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## COPULATION BEHAVIORS OF INDIAN VULTURE (*GYPS INDICUS*) IN UDAIPUR DISTRICT, RAJASTHAN, INDIA

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**ABSTRACT:** Frequency of copulation was recorded in Indian vulture (*Gyps indicus*) throughout the year or before and after egg laying periods. During the study total average 192 to 193 copulation attempts were recorded in each breeding pairs of Indian vulture. Maximum copulation attempts were observed in morning (6.00-8.00 and 8.00-10.00 am) and evening (4.00-6.00pm) hours. Very few copulations attempts were observed afternoon (12.00 to 4.00 pm). Overall mean copulations attempts were highest recorded in month of October (10.4) followed by September (6.733), April (2.667), November (2.3), May (2.3), March (2.13) and lowest copulations attempts were recorded in June (1.9) or summer season. No copulation attempts were sighted during Dec – February month, the reason for this might be, because during these months Indian vultures usually spend time in incubation and pre hatchling cares. During study in study area before copulation aerial display behavior was completely absent in Indian vulture. Allopreening and self-preening activities were frequently sighted before and after copulations.

**KEYWORDS:** Indian vulture, frequency of copulation, aerial display, Allopreening, self- preening.

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### INTRODUCTION

Normally vertebrates perform limited attempts of copulation for increase their progeny while some species performed numerous attempts of copulation throughout year before and after fertilization takes place like dolphins, birds<sup>21,32</sup>. A vulture shows monogamous behavior and remains throughout their life cycle. In *Gyps* genus male and females usually performs aerial display before copulation<sup>1</sup>. The aerial display in vultures could be seen one to three times before matting in time interval of 5-20 minutes and some time more than 20 minutes<sup>6</sup>. The aerial display of Accipitridae family for the *Gyps* genus were not a highly specialized and majestic as compare to other raptors<sup>8,14,18</sup>. Some largest

vulture's performed very simplest types of aerial display and flights during day time. Generally vultures performed two types of aerial display one is cyclic in which two or more individuals fly parallel. Cyclic display behavior was generally seemed throughout the years when two or more than two vultures flying together<sup>20</sup>. The aerial display for long billed vulture is cyclic in which females flight slightly lower heights as compare to male. The aerial display of Indian vultures was recorded 5-20 minutes and sometimes half hours<sup>9</sup>. In other vulture species like *Gypaetus barbatus* perform gymnastic aerial display during breeding season at the end of January and begging of February of every year<sup>2</sup>. Reciprocal preening was frequently shown in vultures

group and usually before and after copulation<sup>4,9,11,17</sup>. Purpose of reciprocal preening was probably to maintain breeding pair strength throughout breeding season<sup>14</sup>. Reciprocal preening performed vital role in maintaining breeding pair strengths, intra-social interactions and removal of ectoparasite from various body parts<sup>8,10,12,19</sup>. Most detailed study of copulation behavior seems only after it was recognized that matting completion in various male individuals for single females has a significant impact on matting evolution<sup>23,24,25,34</sup>. In consequence, almost all investigation of copulatory behavior in the past two decades described frequent within pair copulation (WPCs) as paternity guarding (generally called paternity assurance hypothesis: Mollar, 1987; Simmon, 1990), for example *Panthera leo*<sup>28</sup>, *Ovis aries*, Primates<sup>28</sup> and birds<sup>32</sup>. Generally the paternity assurance hypothesis also known as sperm competition hypothesis<sup>30</sup> and the paternity confidence hypothesis, seems in adequate for at least some frequently copulating species that have for at least some frequently copulating species that have (a) low frequencies of extra pair (EPC- Tortosa and Redondo, 1992), (b) copulations before fertile period (Negro *et al.*, 1992) and (c) a decrease in frequency of WPCs during the fertile period<sup>32</sup>.

### OBJECTIVE OF STUDY

The objective of this study was to analyze frequent copulatory behavior before egg laying and after hatchling period in

Indian vultures. This study also focused on study of total matting attempt in Indian vulture of every breeding pair throughout study periods.

