

The “Sanitary” Role of the Necrophagous Birds in the Ecosystems

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Abstract. The objective of the research work was to study the "sanitary" role of necrophagous birds (*Gyps fulvus*, *Aegypius monachus*, *Gypaetus barbatus*, *Neophron percnopterus*) in the Azerbaijani part of the Lesser Caucasus. For this purpose, monitoring was conducted in the Korchay State Nature Reserve and adjacent territories in June 2013. During this period, we identified carcasses of animals that had died from various causes, including those carrying infectious diseases. In total, 28 carcasses of domestic (n=5) and wild (n=5) mammals were found. Among these, 13 carcasses were associated with six infectious diseases: rabies (five cases), toxoplasmosis (one case), brucellosis (two cases), equine adenitis (two cases), tuberculosis (one case), and canine disease (two cases). *Echinococcus* was identified in four animals. Notably, the number of sick animals included eight domestic and nine wild specimens. The primary causes of death for sick domestic animals were predation by mammals in pastures, old age, weakness, and hunger. Among wild animals, mortality was predominantly observed in young individuals, attributed to their inexperience and underdeveloped adaptive responses, which led them to venture into populated areas for food, making them vulnerable to hunting, traps, and transportation hazards.

Keywords: Ecosystem, necrophagous birds, animal carcasses, infectious diseases, Lesser Caucasus, Azerbaijan

1 Introduction

The Griffon Vulture (*Gyps fulvus* Hume, 1869), Cinereous Vulture (*Aegypius monachus* Linn., 1766), Egyptian Vulture (*Neophron percnopterus* Linn., 1758) and Lammergeier (*Gypaetus barbatus* Habl., 1783) have been studied for their "sanitary" role in ecosystems. These species belong to the Accipitridae family in the Falconiformes order. The Griffon Vulture, Cinereous Vulture and Lammergeier are mostly sedentary in Azerbaijan, remaining in the area throughout the year. In contrast, the Egyptian Vulture migrates to wintering grounds in September after the breeding season, making it a nesting-migratory species.

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These necrophagous birds (they feed on the corpses of dead animals) perform 3 main functions in natural ecosystems: [1]. Firstly, it provides the stability in the food chain as a consumer in the ecosystems. Secondly, they distribute the nutrients in and out of the ecosystems. Thirdly, they limit the spread of the diseases in the ecosystems as "sanitary" by eating the dead animal carcasses [2-4].

Let us consider an example related to the role of these necrophagous birds in ecosystems. In India, the use of the drug diflofenac in livestock farming has led to the mass death of these necrophagous birds (they die when they eat the carcass of an animal that has been injected with diflofenac). As a result, the number of stray dogs and rats, which carry rabies and leptospirosis, has increased, and the government has spent ten billion pounds sterling to prevent epizootics. [5].

It should be noted that the territory of Azerbaijan is one of the main habitats of these scavenger birds. During the monitoring we conducted in 2016, the distribution of 61 pairs of griffon vultures, 59 pairs of Egyptian vultures, 16 pairs of black vultures and 9 pairs of bearded vultures (145 pairs in total) was determined on the territory of our country. In Azerbaijan, the nesting sites of these scavenger birds are located in the Greater and Lesser Caucasus, as well as in the Talysh Mountains. [6-8].

These species search for food by flying both in their nesting areas and in areas 40-50 kilometers away from their nests. Thus, in these areas they find and eat the corpses of wild and domestic animals that have died for various reasons (death in river floods, falling from a cliff, getting caught in a trap, being hit by a vehicle, death from disease and weakness, dismemberment by predatory mammals, etc.), and bring them to the nest for their chicks. These birds also feed on the corpses of animals that their owners throw into dumps, streams, and rivers. Since these corpses are in most cases located in inaccessible, hidden places, they are not discovered and are not disposed of by veterinary and sanitary organizations. It should also be noted that the process of collecting corpses and disposing of them in accordance with the relevant rules and conditions requires a lot of labor, technical resources, and time. Animal carcasses that are not disposed of for the above reasons become a source of infectious diseases in natural and anthropogenic ecosystems. [9, 3, 10, 1].

