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Behavioral Differentiation between *Anas poecilorhyncha* and Domestic Duck

Shenglin Yang[1], Lin Zhou[1], Wei Lin[1], Xiaomeng Li[2], Man Lu[2] and Chenggang Liu[2]

1. College of Animal Science, Guizhou University, Guiyang 550025, People's Republic of China

2. Key Laboratory of Animal Genetics, Breeding and Reproduction in Plateau Mountainous Region, Ministry of Education, Guizhou University, Guiyang 550025, Guizhou Province, People's Republic of China

Abstract: *Anas poecilorhyncha* is one of improved variety of mallards, which was the protected bird species listed by International Union for Conservation of Nature (IUCN). Little is known until now about behavioral characteristics of the mallard. The objective of this study was to compare the behavioral differentials between *A. poecilorhyncha* and domestic duck in order to make a strategy to manage *A. poecilorhyncha* under the condition of animal welfare. A total of 180 birds were distributed into six groups with 30 birds for each group. They were placed in a room of 3 m × 4 m and fed for one year old. Sansui ducks, a kind of native domestic duck (Sansui laying duck) were used for behavioral comparison. Two different rooms in the same building were applied, one room for *A. poecilorhyncha* and another one for Sansui ducks. All behaviors for *A. poecilorhyncha* and Sansui ducks were coded using the program The Observer XT 11.5 (Noldus Information Technology, Beijing). The duration of observation was from 8:00 am to 18:00 pm daily and lasted 5 d. The results showed that there were similar behavioral percentages between *A. poecilorhyncha* and domestic duck. Percentages of standing activity spent for *A. poecilorhyncha* and Sansui duck were 34.59% and 30.25%, respectively. Accordingly, the activities, such as wing plugging, preening and head stretching, were more than 5.51%. The other activities, including walking, drinking and tail wagging, occupied less proportions (≤ 3%). While the specific behaviors, like aggression, alerting, wing dithering, clawing, nodding, pendulum clawing and crawling, took less than 1% of percentage. There were large differences between *A. poecilorhyncha* and domestic duck when comparing eight behavioral peaks. Lag sequential analysis was used to calculate frequency of transition between a pair of activities. Some parameters were very significant, like the frequency value from foraging converted to drinking in Sansui duck was 369-515, but 37-65 in *A. poecilorhyncha*. The best explaining could be given that Sansui duck was better domesticated than spot-billed duck. This study provides the basic data to study and develop spot-billed duck.

Key words: Behavioral ethogram, *Anas poecilorhyncha*, Sansui duck, lag sequential analysis.

1. Introduction

Anas poecilorhyncha, a sort of mallard found in 1861-1862, is mainly distributed in the Eastern Asia, Indo-China Peninsula and India [1, 2]. There are two academic views about the origin and evolution of Chinese domestic ducks. Some scholars hold that Chinese domestic ducks originated from wild mallards (*A. platyrhynchos*), while others argued that Chinese domestic ducks originated from the hybrid of wild mallards (*A. platyrhynchos*) and spot-billed duck (*A. zonorhyncha*), domesticated in different areas or domesticated from hybrids of *A. platyrhynchos* and *A. zonorhyncha* [3, 4]. However, there is still no consensus conclusion about this. A few of reports have been found related to the genetic relationship between *A. poecilorhyncha* and *A. platyrhynchos*. Kulikova et al. [5] reported the genetic diversity and phylogenetic relationships in two groups of river ducks—*A. platyrhynchos* and *A. poecilorhyncha* using random amplified polymorphic DNA-polymerase chain reaction (RAPD-PCR), and the genetic distance between them was 0.401, suggesting that there were a low genetic differentiation and a close evolutionary relationship between *A. platyrhynchos* and *A. poecilorhyncha*.

According to the regulation of wild animal

Corresponding author: Shenglin Yang, professor, research field: animal genetics, especially in native animals.

conservation of China, wild animals through artificial rearing can be conducted after they reproduce into the second generation. In fact, mallard has been utilized many years because of its good tolerance to crude feed and good quality of meat, especially its plenty of essential amino acids. Some researches concerning the productive traits of *A. poecilorhyncha* have been conducted in recent years. Hu et al. [6] studied laying rhythm of *A. poecilorhyncha* and found that the mallard started to lay in six months old with 16 weeks of laying duration and 30 eggs approximately per year. The other productive performances, such as growth rate, reproductive rate, nutritive requirement and domesticating technique, have been investigated [7, 8]. Zhou et al. [9] investigated the whole mitochondrial genome of *A. poecilorhyncha* in 2015. Lavretsky et al. [10] studied the phylogenetics between the mallards and allies using molecular method in 2014. However, up to now, little is known about behavioral characteristics of the mallard. As we know, ethogram is the description to the characteristics of the behavior for some species [11, 12]. It provides the standardized classification and definition for relevant job, so that proceeds quantitative analysis to understand the behavior, existence and breeding of animals [13, 14]. The objective was to compare the behavioral differentials between *A. poecilorhyncha* and domestic duck so as to make a strategy to manage *A. poecilorhyncha* under the condition of animal warfare.

