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Assessing the Effects of the Mating Sex Ratios on Reproductive Performance of Indian Peafowl, *Pavo cristatus*

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Abstract.- This study was conducted to evaluate the role of peacock-peahen ratios on egg production, fertility and hatchability in Indian Peafowl (*Pavo cristatus*) in a Wildlife Park to explore most productive mating sex ratio for a period of 16 weeks. A total of 42 birds (12♂ & 30♀) was selected for the study and kept in 12 cages. The sex ratios maintained were 1♂: 1♀ (Group A), 1♂: 2♀ (Group B), 1♂: 3♀ (Group C) and 1♂: 4♀ (Group D). Each group had three replicates. The birds were randomly released into twelve cages with each cage contained one sex ratio. Before data collection, the birds were given an adaptation period of one week. Peacock-peahen ratio (1♂: 3♀) exhibited significant effect (P<.0.05) on mean egg production (1.78±0.14), egg weight (98.21g±7.02), egg fertility (81.25%±6.28), hatchability (61.95%±1.00) and mounting numbers (2.66±0.09). Whereas, the mean display duration, display number, mounting duration and total time taken for mating were not affected by any peacock-peahen mating ratio. Maximum number of eggs were produced having mating sex ratio 1:3 in terms of egg production, egg weight, egg fertility (%), hatchability (%) and number of mating.

Key words: Peafowl, mating ratios, egg production, egg weight, fertility, hatchability.

INTRODUCTION

Indian peafowls (*Pavo cristatus*) also known as common peafowl and also Indian blue peafowl, are a polygamous avian species. These birds stay in small flocks (harems) of 1 peacock (male) and 3-5 peahens (females) and tend to remain closed together during breeding season (Mushtaq-Ul-Hassan, 2012; Grimmett *et al*., 1999) Peacocks establish their breeding territories in close proximity to one another in a breeding arrangement known as a lek. Visiting peahens wander through several territories, sometimes making repeated visits, before selecting a peacock for mating (McGowan, 1994). A peacock usually has 2-3 breeding peahens in its harem (Robert, 1991).

In breeding flocks of birds, mating ratio of male to females plays a pivotal role in optimizing fertility and hatchability in the eggs produced by a flock (Altan and Oguz, 1993).There is a general hypothesis that fluctuating selection driven by sex ratio dynamics contributes to explain the maintenance of genetic variation in personality traits, so, any change in the ratio exhibits a marked effect on fertility and hatchability of eggs (Newcombe, 1996; Kiers, 1997; Giudice, 2012). The ratio of males to females in a population is an important factor in determining behavior in animals. Too many or too few males in a unit may lead to higher proportion of infertile eggs. Male to female ratios for optimum fertility and hatchability varies from species to species i.e. in chicken 8-9 males/100 females (Hazary *et al*., 2001; Lesson and Summers, 2001; Griskevicius *et al*., 2012), in ostrich 1 male: 3 females (Lambrechts *et al*., 2004) and 1 male: 2 females in quails (Shanaway, 1994).

To date, peacocks are being raised in captivity by the fancies and commercial farmers. However, scientific information regarding the most efficient mating ratio in breeding flocks of these birds kept in confinement is still scarce. Therefore, the present trial was carried out using four sex ratios (1♂:1♀, 1♂:2♀, 1♂:3♀ and 1♂:4♀ respectively) to explore effects mating ratios on egg production, fertility and hatchability of eggs in Indian Peafowl (*P. cristatus*).

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MATERIALS AND METHODS

This study was conducted on 42 peafowls (12♂ & 30♀ respectively) at Wildlife Park Bahawalnagar (Pakistan) for a period of 16 weeks. The age of the experimental birds averaged 5 years, whereas weight of males varied from 4.2-5.7 kg and 3.4-4 kg in females. The peafowls were distributed in four experimental groups according to sex ratios i.e. 1♂:1♀ (Group A), 1♂: 2♀ (Group B) 1♂:3♀ (Group C) and 1♂:4♀ (Group D). Each treatment had three replicates. The replicates were designated as A1, A2 and A3 for group A and for group B, C and D these were B1, B2, B3; C1, C2, C3 and D1, D2, D3, respectively. The experimental birds were kept in cages and each cage contained one sex ratio. The cages were allocated to the birds randomly using completely randomized design.