That is why in the area of habitat of necrophagous birds, studying their health-improving role in ecosystems is also relevant. Based on the above, we studied the "sanitary" role of carrion-eating birds in the Korchai State Nature Reserve. For this purpose, we marked the corpses of dead animals in this area and determined the number of animals that are carriers of diseases. We also studied the duration of eating corpses by birds..

2 Materials and methods

The objects of the research are necrophagous birds and the corpses of dead animals they eat. The main research methods are observations and records in hospitals and on the route, as well as laboratory analysis of biomaterial. [11, 4].

2.1. The area where the research and bird count were carried out

Research work was carried out in 2013 in the Korchay State Nature Reserve (Korchay SNNR), located in the Goranboy district of the Republic of Azerbaijan. The area of the reserve is 4833.6 hectares. The absolute altitude of the reserve varies between 300-800 m. The highest peaks of the Lesser Caucasus - Gamishdag (3724 m), Murovdag (3340 m) and Kechaldag (2225 m) - are located on the Murovdag ridge, located in the south of the reserve. The diversity of natural conditions of the reserve is also manifested in the variability of the climate: thus, the climate of the foothill and mountain tundra zones of the reserve is characterized by relatively harsh winters and cool summers. The average temperature in

January rises from $-1.5\text{ }^{\circ}\text{C}$ to $-1\text{ }^{\circ}\text{C}$, in July from $22\text{ }^{\circ}\text{C}$ to $26.5\text{ }^{\circ}\text{C}$. The annual precipitation is 300-600 mm. The main rivers of the reserve and adjacent territories are Kurakchay, Goranchay and Korchay. The vegetation of the reserve territory is represented by mountain forests and wormwood-salt marsh, salt marsh-wormwood plant groups, as well as sparse tree-shrub plant complexes of river beds.

The colorful orography of the area where the research was conducted (mountain ranges, plateaus, plains, valleys, dips, river basins, phytocenoses, etc.) also influenced the richness of the species composition of animals and birds. The main purpose of creating the reserve is to preserve rare and endangered species of animals and birds of the natural landscape of Bozdag. The territory of the reserve, along with other bird species, is also one of the breeding and feeding sites for carrion birds such as griffon vulture, black vulture, Egyptian vulture, bearded vulture, which are included in the Red Book of Azerbaijan (2023, III edition). Nests of three pairs of vultures are located on the Bozdag ridge on the territory of the reserve. Nesting biotopes of the Egyptian vulture, bearded vulture, griffon vulture, black vulture are located in the territories of Gamishdag and Dalidag of Kelbajar region bordering the reserve. In 2020, nesting of 12 pairs of all four species was established. Also, in the area of the village of Dastafur in the Dashkesan district, bordering the reserve, nesting of six pairs of griffon vulture, Egyptian vulture and three pairs of black vulture was noted. It should be noted that these four species of scavenger birds that have settled in the territories bordering the reserve have trophic links with the reserve territory. That is, these scavenger birds regularly fly to the reserve territory to search for food.

2.2. The registration of the animal carcasses

The monitoring was conducted in June during the breeding season of wild animals. Since newborns and young animals do not adapt to the environment at the proper level during this period, they die more often. The food needs of carrion-eating birds also increase during this period. Thus, parent birds intensively search for food due to feeding their chicks in the nest for 2-3 months. In order to easily detect the carcasses of animals eaten by these birds, we tracked their search for food (Figure 1). That is, the landing of a bird flying in the sky means that it has found a carcass.

The fact that necrophagous birds gathered in groups over the area and flew in the sky was a sign that there was an animal carcass there. We went to the place where the carcass was found and determined whether the animal was a carrier of the disease. In this case, we recorded both the number of necrophagous birds that gathered on animal corpses and the time spent feeding (hours, days) by conducting stationary observations in this place.

