossed with Black-and-White Lowland bulls. Although no studies were carried out in this respect, observations have shown that the crosses (PR x BWL) had very good milk traits but poor musculature.

It should also be mentioned that attempts were made to cross PR cattle with Pinzgauers, but this practice was not very common.

Commercial crossing of PR cattle involved both the breeds found in Poland (Black-and-White Lowland, Red-and-White Lowland, Simmental) and those imported from England, France and Italy. At the experimental station in Okocim, suitability for fattening and slaughter merit of PR bulls and their crosses with BWL, RWL, Simmental and Charolais were evaluated by feeding farm-produced fodders to the final weight of about 480 kg. The best parameters of beef performance were characteristic of PR x Simmental, although in the other cases crossbreds were superior to PR bulls.

However, the export of young slaughter cattle to Italy made it necessary to intensify fattening. For this reason, intensive experimental fattening and slaughtering of PR bulls and heifers crossed with Charolais, Piemontese, Limousin, Blonde d'Aquitaine breeds was carried out at the Experimental Station of the National Research Institute of Animal Production in Rymanów (Choroszy, 1987; Choroszy, 1987). It was found that the meat of PR x Charolais crosses had the best quality, while PR x Simmental fattening bulls had the highest mean daily weight gains.

Crosses derived from Piemontese and Blonde d'Aquitaine bulls were the best muscled and had the highest slaughter value. Also these studies confirmed the fact that the crossbreds are generally superior to PR bulls in terms of beef traits.

The extent of crossing PR cattle with other breeds has varied, but it often led to PR cattle being completely ousted from particular farms and regions of Poland. For example, Danish Red bulls and heifers were imported to the extent that in many State Pedigree Breeding Centres they completely replaced PR cattle (Szarek *et al*., 1993). What is more, the efforts to improve milk performance traits through imported animals were associated with the introduction of leukemia, which had so far been non-existent in Poland (Dymnicki, 1974). It is also worth noting that in order to strengthen the constitution of the Danish Red breed, Danish breeders improved it with the Brown Swiss breed on a national scale. It is no wonder, then, that no Danish Reds are found in the results of performance tests published in recent years (KCHZ, 2001). These cows were observed to have decreased milk yields, weakened constitution, greater susceptibility to disease, poorer growth and development of young stock, and decreased fertility. According to Kaczmarek *et al*. (1963) the main reasons for health-related culling of PR x DR and DR cows were tuberculosis (37.5% of the cases), low milk yield (15.3% of the cases) and barrenness (13.9% of the cases). The only sign of crossing PR cattle with Danish Reds (DR) is the contribution of DR cattle to the genetic structure of PR cattle. Pedigree analysis of cows from the Animal Breeding Centre in Jodlownik has shown that their genotypes comprise 49% PR, 23% DR and 28% Angler (Kuczaj, 1998).

It should also be mentioned that attempts have recently been made at the Kraków Centre to improve PR cattle with the Swiss breed with promising results (Mazur *et al*., 1998).

A synthesis of almost all works (for the period 1946-1997) on the crossing of PR cattle with other breeds can be found in a monograph by Kuczaj (2001). In summing up the attempts to improve PR cattle with dairy breeds (Danish Red, Angler, Jersey) as well as Black-and-White Lowland and Simmental, he found that the results obtained under experimental conditions were better than in commercial conditions. The same authors also asserted that Red-and-White Lowlands (RWL) proved the best option for crossing with PR cattle, but this led to PR animals being ousted by RWL animals from the areas of their traditional breeding.

Conclusion

At present the only existing native breed of cattle is threatened with extinction, despite the fact that the Polis Red (PR) in the 1940s the breed was found almost all over Poland and was important internationally.

Unfortunately, mistakes in breeding policy have wasted the opportunity to use the breed to advantage. The current stock of PR cattle is tragically small: there are only about 300 cows involved in the "purebred" genetic resources conservation program and several hundred embryos and semen in the semen bank of the National Research Institute of Animal Production in Balice (Program hodowlany zasobów genetycznych bydla polskiego czerwonego, 2000).