Birds received an adaptation period of one week and were fed a slandered breeder diet containing 180 g crude protein, 11.3 MJ of metabolizable energy and 30 g calcium per kg diet (Islam *et al.*,2002). The diet was offered to the birds daily at 09:00, whereas water was given ad libitum to all the birds. The cages were daily cleaned to prevent any disease outbreak. Vaccination and medication was done as and when required during the experimental period. Water soluble premix was offered for 4 days in the drinking water during the adaptation period and the process was repeated after every two weeks.

Diet was rationed at @ 200g/peafowl per day as scheduled by Punjab Wildlife Department (Pakistan). Residual feed was removed from each feeder and then filled with fresh feed daily.

Egg production was daily recorded from the onset of egg laying. Eggs of each group were marked as described by Khan *et al*. (2006). Weekly egg production/bird was also calculated for each group. Eggs weight (g) was recorded on weekly basis by using all eggs collected during the week (Zou and Wu, 2005).

Eggs were stored in a store room at 15^{o}C to 18^{o}C having 75-80% relative humidity, till setting in an incubator. At the end of incubation period (waiting for five days since the appearance of first hatched egg) non-hatched eggs were separated and broken to see late embryonic mortality (chicks dead in shell), if any. The data obtained for each group were used to calculate fertility (%) of incubated eggs (Seker *et al.*, 2004).

Data on courtship behavior were collected for each mating sex ratio from 8 O'clock to 18 O'clock for 5 times daily. Data for display numbers, display duration, number of mountings and total time taken for mating were recorded for each group.

Completely Randomized Design (CRD) was used to analyze the data (Minitab, 2000) and Duncan's Multiple Range (DMR) test was used to compare difference in the means of all parameters (Steel *et al*., 1996).

RESULTS

Table I shows the effects of different peacock-peahen ratios on reproductive performance of Indian peafowl (*P. cristatus*). Peacock-peahen ratios exhibited a significant ($P<0.05$) effect on egg production. Maximum number of eggs was produced by the peahens of group C (1.78±0.14) whereas group A, B and D produced statistically similar mean egg production (0.77±0.09, 0.79±0.07 and 0.79±0.08, respectively). Peahens of group C had significantly higher ($P<0.05$) mean egg weight (98.21±7.02) than those of groups A and D (71.04±8.06 and 79.15±4.56, respectively), whereas peahens of group B had statistically similar egg weight as those of peahens of group A, C, and D.

Peacock-peahen ratios also markedly affected the egg fertility (%). Group A and D produced the minimum number of fertile eggs whereas maximum fertile eggs were produced by group C. Mean egg fertility (%) was 33.75±1.43 in group A, 60.61±2.68 in group B, 81.25±2.68 in group C and 34.59±1.68 in group D. Group D produced minimum mean hatch-able eggs whereas maximum mean hatchability was noted in group C. Mean hatchability in group A was 23.43±5.28, in group B was 39.84±3.80, in group C was 61.95±1.00 and in group D was 20.47+2.75. This variation was also statistically significantly different ($P<0.05$).

Peacock-peahen ratios did not affect average display duration ($P<0.05$). Mean display duration was 8.21±0.05, 7.49±0.30, 6.47±0.35 and 7.83±0.69, in group A, B, C and D, respectively. These mating ratios also did not affect mean display

Table I.- Influence of male: female ratios on reproductive performance (Mean±SE) of Indian Peafowl (*P. cristatus*) at Wildlife Park, Bahawalnagar, Pakistan.

Parameters	Groups			
	A (1:1)	B (1:2)	C (1:3)	D (1:4)
Egg production (No)	0.77±0.09 B	0.79±0.07 B	**1.78±0.14 A**	0.79±0.08 B
Egg weight (g)	71.04± 8.06 B	85.87±7.32 AB	**98.21± 7.02 A**	79.15±4.56 B
Egg fertility (%)	33.75±1.43 C	60.61±2.68 B	**81.25±2.68 A**	34.59±1.68 C
Egg hatchability (%)	23.43±5.28 C	39.84±3.80 B	**61.95±1.00 A**	20.47±2.75 C
Display duration (Minutes)	8.21±0.05	7.49±0.30	6.47±0.35	7.83±0.69
Display number	10.40±1.19	7.37±3.56	11.93±0.12	9.93±0.95
Mounting duration (Sec)	0.84 ± 0.09	0.44 ± 0.10	0.18 ± 0.03	0.14 ± 0.02
Mounting number	0.16 ± 0.01 C	0.56 ± 0.06 B	**2.66 ± 0.09 A**	0.14 ± 0.02 C
Total time for mating (minutes)	13.17 ± 1.33	12.29 ± 2.54	14.36 ± 1.35	14.13 ± 2.48