### MATERIALS AND METHODS

The study was conducted for two years from Sept. 2017 – Sept. 2019 by regular visiting of selective Indian vulture breeding colony. The observations were recorded on the weekly basis. Observations of Indian vulture breeding pairs were made by Nikon binocular (8x40), Nikon P900 and P1000 and Canon 60D Camera and sigma 150-500 lens. Observation were taken total 12 hours in a week; For every Indian vulture breeding pair for first 6 hours observation were recorded from (6.00 am to 12.00pm) and second observation were taken from (12.01pm to 6.00pm). We select five Indian vulture breeding pair to understand frequent copulatory attempt and skipping of aerial display throughout study. Observations were made from very safe and appropriate distance of Indian vulture breeding colonies without disturbing them. Data's were analyzed using through MS-Excel and SPSS Software.

### RESULTS AND DISCUSSION

In Accipitriformes and falconiformes showed courtship display behavior before copulations. They performed various mode of behavior like aerial display, vocalization, feeding of females by males before copulation and reciprocal preening (e.g. Poole, 1985). Courtship feeding generally

referred as mate feeding, was generally sighted in some raptors species<sup>15</sup>. Only single copulation was sufficient for fertilization and development of entire clutch size. But some small group's raptors performed frequent copulatory behavior throughout breeding season and year<sup>38</sup>. Male feed their mate female before copulation it's probably for conserve energy for egg laying and to keep female's health in good condition for successful breeding. Frequent copulation generally observed in some raptor groups like- the American kestrel (*Falco sparverius*), 690 times copulation attempt were recorded for single breeding season<sup>3</sup>. Some raptor species performed frequent copulation before and after fertilization, which presumably may be other function than fertilization such as mate assessment, pair bonding and territorial signaling<sup>33,34,35,36,37,38,39</sup>. In most of raptor species copulations sighted before egg laying period and it was gradually increase at reached maximum up to closer date of egg laying<sup>35</sup>. Many copulations attempts were considered false matting attempts, aim of these attempt to establishment and define territorial behavior in same nestling sites<sup>13</sup>. Extra pair copulations (EPCs) have been recorded in several bird species while frequently copulation within pair (WPCs) established monogamous pairing throughout single breeding season or may be life time. Frequent copulation activities also responsible for establishment breeding pair bonding between male and female<sup>30,34</sup>. In Indian vulture we observed frequent

copulation before egg laying and after hatchling throughout year. The frequent copulation and skipping of aerial display was not well understood before our study in Indian vulture. We analyzed the frequent copulation and skipping of aerial display of five pair of Indian vultures in selective breeding site of Udaipur district and we recorded average 192 to 193 copulation attempts for every Indian vulture breeding pair throughout study. We investigated the frequent copulation in within Indian vulture pair and skipping of aerial display among vultures. The frequent copulatory behavior and skipping of aerial display behavior study of five pairs of Indian vulture for two years (Sept. 2017 -Sept. 2019) frequent copulation activities were more frequent sighted before egg laying activities and generally not seems in incubation time and gradually increased after hatchling periods. Copulations was mostly frequently sighted in morning hours (6.00am to 10.00am) followed by evening time (4.00pm to 6.00pm) and minimum was recorded between 12.01pm - 4.00 pm during time they spend time in thermoregulation, drinking water, foraging and feeding activities. Copulation activities start without aerial display behavior and initially Indian vulture breeding pair start self grooming & preening and occasionally performed reciprocal preening prior to copulation. Extra pair copulation was not recorded during the study. Sometime allopreening frequently observed in day time before and after matting in Indian vulture<sup>5</sup>. But during the study we have not observed aerial

display behavior in Indian vulture before copulations. Male and female directly came in contact and some time reciprocal preening was recorded before copulation in Indian vulture. Indian vulture's male and female both produce frequent and loud sound from starting to end of copulation. During study we observed first preening and reciprocal preening starts before 5-10 minutes of copulations. Then Indian vulture's male mount on top of female body and hold it properly. During copulation and ejaculation male and female both produces loud and frequent vocalization calls. We observed a copulation time varies from 2-4 minutes they vary from one pair to another. In Long billed vulture frequent and re- matting attempts were also observed after juvenile deaths<sup>5</sup>.