The sad history of PR cattle breeding presented in this paper leads to several conclusions. The current situation of PR cattle in Poland is very similar to the situation just after the end of World War I and II. Mr. Lewandowski (1998) wrote in the "Farmer" magazine that Poles have never bred a breed of international importance. To be more precise, they "did but wasted Polish Red cattle". Breeding is a difficult skill, requiring great knowledge and patience, love of animals and most of all honesty. Although we have often heard recently that we do not need our own pedigree breeding program and it is enough to take advantage of breeding efforts in other countries, it must be stressed that without our own breeding program a large number of breeders will be unable to achieve high levels of animal production. The paper's authors, being emotionally involved in animal breeding (and especially with the breeding of Polish Red cattle) make an appeal, echoing the call of Prof. Zygmunt Moczarski (1917): "Let's Breed Breeders".

List of References

Adametz, L. 1901. Studien über das Polnische Rotvieh. Oesterreichischen Molkerei Zeitung, Wien, 133.

Bujwid, J. 1971. Informacje ustne o hodowli pc i wynikach doswiadczen prowadzonych w ZZD IZ w Rymanowie (Verbal report about Polish Red cattle breeding and researches realized in Experimental Station of The National Research Institute of Animal Production Rymanów).

Choroszy, B. 1987. Wartosc opasowa i rzezna jalówek mieszanców pochodzacych z krzyzowania krów rasy pc z buhajami rasy charolaise, piemontese, limousine, blonde d'aquitaine i simentalskiej (Fattening capacity and slaughter value of two-way cross heifers (Polish Red x Charolaise, Polish Red x Piemontese, Polish Red x Limousine, Polish Red x Blonde d'Aquitaine, Polish Red x Simmental)). Rozpr. doktorska, maszynopis, AR Kraków, pp. 100.

Choroszy, Z. 1987. Przydatnosc buhajków mieszanców pochodzacych z krzyzowania krów rasy pc z buhajami rasy charolaise, piemontese, limousine, blonde d'aquitaine i simental w opasie intensywnym (Results of two-way bulls' intensive fattening: Polish Red x Charolaise, Polish Red x Piemontese, Polish Red x Limousine, Polish Red x Blonde d'Aquitaine, Polish Red x Simmental). Rozpr. doktorska, maszynopis, AR Kraków, pp. 119 (in Polish).

CSHZ. 2000. Program hodowlany zasobów genetycznych bydla polskiego czerwonego (Breeding program of Polish Red cattle genetic resources). Maszynopis, Warszawa, pp. 11 (in Polish).

Dymnicki, E. 1974. Wyniki krzyzowania bydla polskiego czerwonego z dunskim czerwonym w warunkach produkcyjnych. II. Plodnosc (Results of the crossbreeding Polish Red cattle with Danish Red in the production conditions. Part II: Fertility). Prace i Mater. Zoot., 6, 51-60 (in Polish).

Felenczak, A., T. Maj, W. Musial & K. Zukowski. 1990. Kierunki poprawy produkcji pasz i zywienia krów mlecznych w gospodarstwach woj. nowosadeckiego (Improvement of the fodder production and dairy cows' nutrition in farms of Nowosadeckie Province). Biul. Inf. IZ, nr 1-2, 22-35 (in Polish).

Felenczak, A. 1997. Efekty doskonalenia bydla pc przy uzyciu rasy angler (Effects of the crossbreeding Polish Red cattle with Angler). Rozpr. habil., nr 224, AR Kraków, 79 (in Polish).

Glus, R. 1987. Do projektu bydla czerwonego. Hodowla bydla czerwonego w Europie (Red cattle breeding in Europe – informations for the project). Konferencja Nauk.-Techn., Inf. Reg. ZUP, AR w Krakowie, nr 261, 58-60 (in Polish).

Jasiorowski, H., S. Poczynajlo & J. Kwiatkowski. 1988. Rasa jersey w doskonaleniu bydla pc (Crossbreeding Polish Red cattle with Jersey). Przegl. Hod., 24, 2-4 (in Polish).

Juszczak, J. & W. Zalewski. 1986. Hodowla bydla (Cattle breeding). PWRiL, wyd. II, pp. 474 (in Polish).

