

## GENETIC POLYMORPHISM AND RELATIONSHIPS AMONG SEVERAL SWINE POPULATIONS OF LANDRACE, LARGE WHITE AND DUROC BREEDS

### POLIMORFISMOS GENÉTICOS E O RELACIONAMENTO ENTRE VÁRIAS POPULAÇÕES DE SUÍNOS DAS RAÇAS LANDRACE, LARGE WHITE E DUROC

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#### SUMMARY

The data of three protein polymorphisms were used to investigate the genetic relationships among the Landrace, Large White and Duroc swine breeds reared in Brazil, 12 other populations of these same breeds from various countries and a population of Belgium Landrace. The dendrogram, constructed from matrix of genetic distance coefficients, disclosed three large groups clustered by breed. Among them, the Landrace and the Large White showed in average closer resemblance ( $\bar{D} = 0.203$ ) than between them and Duroc ( $\bar{D} = 0.241$ ). In the three breeds, the smallest genetic distances were found between Brazilian and Cuban pig populations (Landrace:  $D = 0.060$ ; Large White:  $D = 0.052$ ; Duroc:  $D = 0.065$ ), although there were not reports of pig exchanges between these two countries.

**Key words:** swine, protein polymorphisms, genetic relationships.

#### RESUMO

Para estudar o relacionamento genético entre as raças suínas Landrace, Large White e Duroc foram utilizados os dados sobre três polimorfismos protéicos, investigados em três amostras brasileiras e em 13 populações de outros países, incluindo uma população de Landrace Belga. O dendrograma, construído a partir da matriz dos coeficientes de distância genética, mostrou três grandes grupos reunidos por raça. Os agrupamentos de Landrace e os de Large White mostraram em média maior semelhança entre si ( $\bar{D} = 0,203$ ) do que entre eles e os de Duroc ( $\bar{D} = 0,241$ ). Nas três raças, as menores distâncias genéticas foram verificadas entre as populações brasileiras e as cubanas (Landrace:  $D = 0,060$ ; Large White:  $D = 0,052$ ; Duroc:  $D = 0,065$ ), apesar de não haver relatos de trocas de animais entre estes dois países.

**Palavras-chave:** suínos, polimorfismo protéico, relacionamento genético.

#### INTRODUCTION

The swine ancestors of the commercial breeds reared nowadays in Brazil were imported from several European and American countries (Table 1). Biochemical polymorphisms have been used to characterize pig populations and to verify the relationships among them (OISHI and TOMITA, 1976; OISHI *et al.*, 1980; TAGLIARO *et al.*, 1993; TANAKA *et al.*, 1983; VAN ZEVEREN *et al.*, 1990).

The aim of the present study was to investigate by means of the gene frequencies of three polymorphic systems (hemopexin, transferrin and amylase) the genetic relationships among Landrace, Large White and Duroc herds from Brazil and twelve other pig populations, of the same breeds, from several countries. A population of Belgium Landrace breed was included in the analysis due to the morphological phenotype similarities shared with Landrace animals. Moreover, according to data from "The Pig Book of Brazil", maintained by the Brazilian Association of Swine Breeders (Associação Brasileira de Criadores de Suínos) and containing the genealogical information about all Brazilian registered herds, the Brazilian Landrace pigs are also descendants of Belgium Landrace swine (ABCS, 1959-1990).

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Table 1 - Countries which exported swine to Brazil during the period 1959 to 1990.

Breed	Countries
Landrace	Belgium*, West Germany, Holland, England, Argentina, Mexico, Sweden, Denmark, USA, Austria, Canada, France.
Large White	USA, England, Holland, Sweden, Denmark, West Germany, Canada.
Duroc	USA, Argentina, Denmark, Canada, West Germany.

Source: The Pig Book of Brazil (ABCS, 1959-1990).

