**THESIS OF DOCTORAL (PhD) DISSERTATION**

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# STUDIES OF RARE HUNGARIAN AND VIETNAMESE POULTRY BREEDS WITH SPECIAL REGARD TO PARTRIDGE COLOURED HUNGARIAN CHICKEN AND ITS CROSSBREDS IN CONTINENTAL AND TROPICAL CLIMATES

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# 1. INTRODUCTION AND AIMS

Indigenous or local breeds make up most of the world's poultry genetic diversity and play important role in rural economies in most of the developing and underdeveloped countries. However, in Europe, over the last decades, old, locally adapted chicken breeds are suffering dramatic decrease in numbers. In Hungary, 7 native chicken breeds, including the Partridge Coloured Hungarian chicken (PHc), are officially registered and conserved under the Association for Hungarian Farm Animal Gene Conservation (MGE). Most of these stocks are kept by Hungarian academic institutions as in vivo gene banks. Involving Hungarian indigenous poultry breeds such as the Partridge Coloured Hungarian chicken in sustainable agricultural production is highly recommended by many scientists.

The main goals of the research work is to (1) analyse the population data of 14 local Hungarian poultry breeds; (2) investigate the adaptation and conservation potential of Partridge Coloured Hungarian chicken in the subtropics; (3) examine the performance of crossbreds of Partridge Coloured Hungarian chicken and other chickens (commercial lines, old Hungarian and Vietnamese chicken breeds); (4) identify the heterosis in the crosses of Partridge Coloured Hungarian chicken and other chicken breeds; and (5) determine the quality characteristics of Partridge Coloured Hungarian chicken crossbreds that may be valued by modern consumers in terms of overall acceptability.

# 2. MATERIALS AND METHODS

The research work included 6 studies (1) Population study of 14 indigenous Hungarian poultry breeds; (2) Egg production study of 7 indigenous Hungarian chicken breeds; (3) Adaptation study of Partridge Coloured Hungarian chicken in the subtropics; (4) Crosses of Partridge Coloured Hungarian chicken and White Transylvanian Naked Neck chicken (WTc) ; (5) Crosses of Partridge Coloured Hungarian chicken and Vietnamese Mia chicken (MIc); (6) Crosses of Partridge Coloured Hungarian chicken and 2 Bábolna Tetra's chicken lines. The studies were conducted at poultry farm of the Research Centre for Farm Animal Gene Conservation (HáGK), Gödöllő, Hungary and Thuy Phuong Poultry Research Centre (POREC) in Northern Vietnam (PHc adaptation and PHc x MIc crossing studies). Breeds and lines covered by the research are described in the list below.

***Poultry genotypes used in the study***

| | |
|---|---|
| BHc | Bábolna Harco, egg type, mother line (study 6) |
| BRt | Bronze Turkey (study 1) |
| BTc | Black Transylvanian Naked Neck chicken (study 1) |
| COt | Copper Turkey (study 1) |
| FHg | Frizzled Hungarian Goose (study 1) |
| HLgf | Hungarian Landrace Guinea Fowl (study 1) |
| HUg | Hungarian Goose (study 1) |
| MIc | Vietnamese Mia chicken (study 5) |
| PHc | Partridge Coloured Hungarian chicken (study 1, 2, 3, 4, 5, 6) |
| SHc | Speckled Hungarian chicken (study 1, 2) |

STc Speckled Transylvanian Naked Neck chicken (study 1, 2)

THc Bábolna Tetra H dual purpose, father line (study 6)

WHc White Hungarian chicken (study 1, 2)

WHd White Hungarian Duck (study 1)

WId Wild Coloured Hungarian Duck (study 1)

WTc White Transylvanian Naked Neck chicken (study 1, 2, 4)

YHc Yellow Hungarian chicken (study 1, 2)

Husbandry technology described by MGE was applied in both locations. Although various locally available feedstuffs were used, feed diet was calculated based on the same chemical feed composition. Four different keeping systems were applied including closed (study 6); semi intensive (studies 3, 5); semi free-range (studies 2, 4) and complete free range (study 3) keeping systems. No lighting and heating regimes were applied. The female to male ratio in egg production trials was 7:1.