2. Materials and Methods

2.1 Subjects

The experiment was performed in the Veterinary Hospital of Guizhou University, Guizhou province, China. All mallards used for this trail were bought from Poyang mallard breeding farm in Jiangxi province. A total of 180 birds were distributed into six groups with 30 birds for each group, and fed in the room of 3 m × 4 m until one year old. To understand the specific behavior for the mallards, Sansui duck, a kind of native domestic duck (Sansui laying duck) was used as for behavioral comparison. Two different rooms but the same building were applied, one for *A. poecilorhyncha* and another one for Sansui ducks. To acquire all behavioral definitions, a pre-observation experiment was conducted before starting the formal observation. The formal observation experiment was conducted using 30 Sansui ducks and 30 mallards by Samsung PC camera with Media Recorder Software (Noldus Information Technology, Beijing). The duration of observation was from 8:00 am to 18:00 pm and lasted 5 d. All behaviors for *A. poecilorhyncha* and Sansui ducks were coded using the program The Observer XT 11.5 (Noldus Information Technology, Beijing). A total of 21 sorts of behaviors for *A. poecilorhyncha* and 17 sorts of behaviors for Sansui ducks were coded, and each behavior could not occur simultaneously. Both instantaneous observation and continuous observation methods were applied in this study. A time unit 60 s was used to record the behavioral times, and 60 times/h and 600 times/d were recorded, lasting 5 d.

2.2 Behavioral Description and Definition

Behaviors were described and defined according to the function of the described behaviors, and data were from pre-observation and the previous studies on duck’s behavior [15, 16]. A total of 21 sorts of behaviors including *A. poecilorhyncha* and Sansui duck were defined, and listed in Table 1.

2.3 Statistical Analysis

To check reliability of data, it was necessary to run the same data more than two times or to analyze data by more than two people. It was regarded as available (Nuldus) while the reliability value was more than 75%. In this experiment, the reliability values were 99.87%, 99.81%, 99.85%, 99.82%, 99.85%, respectively, so these data were available for subsequent work. Behavioral data were used as statistical and correlative analysis with The Observer XT 11.5 and SPSS 18.0. The total behavioral frequency

Table 1 Ethogram of behaviors of *A. poecilorhyncha* and Sansui duck.

Behavior	Definition
Walking	Walking without performing other behavior
Standing	A bird is standing on the ground with two feet, maintaining an erect upright position
Lying	A bird is lying on the floor; its belly is resting on the floor with its wings and legs tucked underneath it; relaxed
Head wiggling	Movement of head towards different directions
Foraging	A bird is pecking at food at the feeder, including brief inter-pecking intervals
Preening	Rubbing the beak or lower limbs over or between the feathers
Head stretching	A duck is stretching its head for a period of time
Wing plugging	A duck's beak and head are stretching under the wings
Drinking	A duck drinks by suction of water through the beak
Paddling	Swiping duck's web or the whole body into water, stealth a distance to emerge from the water
Crawling (only *A. poecilorhyncha*)	A bird's body is moving in a slowly velocity when it is lying on the ground; its legs are curled underneath wings
Wing dithering	A duck is jittering its wings ceaselessly
Aggression	Stretching out by head and pecking other individuals
Tail wagging	A duck is moving his tail from left side to right side
Alerting (only *A. poecilorhyncha*)	A quiet upright waking posture with the animal standing on both legs, with both eyes showing fast blinks, but no head/body exploratory movements
Clawing	A bird is tickling the duck's head with palm
Defecating	Releasing feces from cloaca
Nodding	A duck is moving its head slightly downwards
Pendulum clawing	A duck is wiggling its a palm when standing with one leg
Running	The action or movement of duck by foot at fast velocity
Flying	Wings vibration, legs off the ground for a period of time

for *A. poecilorhyncha* and Sansui duck was 3,000 times. The other data analysis concerning behavioral percentage, time, frequency and lag sequence was calculated by The Observer XT program.

3. Results

3.1 Behavioral Percentage and Change Occurred

The proportions of all behaviors spent both for *A. poecilorhyncha* and Sansui duck were listed in Table 2. Percentages of standing activity spent for *A. poecilorhyncha* and Sansui duck are 30.25% and 34.59%, respectively. Lying took up the second large percentage, 27.02% and 20.75%, respectively. Accordingly, the activities, such as wing plugging, preening, and head stretching, were more than 5.51%. The other activities, including walking, drinking and tail wagging, occupied less proportions (≤ 3%). While the specific behaviors, like aggression, alerting, wing dithering, clawing, nodding, pendulum clawing and crawling, took less than 1% of percentage. Particularly, a few of frequencies for pendulum clawing and paddling could be observed for *A. poecilorhyncha* (spot-billed duck).

Frequencies of all behaviors occurred each day and total frequencies for 5 d were displayed in Fig. 1, which recorded the activities occurred for both of *A. poecilorhyncha* and Sansui ducks from day 1 to day 5 at day time. The main behaviors spent each day were largely similar. Fig. 2 represented the principal behavioral change both of *A. poecilorhyncha* and Sansui ducks from day 1 to day 5. The frequency of mainly behavior—standing spent for *A. poecilorhyncha* was relatively stable (Fig. 2b), and the similar situations could be detected in smaller percentage of behavior occurred, like walking and preening (Figs. 2a and 2f). Unstable behavioral changes could be found in lying, heading dithering, foraging, drinking and wing plugging. However, it needs the further confirmation by doing a longer duration experiment.

Table 2 Proportions of behaviors spent from day 1 to day 5 for *A. poecilorhyncha* and Sansui duck.

