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## *Occurrences of the Cinereous Vulture (Aegypius monachus) in the Eastern Rhodopes, Bulgaria*

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**Abstract.** The Cinereous Vulture (*Aegypius monachus*) is the largest vulture species in Europe. It is currently extinct in Bulgaria, but individuals from the only Balkan population of the species located in northern Greece frequently forage in the Bulgarian side of the Eastern Rhodope Mountains. We studied the patterns of occurrences, numbers and age structure of Cinereous Vultures in the Eastern Rhodopes, Bulgaria. During 2016 - 2019 we recorded 215 Cinereous Vulture occurrences. The majority of the observed individuals (72.7%) were immature while adults totaled 23.7%. The highest number of vultures were recorded in spring and summer. Cinereous Vultures visited local supplementary feeding stations singularly or in groups of up to eight individuals. Our study shows that Eastern Rhodopes and specifically SPAs 'Studen kladenets', 'Byala reka' and 'Krumovitsa' are important foraging areas and hence high priority conservation areas for the species in Bulgaria.

**Key words:** *Aegypius monachus*, foraging, age structure, viewpoint monitoring, feeding station.

### **Introduction**

The Cinereous Vulture *Aegypius monachus* is a large scavenger with a wide distribution spanning from Portugal to China (Ferguson-Lees & Christie, 2001). The global population of the species is estimated to comprise 7 800 - 10 500 pairs, which equals 15 600 - 21 000 mature individuals (BirdLife International, 2020). Europe holds 2 536 - 2 838 breeding pairs distributed across five countries - Spain, Portugal, France, Greece and Ukraine (Andevski et

al., 2017). The Cinereous Vulture is considered "Near threatened" according to the IUCN Red List (BirdLife International, 2020). The only breeding population of the species on the Balkan Peninsula occurs in Greece (Skartsi et al., 2008). This population was at the edge of extinction with only 4 - 5 breeding pairs and 26 individuals in 1979 (Hallman, 1979). Over the next 10 years the population started to slowly recover. Two decades later the number of breeding pairs reached 21 (Vlachos et al., 1999) but

remained stable over the next decade (Skartsi et al., 2008). Nowadays, it is confined to a colony of about 30 breeding pairs in the Dadia-Lefkimi-Soufli Forest National Park (Zakkak & Babakas, 2015). However, small populations restricted to confined areas are fragile and face higher extinction risk due to persistent threats, such as poisoning or stochastic events. Despite applied large-scale conservation measures, the population still suffers increased mortality due to poisoning (Pantovic & Andevski, 2018; Vavylis et al., 2020) and other threats, such as collision with energy infrastructure, such as wind turbines (Vasilakis et al., 2016, 2017).

In Bulgaria the species had wide distribution until the beginning of the 20<sup>th</sup> century. In some areas it was considered more abundant than the Griffon Vulture *Gyps fulvus*. It occurred in the Rhodopes, Balkan Mountains, Rila, Pirin, Dobrudzha, Danubian Plain, Provadia-Royak Plateaus etc. (Farman, 1869; Reiser, 1894). However, in the middle of the 20<sup>th</sup> century the population has undergone a dramatic decline, mainly due to mass poisoning campaigns against terrestrial predators (Patev, 1950). Around 1960 it hardly occurred in Bulgaria, although it is possible that single pairs were breeding in the Eastern Rhodopes and the Eastern Balkan Mountain until the 1980s (Michev, 1985). The last confirmed breeding record in Bulgaria dates back to 1993, when a single pair bred near Studen kladenets reservoir in the Eastern Rhodopes (Marin et al., 1998). In subsequent years there were numerous observations of pairs with courtship behavior, but breeding was not confirmed (Iankov et al., 1998; Tewes et al., 2004). Cinereous Vultures frequently forage far from their breeding sites and especially over areas with high food availability (Carrete & Donazar, 2005; Moreno-Opo et al., 2010). The large number of free ranging livestock (mainly cattle) and wild ungulates in Bulgaria creates favorable feeding opportunities for vultures. High food

availability along with long-term implementation of conservation measures resulted in the significant increase of the Griffon Vulture population in the area (Demerdzhiev et al., 2014; Dobrev et al., 2019) and probably had a positive impact on the Cinereous Vulture population as well. Through radio tracking and GPS telemetry it has been confirmed that individuals from the breeding population in Greece are foraging in the Bulgarian side of the Eastern Rhodopes (Vasilakis et al., 2008, 2016). Furthermore, a study on the diet of the species confirms that it is feeding on carcasses found in Bulgaria (Skartsi et al., 2015). However, there is a lack of knowledge on the phenology and age structure of the Cinereous Vultures foraging in Bulgaria. Information on the main foraging areas and seasonal dynamics of vulture occurrences is crucial to inform species conservation programs and plan the implementation of adequate conservation actions.