#### **Overall copulation attempt performed by Indian vulture in different time intervals**

During study we recorded (6.00am to 8.00am) maximum copulation attempts in October (65) followed by September (48), November (29), April (23), March and June every month carry out (13) attempts, August (9) and minimum copulation attempt present in July (7). No copulation attempt was made in December. January and February month in all five breeding pair of Indian vulture (Figure 1). Time duration (8.01 am to 10.00am) recorded maximum copulation attempts in October (97) followed by September (31), March (28), June (23), April (19), July (18) and minimum were recorded in May (17). No copulation activities were recorded in December, January and February (Figure 2). Time

duration (10.01am to 12.00pm) recorded maximum copulation attempts in October (25) followed by September (14), November (12), March and April contains nine and nine attempts, May (8) and three- three copulation attempts were recorded in June, July & August months. No copulations attempts were recorded in December, January and February months (Figure 3). Time interval (12.01pm to 2.00pm) maximum copulation attempts were observed in October (29) followed by September (15) and single - single copulation attempts recorded in December, January, February, March, April, May, June, July and August months (Figure 4). No copulation attempts were recorded in December,

January and February during this duration. During (2.01pm to 4.00pm) maximum copulations attempts recorded in October (27) followed by September (16), April (4), November (3) and single copulation attempted recorded in May during this time. No copulation attempts were recorded in December, January, February, March, June, July and August throughout study periods (Figure 5). During (4.01pm to 6.00pm) maximum copulation attempts were recorded in September (78) followed by October (69), April and May month shows 25-25 copulations attempted, July (22), August (21), June (18), March (11) and minimum were recorded in November (6). No attempts were recorded in December, January and February months. During study we have not observed any

copulation attempts in December, January and February months throughout the early morning to late evening.

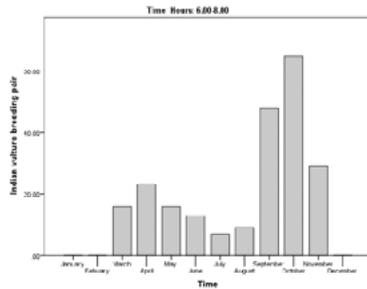


Figure 1– Monthly copulation attempts in all five breeding pair of Indian vultures between 6.00am to 8.00am.

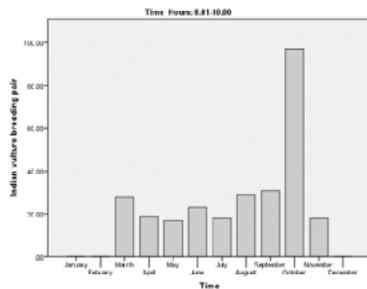


Figure 2- Monthly copulation attempts in all five breeding pair of Indian vultures between 8.01 am to 10.00am.

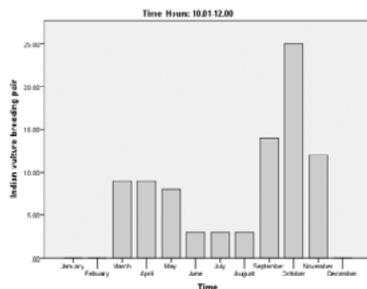


Figure 3 - Monthly copulation attempts in all five breeding pair of Indian vultures between 10.01am to 12.00pm.

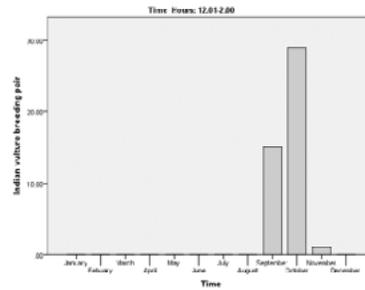


Figure 4 – Monthly copulation attempts in all five breeding pair of Indian vultures between 12.01pm to 2.00pm.

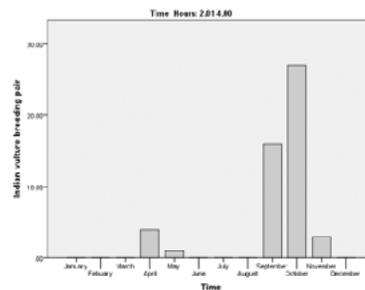


Figure 5 – Monthly copulation attempts in all breeding pairs of Indian vultures between 2.01pm to 4.00pm.