In study 1, the population data of entirely controlled stocks of 14 local Hungarian poultry breeds (YHc, WHc, SHc, PHc, WTc, BTc, STc, HLgf, FHg, HUg, WHd, WId and BRt) officially registered by MGE between 2000 to 2015 were evaluated. Based on the yearly number of breeding stocks, the number of breeding males and females, sex ratio, effective population size and in breeding rate were calculated for the mentioned years and breeds.

In study 2, egg production of 7 old Hungarian chicken breeds (Yellow Hungarian chicken, White Hungarian chicken, Partridge Coloured Hungarian chicken, Speckled Hungarian chicken, Black Transylvanian Naked Neck chicken, White Transylvanian Naked Neck chicken and Speckled Transylvanian Naked Neck chicken) from *in vivo* gene bank of

HáGK were examined. In the first trial, the first lay was studied in two consecutive years. In the second one, the first and the second lays were compared.

In study 3, the performance of Partridge Coloured Hungarian chicken reared parallel at the poultry farm of HáGK, Hungary and at POREC, Vietnam, were compared.

In study 4, 5 and 6, Partridge Coloured Hungarian chicken was crossed with White Transylvanian Naked Neck chicken, Vietnamese Mia chicken, Bábolna Tetra H father line and Bábolna Harco mother line. Liveability, body weight, feed conversion ratio, eviscerated carcass weight, deboned breast weight, deboned thigh weight, egg production, egg mass per layer, egg weight, egg yolk weight, albumen weight, eggshell weight, egg length, egg width, egg shape index, eggshell strength, eggshell thickness, breast meat and eggshell colour (lightness L*, redness a*, yellowish b*, colour index) of both purebred and crossbred genotypes were investigated. The heterosis of crosses and reciprocal effect were also calculated.

Data were first subjected to Levene's test and two-way analysis of variance (ANOVA) test. If variances were equal across groups, ANOVA test was expected to give information about the effects of breed, pen and time factors, as well as their interacting effects on studied parameters. Significant differences amongst the average values were examined by post hoc Tukey HSD test. In some cases, t-test was applied to determine the significance of the difference of two data sets. If variances were not equal across groups, Welch's test (unequal variances t-test) was used. All tests were operated by SPSS software.

# 3. RESULTS

## 3.1. Population study of 14 old Hungarian poultry breeds

There were no data of Partridge Coloured Hungarian chicken, Hungarian Landrace guinea fowl, White Hungarian duck, Wild Hungarian duck breeding stocks registered before 2004 and of Hungarian goose before 2005. Except Hungarian goose, the total number of breeding stocks increased year by year, reaching the peak in 2012. From 2013, a slight decrease of breeding stock number in most breeds can be seen. Effective population size varies widely and was generally higher in the period between 2011 and 2013. Huge enhancement of effective population size can be seen in Partridge Coloured Hungarian chicken (from 242 in 2009 to 1640 in 2013), in Hungarian Landrace guinea fowl (from 633 in 2009 to 2581 in 2012) and in Hungarian goose (from 163 in 2010 to 1262 in 2012). In case of inbreeding rate, the lowest of 0.02% and highest of 0.79% were recorded in 2012 (Hungarian Landrace guinea fowl) and 2009 (White Hungarian duck), respectively. In 2014 and 2015, only Hungarian goose and White Hungarian duck had inbreeding rate higher than 0.2%. Noticeably, there was a gradual decline inbreeding rate of Partridge Coloured Hungarian chicken, Hungarian Landrace guinea fowl, Hungarian Copper turkey and Bronze turkey. In the breeds studied, the number of breeding stocks correlates positively with effective population size, but negatively with inbreeding rate (except for Hungarian goose, where number of breeding stocks was constant).