Behavior	Sansui duck		*A. poecilorhyncha*		*P* value
	Frequency	Proportion (%)	Frequency	Proportion (%)	
Standing	5,428	34.59	4,523	30.25	0.058
Lying	3,257	20.75	4,040	27.02	0.068
Wing plugging	1,929	12.3	2,217	14.83	0.044
Head wiggling	715	4.56	1,099	7.35	0.133
Preening	959	6.11	1,076	7.20	0.037
Head stretching	1,183	7.54	824	5.51	0.113
Foraging	980	6.24	418	2.80	0.243
Walking	387	2.47	285	1.91	0.096
Drinking	439	2.80	152	1.02	0.288
Tail wagging	265	1.69	133	0.89	0.204
Aggression	11	0.07	78	0.52	0.411
Clawing	37	0.24	34	0.23	0.027
Alerting	14	0.08	33	0.22	0.245
Wing dithering	56	0.36	22	0.15	0.262
Defecating	9	0.05	8	0.05	0.037
Nodding	8	0.05	4	0.03	0.205
Crawling	1	0.01	0	0.02	0.500
Pendulum clawing	8	0.05	1	0.00	0.421
Paddling	7	0.04	3	0.00	0.242
Total	15,693	100.00	14,950	100.00	0.015

3.2 Lag Sequential Analysis of A. poecilorhyncha and Sansui Duck

In The Observer XT 11.5, lag sequential analysis calculates the frequency of transitions between pairs of events within a certain lag. The first event of the pair is called criterion and the second is target. Depending on what direction in time you choose (positive or negative), we can calculate how often the event A is followed by B, or how often A is preceded by B, and in relation to other behaviors. Here, the frequency was selected instead of probability; in the result of matrix, each row represents a criterion activity and each column is a target activity (Fig. 3).

From Table 3, it can be seen that the frequency for standing for *A. poecilorhyncha* with two legs transited to walking activity was 1,710 and walking converted to standing with two legs occurred 1,724 times. While, the frequency of walking to standing with two legs in Sansui duck was 3,758 and from standing to walking was 3,715 (Table 4). It can be seen that transition for standing and walking activity was easy to be detected both in *A. poecilorhyncha* and Sansui duck, but more often in Sansui duck than that in *A. poecilorhyncha*. Similarly, frequency for standing with two legs converted to standing with one leg was 536 and from standing with one leg to standing with two legs was 512 times for *A. poecilorhyncha* (Table 3). But frequency for standing transited to running or flying were zero, while walking to running was two, no standing process from walking to running or flying. Conversion from lying to walking was 49 and from walking to lying was 36; it can be explained that transition between walking and lying was often and easy. In Sansui duck, from standing with two legs to running was three and no flying activity could be observed (Table 4). But, the frequency of transition from lying to standing was often to be observed both in two sorts of ducks (296 and 318, respectively). Interestingly, the frequencies from standing to running both for *A. poecilorhyncha* and Sansui duck were zero, except standing with two legs to running in Sansui