In addition, for the rapid detection of animal carcasses and timely collection of material for analysis, organizational work was carried out in advance with veterinary and sanitary workers. That is, monitoring routes were determined along which observations would be carried out. Observations were carried out in the morning and evening hours, in the valleys of the Korchay and Kurakchay rivers, mountain valleys, pastures and on roads, where the probability of animal death is generally high. At the same time, the purpose of our research was explained to the reserve employees, shepherds and villagers. From them we received information about the locations of carcasses. During the monitoring period, 139 km were covered by car, 11 km by horse, 6 km on foot. Both stationary and on the move along the route, observations were carried out using Yukon 10x50 binoculars and an Aquarius TSN-601 telescope.



Fig. 1. In the first row - Griffon Vulture, Egyptian Vulture; In the second row - Bearded Vulture, Black Vulture.

2.3. Taking biomaterials from the carcasses for analysis

Samples were collected for analysis from 17 out of 28 animal carcasses (not fully decomposed) identified during the monitoring period. The samples included skin, heart, liver, spleen, and bone marrow. Due to the hot weather, each sample was placed in a 30% glycerin solution and sterile paraffin oil. Detailed information about the biomaterials—such as the animal species, organ, pathological signs and changes, as well as the date of collection—was documented and sent to the veterinary laboratory in Goranboy. Standard accepted methods were used for the analyses [12-14].

3 Results and Discussion

In the monitored areas, 28 animal carcasses were found and recorded, which died due to various causes. The following table describes the causes of death, diseases found in the carcasses, and the number of disease carriers (Table 1). Five of the carcasses found were domestic animals (12 carcasses) and five were wild mammals (16 carcasses). 57% of the 28 carcasses found were wild animals, 42% were domestic animals. It was found that 13 (46.4%) of the 28 carcasses were carriers of six different infectious diseases (rabies, brucellosis, tuberculosis, toxoplasmosis, adenitis equirum, canine distemper disease) and one was a carrier of the echinococcus parasite.

Of the animal carcasses taken for analysis, 5 were found to have rabies, 4 had echinococcus, 2 had brucellosis, 2 had adenitis equirum, 2 had canine disease, 1 had toxoplasmosis, and 1 had tuberculosis.

Wild mammals accounted for 53.0% of the carriers of diseases and parasites, and domestic animals accounted for 47.0%. It was established that the majority of dead animals (they were torn apart by predators, drowned in river floods, hit by vehicles while crossing the road) were inexperienced young individuals with insufficiently developed adaptive reactions, as well as weak and old individuals. Among the carriers of diseases, the largest number of animals were those with rabies. It was established that the main carriers of rabies are wolves, jackals, and foxes. They also infect domestic animals (mainly dogs) in pastures and near populated areas. For prevention, in 2014 alone, about 250 thousand dogs were vaccinated against rabies [15].

It should also be noted that in most areas it is impossible to isolate the habitats of wild mammals that are carriers of diseases (mainly rabies). In recent years, to prevent mass infection with rabies, animals such as wolves, jackals and foxes have been vaccinated (by mixing the drug into their feed). However, it is impossible to eliminate the transmission routes (mainly in pastures, migration routes, landfills) of wild animals that are carriers of infectious diseases to domestic animals, and to promptly treat sick domestic animals, as well as to find and dispose of the corpses of dead animals. As a result, undisposed corpses quickly decompose and spoil (especially in the hot summer months), and the bacterial toxins produced in the corpse become a dangerous food source for other animals that feed on corpses. At the same time, infectious diseases contained in this carcass are spread to pastures, water sources and food objects in the environment by flies, predators and rodents [10, 16, 17].

Birds feeding on carcasses limit sources of diseases in natural ecosystems and perform an important function by finding and eating animal carcasses that have not been utilized and are located in inaccessible places. Thus, during the monitoring period, we noted a minimum of 4 and a maximum of 30 individuals of griffon vulture, Egyptian vulture, black vulture and bearded vulture on each of the 28 animal carcasses we noted. During our observations, we noted that the soft tissues of the carcasses of cattle, horses and donkeys, with a live weight of about 100-300 kg, were completely eaten (except for the bones) within 2-3 days. On the first day of discovery of the carcass, 15-30 birds were observed around it, and, apparently, 70-80% of the carcass was consumed. On the following second and third days, 3-5 birds were observed around the carcass. After the carcass was completely consumed, we did not observe any birds around its remains. We observed 7-12 birds congregating on the carcasses of relatively small and medium-sized animals (such as Indian crested porcupine, raccoon, jackal, dog, wolf, sheep). We noted that the carcasses of these animals were consumed within 1-2 hours. There is a reason why birds around the carcass quickly consume them. That is, by eating quickly, the birds eliminate the possibility that nearby predatory mammals and dogs will become "partners" in consuming the carcass. It is also worth noting that we did not encounter a single case of competition between birds during feeding, resulting in bleeding. It has been determined that these necrophagous birds have social behavior characteristics. This social behavior allows these birds to browse large areas and search for food and feed collectively [18, 6].