### 3.2. Egg production study of 7 indigenous Hungarian chicken breeds

Egg production was consistently high in White Hungarian chicken and Yellow Hungarian chicken, and low in Speckle Transylvanian Naked Neck chicken. Partridge Coloured Hungarian chicken could reach 0.490 eggs/hen/day. All the Transylvanian hens tended to produce much fewer eggs during wintertime. Significant difference between the 1$^{st}$ and 2$^{nd}$ lay was found only in Speckled Hungarian chicken, White Hungarian chicken, Speckled Transylvanian Naked Neck chicken, and Black Transylvanian Naked Neck chicken (Figure 1).

The 2$^{nd}$ lay of Speckled Transylvanian Naked Neck chicken and Black Transylvanian Naked Neck chicken was better than the 1$^{st}$ one. The opposite was true for Speckled Hungarian chicken and White Hungarian chicken.

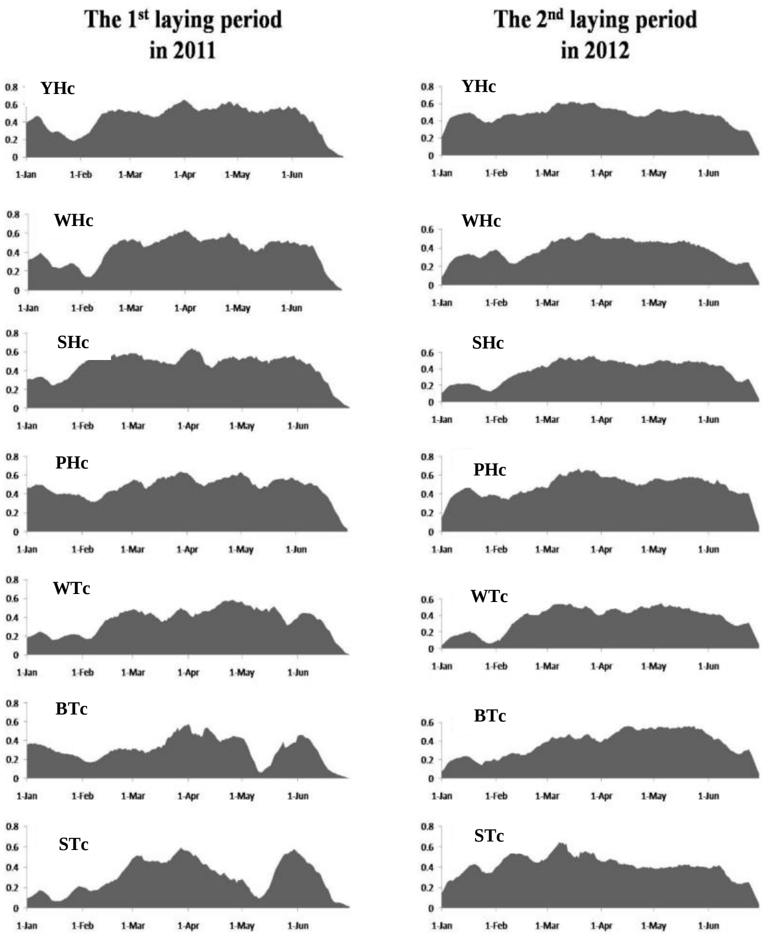


Figure 1. Eggs/hen/day of the same flocks of 7 Hungarian chicken breeds in the 1st (2011) and the 2nd (2012) laying period

*YHc: Yellow Hungarian chicken, WHc: White Hungarian chicken, SHc: Speckled Hungarian chicken, PHc: Partridge Coloured Hungarian chicken, WTc: White Transylvanian Naked Neck chicken, BTc: Black Transylvanian Naked Neck chicken, STc: Speckled Transylvanian Naked Neck Chicken (STc)*

### 3.3. Adaptation study of Partridge Coloured Hungarian chicken in the subtropics

The liveability of birds was relatively high, both at 12 weeks of age and during the laying period: 92% and 93% in Hungary, vs. 96% and 97% in Vietnam. At the age of 12 weeks, the Hungarian flock had higher body weight (Hungary: 1198g vs. Vietnam:1093g) and feed conversion ratio (Hungary: 3.6kg/kg vs. Vietnam: 3.4kg/kg). Eggs produced by Hungarian flock were heavier (Hungary: 58.3g vs. Vietnam: 54.9g), however, Vietnamese flocks laid more eggs in 7 months (Hungarian: 83 eggs/layer vs. Vietnam: 112 eggs/layer). Thus, their total egg mass was markedly superior (Hungary: 4.9kg vs. Vietnam: 6.1kg). Figure 2 demonstrates the egg producing patterns of the two flocks.