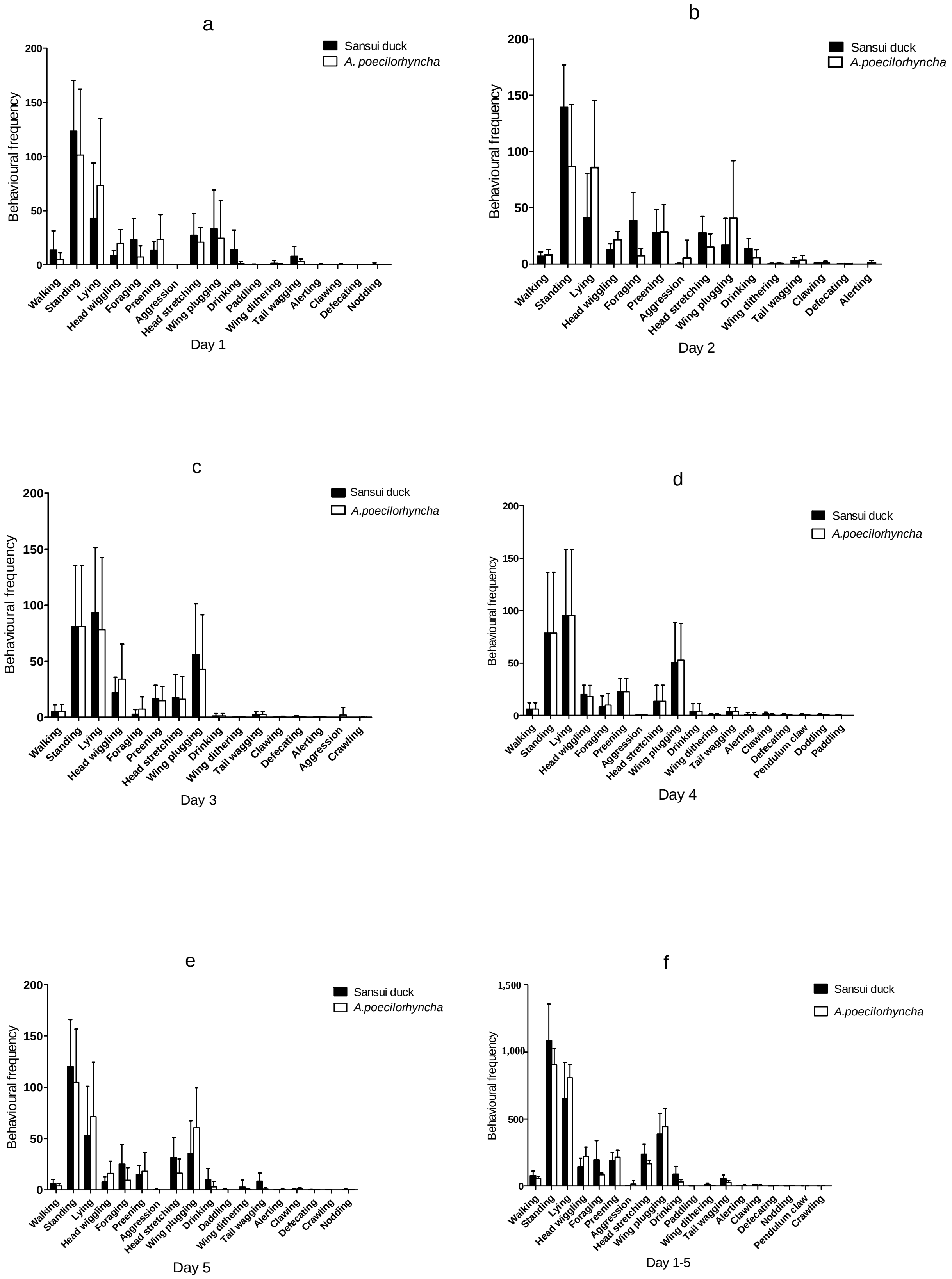

Fig. 1 Behavioral frequency of observation from day 1 to day 5 (a-e) and total behavioural frequency of 5 d (f) for *A. poecilorhyncha* and Sansui duck in the experiment.

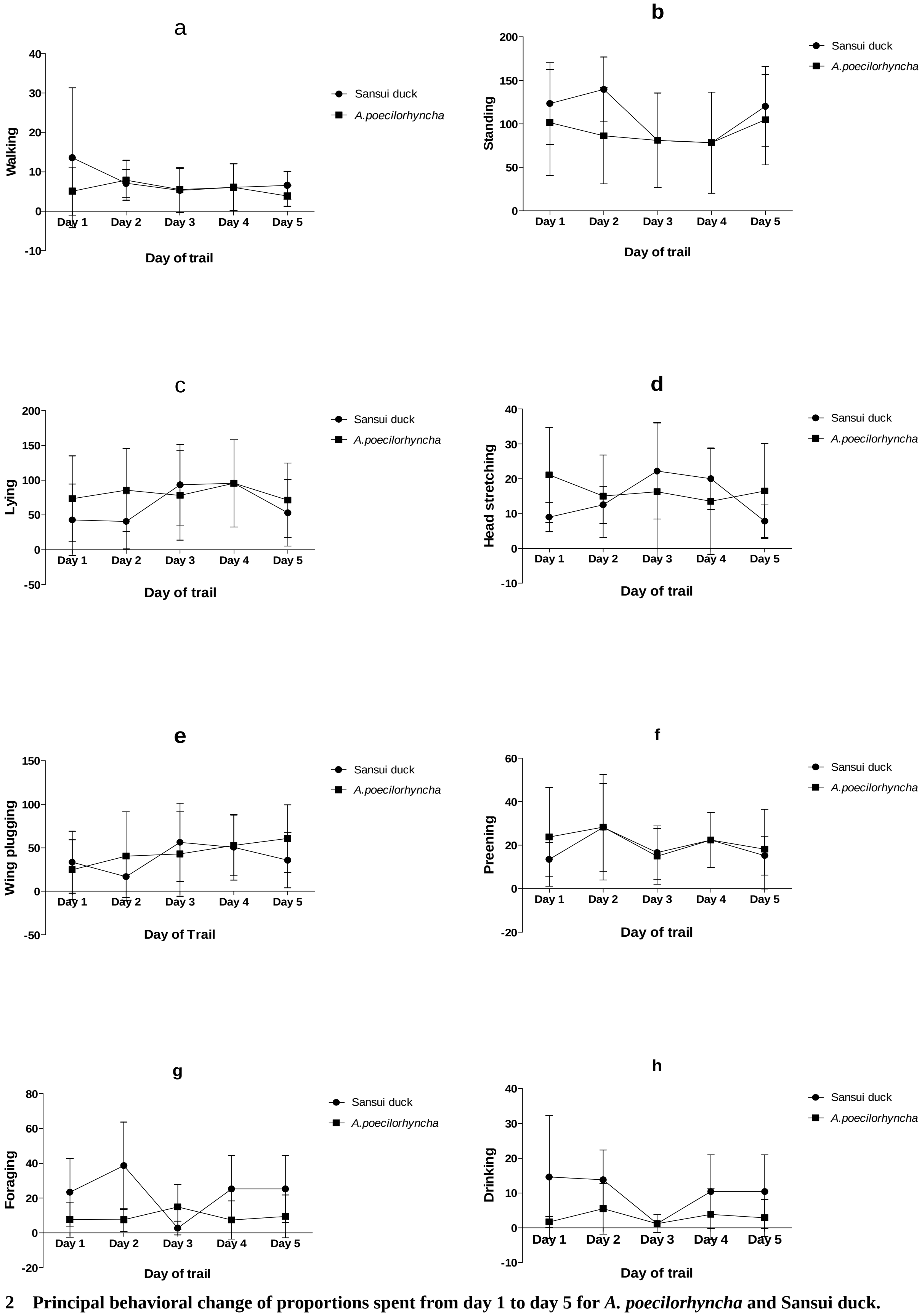

Fig. 2 Principal behavioral change of proportions spent from day 1 to day 5 for *A. poecilorhyncha* and Sansui duck.