Kaczmarek A., K. Muller & W. Walczak. 1963. Czerwone bydlo dunskie i jego krzyzówki z bydlem czerwonym polskim hodowane w Wielkopolsce. (Danish

Red cattle and their crossing with Polish Red cattle breeding in Wielkopolska region). Rocz. Nauk Rol., B-83-1, 69-87 (in Polish).

KCHZ w Warszawie. 2002. Ocena wartosci uzytkowej krów oraz ocena i selekcja buhajów – wyniki za 2001 rok (Evaluation of cows' production value, evaluation and selection of bulls – the results for 2001), 19-65 (in Polish).

KCHZ w Warszawie. 2001. Ocena wartosci uzytkowej krów oraz ocena i selekcja buhajów – wyniki za 2000 rok (Evaluation of cows' production value, evaluation and selection of bulls – the results for 2000), 17-66 (in Polish).

Konopinski, T. 1949. Hodowla bydla (Cattle breeding). Instytut Nauk.-Wydawn. Ruchu Ludowego, Poznan, t. I, wyd. II, pp. 453 (in Polish).

Konopinski, T. & J. Bormann. 1931. Rasy bydla w Polsce (Breeds of cattle in Poland). Wyd. Rolnicza Drukarnia i Ksiegarnia Nakladowa, Poznan, pp. 84 (in Polish).

Kowol, P. 2002. Wykaz gospodarstw uczestniczacych w programie hodowlanym ochrony zasobów genetycznych bydla polskiego czerwonego w 2002 roku (Specification of Polish Red cattle breeders taking part in the National Program for the Conservation of Genetic Resources of Farm Animals in 2002). Inspektorat Krakowski RCHZ w Parzniewie. maszynopis, pp. 2 (in Polish).

Kuczaj, M. 1998. Praca hodowlana w stadach zarodowych bydla pc w OHZ w Jodlowniku (wl. Fundacji S. Romera) [Breeding work on Polish Red herd at the State Pedigree Breeding Centre in Jodlownik (owner: Romer's Foundation)]. Maszynopis, KHB i PM AR Wroclaw, pp. 6 (in Polish).

Kuczaj, M. 2001. Skutki krzyzowania i kojarzenia bydla w Polsce w latach 1946-1997 (Effects of cattle crossbreeding in Poland in 1946-1997). Wyd. AR we Wroclawiu, pp. 297 (in Polish).

Leonhard-Kluz, J. 1976. Charakter mleka krów rasy ncb, nczb, pc i sim z kilku obór woj. rzeszowskiego (Milk characteristic of Black-and-White, Red-and-White, Polish Red and Simmental cows kept in the Rzeszowskie Province's farms). Zesz. Przegl. Post. Nauk Roln., nr 180, 359-364 (in Polish).

Lewandowski E. 1998. Hodujmy hodowców (Let's Breed Breeders). Magazyn Farmer, nr 15, 3.

Mazur, A., J. Szarek, A. Felenczak & J. Makulska. 1998. Charakterystyka rasy brunatnej szwajcarskiej (Characterization of Swiss Braunvieh). Przegl. Mleczarski. 11, 394-396 (in Polish).

Moczarski Z. 1917. Rasy bydla (Breeds of cattle). Warszawa. ss. 56 (in Polish).

MRiGZ. 1996. Program hodowli bydla i produkcji bydlecej do roku 2000 (Program of cattle breeding and production till 2000), Warszawa (in Polish).

Pajak, J. 1968. Zarys chowu bydla (The outline of cattle husbandry). Wyd. IV, PWRiL, Warszawa. pp. 557 (in Polish).

Piestrak, T. 1961. Obliczanie stopnia zinbredowania i stopnia spokrewnienia u krów czerwonych polskich zapisanych do ksiegi krajowej (Estimation of inbreeding and kinship degree of Polish Red cows registered in the pedigree books). Praca magisterska, maszynopis, Kat. Hod. Og. Zw. WSR w Krakowie, pp. 18 (in Polish).