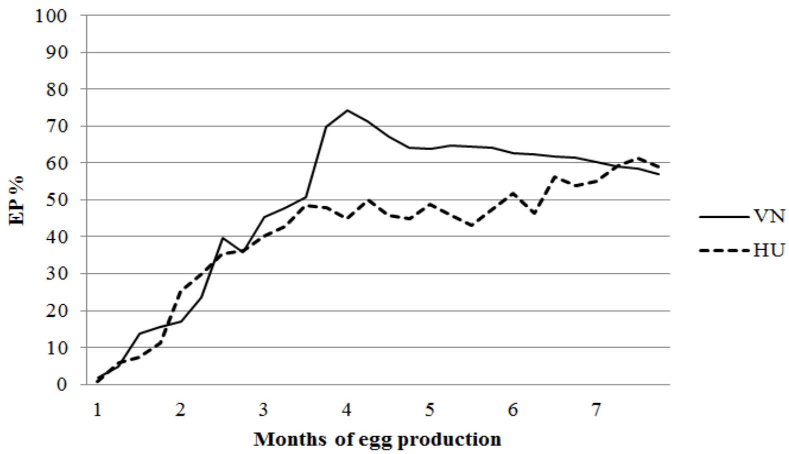


Figure 2. Egg producing patterns of the 1st egg laying period, started in November, of Partridge Coloured Hungarian chicken reared parallel at the Research Centre for Farm Animal Gene Conservation in Hungary (HU) and at the Thuy Phuong Poultry Research Centre for adaptation study in subtropical climatic zone of North Vietnam (VN)

Fertility and hatchability of the two flocks were relatively high (Hungary: 97% vs. Vietnam: 96% for fertility; Hungary: 85% vs. Vietnam: 86%, for hatchability). Eggs of Hungarian flocks showed less cases of embryonic disorders than Vietnamese ones (Hungary: 8.4% vs. Vietnam: 10.1%). Results of egg shape index suggested that the eggs of Hungarian flock were rounder than those of Vietnamese flock (Hungary: 74% vs. Vietnam: 87%).

### 3.4. Crosses of Partridge Coloured Hungarian chicken and White Transylvanian Naked Neck chicken

The phenotypic appearance of reciprocal crosses of Partridge Coloured Hungarian Chicken (PHc) and White Transylvanian Naked Neck chicken (WTc) are shown in Figure 3. Liveability at 16 weeks ranged between 87% (♂ WTc x PHc and ♀ WTc x PHc) and 95% (♂ PHc x WTc and ♀ PHc x WTc). ♂ PHc, ♂ PHc x WTc and ♂ WTc x PHc had the best performance in terms of body weight, feed conversion ratio, carcass weight, breast weight and thigh weight (16-week-old, body weight: 1.4 - 2.1kg; feed conversion ratio: 2.6 - 3.7kg/kg; carcass weight: 1.0 - 1.3kg; breast weight: 235 - 269g; thigh weight: 281 - 377g). However, ♀ WTc showed the highest carcass percentage (83%).

Positive heterosis of body weight and slaughtering yields and negative heterosis of feed conversion ratio were observed in all female crossbreds except for ♀ WTc x PHc's thigh meat weight. In case of male crossbreds, noticeable positive heterosis of slaughtering yields and negative heterosis of feed conversion ratio could be found in ♂ WTc x PHc and ♂ PHc x WTc, respectively.

Figure 3. The appearance crossbreds in the crosses between Partridge Coloured Hungarian chicken (PHc) and White Transylvanian Naked Neck chicken (WTc)

### 3.5. Crosses of Partridge Coloured Hungarian and Vietnamese Mia chicken

Liveability of birds ranged between 94-97%. The appearance of crossbreds in the crosses between ♂ Mia chicken and ♀ Partridge Coloured Hungarian chicken is shown in Figure 4.