Mean values in a row with different superscripts are significantly (P<0.05) different.

number which was 10.40±1.19, in group A, 7.37±3.56, in group B, 11.93 ±0.12, in group C and 9.93±0.95, in group D.

Mean mounting duration was not influenced by Peacock-peahen ratios. Mean mounting durations in group A was 0.84±0.09, in group B was 0.44± 0.10, in group C was 0.18±0.03 and in group D was 0.14±0.02. However, Peacock-peahen ratios significantly (P<0.05) influenced the mean mounting numbers of the males. Mean minimum number of mountings was observed in group D (0.14±0.02) but found to be the highest in group C (2.66±0.09), whereas mean number of mountings in group A and B was 0.16±0.01 and 0.56±0.06, respectively. However, Peacock-peahen ratios did not exhibit any statistical effect on the mean total time taken for mating in any group.

DISCUSSION

In the present study, the higher number of eggs was produced by the peahens at mating sex ratio 1:3. The results of the present study are in line with the findings of Bates *et al*. (1987) who reported that increasing the sex ratio from 1:12 to 1:18 increased egg production. However Mushtaq-ul-Hassan *et al*. (2012) found 1:2 sex ratio showed better results in terms of egg production and egg weight but the results of present study *i.e.*,1:3 sex ratio gave better results in terms of less feed consumption, more egg fertility (%), egg hatchability (%) and number of mountings. A probable explanation of the better egg production may be related to the less stress experienced by the females due to optimum number of male to females mating ratio in the group which might have reduced preferential mating. Kevin and Alexander (2010) and Sueuri *et al*. (2011) reported that preferentially associating with certain individuals belonging to same species is accomplished to create an effect on the sexual selection they experience. In this respect not only the social and behavioral processes by which variation arises in mating success, but also sexual selection in many species (mostly by females) must be the result of social structure in estimates of sexual selection and predicted change evolution.

Eggs having the higher weight exhibited better hatchability (%) in this study. The results of the present study are in accordance with those

observed by Seker *et al.* (2004) and Ali (2006) who observed better hatchability (%) in heavier eggs than those in lighter chicken eggs. Better hatchability of the peahens having mating sex ratio 1:3, may be due to better fertility of the birds kept in this group.

Maximum egg fertility (%) was found to be in the birds having sex ratio of 1:3 as compared to other treatment groups. According to Coony (1943) fertility and hatchability are interrelated heritable traits having variation among breeds, varieties and individuals within breeds and varieties. Jayarajan (1992) had reported that environment and management may also influence the effect of breed on egg fertility and hatchability. The male to female mating ratio has shown a significant effect on fertility of the eggs produced by the peahens of the group kept with 1 male: 3 females as compared to other mating ratios indicating that too many or too few males in a breeding flock may lead to higher proportion of infertile eggs in peafowls.

Fertility of the eggs is one of the major factors determining hatchability of all egg set (Deeming and Wadland, 2002). Fertility and egg quality are the two important factors affecting hatchability, if management would not be a limiting factor during the process of incubation and hatching, fertility would affect hatchability. Hatchability is reduced with reduction in fertility (Farooq *et al.*, 2001). Hatchability was found to be higher on the basis of fertile eggs than that on the basis of total eggs set (Murad *et al.*, 2001). In the present study similar relationship between percent fertile eggs and percent hatchability was recorded *i.e.* higher the percent of fertile eggs, higher was the percent hatchability. Ali (2006) also obtained a similar relationship between fertility and hatchability in his experiment involving the effect of sex ratio on performance, fertility and hatchability.