\* Belgium Landrace

## MATERIAL AND METHODS

In order to study the genetic variability of Landrace, Large White and Duroc swines, blood samples of 282 animals were obtained in two places of Rio Grande do Sul: Boars Test Station of Venâncio Aires and Boars Test Station of Estrela. At these Stations the pigs are tested to select the best animals for the Swine Artificial Insemination Center of Rio Grande do Sul.

The blood samples of 109 Landrace, 116 Large White and 57 Duroc were investigated for 15 protein loci (TAGLIARO *et al.*, 1993). For the present study, there were only three systems considered: hemopexin (Hpx), transferrin (Tf) and amylase (Amy) for which there were informations of the literature in other 13 populations.

The serum protein types were examined by starch gel electrophoresis. The Hpx and Amy were typed according to KRISTJANSSON (1963) and Tf by the method described by OISHI and TOMITA (1976). The band patterns obtained for the three systems were compared with standard samples kindly provided by Dr. P. Vögeli from the Swiss Federal Institute of Technology, Zurich. The allele frequencies were calculated by the gene counting method. Genetic distances were estimated according to ROGERS (1972) and by the UPGMA (SNEATH and SOKAL, 1973) using the Biosys program of SWOFFORD and SELANDER (19810).

## RESULTS AND DISCUSSION

Tables 2, 3 and 4 show the Tf, Hpx and Amy alleles frequencies respectively, estimated for 16 populations of Landrace, Large White and Duroc breeds from several countries.

Table 2 - Frequencies of transferrin alleles in 16 distinct populations of Landrace, Large White and Duroc breeds from several countries.

Population	Number of animals	Transferrin allele frequencies				References
		A	B	C	D	
Cuban Landrace	300	-	0.975	0.025	-	Bardisa & Ezcurra (1987)
Czechoslovakian Landrace	174	-	0.991	0.009	-	Gavalier <i>et al.</i> (1966)
Danish Landrace	400	-	1.000	-	-	Agergaard <i>et al.</i> (1976)
British Landrace	95	-	0.980	0.020	-	Imlah (1965)
Belgium Landrace	1227	-	1.000	-	-	Van Zeveren <i>et al.</i> (1990)
Brazilian Landrace	109	0.037	0.963	-	-	Tagliaro <i>et al.</i> (1993)
Cuban Large White	370	0.186	0.812	0.002	-	Bardisa & Ezcurra (1987)
Czechoslovakian I Large White	236	0.254	0.744	-	0.002	Gavalier <i>et al.</i> (1966)
Czechoslovakian II Large White	195	0.295	0.684	-	0.021	Meyer (1973)
British Large White	161	0.360	0.640	-	-	Imlah (1965)
French Large White	265	0.298	0.702	-	-	Van Zeveren <i>et al.</i> (1990)
Brazilian Large White	116	0.168	0.832	-	-	Tagliaro <i>et al.</i> (1993)
Cuban Duroc	338	0.152	0.836	0.012	-	Bardisa & Ezcurra (1987)
American I Duroc	2877	0.240	0.760	-	-	Smith <i>et al.</i> (1968)
American II Duroc	248	0.230	0.770	-	-	Baker (1968)
Brazilian Duroc	57	0.096	0.904	-	-	Tagliaro <i>et al.</i> (1993)



Table 3 -Frequencies of hemopexin alleles in 16 distinct populations of Landrace, Large White and Duroc breeds from several countries.