Figure 4. The appearance of crossbreds in the cross between Vietnamese Mia cockerel (♂MIc) and Partridge Coloured Hungarian layer (♀PHc)

Total egg production of PHc and MIc layers in the period of 6 months was significantly different (PHc: 142 eggs/layer vs. MIc: 66 eggs/layer). Egg production of PHc and MIc is shown in Figure 5.

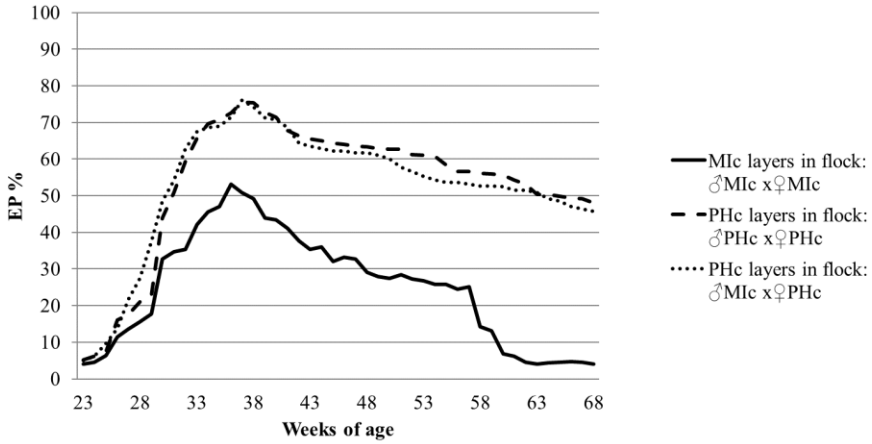


Figure 5. Egg production (%) of Mia (MIc) layers and Partridge Coloured Hungarian (PHc) layers in ♂MIc x ♀MIc, ♂PHc x ♀PHc and ♂MIc x ♀PHc flocks

Eggs produced in Vietnamese Mia cockerel x Partridge Coloured Hungarian hen flock had significantly higher fertility (97%) and hatchability (85%) than in purebred MIc. In semi intensive system, MIc x PHc chickens showed significantly better performance than MIc and PHc in terms of body weight (12-week-old, 1.6kg vs. 1.3kg and 1.4kg for males; 1.4kg vs. 1.1kg and 1.2kg, for females, respectively) and feed conversion ratio (2.85kg/kg vs. 2.99 kg/kg and 3.06kg/kg, respectively). The abdominal fat percent of MIc x PHc reared in semi intensive system was the lowest among 3 genotypes (1.4% for male and 2.0% for female). Crossbred male chickens, reared in semi free range and semi intensive system were significantly heavier than those reared in complete free range. Amongst female birds, semi free-range conditions showed positive effect on body weight, in comparison with semi-intensive rearing.

### 3.6. Crosses of Partridge Coloured Hungarian and 2 Bábolna Tetra's chicken lines

The phenotypic appearance of crossbreds from the reciprocal crosses between Partridge Coloured Hungarian chicken (PHc) with Bábolna Tetra H dual purpose, father line (THc) and Bábolna Harco, egg type, mother line (BHc): ♂ THc x PHc, ♀ THc x PHc, ♂ PHc x THc, ♀ PHc x THc, ♂ BHc x PHc, ♀ BHc x PHc, ♂ PHc x BHc and ♀ PHc x BHc are shown in Figures 6 and 7. Liveability of crossbreds recorded during the first 12 weeks rearing were relatively high (95 - 100%). Pure Bábolna Tetra H chicken and their crosses with Partridge Coloured Hungarian chicken were significantly heavier than other genotypes in both sexes. The offspring of purebred Bábolna Tetra H chicken (♂ THc: 3.2kg and ♀