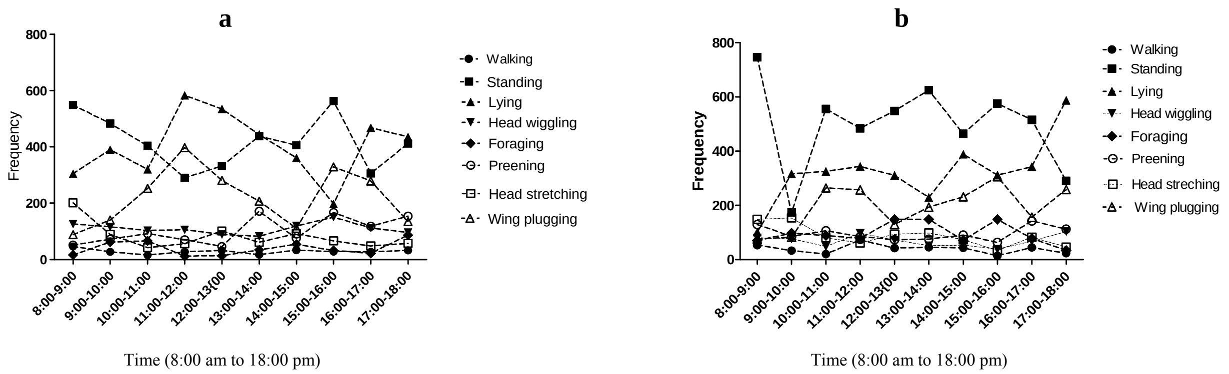

Fig. 3 The diurnal activities frequency of main behavior both in *A. poecilorhyncha* (a) and Sansui duck (b).

duck was three, suggesting that running activity does not require standing as a preparatory activity.

From Tables 5 and 6, the frequency for head wiggling converted to preening was 273 in spot-billed duck, but 132 in Sansui duck. The frequency of head wiggling transited to head stretching in spot-billed was 266, but 150 in Sansui duck. Frequency conversion from foraging to head stretching was 127 in spot-billed duck, but 472 in domestic duck. This may be explained that domestic duck has more comfortable time than wild duck after foraging. Transition from forging to dinking for spot-billed dick was 65, but 515 in domestic duck, which means that domestic duck needs much more time to drink than wild duck after foraging. It may be concluded that wild duck has stronger ability to adapt natural environment than domestic duck.

The transition values can be compared for small percentage of behavior. The transition frequency between foraging and head wiggling was 63 to 69 in spot-billed duck, but 167 to 217 in Sansui duck. The transition frequency between preening to head stretching was 66 to 91, while 94 to 95 in Sansui duck. Drinking to head stretching was 75 to 82, but 240 to 247 in Sansui duck. Drinking to head wiggling was 65 to 86, but 125 to 143 in Sansui duck. The larger differences of frequencies transition could be observed between spot-billed duck and Sansui duck. The other transitions concerning nodding and clawing, aggression and clawing, foraging and nodding, etc., could not be found both in spot-billed duck and Sansui duck. About some specific behaviors, such as paddling and aggression, a few of transitions occurred due to their smaller percentage of activities in this study.

3.3 Correlations of Behavioral Activities of A. poecilorhyncha

The Pearson correlation analysis in *A. poecilorhyncha* was listed in Table 7. It showed that drinking and alerting, aggression and clawing, paddling and aggression, aggression and wing dithering, paddling and wing dithering were significant correlative (R = 0.981, P < 0.01; R = 0.917, P < 0.01; R = 0.913, P < 0.05; R = 0.942, P < 0.05; R = 0.975, P < 0.01). Conversely, lying and standing, nodding and lying, tail wagging and nodding were significant negative correlation (R = -0.996, P < 0.01; R = -0.895, P < 0.01; R = -0.925, P < 0.01).

3.4 The Diurnal Activities of A. poecilorhyncha and Sansui Duck

Fig. 3 showed that the eight main behaviors of *A. poecilorhyncha* were included from the time 8:00 am to 18:00 pm, and the highest frequencies for standing achieved 563 at 15:00 to 16:00 pm, while the lowest was 290 at 11:00 to 12:00 am. However, the standing peak for Sansui duck at 8:00 to 9:00 am with a frequency value of 746, and the lowest value was 173 at 9:00 to 10:00 am. The activity lying peak for wild duck was at 11:00 to 12:00 am with the total frequency 583, and the lowest frequency was 198 at 15:00 to

Table 3 Lag sequential analysis of *A. poecilorhyncha* (group I).

Behavior	Walking	Running	Flying	Circling	Standing with two legs	Standing with one leg	Lying	Y_0
Walking	29	2	2	0	1,724	64	36	1
Running	3	0	0	0	0	0	0	0
Flying	0	0	0	0	2	0	0	0
Circling	0	0	0	0	1	0	1	0
Standing with two legs	1,710	0	0	0	2,599	536	292	12
Standing with one leg	65	0	0	2	512	605	241	2
Lying	49	0	0	0	296	220	3,669	5
X_0	0	0	0	0	15	0	0	0

X_0 refers to transitions where a target activity has been identified, but the criterion activity is not found. Y_0 refers to transitions where no target activity is found.

Table 4 Lag sequential analysis for Sansui duck (group I).

Behavior	Walking	Running	Standing with two legs	Standing with one leg	Lying	Y_0
Walking	16	8	3,758	35	61	0
Running	14	0	0	0	0	0
Standing with two legs	3,715	3	5,147	434	317	18
Standing with one leg	41	0	399	232	93	0
Lying	92	3	318	64	1,910	2
X_0	0	0	12	0	8	0

X_0 refers to transitions where a target activity has been identified but the criterion is not found. Y_0 refers to transitions where no target activity is found.

Table 5 Lag sequential analysis of *A. poecilorhyncha* (group II).

