ISSN: 0973-4929, Vol. 15, No. (2) 2020, Pg. 353-362

Current World Environment

www.cwejournal.org

# Seasonal Fluctuation in Thermoregulatory Behaviour of Long-Billed Vulture (*Gyps indicus*) by Wing Stretching at Southern Rajasthan, India

**NADIM CHISHTY* and NARAYAN LAL CHOUDHARY**

Wildlife, Limnology & Toxicology Research Laboratory, Department of Zoology, Govt. Meera Girl's College, MLSU, Udaipur, Rajasthan, India.

**Abstract**

Long-billed vulture is warm-blooded and they regulate body temperature by solar radiation. Thermoregulatory behaviour plays an important role for organism survival and its fitness. It also plays a major role in removal of ectozoons, cleaning of body and feathers, elimination of sand particles, wing flexibility and is also helpful in long distance flight. Maximum thermoregulation time recorded in winter were (680±95.65) and minimum were (516.07 ±68.66) seconds in summer in per day. Maximum thermoregulation time's record in winter was due to low environmental temperature, high humidity and low wind velocity. In winter maximum average temperature was (27.12±2.88°C) and minimum was (8.63±3.03°C), while thermoregulation time minimum recorded in summer due to high environmental temperature. In summer season maximum average temperature was recorded (39.34±2.10°C) and minimum was (23.08±4.49°C). Thermoregulation is influenced by various ecological parameters like- temperature, rain, sunshine period, wind velocity and cloudy weather. Thermoregulatory times reduced when environmental temperature increased. In summer long billed vulture protect nestling from direct sunlight.

**Article History**

Received: 19 March 2020
Accepted: 08 August 2020

**Keywords**

Ecological Parameter, Ectozoons, Long-Billed Vulture, Thermoregulation, Warm-Blooded.

## Introduction

Sun-bathing or basking is a behaviour seen in birds for many kinds of reasons (Kennedy, 1969). Thermoregulation phenomenon is observed in a wide variety of avian species including large falconiformes, King Vulture (*Sacoramphus papa*), White-backed vulture (*Gyps africanus*), Indian King vulture (*Sarcogyps calvus*) and Bald eagle (*Haliaeetus leucocephalus*); various species of Psittaciformes, Piciformes, Coracciformes,

**CONTACT** Nadim Chishty nadimchishty@gmail.com Wildlife, Limnology & Toxicology Research Laboratory, Department of Zoology, Govt. Meera Girl's College, MLSU, Udaipur, Rajasthan, India.


Doi: http://dx.doi.org/10.12944/CWE.15.2.23

Columbiformes, Ciconiiformes, Corvidae and passerine birds. The thermoregulatory behaviour is performed by many avian species and reported in more than 170 species of birds belonging to 48 families (Kennedy, 1969). Sunbathing is not only used to maintain body temperature, but also plays a vital role in maintaining flight muscle, healthy wing, able to fly longer distance , aerial flight and searching food and water for its survival. It also plays a key role in survival of warm-blooded animals like reptiles, birds and other organisms living in dry and cold environment. Vultures have special characteristics to maintain body temperature by absorbing sunlight (Heath, 1962; Curry-Lindahl, 1970; Kushlan, 1973; Tom J. cade, 1973). Thermoregulation is an important adaptive phenomenon in birds, and they play a key role in its survival like plumage maintenance, sunbathing, sun basking, and water bathing (Slessers, 1970).Vultures spend most of their time preening and maintaining plumage. Vultures absorb high portion of solar radiation in comparison to other birds, by spreading wings in position of sunlight with an intention to dry the feathers, removing sand particles and ectozoons from feathers (Clark and Ohmart, 1985) and their dark colored wings absorb maximum heat from sunlight (Hamilton and Heppner, 1967; Lustick, 1969; Marder, 1973) at low wind velocity (Walsberg *et al.,* 1978). Vultures stretch their wings to more time duration in winter as compared to summer season (A.G. Clark, 1969; Mueller, 1992). Many studies have been done on energy demands by organism for different types of activities and functions. Some scientist have focused on thermoregulatory behaviour and adaption by warm-blooded animals to live in dry and cold environmental conditions (Schmidt-Nielsen, 1964; Scholander, 1955; Scholander *et al.,* 1955; and Irving *et al.,* 1955).

The study was mainly focused on fluctuation of time according to seasonal variation in thermoregulation behaviour in long-billed vulture. Study will provide details observation of environmental factors like-temperature, humidity, wind velocity and season on thermoregulation behaviour of long billed vulture.