THHc: 2.4kg) were the heaviest, followed by birds from the crosses in which Bábolna Tetra H chicken was used as cockerels (♂ THc x PHc: 2.3kg and ♀ THc x PHc: 1.7kg). In the cross with Bábolna Harco chicken (BHc), ♂ PHc x BHc (1.73kg) and ♀ PHc x BHc (1.24kg) were relatively heavier than ♂ BHc (1.70kg) and ♀ BHc (1.20kg), respectively. High carcass percentage and breast percentage were found not only in ♂ THc (75% for carcass percentage and 20% for breast percentage) but also in ♂ PHc x THc (73% for carcass percentage and 18% for breast percentage). Feed conversion ratio was highest in Bábolna Harco (♂ BHc: 3.50kg/kg and ♀ BHc: 4.83kg/kg), lowest in Bábolna Tetra H (♂ THc: 2.90kg/kg and ♀ THc: 2.20kg/kg). At 3 hours after cutting, the colour index of breast meat was the highest in ♂ THc x PHc (44).

♂ PHc x THc

♀ PHc x THc

♂ THc x PHc

♀ THc x BHc

Figure 6. The appearance of crossbreds in the reciprocal crosses between Partridge Coloured Hungarian chicken (PHc) and Bábolna Tetra H dual purpose, father line (THc)

♂ PHc x BHc

♀ PHc x BHc

♂ BHc x PHc

♀ BHc x BHc

Figure 7. The appearance of crossbreds in the reciprocal crosses between Partridge Coloured Hungarian chicken and Bábolna Harco, egg type, mother line (BHc)

Egg production of the studied genotypes is shown in Figure 8. Egg weight, length and width of most genotypes increased over time. Egg weight of crossbreds were comparable to purebred ♀ BHc and THc at 28 weeks of age. Egg shape index of most genotypes were higher than 76%. The highest eggshell strength and thickness were found in ♀ PHc x BHc at 34 weeks of age (5.1 $kg/cm^2$ and 0.49mm, respectively). The eggs from ♀ BHc x PHc had the lowest colour index (31 - 35). Meanwhile, the highest colour index was found in ♀ THc x PHc at 28 weeks of age (47).

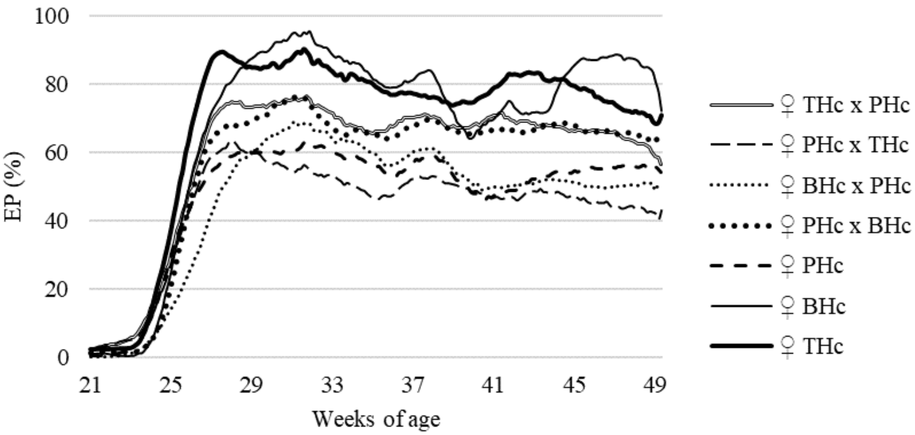


Figure 8. Egg production (EP) in percent of crossbred layers

*(PHc: Partridge Coloured Hungarian chickens; THc: Bábolna Tetra H dual purpose, father line; BHc: Bábolna Harco egg type, mother line; ♀ THc x PHc: female offspring of THc male and PHc female; ♀ BHc x PHc: female offspring of BHc male and PHc female; ♀ PHc x THc: female offspring of PHc male and THc female; ♀ PHc x BHc: female offspring of PHc male and BHc female; ♀ PHc: female offspring of PHc male and female; ♀ THc: female offspring of THc male and female; ♀ BHc: female offspring of BHc male and female)*