Romer, J. 1973. Doskonalenie produkcji bydlecej w Polsce metodami hodowlanymi w swietle wyników badan (Improvement of cattle production in Poland by means of breeding methods in the light of the researches' results). Wyd. Wlasne IZ, nr 339/1973a, 4 (in Polish).

Romer, J., H, Czaja, P, Cieslar & E. Smieciuch. 1976. Przydatnosc krów rasy nizinnej czerwono-bialej, polskiej czerwonej i mieszanców tych ras do produkcji mlecznej w rejonie Beskidu Slaskiego (Usefulness of Polish Red-and-White, Polish Red cattle and their crosses for milk production in Beskid Slaski region's conditions). Roczn. Nauk. Zoot., Monografie, z. 5, Warszawa-Wroclaw, 3-16 (in Polish).

Rostafinski, J. 1920. Rasy bydla domowego, jego hodowla i zywienie (Cattle breeding and nutrition). Ksieg. Roln., Warszawa, pp. 253 (in Polish).

Szarek, J., P. Brzuski, K. Zukowski, K. Pawlowski & A. Felenczak. 1980a. Przydatnosc rasy nczb do intensywnej produkcji mleka i miesa w warunkach gospodarstw podgórskich (Usefulness of Polish Red-and-White cows for milk and beef production in the Polish Sub-montaineous region's conditions). Zesz. Nauk. AR Kraków, Zoot., nr 20 (159), 165-177 (in Polish).

Szarek, J., T. Kolczak, P. Brzuski, Z. Gil & J. Mleczko. 1980b. Wlasciwosci fizyko-chemiczne miesni buhajów pochodzacych z krzyzowania krów rasy pc z buhajami innych ras (Physico-chemical characteristic of two-way cross bulls' meat (crossbreeding Polish Red cows with beef bulls)). Acta Agr. et Silv., Zoot., 19, 189-197 (in Polish).

Szarek, J., Z. Stalinski, P. Brzuski, Z. Gil & K. Pawlowski. 1980c. Porównanie wartosci opasowej i rzeznej buhajków pochodzacych z krzyzowania polskiego bydla czerwonego z rasami czb, cb, simental i charolaise (Comparison of the fattening capacity and slaughter value of two-way cross bulls (Polish Red x Polish Red-and-White, Polish Red x Polish Black-and-White, Polish Red x Simmental, Polish Red x Charolaise)). Zesz. Nauk. AR Kraków, nr. 20 (159), 145-163 (in Polish).

Szarek, J., Z. Stalinski, P. Brzuski, A. Felenczak & K. Pawlowski. 1981. Porównanie wydajnosci mlecznej pierwiastek rasy pc, nczb i pierwiastek pochodzacych z krzyzowania tych ras (Comparison of heifer-cows' milk yield of the following genetic groups: Polish Red, Polish Red-and-White and Polish Red x Polish Red-and-White). Acta Agr. et Silv., 20, 225-240 (in Polish).

Szarek, J., A. Felenczak & H. Czaja. 1993. Stan hodowli bydla polskiego czerwonego i jej perspektywy (Polish Red cattle breeding and its perspectives). PZ ZG PAN, z. 36, 35-43 (in Polish).

Szarek, J. A. Felenczak & P. Kowol. 2000. Wczoraj, dzis i jutro polskiego bydla czerwonego (Past, present and future of Polish Red cattle). Wies Jutra, nr 7, 33-35 (in Polish).

Szostakowski, S. 1959. Zarys rozwoju hodowli bydla czerwonego polskiego w bialostocczyznie w latach 1945-1955 (The outline of Polish Red cattle breeding development in Bialystok region in 1945-1955). Roczn. Nauk Rol., PWRiL, Warszawa, 5-109 (in Polish).

Szumowski, P. 1936. BydLo czerwone polskie (Polish Red cattle). Rozprawa doktorska, SGGW Warszawa, pp. 441 (in Polish).

Twardzicki, T. 1937. Hodowla bydla czerwonego polskiego na tle trwalych mozliwosci eksportowych (Polish Red cattle breeding against the background of lasting export possibilities). Krakowska Izba Rolnicza, pp. 50 (in Polish).