It is necessary to answer the question of why necrophagous birds that feed on dead animals do not get poisoned or die. It has been established that during the course of evolutionary processes, the organisms of these birds have developed immunity against pathogenic bacteria in carcasses. Pathogenic bacteria that enter the digestive system of birds, such as Fusobacteria and Clostridia (which have formed a symbiosis), are also neutralized by highly acidic gastric juice (which is 10 times more acidic than that of humans) [18, 19].

After eating a carcass, the birds go to drink water together to protect themselves from pathogenic bacteria and toxins that have entered their digestive system with food. We have observed that after eating food, birds fly in groups to high cliffs to get rid of bacteria that come into contact with the carcass. The purpose of such social behavior is to neutralize bacteria in their feathers under the influence of ultraviolet rays of the sun [7].

Table 1. The number of the detected and noted animal carcasses and disease carriers.

Animal	Carcass number	The causes of the death	Detected disease	The carrier of the disease individual
Domestic animals				
Cow – <i>Bostaurus domesticus</i>	1	old, sick hunger	brucellosis	1
Donkey – <i>Equus africanus asinus</i>	1	The wolf tore	adenitis equorum *	1
Horse - <i>Equus ferus caballus</i>	1	sick individual	adenitis equorum *	1
Sheep – <i>Ovis aries</i>	5	The predator tore	tuberculosis	1
			rabies	2
Dog - <i>Canis lupus famillaris</i>	4	hunger, weakness	Dog disease (canine distemper)	2
Wild animals				
Gray Wolf - <i>Canis lupus</i>	2	killed by a trap	rabies	1
Golden Jackal - <i>Canis aureus</i>	4	was killed by fire	rabies	1
			echinococcus	2
Red Fox - <i>Vulpes vulpes</i>	6	killed by traffic and fire	rabies	1
			echinococcus	2
Indian Crested Porcupine – <i>Hystrix indica</i>	2	traffic hit	brucellosis	1
Northern Raccoon - <i>Procyon lotor</i>	2	was killed by fire	toxoplasmosis	1
Total	28			17

Note*- the inflammation of the mucous membrane of the nose and throat.

Monitoring has shown that these species also limit the spread of diseases in anthropogenic landscapes by eating the carcasses of animals thrown into landfills and those that died in pastures in about 10 settlements located around the Korchay River, as well as in pastures (from diseases, weakness, dismemberment by wolves, etc.). Alternative results were noted during monitoring conducted in the Greater Caucasus (Turyanchay State Nature Reserve) and in the Talysh Mountains [7, 8]. That is, the therapeutic effect of these species on ecosystems was also established in these areas.

Undoubtedly, effective protection of these necrophagous species, which have a beneficial effect on the sanitary and hygienic state of natural and anthropogenic ecosystems, is of great importance for the conservation of biodiversity. It is no coincidence that the griffon vulture,

bearded vulture, black vulture and Egyptian vulture are included in the Red Book of the Republic of Azerbaijan (2023) and the IUCN Red List.

4 Conclusion

The analysis of the collected materials confirms that the Griffon Vulture, Black Vulture, Egyptian Vulture, and Bearded Vulture consumed 17 animal carcasses within a single month. These carcasses carried six pathogens of infectious diseases, along with echinococcus, which were not disposed of in the Korchay State Nature Reserve and its surrounding areas, covering less than 6,000 hectares. This feeding behavior helps reduce disease outbreaks and positively impacts the sanitary and hygienic condition of both natural and anthropogenic ecosystems.

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