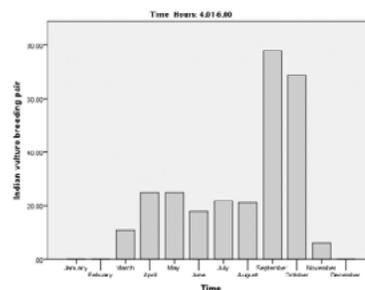


Figure 6- Monthly copulation attempts in all five breeding pair of Indian vultures between 4.01pm to 6.00pm.

**Month wise mean copulation attempts shown by Indian vulture in different time intervals-**

During the observation (6.00-8.00am) maximum mean copulations attempts recorded in October (13) followed by September (9.6), November (5.8), April (4.6), May and March (3.2 and 3.2), June (2.6), August (1.8) and minimum mean copulations were recorded in July (1.4). During the observation between (8.01-10.00 am) maximum mean copulation attempts were observed in October (19.4) followed by September (6.2), August (5.8), March (5.6), June (4.6), April (3.8), July and November (3.06 and 3.06), minimum in May (3.4) and no copulation attempt recorded in December, January and February. Monthwise mean copulation comparison between (10.01-12.00pm) maximum were recorded in October (5) followed by September (2.8), November (2.4), March and April (1.8 and 1.8), minimum were recorded in May (1.6) and totally absent in January, February and December months. Month wise mean copulation comparison between (12.01-2.00) maximum were recorded in October (5.8) followed by September (3) and minimum copulations were recorded in November (0.2). Month wise mean copulation comparison (2.01-4.00pm) maximum recorded in October (5.4) followed by September (3.2), April (0.8), November (0.6) and minimum were observed in May (0.2). Mouth wise mean comparison copulations attempts (4.01-6.00pm) highest recorded in

September (15.6) followed by October (13.8), April and May (5 and 5), July (4.4), August (4.2), June (3.6), March (2.2) and minimum copulation attempts were recorded in November (1.2) (Table-1; Figure 7 and 8).

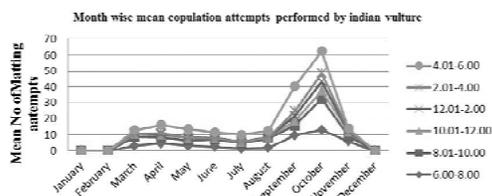


Figure 7- Month wise mean copulation attempts performed by all five breeding pair of Indian vulture.

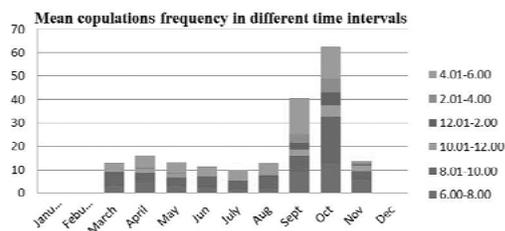


Figure 8- Month wise mean copulation frequencies in different time intervals in day by all five pair of Indian vulture.

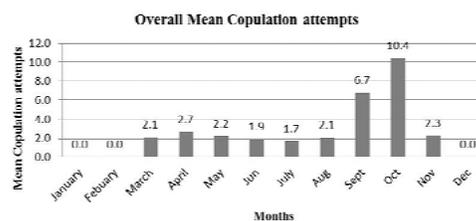


Figure 9- Overall mean copulation attempts in Indian vulture during the study period (September, 2017- September, 2019) by all five breeding pair of Indian vulture.

### Overall mean copulations attempt in Indian vulture-

During the study (September, 2017 to September, 2019) overall mean copulation attempts highest recorded in October (10.4) followed by September (6.7333), April (2.667), November (2.3), May (2.23), March (2.13) and lowest copulation attempt were recorded in June (1.9) (Table 2; Figure 9). In December, January and February month

copulation attempts were generally not observed because these time periods of Indian vulture for an egg laying, egg incubation and early hatchling time. To conserve and invest energy in parental care of nestling when copulations were completely absent. Highest copulations attempt were recorded in October of all year of studies.