Population	Number of animals	Transferrin allele frequencies						References
		0	1 <sup>F</sup>	1	2	3 <sup>F</sup>	3	
Cuban Landrace	300	0.139	-	0.618	0.058	-	0.185	Bardisa & Ezcurra (1987)
Czechoslovakian Landrace	174	0.040	0.075	0.276	0.014	-	0.595	Gavalier <i>et al.</i> (1966)
Danish Landrace	400	0.030	-	0.297	0.124	-	0.549	Agergaard <i>et al.</i> (1976)
British Landrace	55	0.060	-	0.510	0.050	-	0.380	Imlah (1965)
Belgium Landrace	1227	-	0.037	0.733	0.099	-	0.131	Van Zeveren <i>et al.</i> (1990)
Brazilian Landrace	109	0.064	-	0.624	0.046	-	0.266	Tagliaro <i>et al.</i> (1993)
Cuban Large White	370	0.051	-	0.788	-	-	0.161	Bardisa & Ezcurra (1987)
Czechoslovakian I Large White	236	0.046	-	0.783	0.005	-	0.166	Gavalier <i>et al.</i> (1966)
Czechoslovakian II Large White	195	0.007	0.042	0.722	-	-	0.229	Meyer (1973)
British Large White	85	0.050	-	0.840	0.050	-	0.060	Imlah (1965)
French Large White	265	0.017	0.158	0.693	-	-	0.132	Van Zeveren <i>et al.</i> (1990)
Brazilian Large White	116	0.004	-	0.746	-	-	0.250	Tagliaro <i>et al.</i> (1993)
Cuban Duroc	338	-	-	0.206	0.013	-	0.781	Bardisa & Ezcurra (1987)
American I Duroc	2877	-	0.010	0.260	0.140	0.340	0.250	Smith <i>et al.</i> (1968)
American II Duroc	116	-	-	0.320	0.100	-	0.580	Baker (1968)
Brazilian Duroc	57	-	-	0.070	0.140	-	0.790	Tagliaro <i>et al.</i> (1993)

Table 4 - Frequencies of amylase alleles in 16 distinct populations of Landrace, Large White and Duroc breeds from several countries.

Population	Number of animals	Amylase allele frequencies				References
		A	B <sup>F</sup>	B	C	
Cuban Landrace	300	0.067	-	0.993	-	Bardisa & Ezcurra (1987)
Czechoslovakian Landrace	174	0.158	-	0.833	0.009	Gavalier <i>et al.</i> (1966)
Danish Landrace	400	0.140	-	0.855	0.005	Agergaard <i>et al.</i> (1976)
British Landrace	95	0.200	-	0.800	-	Imlah (1965)
Belgium Landrace	1227	0.013	0.150	0.834	0.003	Van Zeveren <i>et al.</i> (1990)
Brazilian Landrace	109	0.133	-	0.862	0.005	Tagliaro <i>et al.</i> (1993)
Cuban Large White	370	0.031	-	0.969	-	Bardisa & Ezcurra (1987)
Czechoslovakian I Large White	236	0.256	-	0.744	-	Gavalier <i>et al.</i> (1966)
Czechoslovakian II Large White	195	0.250	-	0.737	0.013	Meyer (1973)
British Large White	161	0.050	-	0.950	-	Imlah (1965)
French Large White	265	0.145	-	0.855	-	Van Zeveren <i>et al.</i> (1990)
Brazilian Large White	116	0.090	-	0.910	-	Tagliaro <i>et al.</i> (1993)
Cuban Duroc	338	-	-	1.000	-	Bardisa & Ezcurra (1987)
American I Duroc	2877	-	-	1.000	-	Smith <i>et al.</i> (1968)
American II Duroc	248	-	-	1.000	-	Baker (1968)
Brazilian Duroc	57	-	-	1.000	-	Tagliaro <i>et al.</i> (1993)



Four alleles were verified for the transferrin (Table 2). In all of the three breeds herds, the Tf\**B* allele was the most frequent. The Tf\**A* allele was present in relatively high frequencies in all Large White and Duroc herds, but was only detected in the Landrace of Brazil. The other alleles were detected in low incidences in some populations.

For hemopexin (Table 3), six alleles have been described for these breeds with variable frequencies among and within breeds. But, in general, the Hpx\**1* and the Hpx\**3* were the most frequent, while the Hpx\**1<sup>F</sup>* variant occurred with low frequencies. On the other hand the Hpx\**3<sup>F</sup>* allele was not verified in Landrace and in Large White herds, while the Hpx\**0* allele was not detected in Duroc pigs.