Behavior	Head wiggling	Forging	Preening	Alerting	Clawing	Aggression	Nodding	Head dithering	Head stretching	Wing plugging	Drinking	Paddling	Y_0
Head wiggling	216	63	273	6	20	6	0	3	266	115	65	0	2
Forging	69	97	26	1	10	6	1	0	127	5	65	0	0
Preening	254	27	171	0	28	0	1	1	91	29	42	0	4
Alerting	7	2	2	3	0	0	0	0	12	0	0	0	0
Clawing	34	10	23	0	4	0	0	7	19	4	12	0	0
Aggression	10	3	0	1	0	0	0	0	7	0	3	0	0
Nodding	3	0	0	0	0	0	0	0	6	2	0	0	0
Head dithering	3	0	1	0	1	0	0	0	49	0	0	0	0
Head stretching	267	139	66	14	29	10	6	41	315	8	76	1	5
Wing plugging	142	7	38	0	4	0	2	0	19	1,763	3	0	3
Drinking	86	37	33	2	25	4	0	0	82	0	23	0	1
Paddling	0	0	0	0	0	0	0	1	2	0	1	0	0
X_0	1	0	1	0	0	0	0	0	0	0	0	0	0

X_0 refers to transitions where a target activity has been identified but the criterion is not found; Y_0 refers to transitions where no target activity is found.

Table 6 Lag sequential analysis of Sansui duck (group II).

Behavior	Head wiggling	Forging	Preening	Clawing	Aggression	Nodding	Head dithering	Head stretching	Wing Plugging	Drinking	Paddling	Y_0
Head wiggling	55	167	132	3	0	5	1	150	42	125	6	0
Forging	217	614	61	17	8	0	0	472	45	515	1	5
Preening	112	77	131	36	0	1	0	95	33	23	0	2
Clawing	26	31	3	0	0	0	10	12	0	29	0	0
Aggression	0	5	0	0	0	0	0	3	1	1	0	0
Nodding	0	0	0	0	0	2	0	2	2	4	0	0
Head dithering	6	3	13	0	0	0	0	19	0	8	3	0
Head Stretching	151	520	94	11	0	0	20	547	29	240	7	2
Wing plugging	41	52	43	0	0	0	0	49	1,020	21	0	0
Drinking	143	396	35	27	5	1	6	247	23	133	40	2
Paddling	7	2	0	0	0	0	0	27	3	33	0	0
X_0	0	0	0	0	0	0	0	17	0	1	0	0

X_0 refers to transitions where a target activity has been identified but the criterion is not found; Y_0 refers to transitions where no target activity is found.

Table 7 Correlations for frequencies of behavioral activities of *A. poecilorhyncha*.

Behavior	Walking	Standing	Lying	H. Wig	Foraging	Preening	Alerting	Clawing	Aggression	Nodding	H. str	W. pl	Drinking	Padding	W. dit	T. weg	P. claw	Defec
Walking	1																	
Standing	-0.634	1																
Lying	0.566	-0.996**	1															
H. wig	0.679	-0.603	0.573	1														
Foraging	-0.123	0.651	-0.687	-0.537	1													
Preening	0.780	-0.079	-0.004	0.375	0.486	1												
Alerting	0.707	-0.182	0.112	-0.002	0.517	0.832	1											
Clawing	0.128	-0.167	0.157	0.004	0.465	0.356	0.346	1										
Aggression	0.415	-0.495	0.475	0.140	0.264	0.432	0.532	0.917*	1									
Nodding	-0.806	0.921*	-0.895**	-0.846	0.573	-0.347	-0.24	-0.17	-0.456	1								
H. str	-0.297	0.466	-0.457	0.331	-0.124	-0.122	-0.62	-0.33	-0.593	0.209	1							
W. pl	-0.351	-0.200	0.252	-0.499	-0.408	-0.708	-0.23	-0.413	-0.243	0.161	-0.50	1						
Drinking	0.710	-0.238	0.171	-0.031	0.404	0.746	0.981**	0.197	0.436	-0.262	-0.684	-0.066	1					
Padding	0.182	-0.565	0.576	-0.053	0.066	0.060	0.321	0.799	0.913*	-0.375	-0.728	0.145	0.278	1				
W. dit	0.186	-0.419	0.484	-0.152	0.282	0.195	0.455	0.059	0.942*	-0.258	0.883	0.045	0.391	0.975*	1			
T. weg	0.856	-0.776	0.732	0.804	-0.238	0.607	0.447	0.456	0.666	-0.925*	-0.211	-0.446	0.394	0.469	0.422	1		
P. claw	-0.043	-0.035	0.038	0.110	0.377	0.224	0.048	0.932*	0.745	-0.102	0.012	-0.552	-0.127	0.612	0.656	0.376	1	
Defec	-0.260	0.070	-0.040	0.521	-0.465	-0.322	-0.786	-0.186	-0.373	-0.102	0.875	-0.356	-0.838	-0.408	-0.515	0.021	0.167	1

H. wig = heading wiggling; H. str = head stretching; W. pl = wing plugging; W. dit = wing dithering; T. weg = tail wegging; P. claw = pendulum clawing; Defec: defecating.

