SHORT NOTE

ESTIMATION OF INBREEDING RATES AND EXTINCTION RISK OF FORTY ONE BELGIAN CHICKEN BREEDS IN 2005 AND 2010

ESTIMACIÓN DE TASA DE CONSANGUINIDAD Y RIESGO DE EXTINCIÓN EN CUARENTA Y UNA RAZAS BELGAS DE POLLOS EN 2005 Y 2010

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ADDITIONAL KEYWORDS

Biodiversity. Conservation. Local chicken breed.

PALABRAS CLAVE ADICIONALES

Biodiversidad. Conservación. Razas locales aves.

SUMMARY

In Belgium, as generally in Europe, the dominant position of the high producing commercial strains specialized in meat or eggs production threats of extinction the local traditional breeds. In this work, a follow up of the changes in populations size, and the rates of inbreeding of the Belgian poultry breeds, has been carried out in 2005 and 2010. About forty breeds were concerned. The Belgian hen breeds being overwhelmingly under threat of extinction, because of the low number of individuals by breed. For each of these breeds, various criteria were considered, risk status, breeding male to breeding female ratio, effective population size, effective population size to actual size ratio and rate of inbreeding.

RESUMEN

En Bélgica, y generalmente en Europa, la posición dominante de estirpes comerciales altamente productivas, especializadas en la producción de carne o huevos, amenaza de extinción a las razas locales tradicionales. Se ha realizado, en 2005 y 2010, un seguimiento de las tasas de consanguinidad de razas de gallinas belgas. Unas cuarenta razas han sido consideradas. Las razas belgas de gallinas se encuentran abrumadoramente en peligro de extinción a causa del escaso número de individuos en cada raza. Para cada una de las razas fueron considerados varios criterios: estado de riesgo, relación reproductores machos/reproductores hembra, tamaño efectivo de población, relación tamaño efectivo/tamaño actual y tasa de consanguinidad.

INTRODUCTION

The conservation of animal genetic resources is capital for the sustainable development of the poultry production. However, a gradual and relentless depleting of available breeds is now rife at the scale of the planet.

The extreme specialization of some breeds and their dissemination across the world, have taken place at the expense of local breeds which are less profitable. Infectious diseases and epidemics, natural disasters and other conflicts also threaten these resources.

Traditional poultry breeds contribute significantly to meat and egg production, they represent more than 80 % of the world production (Besbes, 2009). However, most of these breeds have not been studied by the scientific community. According to the FAO, about 40 % of the avian breeds are not inventoried (Besbes, 2009). Important efforts are therefore necessary to evaluate the situation of these breeds. The efficient management of any animal genetic resources requires the identification of the concerned breeds, their risk status, the estimation of their phenotypic and genetic variations and the identification of peculiarities if any.

Belgium has a unique avian genetic capital with forty breeds and many hundreds of varieties (Moula, 2012).

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The present study aims to evaluate the risk status and the inbreeding rate of the Belgian traditional chicken breeds populations bred by small-scale traditional farms, fanciers and research institutions.

MATERIAL AND METHODS

The data collected in 2005 by Larivière and Leroy (2007) and in 2010 by the Belgian National Federation of Farmyard Animal Breeders and by the Faculty of Veterinary Medicine, University of Liege, consisted of the number of breeding males (Nm) and breeding females (Nf) for each traditional Belgian chicken breed in traditional flocks, farm-parks and research centers.

The risk status risk categorization was based on the criteria of the FAO (2007). Endangered: female 100-1000, male 5-20. Critical: female < 100, male < 5.

The effective population size (Ne) is the number of individuals of an ideal population that would give rise to the same inbreeding rate observed in the actual population. Calculations are based on the formula (Wright, 1931):

$$Ne = 4N_f N_m / N_f + N_m$$

where:
Nf= the number of breeding females;
Nm= the number of breeding males.

Inbreeding rate (ΔF)per generation was calculated for the 41 traditional chicken breed's populations using the formula (Wright, 1931):

$$\Delta F = 1/2N_e$$

RESULTS AND DISCUSSION

A total of 41 chicken breeds were listed in 2005 and 40 in 2010 **(table I)**. In 2005, the total number of individuals censored was 10 220 (small size breeds: 4903, standard size breeds: 5317 individuals). In 2010, the overall number decreased to 9592 individuals (small size breeds: 4892, standard size breeds: 4700 individuals).

As mentioned in **table I**, in 2005, 14 Belgian chicken breeds were endangered, 25 were in critical situation and two breeds (Malines and Barbu d'Anvers) were not at risk. In 2010, 16 breeds were endangered (40 %), 23 in critical situation (57.5 %) and only one breed (Ardennaise) was not at risk. The genetic erosion hitting the Belgian chicken breeds continues to increase. In 5 years (2005-2010), the proportion of breeds in endangered or critical status increases from 95.12 to 97.56 %.

