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NOTES ON BEHAVIOR OF THE GRIFFON VULTURES (*GYPS FULVUS*) DURING RECOVERY OF THE SPECIES IN KRESNA GORGE AND KOTLENSKA PLANINA

VENCESLAV DELOV

Department of Zoology and anthropology, Faculty of Biology, Sofia University "St. Kliment Ohridski", 8 Dragan Tzankov str., 1421 Sofia, Bulgaria
**Corresponding author: vencidelov@abv.bg*

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Abstract: Restoring populations of Griffon Vulture in Bulgaria is a complex process, which includes importing of birds from Spain. They are later released in the Kotlenska Planina (near the town of Kotel) and in Kresna Gorge. The birds were preliminary hold in aviary, then released into the wild. The data on bird's behavior was collected by direct observations and by analyzing videotapes. The method used is free description of the behavior "*ad libitum*". In the present work are described mainly forms of social and agonistic behavior from interspecific and intraspecific points of view, nesting behavior, incubation behavior. Specific behavioral strategies were analyzed - associated with feeding behavior and diurnal activity.

INTRODUCTION

Griffon vultures are cliff-nesting raptors and are the most social raptors in Europe, because they breed colonially and feed gregariously in large groups. Their species-specific communication system for exchange of information between individuals and groups is based on simultaneously watching each other's behaviour. It optimises food finding species strategy. Another highly social European raptors that breed colonially such as Lesser kestrel *Falco naumanni* and Montagu's harrier *Circus pygargus* are not so social in searching of food as griffons are. This social lifestyle is regarded as an indirect consequence of their clumped and irregular food supply (Houston, 1979; Donázar, 1993). As they are almost exclusively scavengers they have to compete with time, another birds and mammalian competitors. The vultures forage predominately over open areas with rocks. Their cooperation and information exchange are important in order to forage successfully. The

birds modify their foraging behaviour according to the spatial and temporal distribution of the animal carcases.

Foraging techniques and foraging time budget are dependent of seasonal food availability and population density. The intra-specific competition is important factor for population regulation (Sillett et al., 2004; Dobbs et al., 2007; Bosé and Sarazzin 2007; Hutto 1990; Lovette, Holmes 1995, Hiraldo and Donázar, 1990.

Reintroductions of Griffon Vultures have been implemented in several European countries. Moreover, almost everywhere in the species range is practiced to support populations by artificial feeding. All this makes the species especially appropriate for behavioral research. Summary data on the behavior of species, including a catalog of behavior and the description of the basic species adaptive strategies is represented by Glutz Von Blotzheim *et al*., (1971); Cramp and Simmons (1980). Intraspecific competitive behaviours in relation to understand the potential consequences of food management on competition were studied in a reintroduced population of Griffon Vultures by M. Bose and F. Sarrazin (2007). GPS satellite telemetry was used to assess the home-ranges of non-breeding Eurasian Griffon Vultures in Spain (García-Ripollés et al., 2011). Xirouchakis and Andreou (2009) studied the foraging behavior of Eurasian griffons on the island of Crete during 1997-2005 by direct observations in four colonies and by monitoring the movements of seven radio-equipped individuals.

Despite longstanding protection and maintenance of Griffon vulture in Bulgaria, as well as new activities for the reintroduction of the species in some of its traditional localities in the past, specialized studies on behavior in Bulgaria at the time were not performed. At present, the situation related to the reintroduction of the species is represented in several articles and annual reports (Stoynov and Peshev, 2011; 2012; 2013, Stoynov *et al*., 2011; 2013; 2014; 2015). Stoynov et al. (2014) also commented some related topics as the human-predator conflict in the area, which directly influenced the prosperity of the Griffon vultures.

The reintroduction activities for the Griffon Vulture (*Gyps fulvus*) began in 2010 and the following establishment of a vulture feeding stations occur in Kresna Gorge and Kotlenska Planina – near the town of Kotel.