16:00 pm. While, the lying peak for Sansui duck was at 17:00 to 18:00 pm with the value of 587, and the lowest value was 101 at 8:00 to 9:00 am. The walking peak for wild duck at 16:00 to 17:00 pm with frequency value of 118, and the lowest value was 27 at 9:00 to 10:00 am. In Sansui duck, the walking peak at 11:00 to 12:00 am with the value of 72, while the lowest value was 14 at 15:00 to 16:00 pm. There were larger differences between *A. poecilorhyncha* and Sansui duck. The wing plugging for wild duck peak at 11:00 to 12:00 am with the value of 398, and the lowest value was 88 at 8:00 to 9:00 am, but the largest 305 in Sansui duck at 15:00 to 16:00 pm and the smallest value was 76 at 8:00 to 9:00 am. The foraging for wild duck peak at 17:00 to 18:00 pm with the frequency value of 87 and the smallest value was 16 at 8:00 to 9:00 am. However, there were three peaks of foraging for Sansui duck at 12:00 am to 13:00 pm, 13:00 to 14:00 pm and 15:00 to 16:00 pm with the value of 148. The comfortable behavior preening peak for wild duck was at 13:00 to 14:00 pm with the value of 171 and the lowest point was 46 at 12:00 am to 13:00 pm; while 142 at 16:00 to 17:00 pm for Sansui duck and the lowest 63 at 15:00 to 16:00 pm. In total, there were large differences between spot-billed duck and domestic duck when comparing the eight behavioral peaks (Fig. 3).

4. Discussion

4.1 Behavioral Percentages, Changes and Peaks for A. poecilorhyncha and Sansui Duck

Behavior is the well expression of animals to the environment change [17], and to understand animal ethogram can help people to know evolution history between two kinds of animals. It is necessary for people to understand animal behaviors, because it can provide ideas to make effective methods to protect and utilize them [18]. In the current study, the principal behavioral types spent between spot-billed duck and Sansui duck were similar, but percentages were not identical. A total of 21 types of behaviors for *A. poecilorhyncha* and 19 sorts of behaviors were coded and defined using the continuous and instantaneous observation methods [19-21]. The principal behavioral change both of *A. poecilorhyncha* and Sansui ducks was determined from day 1 to day 5 in this study. The frequency of mainly behavior, standing spent for *A. poecilorhyncha* was stable (Fig. 2b), the other behaviors were relatively unstable. There are a large number of reports related to genetic structure and growth performance of mallards comparing with other domestic ducks [22, 23]. However, a few of reports concerning the behavior of mallards could be found. It is difficult to compare with the other papers which refer to behavior of *A. poecilorhyncha*, although the report in this study is primary.

The behavioral peaks spent among eight main behaviors both for *A. poecilorhyncha* and Sansui ducks were compared. Results showed the differences between spot-billed duck and Sansui laying duck. Some rules can be found by use of study on behavioral rhythm, for instance, the preening peak at 13:00 to 14:00 pm and 15:00 to 16:00 pm for *A. poecilorhyncha*, and the forging peak at 12:00 am to 13:00 pm both for *A. poecilorhyncha* and Sansui duck. This can be explained by the fact that they have two different origins and different genetic structures [18, 22]. Additionally, behavior is the complicated trait which is controlled by genes. So, animals displaying their behavioral performance at different time duration can be understood.

4.2 Behavioral Transition Frequencies through Lag Sequential Analysis

Lag sequential analysis has been widely used for studies in psychology, neurology, business and education [24-26]. Although papers concerning human behaviors in medical science or management behaviors in business can be found in many sorts of journals, up to now, no reports in relevant to animal behavior using lay sequential analysis could be found. In the present study, lag sequential analysis was used to calculate frequency of transition between a pair of activities calling criterion and target (Fig. 3). Some parameters were very significant, like the frequency value from foraging converted to drinking in Sansui duck was 369-515, but 37-65 in spot-billed duck. The best explaining could be that Sansui duck was better domesticated than spot-billed duck. Domestic duck need much time to drink after foraging, but mallard could adapt to natural environment better than domestic duck. Another parameter, 36-49 from walking to lying in spot-billed duck, but 61-92 in Sansui duck, suggested that domestic duck had more percentages of comfortable behaviors than that of mallard, particularly, when they were caged in the environment of artificial rearing. This study provided an idea to study animal behavioral conversion using lag sequential analysis and to annotate how often the target behavior occurs or to predict what activity will happen.

In the current study, behaviors of spot-billed duck and Sansui duck were tracked with Media Record and The Observer XT 11.5 in captivity conditions. Compared with the method of observation by eyes, The Observer XT is more scientific and reliability. It may avoid the impact of human disturbance to investigate behavioral rule, time distribution and their correlation, to compare with the data from domestic ducks and to find the specific behavior and give the definition. This research is also the beginning of conducting the research of behavior ecology in spot-billed duck. This study provides the basic data to study and develop spot-billed duck.

5. Conclusions

This research has showed that there were similar behavioral percentages between *A. poecilorhyncha* and domestic duck through behavioural comparison. However, large differences between *A. poecilorhyncha* and domestic duck could be detected when comparing the eight behavioral peaks. An available explaining could be that Sansui duck was better domesticated than spot-billed duck.

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References

[1] Chen, Y. X., Zhao, Y., Lu, L. J., and Lai, Y. Z. 1999. "Comparative Study of Mitochondrial DNA Restriction Maps of Genus *Anas* Ducks in Fujian Province." *J. Xiamen Univ. (Natural Science)* 38 (1): 108-11. (in Chinese)

[2] Chen, Y. X., and Zuo, Z. H. 2001. "Study on Genetic Relationship and Diversity in Ducks by RAPD." *J. Xiamen Univ. (Natural Science)* 40 (1): 141-2. (in Chinese)

[3] Qiu, X. P. 1989. *China Chicken Breeds Collection.* Shanghai, China: Scientific and Technical Publishers. (in Chinese)

[4] Chang, H. 1995. *Conspectus of Genetic Resources of Livestock.* Beijing, China: Chinese Agriculture Press. (in Chinese)

[5] Kulikova, I. V., Chelomina, G. N., and Zhuravlev, Y. N. 2003. "Low Genetic Differentiation of and Close Evolutionary Relationships between *Anas platyrhynchos* and *Anas poecilorhyncha*: RAPD-PCR Evidence." *Russian J. Genet*. 39 (10): 1143-51.