Offspring of Partridge Coloured Hungarian cockerels and Bábolna Harco hens (♂ PHc x ♀ BHc) exhibited more positive heterosis than other crossbred genotypes. The results of reciprocal effect revealed that offspring of Bábolna Tetra H cockerels and Partridge Coloured Hungarian hens (♂ THc x ♀ PHc) performed better than that of Partridge Coloured Hungarian cockerels and Bábolna Tetra H hens (♂ PHc x ♀ THc) in term of body weight, carcass, breast and thigh weight, thigh percentage, egg production and egg weight. And, offspring of Bábolna Harco cockerels and Partridge Coloured Hungarian hens (♂ BHc x ♀ PHc) performed better than that of Partridge Coloured Hungarian cockerels and Bábolna Harco hens (♂ PHc x ♀ BHc) only in term of egg weight at 28 and 40 weeks of age. Apparently, the most beneficial effect of crossing on each genotype was achieved in carcass weight (♂ BHc x ♀ PHc), breast weight (♂ PHc x ♀ BHc) and egg weight (♂ THc x ♀ PHc and ♂ PHc x ♀ THc).

## 4. NEW SCIENTIFIC RESULTS

[1] Comparison of breed specific egg production patterns of all seven Hungarian indigenous chicken breeds revealed, that egg production was consistently high in Yellow Hungarian chicken (0.493 eggs/hen/day) and White Hungarian chicken (0.468 eggs/hen/day). Meanwhile, Partridge Coloured Hungarian chicken could reach 0.490 eggs/hen/day. Transylvanian Naked Neck chickens can produce higher amount of eggs in the 2$^{nd}$ lay then in the 1$^{st}$ lay.

[2] Excellent adaptability of Partridge Coloured Hungarian chicken was scientifically proved in subtropical regions of Vietnam, which was realised by production traits (12-week body weight: 1.1kg to 1.4kg; egg production: 111 eggs/hen/7 months; peak of egg production: 70%; hatchability: 85%; mortality: 5%). It was verified that the breed can respond well to the challenge of climatic changes in continental climate, even as a crossing partner.

[3] Heterosis in productive traits was clearly demonstrated in crosses of the Partridge Coloured Hungarian chicken with a Transylvanian Naked Neck and the Vietnamese Mia chicken breed. In the cross of Partridge Coloured Hungarian chicken and Mia chicken, the average body weight of the offspring at 12

weeks is 1.3kg (female) and 1.6kg (male), and the eviscerated carcass percentage is approximately 75%.

[4] High performance of crossbred offspring was proven for reciprocal crosses of Partridge Coloured Hungarian chicken and commercial breeding lines (Bábolna Tetra H and Bábolna Harco). At 12 weeks, crossbreds of Partridge Coloured Hungarian chicken weighed approximately 1.6-2.2kg in the crosses with Bábolna Tetra H father line, and 1.2-1.6kg in the crosses with Bábolna Harco mother line. Feed conversion rate of both male and female offspring was below 3.3kg/kg and 3.2kg/kg, and eviscerated carcass percentage was about 72%. Their average egg production of crossbreds reached 53%.

[5] Solid heterotic effect in meat and egg production was demonstrated in reciprocal crosses of Partridge Coloured Hungarian chicken and egg type Bábolna Harco, mother line in such quantitative characteristics as growth (+1.81% to +7.27% for body weight, -23.8% to -11.0% for feed conversion rate and +0.565% to +0.979% for carcass percentage. Their breast meat's colour index was below 47, while egg shell strength and egg shell thickness were higher than 4.3kg/cm$^2$ and 0.3mm.

## SCIENTIFIC PUBLICATIONS AND PRESENTATIONS RELATED TO THE TOPIC OF THE PhD DISSERTATION

### Papers published in peer-reviewed scientific journals


[1] Lan Phuong, T.N., Barta, I., Bódi, L., Dong Xuan, K.D.T., Kovács, J.N. Ferencz, T.R. and Szalay, I.T. (2014) Egg production profiles of seven traditional Hungarian chicken breeds. *European Poultry Science*, 78, Paper 10.1399/eps.2014.69. 9 p.