Sex ratio used in the present study did not show any significant effect on display duration, display number, mating duration and total time taken for mating. However, sex ratio exerted a significant effect on mounting numbers (mating) in different treatment groups. The mounting numbers were higher in 1:3 ratios (2.66±0.09). The results of the present study agree with those reported by Ali (2006) and Mushtaq-ul-Hassan (2012) who found that number of mountings was influenced due to different mating sex ratios in peafowls. It is proved in the present study that the most appropriate sex ratio for obtaining maximum number of fertile eggs in peafowls is 1:3 whereas higher ratio produced less fertile eggs as depicted from the results of present study for sex ratio 1:4, *i.e.* 0.14±0.02 mountings.

Peafowl behavior in its native habitat broadly conforms to that documented from captive and introduced populations. However, there were some differences between the wild and captive populations in vocalizations, maintenance behavior and spatial distribution of adult males. Since the time spent engaging in these behaviors may affect the cost of display, these results emphasize the need to assess the signaling cost *in situ* where the behavior evolved (Harikrishnan *et al*., 2010). There is a scope for investigation of breeding behavior of birds under captive conditions to assess their effects on egg production. Different ecological and social factors affect hatchability of eggs in different species of birds. Significant relations among these factors and hatchability of eggs were obtained by Koenig (1982).

Based on the results of this study, it may be concluded that the 1:3 ratio has shown better results in terms of egg production, egg weight, egg fertility, hatchability and number of mating. Since the aim of this study was the conservation of peafowl (*P. cristatus*) with reference to wildlife point of view, it is proposed that 1:3 sex ratio could be used for the breeding of this wild bird (peafowl) under captive conditions.

REFERENCES

ALI, Z., 2006. *Effect of mating sex ratio in Indian peafowl (*Pavo cristatus*) on productive performance, fertility and hatchability*. M.Sc. thesis, Department of Zoology, GC University, Faisalabad.

ALTAN, O. AND OGUZ, I., 1993. Bildiricinlarda *(Coturnix coturnix jqaponica)* yasin ve erkek disi oraninin kulucka ozellikleri ve dollu sure uzerine etkileri (Turkish of: Effect of mating ratios and parental are on fertility, hatchability duration and recovery of fertility in Japanese quail *(Coturnix coturnix jqaponica)* E.U. *Zir. Fak. Derg*., **30**: 57- 64.

BATES, D.P., HANSON, L.E. AND COOK, M.E., 1987. Lightening and sex ratio for breeding ring-necked

pheasants in confined housing. *Poult. Sci*., **66**: 605-612.

COONY, W.T., 1943. Pre-incubation humidity variation effects on chicken eggs hatchability. *Oreg. Agricultural Experimental Statistical Technology Bulletin, Fertility and hatchability*, Wileg and sons, Inc., New York.

DEEMING, D.C., AND WADLAND, D., 2002. Influence of mating sex ratio in commercial pheasant flocks on bird health and the production, fertility, and hatchability of eggs. *Br. Poult. Sci*., **43**: 16-23.

FAROOQ, M., DURRANI, F.R., ALEEM, M., CHAND, N. AND MUQARRAB, A.K., 2001. Egg traits and hatching performance of Desi, Fayoumi and Rhode Island Red chickens. *Pak. J. biol. Sci*., **4**: 909-911.

GIUDICE, M.D., 2012. Sex ratio dynamics and fluctuating selection on personality. *J. theor. Biol*., **297**: 48–60

GRIMMETT, R., INSKIPP, C. AND INSKIPP, T., 1999. *Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives.* Princeton University Press. ISBN 0-691-04910-6.

GRISKEVICIUS, V., TYBUR, J.M., ACKERMAN, J.M., DELTON, A.W., ROBERTSON, T.E. AND WHITE, A.E., 2012. The Financial Consequences of Too Many Men: Sex Ratio Effects on Saving, Borrowing, and Spending. *J. Person. Social Psychol.*, 102: 69-80.

HARIKRISHNAN, S., VASUDEVAN, K. AND SIVAKUMAR, K., 2010. Behavior of Indian peafowl *Pavo cristatus* Linn. 1758 during the mating period in a natural population. *Open Ornithol. J*., **3**:13-19.

HAZARY, R.C., STAINES, H.J. AND WISHART, G.J., 2001. Assessing the effect of mating ratio on broiler breeder performance by qualifying sperm: egg interaction. *J. appl. Poult. Res*., **10:** 1-4.