Here we present data on the pattern of occurrences, numbers, age structure and the main foraging areas of the Cinereous Vultures in the Eastern Rhodopes, Bulgaria. This study aims to contribute to the overall knowledge on the distribution and movements of the last breeding colony of the Cinereous Vulture in the Balkan Peninsula and to inform the running conservation programs for the species.

### **Material and Methods**

Pattern of Cinereous Vulture occurrences in the Eastern Rhodopes, Bulgaria were studied in 2016 – 2019 with visual observations from stationary viewpoints and regular observations at two supplementary feeding stations.

#### *Observations from viewpoints*

Visual observations from 19 stationary viewpoints in 7 SPAs (Special Protected Areas) forming part of the Natura 2000 network were conducted twice per month between December and May in 2016 and 2017. Observations from the stationary

viewpoints were held for a total of 1114 hours. Viewpoints were chosen at higher open spots on hills with wide view in all directions to improve visibility. Observations were conducted simultaneously from 3 – 4 viewpoints with constant communication among the observers, in order to avoid double-counting, and follow the movements of the recorded vultures in the area.

#### *Observations at vulture feeding stations*

Observations were performed during organized supplementary feedings at least twice a month between 2016 and 2019, at a supplementary feeding station in SPA 'Studen kladenets'. Observations were also performed less regularly, at a feeding station in SPA 'Most Arda' due to food availability. We observed from a distance greater than 500 m from the feeding stations in order to avoid disturbance. Data collection started right after carcass disposal and lasted until darkness, or until the carcass was fully consumed. The observed Cinereous Vultures were aged following Forsman (2003): individuals in first plumage were considered as juveniles, from second to fifth plumage as immatures and from sixth plumage as adults. For every marked individual the type of tag (wingtag, ring or transmitter), position, colour and inscription were recorded. Observations were made with spotting scopes (20×60) and binoculars (10×60) during daytime, under suitable weather conditions by experienced observers. Data was collected using the SmartBirds Pro app (Popgeorgiev et al., 2015). Spatial data were mapped and processed using QGIS software (QGIS Development Team, 2016).

## **Results**

We observed 215 Cinereous Vulture occurrences during observations from stationary viewpoints and regular observations at supplementary feeding stations. The age was determined for 78.6%

of the observed individuals with immatures representing 72.7% (n = 123), followed by adults 23.7% (n = 40). Juveniles comprised only 3.6% (n=6) of the observed individuals. In total, 27 marked Cinereous Vultures were observed, of which 37% were adults, 59.3% were immatures and 3.7% were juveniles. In total, 45.5% of tagged vultures were recorded in Bulgaria more than once (between 2 and 5 times) during the study. One immature individual was observed on 44 occasions. It was recorded during every month of the year with the highest number of observations in spring and summer. It was a regular visitor of the feeding station and frequently roosting nearby. In 2018 and 2019 we observed courtship behavior with another untagged immature vulture, but no breeding attempts were recorded.

The highest numbers of Cinereous vultures were recorded in April and May (Fig. 1). In January and February only one and two vultures were observed, respectively.

#### *Vultures observed from viewpoints*

We conducted 1 114 hours of observations throughout a period of 68 days and recorded 47 Cinereous Vultures. Overall, we spotted vultures in 37% of the days with field observations. The age was determined for 72.3% of the observed individuals. Immatures were the best represented age class comprising 55.9%, followed by adults – 38.2%. Only two juveniles were observed during the study.

The main flight corridor of the species between Bulgaria and Greece was defined by observations from stationary viewpoints located at elevated spots in all SPAs in the area. We observed 34% (n=16) of the Cinereous Vultures in SPA 'Byala reka'. In SPA 'Krumovitsa' and SPA 'Studen kladenets' an equal numbers of vultures were recorded – 29.8% (n=14). 'Dobrostan' was the only SPA where no vultures were recorded (Fig. 2).