## Materials and Methods

### Study Area

An intensive study was made in the region of high hills and rocky cliffs of Aravalli hills of southern Rajasthan at an elevation of 600-700 meter, where annual precipitation was 600.8 mm. Southern Rajasthanin cludes Chittorgardh, Udaipur, Sirohi, Jalore, Pratapgarh, Banswara and Dungarpur district, situated between 24°34'48.00N" latitude and 73°40'48.00E" longitude. Udaipur division has temperature ranging from 5.6°C in winter and temperature rising during summer up to 43°C. The annual rainfall is approximately 89-93% of total rainfall in the division caused by monsoon season from June to October (RCA, Udaipur, 2018).

### Method

Study was supported by repeated direct observations using binoculars Nikon 8X40, and photography and video-graphy done by Nikon Coolpix P900, Canon D-60 camera with sigma150-500mm lens. Data were collected in early morning to late evening. For thermoregulation behaviour two long billed vulture colonies were observed. Data were analysed with the help of MS-Excel and SPPS software tools.

## Result and Discusion

The key result of sunbathing by wing spreading behaviour represents cleaning of the body and feathers, elimination of sand particles, removal of ectozoons and maintaining the flexibility of the feathers, they also helpful in maintain healthy wing and body. Maximum activities of vultures is recorded in warmer time with the sunrise, environment temperature rises and simultaneously human activities also start and with that in towns & villages vulture activities also start (Sonika K. and Amita K. 2010).Vultures have a larger wing span which help them in flying and a highly specialized mode of flight, they avoid flight in extreme high temperature or afternoon time. They do not fly in day time when the temperature increases above normal range, as well as cloudy weather. According to Cade, sunbathing behaviour by wing spreading of certain raptors develop not only associated with maintaining body temperature but also with features maintains and cleaning, to provided elasticity of flight muscle (Cade, 1973; James A. mosher, 1976).Vulture also spread wing their various other function like drying, maintaining buoyancy, body temperature maintain (Hennemann, 1982). Vulture changes their position according to time during sunbathing to maintain rate of heat exchange that adjust the angle of occurrence of solar transmission rate. Organs such as bald head, skin of neck and interior thigh region play greater important role in heat conversation (Marsha A. S., 1997).

Long-billed vultures spent most of their time in sunlight to gain solar radiation for preening, sunbathing, sun basking and drying wings. Thermoregulatory behaviour of long-billed vultures is generally seen in morning hours and warmer time of day in cloudy and winter season. They used to live in rocky hilly areas, old large trees and old historical monuments and they also use rocks, stones and old trees for sunbathing. The sunbathing behaviour of long-billed vulture included fully extension of both wings and keeping face against sunlight. Sunbathing behaviour is performed by young adults and juvenile. They kept open both the wings for more than a minute and this behaviour is repeated many times in a day. Study has been done by Samson *et al.,* 2014 for sunbath in long-billed vulture where they found vultures extending their wings in different posture at different times of the day (A. Samson *et al.,* 2014). Maximum temperature recorded in May, 2018 and minimum temperature recorded in December, 2017 (Table 1). Sunbathing time is influenced by various climatic conditions like- temperature, rainfall, humidity, wind velocity and sunshine period. The average time of thermoregulation of long-billed vulture was 679.60 second in winter season and 516.8 second during summer season (Table 2, 3).

**Pearson Correlation and Regression Analysis**

A Pearson product moment co-relation was run to determine the relationship between difference in temperature and rainfall. There was a strong, negative correlation in temperature and rainfall, which is statically significant ($r= -0.832$, $p= 0.01$) (Table-4); Temperature and thermoregulations time in winter season was negatively correlated and statically significant ($r=-0.956$, $p=0.05$)(Table-5). Pearson co-relationship in temperature and thermoregulation time in summer season was negatively co related and statically significant ($r= -0.781$, $p = 0.05$)(Table-6). The regression analysis between thermoregulation, temperature and rainfall during study period, it was observed that difference in temperature increase statically significant of $\beta= 3.74$ decrease in rainfall, $p=0.02$.

**Regression Analysis of Different Variables**

Regression analysis between another variables like winter season temperature and humidity were observed and found no significant increase $\beta= 0.248$ times in humidity was observed, $p= 0.676$. The regression analysis between difference in winter season temperature and wind velocity were observed and found that difference in temperature increase statically non-significant effects of $\beta= 0.007$ times in wind velocity observed, $p= 0.945$. The regression analysis between the temperature and thermoregulation time in winter season; it is observed that as difference in temperature increase statically non significant decrease $\beta= 13.737$ time in thermoregulation time is winter season is observed, $p= 0.124$.