For the restoration of griffon vulture in the region of Kresna Gorge and Kotlenska Planina were used immature birds imported mainly from Spain. Birds spend adaptation period in the aviary in the area and then are released.

After the release in the most general two categories of birds are formed. The first category brings together individuals with high adaptability of behavior. This are successful individuals who quickly acquire the necessary skills to use the resources available in the region - the platform for eating, opening places for roosting, effective use of low air flow in the area. The other category are birds with low adaptive behavior. They difficult learning new habits necessary for survival. A major problem is that they are not capable to learn to use platform for eating, so exhausted and if special measures are not taken they perish. Naturally

between these two extreme categories there are intermediate ones. They are not subject to detailed analysis in this work because of difficulties in finding connections between behavior during different phases of the recovery process and the effectiveness of behavioral adaptation to the individual level. Intermediate categories of birds is expected to be analyzed at a later stage, after a preliminary study analyzing the working hypotheses and research questions with the help of statistical methods.

Aims

The purpose of this work is to make a preliminary behavioral analysis of based on free description of behavior and expert assessment in the light of conservation ethology of the species, by seeking links between the effectiveness of behavioral adaptation and specific behavior in different stages of the recovery process at individual level. Categories of behavior were used, that suggests at expert level that they have predictive value in terms of the success of behavioral adaptation of birds in the recovery process. An important aspect in this regard is the formation of research questions and hypotheses in the field of conservation ethology for more detailed follow-up analysis.

METHODS

In this study functional classification of behavior was used, according Dewsbury (1985). The behavior is divided into individual, social and reproductive in intraspecific aspect. As a independent category is differentiated behavior in relation to other species. Here as an object of analysis are mostly antagonistic relationships.

Bird's behavior is described by the method of free description of the behavior "*ad libitum*". Data are collected on the basis of immediate observation and description of behavior, and behavioral analysis of the behavior of photos and videos. The analyses were carried out at expert level and are based on Animal psychology approach. The approach was used to analyze the consequences of the behavior. The description of the behavior itself is not the subject of this work.

RESULTS AND DISCUSSION

The results of this work have a value of preliminary experiment, in accordance with the concept of Tinbergen (1963). It will serve as a basis for forming research questions and working hypotheses for more detailed analysis of the behavior, including appropriate statistical analysis. In this study are analyzed only well differentiated visible categories of behavior.

Behavior before releasing in the wild

Individual behavior

Each of the below described forms of individual behavior show its final and intermediate categories. Object for description and analysis are only the final behavioral categories.

1. Behavior during transportation of the vultures

The birds are transported in transport chests. When transporting the two categories of birds are formed. One category are birds is with a strong reflex for freedom, which is intensively trying to leave the chest and the other category are birds with low intensive reflex for freedom. They are kept relatively quiet. On the basis of an expert assessment, the birds from the first category with a low threshold at the reflex are more successful individuals for the recovery in nature. They are easier to adapt in terms of nutrition and easier learning necessary skills to use the nutrition site.

2. Behaviour during the release from the transport box

Upon the releasation two categories of birds are formed - birds that immediately leave the chest and birds that do not leave immediately or they unwilling to leave. Part of the second category includes birds that are oriented with head at the opposite direction in the terms of output. They try to get out in the wrong direction in terms of the actual output. These two main categories of birds correspond to the categories of items 1.

3. Behavior after the releasing in the aviary

We can distinguish two clearly differentiated categories of individuals. The first category includes birds with low threshold levels of anxiety response and good level of orientation behavior. They depart immediately while trying to leave the aviary showing strong reflex of freedom. The other category combines the birds that away slowly from the humans - usually by walking. Some individuals in this category exhibit quite prolonged orientation response before to perform motor activity. These two main categories of birds correspond to the categories of items 1 and 2.