[6] Hu, R. Q., Fan, Y. F., Li, Y. Q., Ma, J. S., Wang, L. M., and Cen, S. J. 2010. "Study on Laying Rhythm in *Anas poecilorhyncha*." *Zhejiang Anim. Vet. Sci*. 2: 3-4. (in Chinese)

[7] Liu, J. W., Chen, H. C., Pan, D., Deng, X. B., Zheng, S. X., and Huang, L. B. 1995. "The Comparative Anatomy of the Pancreas Lobs and Ducts of 11 Sorts of Mallards." *Acta Anatomica Sinica* 26 (3): 240-60. (in Chinese)

[8] Du, W. D., Li, Y. Q., Fan, Y. F., Hu, S. Q., Luo, S. Q., Seng, J. D., Lu, L. Z., and Tao, Z. R. 2006. "Study on Effects of Artificial Domesticating of *Anas poecilorhyncha*." *Zhejiang Anim. Vet. Sci.* 6: 25-6. (in Chinese)

[9] Zhou, W. L., Zhang, C. L., Pan, T., Yan, L. H., Hu, C. C., Xue, C., Chang, Q., and Zhang, B. W. 2015. "The Complete Mitochondrial Genome of *Anas poecilorhyncha* (Anatidae: *Anas*)." *Mitochondrial DNA* 26 (2): 265-6.

[10] Lavretsky, P., McCracken, K. G., and Peters, J. L. 2014. "Phylogenetics of a Recent Radiation in the Mallards and Allies (Ayes: *Anas*): Inferences from a Genomic Transect and the Multispecies Coalescent." *Mol. Phyloge. Evol.* 70: 402-11.

[11] Brown, J. L. 1976. *The Evolution of Behavior.* New York: Norton Press.

[12] Lehner, P. N. 1996. *Handbook of Ethological Methods.* New York: Cambridge University Press.

[13] Martin, P., and Bateson, P. 1993. *Measuring Behavior: An Introductory Guide.* Cambridge: Cambridge University Press.

[14] Zhao, X. M., Ma, M., Zhang, T., and Zhang, J. B. 2013. "Behavioral Time Budget and Diurnal Rhythm of White-Headed Duck in Northwest China." *Chinese Journal of Ecology* 32 (9): 2439-43.

[15] Feng, S. M., and Zhang, A. J. 2000. "Behavioral Ecology of Black-Necked Crane during Winter at Caohai, Guizhou, China." *Acta Ecol. Sinica* 20 (2): 293-8.

[16] Lu, X. 2004. "Anti-predation Vigilance of Individual Tibetan Eared Pheasants Temporarily Separated from the Flocks." *Acta Zoologica Sinica* 50 (1): 32-6.

[17] Jiang, Z. G. 2000. "Behavior Coding and Ethogram of the Pere David's Deer." *Acta Theriologica Sinica* 20 (1): 1-12.

[18] Tian, J. D., Wang, Z. L, Lu, J. Q., Guo, X. B., and Liu, J. D. 2011. "PAE Coding System-Based Ethogram of Taihangshan Macaque (*Macaca mulatta tcheliensis*), Jiyuan, Henan Province, China." *Acta Theriologica Sinica* 31 (2): 125-40.

[19] Lan, T. M., Tian, Y. P., Hu, X. N., Wang, Y. L., Jing, P., Fan, M., Zou, Q., and Liu, W. S. 2012. "Comparison between Focal-Animal Sampling and Scan Sampling for Behavioral Observation of Black Bear in Captivity." *J. Econ. Anim*. 16 (2): 95-100.

[20] Zhang, J., Chu, H. J., and Zhong, S. L. 2003. "Observation on Behavior of Mandrill (*Mandrillus sphinx*) in Captive." *Sichuan J. Zool*. 22 (2): 69-72. (in Chinese)

[21] Teng, L. W., Li, F., and Liu, Z. S. 2002. "Behavior Observation of Amur Tiger (*Panthera tigris altaica*) in Captivity." *Journal of Forestry Research* 13 (3): 241-4.

[22] Avise, J. C., Ankney, C. D., and Nelson, W. S. 1990. "Mitochondrial Gene Trees and the Evolutionary Relationship of Mallard and Black Ducks." *Evolution* 44 (4): 1109-19.

[23] Hou, Z. C., Yang, F. X., Qu, L. J., Zheng, J. X., Brun, J. M., Basso, B., Pitel, F., Yang, N., and Xu, G. Y. 2012. "Genetic Structure of Eurasian and North American Mallard Ducks Based on mtDNA Data." *Animal Genetics* 43 (3): 352-5.

[24] Ianiro, P. M., Lehmann-Willenbrock, N., and Kauffeld, S. 2015. "Coaches and Clients in Action: A Sequential Analysis of Interpersonal Coach and Client Behavior." *J. Bus. Psychol.* 30 (3): 435-56.

[25] Rick, D., Warlaumont, A., and Richardson, D. 2011. "Nominal Cross Recurrence as a Generalized Lag Sequential Analysis for Behavioral Streams." *International Journal of Bifurcation and Chaos* 21 (4): 1153-61.

[26] Hou, H. T., Chang, K. E., and Sung, Y. T. 2010. "Applying Lag Sequential Analysis to Detect Visual Behavioural Patterns of Online Learning Activities." *British Journal of Educational Technology* 41 (2): 25-7.