The regression analysis between difference in summer season temperature and humidity, it is observed no significantly effect of $\beta= 0.0777$ in humidity was observed, $p= 0.922$. The regression analysis in temperature and wind velocity were observed that as difference in temperature increase statically significant decrease of $\beta=-0.435$ in wind velocity (kmph) was observed, $p=0.001$). The regression analysis in between the temperature and thermoregulation time in summer season; it is observed that as difference in temperature increase non statically significant increase $\beta= 4.60$ times in thermoregulation time in summer season is observed, $p= 0.357$).

**Relationship Between Environmental Factors and Sunbathing Times**

During study period we observed over all maximum average temperature was (36.66±6.02°C), minimum was (11. 53±7.45°C) and the average difference in temperature was (25.13±2.99°C); Average rainfall was (8.31±13.44°C) recorded. During winter maximum average temperature was recorded (27.12±2.88°C), minimum was (8.63±3.03°C) and the average difference in temperature were recorded (18.48±2.89). In winter season humidity of environment was (83.07±6.10) percent and wind velocity (2.28±0.98) Kmph were recorded. In winter thermoregulation time was recorded in seconds (680±95.65)(Table-7). In summer maximum average temperature was (39.34±2.10°C), minimum

(23.08±4.49°C) and the average difference in temperature (16.26±3.81°C) was recorded. In summer season humidity of environment was (44.73±10.66) percent recorded and wind velocity (2.287±0.98) kmph recorded. In summer thermoregulation times was recorded in seconds (516.06±68.60)(Table-7). There was significant difference in maximum temperature in winter (27.11±2.88°C) and summer (39.35±2.1°C) and higher mean temperature was observed in summer, $p<0.0001$. There was significant difference in minimum temperature in winter (8.63±3.03°C) and summer (23.09±4.5°C) and lowest mean temperature observed in winter season $p<0.0001$. There was no significant difference in temperature was (18.48±2.89°C) in winter season and (16.26±3.82°C) in summer and lowest difference in temperature observed is observed in summer ($p=0.083$)(Table-7).

**Table 1: Minimum and Maximum Temperature Recorded for the Study Area During December, 2017- June 2018**

| Sr.no. | Month | Average monthly temperature in °C | | Rainfall in MM |
|---|---|---|---|---|
| | | Maximum | Minimum | |
| 1. | December,2017 | 28.5 | 5.6 | 4.2 |
| 2. | January,2018 | 30.5 | 2.9 | 0.0 |
| 3. | February, 2018 | 32.5 | 5.6 | 0.0 |
| 4. | March, 2018 | 39.0 | 10.2 | 0.0 |
| 5. | April, 2018 | 41.0 | 14.6 | 2.2 |
| 6. | May,2018 | 43.5 | 21.6 | 0.0 |
| 7. | June, 2018 | 41.6 | 20.2 | 33.8 |

**Table 2: Time Spend on Sunbathing by the *Gyps indicus* During Winter Season Recorded from 16th December, 2017 to 1st March, 2018**

| Day | Temperature °C | | Humidity % (Kmph) | Wind velocity | Winter season | |
|---|---|---|---|---|---|---|
| | Maximum | minimum | | | Sunbathing time<br>Time in second | Average time in second |
| 1 | 22.9 | 10.5 | 74 | 3.4 | 853.2 | |
| 2 | 26.0 | 8.3 | 90 | 1.9 | 751.8 | |
| 3 | 24.2 | 4.1 | 88 | 1.3 | 810 | |
| 4 | 25.5 | 6.6 | 89 | 1.8 | 687.6 | |
| 5 | 26.0 | 7.1 | 85 | 1.9 | 673.2 | |
| 6 | 28.6 | 8.5 | 88 | 1.7 | 631.8 | |
| 7 | 27.0 | 6.6 | 90 | 1.7 | 670.8 | 679.60 second |
| 8 | 25.0 | 4.1 | 83 | 4.5 | 745.8 | |
| 9 | 28.5 | 6.6 | 78 | 1.2 | 668.4 | |
| 10 | 28.5 | 8.1 | 83 | 3.4 | 621.6 | |
| 11 | 24.5 | 12.1 | 85 | 1.3 | 733.2 | |
| 12 | 25.0 | 9.1 | 86 | 2.1 | 731.4 | |
| 13 | 31.0 | 11.1 | 80 | 1.8 | 549.6 | |
| 14 | 31.5 | 11.6 | 70 | 3.1 | 564 | |
| 15 | 32.5 | 15.1 | 77 | 3.2 | 507.6 | |