As mentioned in the **table I**, the population size of 21 breeds increased in 2010 compared to 2005, but 18 breeds knew a decline in their effectives.

In 2005, the actual population of Ardennaise was 682 **(table I)**. However, in 2010 due to the repopulation campaigns of the small farms carried by the University of Liege from its own stocks, this value reached more than 1850 individuals (Moula, 2012).

One endangered breed in 2005 improved its situation in 2010, the Ardennaise one and 4 saw their situation to deteriorate among which the *Barbu d'Anvers* from not at risk to endangered. Among the critical breeds in 2005, three passed from stage *critical* to endangered in 2010 and one probably was extinct, the *Bleue de Lasnes*.

A large variation of Ne is recorded in the Belgian chicken breeds. The highest Ne value in 2005 was recorded for *Malines* breed (1465) and the lowest one for Zingem chair chicken breed (2). In 2010, the Ardennaise (1598) and the Zingem chair (6) recorded the highest and the lowest Ne values respectively. The Ne/N and Nm/Nf ratios varied from 57 to 98 % and from 21 to 73 % respectively in 2005 and from 73 to 93 % and from 30 to 57 % in 2010.

The estimated inbreeding rates ΔF varied from 0.03 to 5.6 % per generation in 2005. In 2010, these ratios ranged from 0.03 to 8.75 % per generation **(table I)**.

In a sample of 37 European local breeds,

Table I. *Data of Belgian chicken breeds.* (Datos de razas aviares belgas).

Breeds	2005							2010							Evol.
	Nm	Nf	Nm/Nf	N	Ne	Ne/N	ΔF	Nm	Nf	Nm/Nf	N	Ne	Ne/N	ΔF	(%)Ne 05-10
Normal															
Aarschot[c,c]	11	38	29	49	34	70	1.47	28	77	36	105	82	78	0,61	+114
Ardennaise[e,*]	134	548	25	682	431	63	0.12	583	1268	46	1851	1598	86	0,03	+171
Brabançonne[e,e]	56	181	31	237	171	72	0.29	92	284	32	376	278	74	0,18	+59
Braekel[e,e]	192	639	30	830	589	71	0.08	157	521	30	678	483	71	0,10	-18
Combattant de Bruges[c,e]	13	54	24	66	42	63	1.19	56	141	40	197	160	81	0,31	+198
Combattant de Liège[e,e]	61	216	28	277	191	69	0.26	79	206	38	285	228	80	0,22	+3
Combattant de Tirlemont[c,c]	7	20	34	27	20	76	2.50	13	20	65	33	32	96	1,59	+22
Coucou des Flandres[c,c]	12	41	29	53	37	70	1.35	12	44	27	56	38	67	1,33	+6
Coucou d'Izegem[e,c]	75	242	31	316	229	72	0.22	-	-	-	-	-	-	-	-
Famennoise[c,c]	19	79	24	98	61	63	0.82	8	21	38	29	23	80	2,16	-70
Fauve de Hesbaye[c,c]	14	46	30	59	42	71	1.19	22	69	32	91	67	73	0,75	+54
Herve[e,e]	96	356	27	452	303	67	0.17	47	137	34	184	140	76	0,36	-59
Malines*[,e]	553	1085	51	1637	1465	89	0.03	131	444	30	575	405	70	0,12	-65
Malines tête de dindon[e,c]	62	208	30	269	190	71	0.26	31	92	34	123	93	75	0,54	-54
Poule de la Zwalm[c,c]	3	9	33	12	9	75	5.56	4	16	25	20	13	64	3,91	+67
Poule de Zingem[c,c]	20	96	21	115	66	57	0.76	4	26	15	30	14	46	3,61	-74
Poulet de chair, Zingem[c,c]	1	1	100	2	2	100	25.0	2	5	40	7	6	82	8,75	+250
Sans queue, Ardennes[c,c]	17	59	29	76	53	70	0.94	9	25	36	34	26	78	1,89	-55
Zottegem[c,c]	17	44	39	60	49	81	1.02	7	19	37	26	20	79	2,44	-57
Dwarf															
Ardennaise[e,e]	75	209	36	284	221	78	0.23	64	171	37	235	186	79	0,27	-17
Barbu d'Anvers*[,c]	393	1078	36	1471	1152	78	0.04	321	668	48	989	867	88	0,06	-33
Barbu de Boitsfort[c,c]	5	14	36	19	15	78	3.33	39	86	45	125	107	86	0,47	+558
Barbu de Grubbe[c,e]	40	99	40	139	113	82	0.44	52	120	43	172	145	84	0,34	+24
Barbu de Waes[c,c]	13	41	32	54	39	73	1.28	27	80	34	107	81	75	0,62	+98
Barbu de Watermael[e,e]	162	455	35	617	477	77	0.10	214	549	39	763	616	81	0,08	+24
Barbu d'Everberg[c,c]	11	15	73	26	25	98	2.00	54	98	55	152	139	92	0,36	+485
Barbu d'Uccle[e,e]	163	412	40	575	467	81	0.11	277	645	43	922	775	84	0,06	+60
Bassette Liégeoise[e,e]	123	358	34	481	365	76	0.14	100	271	37	371	292	79	0,17	-23
Belge[e,e]	73	185	40	258	209	81	0.24	46	122	38	168	134	80	0,37	-35
Bleue de Lasnes[c,-]	10	28	36	38	29	78	1.72	13	35	37	48	38	79	1,32	+26
Brabançonne[c,e]	20	56	36	76	59	78	0.85	39	111	35	150	115	77	0,43	+97
Braekel[c,c]	8	21	36	29	22	78	2.27	17	48	35	65	50	77	1,00	+124
Combattant de Liège[e,e]	73	190	38	263	211	80	0.24	58	130	45	188	160	85	0,31	-29
Combattant de Bruges[c,c]	-	-	-	-	-	-	-	4	7	57	11	10	93	4,91	-
Combattant Tirlemont[c,c]	8	14	54	22	20	91	2.50	9	15	60	24	23	94	2,22	+9
Famennoise[c,c]	9	24	35	33	25	77	2.00	3	7	43	10	8	84	5,95	-70
Fauve de Méhaigne[c,c]	23	63	36	86	66	78	0.76	11	28	39	39	32	81	1,58	-55
Herve[c,c]	34	94	36	128	99	77	0.51	34	88	39	122	98	80	0,51	-5
Malines[c,c]	19	80	23	99	60	61	0.83	7	26	27	33	22	67	2,27	-67
Sans queue Ardennes[c,c]	15	42	36	57	44	78	1.14	7	18	39	25	20	81	2,48	-56
Tournaisis[e,e]	40	108	37	148	116	78	0.43	63	110	57	173	160	93	0,31	+17