Occurrences of the Cinereous Vulture (*Aegypius monachus*) in the Eastern Rhodopes, Bulgaria

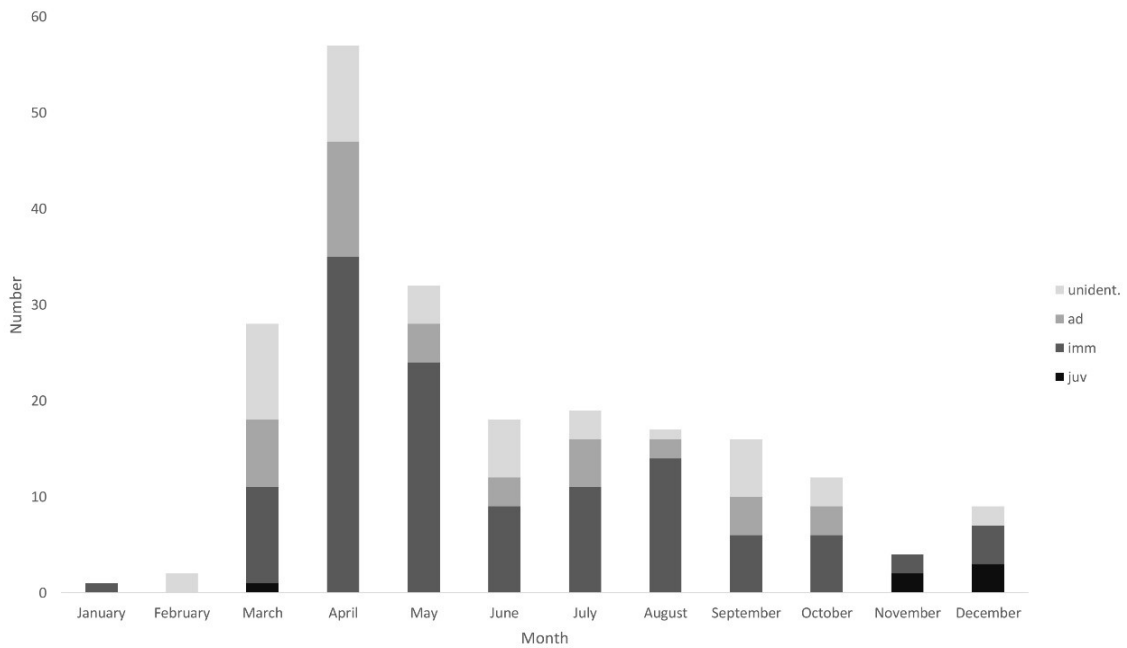


Fig. 1. Monthly dynamic of the observations of Cinereous Vultures in the Eastern Rhodopes, Bulgaria presented per age classes.