4. Motor behavior in the aviary and reflex for freedom

Motor behavior in the aviary originally is motivated by the desire of birds to leave the enclosure. It is manifested by motion and flying activity varying in degrees and intensity. The behavior represents overflights and landing on perches, hunging on the walls and ceiling of the aviary by trapping with the legs on the net. In this case are also are formed two diferent categories of birds the individuals with high and low intensity of the reflex of freedom. These two main categories of birds correspond to the categories of items 1, 2 and 3.

5. Defensive behavior - defensive reaction to the man

Fears response to human is expressed in motion activity similar to the reflex of freedom and grouping of birds at the opposite end of the aviary in terms of man.

The reaction weakens during the halituation. The habituation is strongly influenced by the emulation element of behavior. The presence of already accustomed or inprinted to human birds in the aviary, greatly helps to accelerate habituation to humans of the newly-arrived vultures. The differentiateion between categories in this behavior are largely influenced by the specific individual experience, which is why there is no clear boundary between them.

6. Feeding behavior

Nutrition and feading behavior are a key element in the process of re-acclimatization. Like the previous category, feading behavior is largely influenced by the emulation element of behavior. If there are already accustomed group of birds in the aviary, feeding can begin immidiately, while in the absence of such birds, the first sign of feeding behavior could be deferred by approximately 10 days of accommodation in the aviary. Feading behavior has pronounced social aspects that will be described in social behavior section.

7. Roosting behavior

The roost at griffons is associated with a certain posture and exact place. In this species the roosting behavior perform specific social patterns that will be addressed in the social behavior part.

Social behavior

1. Social interactions during feeding

Foraging behaviour and feeding food searching techniques in relation to the habitat and breeding strategies have been described by Houston (1974); Pennycuick (1972, 1983, 1989); Prinzinger et al. (2002); Ruxton and Houston (2002); Bögel (1999), König (1974), Bahat and Kaplan (1995).

During feeding in the aviary prevail agonistic interactions including threats and skirmishes. The hierarchy is as situational dominance correlated with motivation level at the particular individual. It is slightly influenced by the age group and gender of the individuals.

2. Social aspects of Roosting

The griffons congregate in communal roosts where they probably very important to exchange information on good feeding grounds (Ward and Zahari, 1973). According our observations the collective roosting behaviour structure is predominated by cohesive behaviour and agonistic interactions. During the preparation for spending the night, often was seen competition between birds to appropriate roosting place. Agonistic interactions lead to apparent differentiation of fully subordinated individuals who can not win their place. The rank of these individuals is unstable and situational. In various nights hierarchical status of the same individual may vary from complete domination to complete submission at constant composition of the individuals in the group.

Behavior after the releasing in the wild

Individual behavior

1. Motor behavior

In releasing the birds stay in the area, as usually spend some time perched on the aviary. During this period it is especially important the effective utilization of flight corridors to natural substrates suitable for recreation, roosting and nesting. In this connection, it is especially important for the effective use of air thermals. Non-adaptive behavior in this respect is causing loss of height, landing at inappropriate and dangerous substrates - for example, electric poles, ineffective diets and weight loss. Ultimately, this can lead to exhaustion and death of individuals. For these individuals sometimes are needed special rescue actions.

2. Defensive behavior.

The species is with long standing cohabitation with man in Europe as it is depending on livestock carcasses for thousands of years. In a group of young birds was seen vomiting of food ingested, resulting in fear of approaching people. This is an adaptive response to weight reduction and restoration of the ability to fly. Later a young bird with a high threshold of fear responses began to eat the vomit food. This behavior is obviously beneficial to the individual and is adaptive. High threshold levels of fear responses in some individuals give them an advantage in the use of food playground and recreation areas near the aviary. Habituation to humans, however, is associated with a specific place - in this case the aviary. The process of generalization probably are not so strong to severe as elsewhere the same individuals showed low threshold levels of fear in terms of human, similar to those in wild birds, unaccustomed to human subjects.