Two forms, Amy\**A* and Amy\**B*, have been described in all Landrace and Large White populations for the amylase system (Table 4). The Amy\**C* allele was present in these two breeds with low frequencies and the Amy\**B<sup>F</sup>* was only described in Belgium Landrace. All populations of Duroc breed, here considered, were monomorphic for the Amy\**B* in the amylase locus.

Table 5 gives the genetic distance matrix and Figure 1 shows the phenogram, both obtained using Rogers distance.

As it can be seen in the phenogram (Figure 1), three large groups were clustered by breed. The

patterns of inter-racial genetic relationships revealed that Landrace and Large White showed in average closer resemblance ( $\bar{D} = 0.203$ ) than between them and Duroc ( $\bar{D} = 0.241$ ). Despite Belgium Landrace to be considered a distinct breed, it clustered with Landrace populations. Moreover, the Brazilian Landrace showed more similarity with Belgium Landrace ( $D=0.104$ ) than with Danish Landrace ( $D= 0.119$ ) and Czechoslovakian Landrace ( $D = 0.135$ ). It can be explained by the large number of Belgium Landrace pigs that were introduced in Brazil, where they are ancestors of the present Landrace swine population.

The three Brazilian populations showed the closest genetic similarity with Cuban swines of the respective breeds (Landrace:  $D = 0.060$ ; Large White:  $D = 0.052$ ; Duroc:  $D = 0.065$ ), although there was no register of pig exchange between these two countries.

The genetic relationships obtained in the present study were not in agreement with TANAKA *et al.* (1983). These authors, using 13 biochemical systems, found more similarity between Landrace and Duroc pigs than between Landrace and Large White. The result of the present study could be contested due to the small number of systems that were considered in this analysis, however, according to NEI (1975) genetic distances among populations even if based on a small number of polymorphic loci would be useful to evaluate the genetic relationships among them.

Table 5 - Genetic distances matrix among sixteen swine populations (x 1000).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Cuban Large White	***	93	142	100	120	52	221	175	182	268	250	118	200	264	132	141
2. British Large White		***	140	134	108	130	311	234	223	356	324	185	275	340	207	201
3. Czechoslovakian I Large White			***	46	80	114	314	240	248	361	269	206	182	268	162	205
4. Czechoslovakian II Large White				***	95	108	317	242	243	364	271	191	183	272	158	185
5. French Large White					***	110	290	215	209	335	245	175	198	253	144	185
6. Brazilian Large White						***	213	180	198	261	204	108	156	218	93	137
7. Cuban Duroc							***	82	180	65	165	245	236	156	243	304
8. American I Duroc								***	116	122	137	217	208	160	214	274
9. American II Duroc									***	205	235	222	251	252	233	273
10. Brazilian Duroc										***	158	247	240	161	247	306
11. Danish Landrace											***	152	93	43	119	190
12. Cuban Landrace												***	102	167	60	99
13. British Landrace													***	94	70	145
14. Czechoslovakian Landrace														***	135	208
15. Brazilian Landrace															***	104
16. Belgium Landrace																***