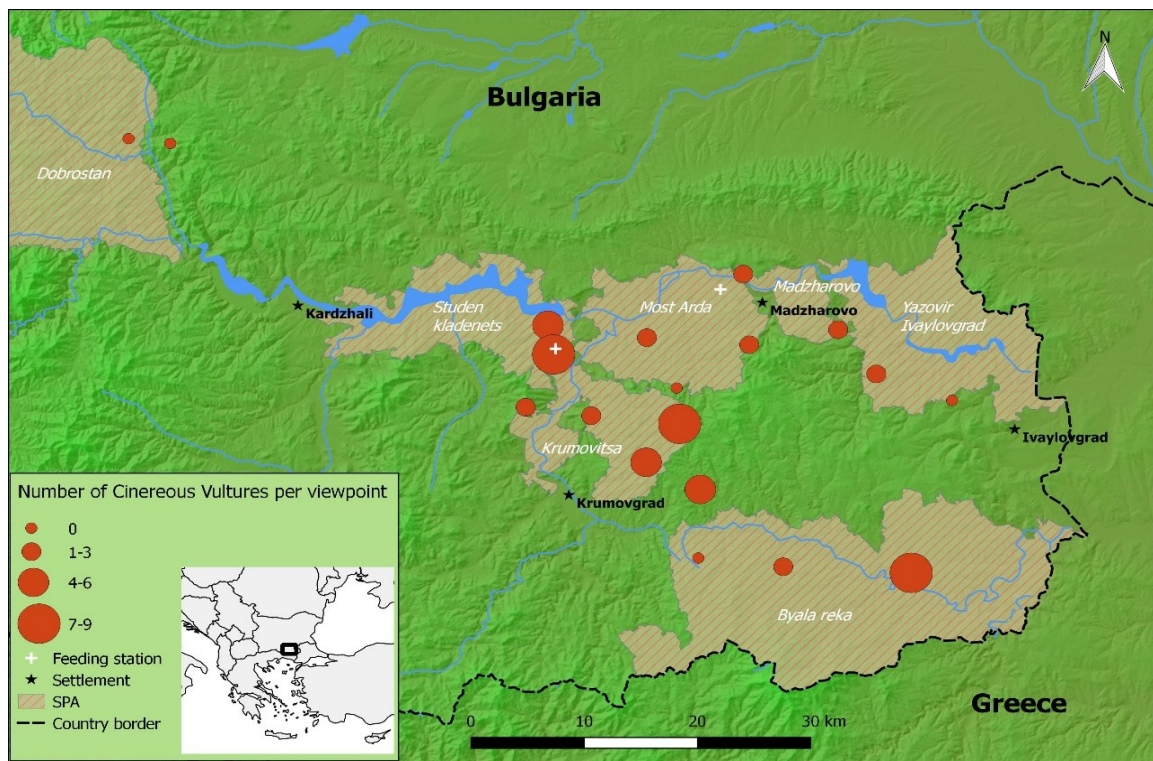


Fig. 2. Distribution and number of Cinereous Vultures observed per viewpoints.

### *Vultures observed at supplementary feeding stations*

On 106 occasions, 168 Cinereous Vultures were observed taking advantage of the supplementary feedings. The majority of the vultures were observed at the supplementary feeding station in SPA

'Studen kladenets' (95.8%), while only 4.2% (n = 7) of the birds visited the feeding station in SPA 'Most Arda'. The age of 80.4% of the Cinereous Vultures visiting the feeding stations was identified. Adults comprised only 20% of observed individuals (Table 1).

**Table 1.** Age structure of Cinereous Vultures observed at supplementary feeding stations in Bulgaria during 2016 to 2019.

Age class	Number of individuals	Number of observations	Number of ind. per observation	Age class %
Adult	27	22	1.22	20%
Immature	104	89	1.17	77.1%
Juvenile	4	3	1.33	2.9%

Cinereous Vultures visited the feeding stations mostly singularly or in small groups of up to three individuals. However, larger groups were also observed. The highest number observed simultaneously at the feeding station in SPA 'Studen kladenets' was eight.

### **Discussion**

Our study confirms that Cinereous Vultures frequently occur in the Bulgarian part of the Eastern Rhodopes throughout most of the year, except for winter. The observed individuals originated from the only breeding colony in the Balkans which is found in the Dadia-Lefkimi-Soufli Forest National Park in Greece (Skartsi et al., 2008). One Cinereous Vulture released as part of a reintroduction program in Kotel, Bulgaria was recorded as well in 2019 (Stoynov, 2019, Blagoevgrad, pers. comm.). These observations are in line with results obtained by GPS tracking of Cinereous Vultures from the colony in Greece (Vasilakis et al., 2016) and previous observations of marked individuals. The majority of vultures were found to fly over SPA 'Byala reka' and SPA 'Krumovitsa' following the valleys of the Byala Reka river and Dushundere stream. This is the shortest route between the breeding colony in Greece and the supplementary feeding station in SPA 'Studen kladenets' in Bulgaria which is used

as a main movement corridor by the species (Noidoi & Vasilakis, 2011). This finding was confirmed by data obtained from 27 Cinereous Vultures tracked with GPS transmitters during the same period (authors' unpublished data) and a study on the feeding pattern and diet of the Griffon Vulture in the Eastern Rhodopes which revealed that vultures find most of their food in SPA 'Studen kladenets' and SPA 'Krumovitsa'. The density of livestock and wild herbivores in this area is high creating favorable feeding conditions for vultures. We found that SPAs 'Madzharovo' and 'Ivaylovgrad' which are mostly covered by forests and dense vegetation were less frequently visited by Cinereous Vultures. The species prefers to forage in open areas where food detection probability is higher (Carrete & Donazar, 2005; Garcia-Baron et al., 2018) which explains the lower visitation rate recorded for these two SPAs. No vultures were recorded in SPA 'Dobrostan', which is located farther from Greece. Despite the number of livestock extensively grazing in this area being high, it is more remote from the breeding colony and is located at higher altitudes making the foraging trips more energetically costly therefore vultures rarely visit it.