4. Migratory behavior

In the area of studies has both migratory and permanent populations. The population of the recovered birds is permanent. A case was observed of joining of the recently released bird at natural conditions to a group of migrating vultures. This individual was permanently assigned to the migrating population. Vultures migrate singly or in different size groups within the species. mixed flocks with other soaring migrants were not observed. The final points of migratory route are not precisely defined. The birds remain to winter in various appropriate places acording to their judgment along the route.

Social behavior

1. Social behavior during feeding

Similar to the situation in the aviary conditions here are also prevailing the agonistic relations between individuals. It was found, however, that the vultures move the feeder at separate distinct groups. Within these groups the individuals probably know each other personally, based on common places for rest and sleep. Formed pairs of birds move together to the food site within the default group, as

during feeding have not been observed agonistic interactions between partners in the pair. Perhaps a couple of individuals are tolerant to each other in a competitive environment.

Reproductive behavior

1. Courtship

One of the clearly visible forms of courtship are synchronous marriage demonstration flights. Partners of the pair are flying synchronized at the same height. Other elements of courship behavior are dive flights accompanied with placing the legs. They were observed also and group demonstration flights in which the behavior of the pair initiated a similar behavior with other individuals. They join to the demonstration. In a group demonstration up to 5-6 participants were observed. During the incubation were observed courship flights of males with unpaired females, at a time when their female partner incubates.

2. Formation of the pair and maintaining the pair bond

The formation of the pair begins in many cases before the reaching of sexual maturity and the appearance of characteristic plumage of adult individuals. Couples are constant, the intensity of contacts between partners increases with the onset of the breeding season. It is possible that males to be banished from a stronger competitor that he takes female and nesting area - seen in one couple. A case was observed in which adult female in reproductive status and strong reproductive motivation for seeking a partner and nesting site, became a major faktor for formation and retention in the region of a group of vultures.

3. Copulation

Copulation in the species is stereotyped behavior occurring mainly between partners in the pair. For the species is characteristic tendency for extrapair copulations. Then some of the males and immature birds are entering in courship interactions with unpaired females. In zoo-garden conditions was observed a case of bigamy in presence of an adult single female in addition to a formed pair, graduated with a failed nesting of the additional female. Feeding of the female as a form of courtship was not observed. It is not known to the moment whether the main female partner in the couple also tends to extrapair copulation like the male.

3. Construction of the nest

The nest is built mainly by the male. Construction material is transferred with the beak. There are significant differences between different couples in terms of size and shape of the nest. Also, a couple was observed which did not build their oun nests and occupied already available nests of other bird species.

4. Incubation and care for young

Caring for the offspring is relatively evenly distributed between the partners, yet differences were observed in some couples. During incubation, the bird is located in the socket, heading towards the inside of the nesting niche. There is currently not enough data on the care for the young.

5. Relationships with other species

Relationships with other species are mostly agonist, resulting from competition for food resources, nesting niches and places for roosting.

Description of the competitive relationship with Raven and Golden Eagle in the Kresna Gorge is provided by Peshev et al. (2015). Most important is the relationship with Golden Eagle *Aquilla chrysaetos*, which may have a significant negative effect on the adaptation process of the vultures released. Golden Eagle is a highly territorial species which fully dominates in agonistic encounters with Griffon Vulture. Griffon Vultures have a strong fear reaction towards this species. It resembles the defensive reaction of the species - victims against their natural enemy. In young and inexperienced birds, the reaction can lead to loss of height during flight and they may fall in an unfavorable location, especially when the chasing happens before the night or in early morning. Golden Eagle avoids direct encounters with large groups of adult vultures at feeding. In some cases Griffon Vultures with a strong motivation can even win the clashes. There is an observation on the expulsion of a young Golden Eagle perched near the nest of brooding vultures, by the incubating female bird. The female Griffon Vulture left the nest and demonstrated threatening behavior. It ruffled plumage and spread its wings towards the Golden Eagle perched nearby forcing it to leave the place. As a result of this threatening behavior the Golden Eagle flew off.