**Table 1:** Month wise copulation attempts in different time intervals in day times (6.00am-8.00am, 8.01am-10.00am, 10.01am-12.00pm, 12.01pm-2.00pm, 2.01pm-4.00pm and 4.01pm-6.00pm)

Months	6.00-8.00	8.01-10.00	10.01-12.00	12.01-2.00	2.01-4.00	4.01-6.00
January	0	0	0	0	0	0
February	0	0	0	0	0	0
March	3.2	5.6	1.8	0	0	2.2
April	4.6	3.8	1.8	0	0.8	5
May	3.2	3.4	1.6	0	0.2	5
June	2.6	4.6	0.6	0	0	3.6
July	1.4	3.6	0.6	0	0	4.4
August	1.8	5.8	0.6	0	0	4.2
September	9.6	6.2	2.8	3	3.2	15.6
October	13	19.4	5	5.8	5.4	13.8
November	5.8	3.6	2.4	0.2	0.6	1.2
December	0	0	0	0	0	0

**Table 2:** Month wise mean copulation attempts in Indian vultures in different time intervals in day times (6.00am-8.00am, 8.01am-10.00am, 10.01am-12.00pm, 12.01pm-2.00pm, 2.01pm-4.00pm and 4.01 pm-6.00pm)

Time	Mean Copulation attempt by five pair of Indian vulture											
	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec
6.00-8.00	0	0	3.2	4.6	3.2	2.6	1.4	1.8	9.6	13	5.8	0
8.01-10.00	0	0	5.6	3.8	3.4	4.6	3.6	5.8	6.2	19.4	3.6	0
10.01-12.00	0	0	1.8	1.8	1.6	0.6	0.6	0.6	2.8	5	2.4	0
12.01-2.00	0	0	0	0	0	0	0	0	3	5.8	0.2	0
2.01-4.00	0	0	0	0.8	0.2	0	0	0	3.2	5.4	0.6	0
4.01-6.00	0	0	2.2	5	5	3.6	4.4	4.2	15.6	13.8	1.2	0
Total	0	0	2.1333	2.6667	2.2333	1.9	1.6667	2.0667	6.7333	10.4	2.3	0

**A Pearson correlation coefficient between various time intervals of day during observation:**

The result of a person correlation coefficient between time intervals of day observed during the study is presented in Table 3. A Pearson correlation coefficient was run to determine the relationship between copulations attempts in various time intervals of day during observation; it is represents by r or rho. A Pearson correlation coefficient were strongly positive between (6.00-8.00 and 6.00-8.00)  $r= 1$  with the 0.01 level of significant. It is continuously decline between (6.00-8.00 and 10.01-12.00) ( $r= 0.972$ ) with 0.01 level of significant followed by (6.00-8.00 and 2.01-4.00) ( $r= 0.934$ ) with 0.01 significant level, (6.00-8.00 and 12.01-2.00) ( $r= 0.893$ ) with 0.01 significant level, (6.00-8.00 and 4.01-6.00) ( $r= 0.875$ ) with 0.01significant level

and minimum positive correlations were observed between (6.00-8.00 and 8.01-10.00) ( $r= 0.01$ ) with 0.01 significant level. In similar manner Pearson correlation coefficient between (8.01-10.00 and 8.01-10.00) were highly positive correlated ( $r=1$ ) with the 0.01 level of significant. They were decline in following manner; (8.01-10.00 and 12.01-2.00) ( $r=0.878$ ) with the 0.01 level of significant followed by (8.01-10.00 and 10.01-12.00) ( $r= 0.877$ ) with 0.01 significant level, (8.01-10.00 and 2.01-4.00) ( $r= 0.861$ ) with 0.01 level of significant and minimum positive correlations were observed between (8.01-10.00 and 4.01-6.00) ( $r=0.750$ ) with 0.01 significant level. Pearson correlation coefficient between (10.01-12.00 and 10.01-12) was highly positive ( $r=1$  with the 0.01 level of significant) and continuously decline between (10.01-12.00 and 2.01-4.00)