The Cinereous Vultures were observed flying singularly or in small groups of up to

three individuals, in rare cases in mixed groups with Griffon Vultures. The results from the viewpoint monitoring indicated that Griffon Vultures are using the same flight corridors during foraging. Both vulture species gained height over the bare hills of the Irantepe ridge located in SPA 'Krumovitsa' which is the highest ridge in the area and then glided southeast or northwest. This area is remote and far from human settlements, but with significant numbers of livestock. About 1 000 cattle are extensively grazed along Irantepe ridge (data obtained from the BFSA [www.babh.government.bg](http://www.babh.government.bg)) providing good feeding opportunities for vultures which explains the regular presence of both species.

At the supplementary feeding stations Cinereous Vultures were frequently outnumbered by the Griffon Vultures which monopolize the carcasses. However, higher numbers of Cinereous Vultures were observed when offal was disposed. The disposal of offal allows more vultures to feed simultaneously and reduces the competition within the vulture guild (Cortés-Avizanda et al., 2010; Moreno-Opo et al., 2015, 2020). In 2017 the proportion of offal disposed at both feeding stations in Bulgaria was higher which might explain the observed increase in the number of Cinereous Vultures visiting the feeding sites. Thus, in order to increase the species visitation rate and the attractiveness of the feeding stations in Bulgaria we recommend the adoption of feeding protocols which envisage regular provisions with smaller pieces of meat and bones scattered around (Cortés-Avizanda et al., 2010).

The highest numbers of Cinereous Vultures in our study area were recorded in spring. The number of vultures observed from the stationary viewpoints or at the vulture feeding stations was low in winter (December - February) and gradually increased towards the summer. Large vultures, being soaring raptors, heavily rely on thermal updrafts to travel long daily distances with low energy expenditures

(Ruxton and Houston 2004; Duriez et al. 2014). The adverse weather in winter impedes thermal creation and determines suboptimal foraging conditions. Rain or snow may impede flights for entire days, especially in winter (Hiraldo and Donazar 1990). Furthermore, in this period, the days are shorter and vultures have less time for foraging. Studies on Cinereous and Griffon Vultures show that in winter they spent significantly less time foraging than during the rest of the year (Hiraldo & Donazar, 1990; Xirouchakis & Andreou, 2009). Juvenile Cinereous Vultures in Spain also have larger home ranges in spring and summer but restrict their movements around the breeding colony during autumn and winter (Castaño et al., 2015). Cinereous Vultures confine their movements to smaller areas in winter and avoid long energetically expensive foraging trips. In January and February 2017, the weather conditions in Bulgaria and northern Greece were harsh with heavy snowfalls and low temperatures over a long period. Under such unfavorable conditions, Cinereous Vultures probably preferred to stay closer to the breeding colony and the supplementary feeding station in the Dadia-Lefkimi-Soufli Forest National Park which was supplied with food on a weekly basis. In spring, when flight conditions are improved, vultures make longer foraging trips (Hiraldo & Donazar, 1990) which can explain the increased number of Cinereous Vultures observed in March and April in the Bulgarian side of the Eastern Rhodopes. On the other hand, the winter months coincide with the onset of the breeding season, when pairs are building and defending their nests and start incubation (Ferguson-Lees & Christie, 2001). During this period breeding vultures have smaller home ranges and exclude long distance movements (Vasilakis et al. 2008). On the contrary, during the chick rearing period vultures increase their home ranges since they have to satisfy food provisioning for their chicks and themselves. This is confirmed by our observations of a marked

adult vulture breeding in Greece, which was observed twice feeding in Bulgaria during the chick rearing period. This shows that under suitable weather conditions some breeding adults may undertake long distance movements in search of food. Furthermore, food availability in the Eastern Rhodopes is high due to the large number of extensively grazing livestock and wild ungulates. However, in winter livestock is kept near the villages or in shelters which leads to a reduction in food availability but in spring and summer livestock suffers increased mortality which creates favorable feeding conditions for the vultures. During this period Griffon Vultures in the Eastern Rhodopes rely mostly on carcasses found in the wild rather than the food provided at the supplementary feeding stations. The combination of the unfavorable flight conditions in winter, the limited food resources available and the start of the breeding season with the associated changes in vulture behavior probably explain the low number of Cinereous Vultures observed in the Eastern Rhodopes during this season.