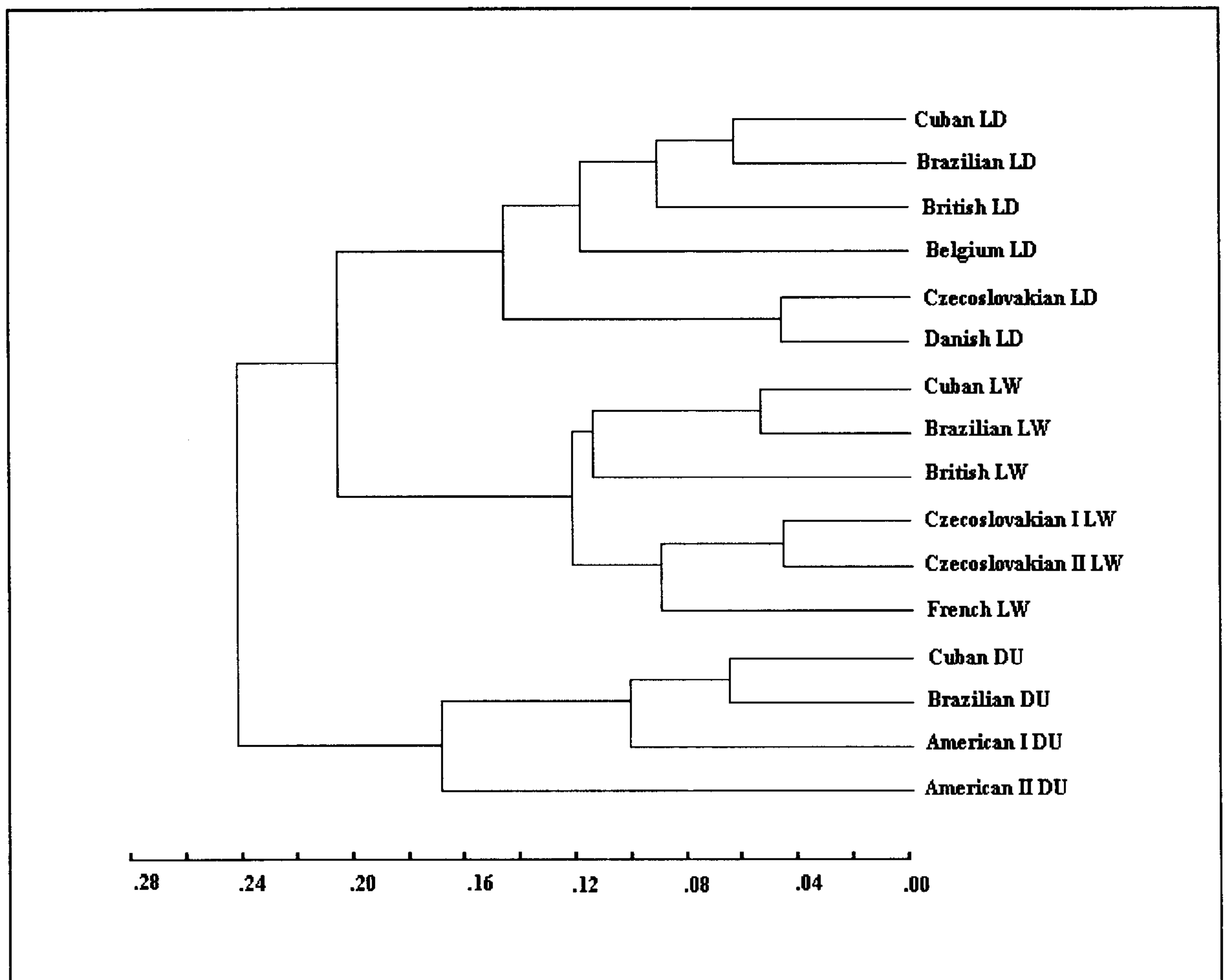


Figure 1 - Cluster analysis by the UPGMA using Rogers Distance Matrix (1972) calculated for 16 swine populations (Cophenetic Correlation= 0.752). LD = Landrace; LW = Large White; DU = Duroc

Moreover, a similar phenogram was obtained when only the three Brazilian breeds were considered using 15 polymorphic loci (TAGLIARO *et al.*, 1993). Furthermore the closest similarity between Large White and Landrace breeds are in agreement with the historical fact that the latter breed was originally developed from Large White swines and native pigs from Denmark (MACHADO, 1973).

The closest similarity between Brazilian and Cuban swine of the respective breeds can not be explained by exchange of pigs between Brazil and Cuba. One possible explanation could come from imports of animals with similar genetic composition by Brazil and Cuba from the same origin. On the other hand, OISHI *et al.* (1983) suggested that animals from the same populations reared in cold or in warm environments can differ in gene frequencies after several generations.

The results of the present study indicate that the Landrace and Large White breeds are the most similar. For each of the three breeds, the Brazilian population is more similar to that of Cuba and less similar to populations from countries that exported swine to Brazil. Finally, the three protein systems used in the present study have good potential as informative genetic markers.

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