Number of breeding males (Nm) and females (Nf); Nm/Nf: male:female ratio; N: total breeding population; Ne: effective population size; Ne/N: ratio of breeders contributing efficiently genes (%); ΔF hypothetical rates of inbreeding per generation (%).

[c,e]risk status: c= critical; e= endangered; letter before comma: 2005, after comma: 2010. *not at risk.

Spanola *et al.* (2007) estimated Ne and ΔF. The actual size of these populations varied from 2800 to 170, Ne from 2285 to 70, Ne/N from 82 to 42 %, Nm/Nf from 40 to 13 % and ΔF from 2 to 71 %. The comparison of these values to those obtained in a subsample of 24 of the Belgian breeds with Ne values between 1598 and 67 in 2010, showed similar ΔF from 3 to 75 % but higher.

With a fitness depression of 1 % of inbreeding and in the absence of correlated response to artificial selection, the critical Ne for which the fitness due to natural selection against deleterious mutation balance the fitness decrease due to inbreeding depression, varies from 30 to 250 owing to the variation and to the heritability of the fitness (Meuwissen and Woolliams, 1994). Using de rules of these latter authors, in adverse conditions (coefficient of variation and heritability of fitness equal to 0.02 and 0.05 respectively), 8 Belgian breeds could maintain their fitness and in favorable conditions (coefficient of variation and heritability of fitness equal to 0.04 and 0.10 respectively), 29 Belgian breeds could maintain their fitness. From a genetic point of view, Lynch *et al.* (1995), concluded that a population with effective size smaller than 100 and therefore with an actual size smaller than 1000, is highly vulnerable to extinction into a hundred of generations due to mutation accumulation. But pointing out other threats due demographic and environmental factors they found inadequate the usual threshold of 100 to 1000 individuals defining endangered population.

In Belgium, as generally in Europe, the commercial strains dominate the production of meat and eggs. Local breeds in turn, are held almost exclusively by hobbyist breeders and fanciers. Most of Belgian chicken breeds have very small numbers and are threaten of extinction **(table I)**. It is therefore necessary to implement an efficient management of the reproduction, such as limiting the Nm/Nf ratio to 25 % or exchanging breeding stocks among flocks, ensuring both a high level of fertility and a low rate of inbreeding. The conservation of the biodiversity in general and of the poultry breeds in particular is a common interest and need public aids.

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