KIERS, R.W., 1997. *Assessing and achieving fertility: The role of male management*. Rosstech, December edition. Ross Breeders Ltd., Newbridge, Midlothian, UK, pp. 1-6.

ISLAM, M.S., HOWLIDER, M.A.R., KABIR F. AND ALAM, J., 2002. Comparative assessment of fertility and hatchability of Barred Plymouth Rock, White Leghorn, Rhode Island Red and White Rock hens. *Int. J. Poult. Sci.*, **1**: 85-90.

JAYARAJAN, S., 1992. Seasonal variation in fertility and hatchability of chicken eggs. *Ind. J. Poult. Sci*., **27**: 36-39.

KEVIN, P.O. AND ALEXANDER, V.B., 2010. structure of social networks in a passerine bird: consequences for sexual selection and the evolution of mating strategies. *Am. Nat.*, **176**: E80-E89.

KHAN, M.K.I., KHATUN, M.J., BHUIYAN, M.S.A. AND SHARMIN, R., 2006. Production performance of Fayoumi chiken under intensive management. *Pak. J. biol. Sci*., **9**: 179-181.

KOENIG, W.D., 1982. Ecological and social factors affecting hatchability of eggs. *Auk*, **99**: 526-536.

LAMBRECHTS, H., SWART, D., CLOETE, S.W.P., GREYLING, J.P.C. AND VAN, SCHALKWYK, S.J., 2004. The influence of stocking rate and male: female ratio on the production of breeding ostriches (*Struthio camelus* spp.) under commercial farming conditions. *S. Afr. J. Anim. Sci*., **34**: 87-97.

LESSON, D. AND SUMMERS, J.D., 2001. Male fertility. In: *Broiler breeder production.* Ist International Book Distribution Company, Lucknow, India, p: 37.

MCGOWAN, P.J.K., 1994. Family Phasianidae. In: *Handbook of the birds of the world*. Vol. 2. (eds. J. Del Hoyo, A. Elliot and J. Sargatal), New World Vultures to Guinea fowl. Lynx Edicions, Barcelona, pp. 434-479

MINITAB, 2000. *Minitab release statistical software.* Copyright Minitab Inc.

MURAD, A., FAROOQ, M., MIAN, M.A. AND MUQARRAB, A.K., 2001. Hatching performance of Fayoumi eggs. *Sarhad J. Agric*., **17**: 1-6.

MUSHTAQ-UL-HASSAN, M., ALI, Z., ARSHAD, M., MAHMOOD, S. AND MAHMOOD-UL-HASSAN, M., 2012. Effects of mating sex ratios in Indian peafowl (*Pavo cristatus*) on production performance at Wildlife Research Institute, Faisalabad (Pakistan). *Iranian J. Vet. Res.*, **13**:143-146.

NEWCOMBE, M., 1996. Managing broiler breeder males in production. In: *Shaver focus* (ed. P. Hunton) Shaver Poultry Breeding Farms Ltd., Cambridge, Ontario, Canada, pp: 1-5.

ROBERTS, T.J., 1991. *The birds of Pakistan.* Vol-I. Oxford University Press. Karachi. Pakistan. pp. 246-248.

SEKER, I., KUL, S. AND BAYRAKTAR, M., 2004. Effect of parental age and hatching egg weight of Japanese quails on hatchability and chick weight. *Int. J. Poult. Sci*., **3**: 259-265.

SHANAWAY, M.M., 1994. Factors affecting the fertility of quail eggs. In: *Quail production systems, A review*. Food and Agriculture Organization of the United Nations, FAO, Rome, p: 18

STEEL, R.G.D., TORIE, J.H. AND DICKEY, D.A., 1996. *Principles and procedures of statistics. A biometric approach* (3rd ed.). McGraw Hill Book Comp. Inc. New York, USA.

SUEURI, C., JACOBS, A., AMBLARD, F., PETIT, O. AND KINGS, J.A., 2011. How can social network analysis improve the study of primate behavior? *Am. J. Primatol*., **71**:1-17.

ZOU, S.G. AND WU, Y.Z., 2005. Effects of protein and supplemental fat on performance of laying hens. *Int. J. Poult. Sci*., **4**: 986-989.

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