[2] Lan Phuong, T.N., Dong Xuan, K.D.T. and Szalay, I. (2015) Traditions and local use of native Vietnamese chicken breeds in sustainable rural farming. *World's Poultry Science Journal*, 71(02), 385-396.

[3] Lan Phuong, T.N., Bódi, L., Dau, N.T., Thuy Linh, N., Thanh My, N., Minh Thu, P.T., Dong Xuan, K.D.T. and Szalay, I. (2016) Technical note on the introduction of Partridge Coloured Hungarian chicken in the Mekong Delta of Vietnam. *Animal Welfare Ethology and Housing Systems*, 12 (1), 1-10.

[4] Szalay, I.T., Lan Phuong, T.N., Barta, I., Kovács, J.N., Dong Xuan, K.D.T., Bódi, L., Mihók, S., Benk, A. and Kovácsné Gaál, K. (2016) Evaluating the trends of population data, effective population size and inbreeding rate as conservation indices of old Hungarian poultry breeds between 2000 and 2015. *European Poultry Science,* 80, Paper 10.1399/eps.2016.132. 14 p.

[5] Szalay, I.T., Lan Phuong, T.N., Barta, I., Bódi, L., Emődi, A., Szentes, K.A. and Dong Xuan, K.D.T. (2017) Conservation aspects of meat producing ability and heterosis in crosses of two natively

different local Hungarian chicken breeds. *International Journal of Poultry Science*, 15 (11), 442-447.

[6] Dong Xuan, K.D.T., Lan Phuong, T.N., Tien, P.D., Thu, P.T.M., Khiem, N.Q., Nhung, D.T., Muoi, N.T., Oanh, N.T.K., Thanh, P.T.K. and Szalay, I.T. (2017) In situ and ex situ assessment of a native Hungarian chicken breed for its potential conservation and adaptation in the subtropics. *Animal Production Science*, 57 (5), 975-980.

**Papers published in conference proceedings**

[1] Lan Phuong, T.N., Dau, N.T., Thuy Linh, N., Thanh My, N., Minh Thu, P.T., Dong Xuan, K.D.T. and Szalay, I. (2015) Introduction and technical figures on adaptation of Partridge Coloured Hungarian chicken breed in the Mekong Delta, Vietnam. In: Szalay, I., Dong Xuan, K.D.T. (ed.) Agrobiodiversity Protection and Research Conference: 8th Hungarian-Vietnamese Symposium. 14 p. Budapest, Magyarország, 2015.09.23 -2015.09.27. Gödöllő: HáGK, p. 7.

[2] Lan Phuong, T.N., Barta, I., Bódi, L., Dong Xuan, K.D.T., Kovács, J.N., Ferencz, T.R., Szalay, I.T. (2014) Investigating the egg production of 7 traditional Hungarian chicken breeds. In: Schmidt, R., Bali Papp, Á. (ed.) XXXV.Óvári Tudományos Nap: A magyar és nemzetközi agrár- és élelmiszer - gazdaság lehetőségei. Mosonmagyaróvár, Magyarország, pp. 177-181. (ISBN: 978-963-334-194-0)

[3] Lan Phuong, T.N. and Szalay, I.T. (2016) Population studies of 14 registered Hungarian poultry breeds conserved in the 21st century. In: Ning Yang, Ling Lian, Jiangxia Zheng, Xiangping Liu, Changxin Wu (ed.), Proceedings of XXV World's Poultry Congress 2016: Abstracts. 656 p. Beijing, China, 2016.09.05 -2016.09.09. World's Poultry Science Association (WPSA), p. 247.\

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[5] Dong Xuan, K.D.T., Lan Phuong, T.N., Minh Thu, P.T., Tien, P.D. and Szalay, I.T. (2016) Status of old Hungarian poultry breeds adapted to the subtropics and tropics of Vietnam. In: Proceedings of 9th Vietnamese-Hungarian International Conference "Research for Developing Sustainable Agriculture". 570 p, Tra Vinh, Vietnam, 2016.09.21 -2016.09.23., pp. 49-57.