( $r=0.887$ ) with 0.01 level of significant, (10.00-12.00 and 12.01-2.00) ( $r= 0.849$ ) with 0.01 level of significant and poorly positive correlation found between (10.01-12.00 and 4.01-6.00) ( $r= 0.781$  with 0.01 level of significant). A Pearson correlation coefficient between (12.01-2.00 and 12.01-2.0) was strongly positive correlated ( $r=1$ ) with the 0.01 level of significant. They were continuously declined in following manner (12.01-2.00 and 2.01-4.00) ( $r=0.988$ ) with 0.01 level of significance, (12.01-2.00 and 4.01-6.00) ( $r=0.844$ ) with 0.01 level of significance (Table-3). A Pearson correlation coefficient between (2.01-4.00 and 2.01-4.00) were strongly positive correlated ( $r=1$ , with 0.01 level of significant) and continuously decline between (2.01-4.00 and 4.01-6.00) ( $r=0.872$ ) with the 0.01 level of significant. Strongly positive person correlation coefficient found between (4.01-6.00 and 4.01-6.00) ( $r=1$ ) with 0.01 level of significance.

#### **A Pearson correlation coefficient between copulation attempts in various months:**

The result of a person correlation coefficient between attempts observed during the study is depicted in Table 4. A Pearson correlation coefficient between March and October were highly positive correlative ( $r=0.904$  with 0.1 level of significance). It was declined between March and June ( $r=0.896$  with 0.05 level) minimum positive correlation were observed between March and August ( $r=0.864$  with

0.05 level) months. No any correlation observed between Marchs to another month except discus above. Pearson correlation coefficient between April and May was highly positive correlated ( $r= 0.968$  with 0.01 significant level) and decrease in following manner – April and June ( $r=0.877$  with 0.05 level of significance), April and July ( $r= 0.835$  with 0.05 level of significance) and poorly correlation were found between April and September ( $r=0.859$  with 0.05 level of significance). A Pearson correlation coefficient strongly positive between May and July ( $r=0.927$  with 0.01 level) and decrease in May and June ( $r=0.894$  with 0.05), May and September ( $r=0.892$  with 0.05) and minimum positive correlation were found between May and August ( $r=0.827$  with 0.05). A Pearson correction coefficient between July and October were strongly positively correction ( $r=0.977$  with 0.01 significant level) recorded. These were continuously decline between June and September ( $r=0.973$  with 0.01 level of significance) and minimum were observed between June and July (0.928 with 0.01 level of significance) months. Pearson correlation coefficient between July to August were positively correlated ( $r=0.941$  with 0.01 significant level and decline between July to August ( $r= 0.852$  with 0.05). Pearson correlation coefficient was positively recorded between August and October ( $r= 0.950$  with 0.01 level of significance).

**Table 3:** Pearson correlation coefficient between different time interval copulation performed by Indian vulture during September, 2017- September, 2019)

Pearson Correlation	Correlations coefficient between different time intervals					
	6.00-8.00	8.01-10.00	10.01-12.00	12.01-2.00	2.01-4.00	4.01-6.00
6.00-8.00	1					
8.01-10.00	.857**	1				
10.01-12.00	.972**	.877**	1			
12.01-2.00	.893**	.878**	.849**	1		
2.01-4.00	.934**	.861**	.887**	.988**	1	
4.01-6.00	.875**	.750**	.781**	.844**	.872**	1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

**Table 4:** Pearson correlation coefficient between various month's copulation attempts done by Indian vulture

Pearson Correlation	Correlation coefficient between the various months											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
January												
February												
March			1									
April			0.729	1								
May			0.698	.968**	1							
June			.896*	.877*	.894*	1						
July			0.701	.835*	.927**	.928**	1					
August			.864*	0.765	.827*	.973**	.941**	1				
September			0.346	.859*	.892*	0.688	0.805	0.601	1			
October			.904*	0.801	0.794	.977**	.852*	.950**	0.592	1		
November			0.724	0.649	0.475	0.533	0.239	0.362	0.242	0.554	1	
December												

\*. Correlation is significant at the 0.05 level (2-tailed). \*\*. Correlation is significant at the 0.01 level (2-tailed).



**A**-Third pair of Indian vulture matting in July



**E**-Fourth pair of Indian vulture in matting in October



**B**-Fourth pair of Indian vulture during copulation in October



**F**-First breeding pair of Indian vulture in copulation after nestling development



**C**-Second pair of Indian vulture during copulation in November



**G**-Second breeding pair of Indian vulture in copulation in nests



**D**-Fourth pair of Indian vulture in matting without showing aerial display

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