The majority of the observed individuals in our study were immature individuals. We must note that since not all individuals were marked we were not able to estimate how many different vultures were actually observed. Our results indicated that some individuals visit Bulgaria more frequently than others and this could have biased the determination of the age structure. However, if we consider only the marked individuals it is still evident that most of the recorded Cinereous Vultures were immatures. They wander further away from the breeding colonies compared to adults (Yamaç & Bilgin, 2012), also observed in other vulture species (Monsarrat et al., 2013; Peshev et al., 2018). In Turkey, Caucasus and Asia large proportions of juvenile and immature Cinereous Vultures are migrant and spent the winter in more southern latitudes (Gavashelishvili et al., 2012; Yamaç & Bilgin, 2012; Kang et al., 2019; Reading et al., 2020).

However, young vultures from Spain and Greece does not migrate but alternatively make long distance movements far from the breeding colonies (Vasilakis et al., 2008; Castaño et al., 2015). Similar to other raptors, immature vultures disperse and explore new areas gaining knowledge on the availability of other suitable foraging and breeding sites. This behavior also helps to reduce the competition with adults near the breeding colony (Watson 2010; Gil et al., 2014). Vasilakis et al. (2008) did not find significant differences in the home range size of adult and immature Cinereous Vultures from the breeding colony in Greece. Both age classes had larger home ranges during the non-breeding season with immatures inhabiting slightly larger territories. However, the frequency of long distance movements has not been studied. Adult vultures need to find the balance between parental care for the offspring and foraging which affects daily travelling distances (Moran-Lopez et al., 2006). They probably spend more time in the vicinity of the nesting sites and less frequently undertake long distance movements compared to immature individuals. This could explain the low number of adults observed in the Eastern Rhodopes but more research is needed to confirm this hypothesis.

However, we recorded some adults during our observations, including individuals breeding in Greece which were making one-day foraging trips to Bulgaria. The relatively low number of adults permanently present in the area suggests that the presence of breeding pairs in the Bulgarian side of the mountain is unlikely. The prevalence of immature vultures and the observed courtship behavior are positive signs for future colonization of the former breeding grounds. Similar processes were observed in Portugal where the colonization of the border areas with Spain was preceded by regular occurrences of immature and adult Cinereous Vultures (Lourenço, 2011; Lourenço et al., 2013; ICNB, 2017). However, the steady increase of the Spanish



population has facilitated this process (Moreno-Opo & Margalida, 2014; ICNB, 2017) while the population in Greece despite increasing over the past 30 years, suffers high mortality and reduced breeding success (Skartsi et al., 2019), thus, is not expanding outside Dadia-Lefkimi-Soufli Forest National Park (Zakkak & Babakas, 2015).

Our study confirms that the Bulgarian side of the Eastern Rhodopes is an important part of the foraging range of the Cinereous Vulture population, hence a high priority conservation area for the species. Cinereous Vultures frequently use this area for foraging and feeding throughout most of the year, except in winter. The supplementary feeding site in SPA 'Studen kladenets' is regularly visited by groups of up to eight individuals and serves as a safe and predictable food source for the species. The high number of immature individuals and the observed courtship behavior suggest that if the population in Greece increases some pairs may settle and breed in Bulgaria creating a second breeding nucleus on the Balkans. The implementation of a reintroduction program in this area must also be considered for enhancing the recovery of the species. Therefore, various conservation measures should be implemented to improve the survival of the vultures in the area e.g. insulation of hazardous powerlines in areas frequently visited by vultures, anti-poisoning and anti-poaching activities, use of lead-free ammunitions in hunting areas, improvement of the feeding conditions by increasing the number of wild animals and supporting traditional livestock husbandry practices.

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