Agonistic encounters with Ravens *Corvus corax* may hinder young and inexperienced birds during feeding, initial attempts at nesting and roosting. The negative impact of Ravens is reduced with the age and by the accumulation of individual experience in young vultures.

Griffon Vultures usually dominate Egyptian Vulture *Neophron percnopterus* in competition for food. When Griffon Vultures are young and inexperienced, it is however possible for Egyptian Vultures to dominate. Domination of Egyptian Vulture over young Griffon Vultures during the feeding has been reported. The situation changed in favor of Griffon Vultures with advancing of the age of the young birds. Unlike Golden Eagle, Eurasian Black Vulture *Aegypios monachus* is not perceived as a natural enemy, but as a member of the group. Because of its size it dominates in direct confrontations over the Griffon Vultures. The opinion of experts who deal with supplementary feeding of vultures is that Eurasian Black Vulture is the only dignified competitor of Golden Eagle in direct clashes around the carcass. The outcome of the clash depends on the individual characteristics of the birds. Agonistic relationships between Peregrine Falcon *Falco peregrinus* and Griffon Vultures have been observed in flight when vultures are passing falcon breeding territories. According to Peshev, et all (2015), Peregrine falcon displays high aggression against Ravens. It therefore reduces the pressure of Ravens on Griffon Vulture and favors the reintroduction of the species. Unlike Peregrine Falcon, Lanner Falcon *Falco biarmicus* (Feldegg‘s falcon *Falco*

biarmicus feldeggi), which appeared in the region of Kresna Gorge and took a nesting territory, showed great tolerance to Griffon Vultures and even perceived their presence as a positive factor. However, general conclusions of this species cannot be made because the observations are just over one female that occupied a territory but failed to form a pair and raise offspring in the area.

The following birds of prey were identified also in the region:

Buzzard *Buteo buteo*, Long-legged Buzzard *Buteo rufinus*, Black Kite *Milvus migrans*, Goshawk *Accipiter gentilis*, Sparrowhawk *Accipiter nisus*, Levant Sparrowhawk *Accipiter brevipes*, harriers, Imperial Eagle *Aqullla heliaca*, Booted Eagle *Hierraetus pennatus* , Short-toed Eagle *Circaetus gallicus* and Lesser Spotted Eagle *Aquilla pomarina*. No interactions were observed between these species and the Griffons. It is interesting to note that the Imperial eagle has used the same feeding place as the Griffons. As opposed to Golden Eagle, Imperial Eagle did not cause defensive reaction. This is an interesting fact, taking into account the significant morphological similarity between Golden and Imperial eagles. Griffon vultures are probably capable of very precise differentiation and assessment of their natural enemies and competitors.

There is not enough information on the interactions with carnivores.

Guidelines for behavior management of the Griffons

The behavior of the species and its competitors can successfully be managed through the use of dummies. Experimental application of **artificial plastic dummies of Griffon Vultures** placed on suitable rocks attracts the birds. At the same time the dummies have a habitational and repellent effect on Golden Eagle, which after repeated unsuccessful attacks on them habituated to their presence and stoped attacking vultures or left the area.

Power lines have been proven to have a significant negative impact on the vultures released. Electrocution resulting from landing on electricity pylons proved to be a serious problem. We therefore recommend the development of a methodology for pre-release training of the vultures in the aviary before releasing them into the wild. This approach is enshrined in the Conservation ethology and has given good results in other species.

CONCLUSION

Based on the preliminary analyzes conducted in the present study we can say that conservation ethology seems to be a valuable tool assisting the reintroduction of Griffon Vultures. Griffon Vulture is a long-lived species with low productivity. This means that the single individual and its adaptive strategies are of great importance for the survival of the population of the entire species. The relationship between the different stages of the reintroduction process and the predictive importance of the early stages for the success of the release are valuable areas

for future studies. The terminal stages are representing the real reintroduction success. Conservation ethology methods may prove to be an important tool for planning specific individual activities for particular birds. They probably are a valuable tool for managing the behavior of the species through conservation methods of ethology.

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