**Table 3: Time Spend on Sunbathing by the *Gyps indicus* During Summer Season Recorded from 1st April, 2018 to 24th June, 2018**

| Day | Temperature °C | | Humidity % (Kmph) | Wind velocity | Winter season | |
|---|---|---|---|---|---|---|
| | Maximum | minimum | | | Sunbathing time | |
| | | | | | Time in second | Average time in second |
| 1 | 38.7 | 16.0 | 62 | 5.9 | 553.8 | |
| 2 | 38.0 | 18.0 | 40 | 5.1 | 574.2 | |
| 3 | 37.5 | 18.6 | 52 | 3.3 | 575.4 | |
| 4 | **37.0** | 18.0 | 38 | 5.2 | **630** | |
| 5 | 38.2 | 16.1 | 41 | 2.3 | 547.2 | |
| 6 | 41.0 | 27.5 | 33 | 8.0 | 493.2 | |
| 7 | 39.0 | 23.1 | 48 | 6.0 | 513 | **516.08 second** |
| 8 | 38.8 | 23.6 | 40 | 6.3 | 565.8 | |
| 9 | 40.2 | 27.6 | 34 | 7.2 | 510 | |
| 10 | 42.0 | 24.1 | 31 | 3.6 | 432 | |
| 11 | **43.0** | 27.1 | 43 | 6.7 | **368.4** | |
| 12 | 40.0 | 28.1 | 34 | 7.1 | 505.8 | |
| 13 | 41.6 | 27.2 | 58 | 9.3 | 451.8 | |
| 14 | 35.0 | 25.8 | 61 | 10.1 | 571.2 | |
| 15 | 40.2 | 25.5 | 56 | 5.6 | 449.4 | |

**Table 4: Pearson Correlation Ship Between Difference in Temperature and Rainfall of Study Area**

| Pearson correlation ship between difference temperature and rainfall | | | | |
|---|---|---|---|---|
| **Pearson Correlation** | **Maximum_ Temprature (°C)** | **Minimum_ Temprature (°C)** | **Difference_ Temprature** | **Rainfall (MM) (°C)** |
| Maximum_Temprature(°C) | 1 | | | |
| Minimum_Temprature(°C) | .923** | 1 | | |
| Difference_Temprature(°C) | -0.285 | -0.632 | 1 | |
| Rainfall (MM) | 0.558 | .785* | -.832* | 1 |

Note - * = Correlation is significant at the 0.05 level (2 tailed); **= Correlation is significant at the 0.01 level (2 tailed).

## Discussion

There was a significant difference in maximum sunbathing time recorded in winter season (680±95.65) seconds and minimum was recorded (516.07±68.60) seconds in summer season. Maximum sunbathing time was observed in winter, $p<0.0001$(Table 7). Maximum sunbathing time was recorded in winter season due to low environmental temperature, high humidity and low wind velocity, this leads to increase thermoregulation time in long billed vulture during winter, but in summer season thermoregulation time decrease due to higher environment temperatures, high wind velocity and low humidity.

**Table 5: Pearson Correlation Ship Between Difference in Temperature and Duration of Sunbathing in Winter Season**

| Pearson Correlation between Humidity and sunbathing time in winter season | Maximum_ Temprature (°C) | Minimum_ Temprature (°C) | Difference_ Temprature (°C) | Humidity (%) (Kmph) | Wind velocity (Second) | Sunbathing time in Summer season |
|---|---|---|---|---|---|---|
| Maximum_Temprature(°C) | 1 | | | | | |
| Minimum_Temprature(°C) | .524* | 1 | | | | |
| Difference_Temprature(°C) | 0.449 | -.526* | 1 | | | |
| Humidity(%) | -0.443 | -.534* | 0.118 | 1 | | |
| Wind velocity (Kmph) | 0.1 | 0.113 | -0.019 | -0.478 | 1 | |
| Sunbathing time in Winter season | -.956** | -0.514 | -0.415 | 0.315 | -0.067 | 1 |

Note - * = Correlation is significant at the 0.05 level (2 tailed); **= Correlation is significant at the 0.01 level (2 tailed).

**Table 6: Pearson Correlation Ship Between Difference in Temperature and Duration of Sunbathing in Summer Season**

| Pearson Correlation between Humidity and sunbathing time in winter season | Maximum_ Temprature (°C) | Minimum_ Temprature (°C) | Difference_ Temprature (°C) | Humidity (%) (Kmph) | Wind velocity (Second) | Sunbathing time in Summer season |
|---|---|---|---|---|---|---|
| Maximum_Temprature(°C) | 1 | .534* | | | | |
| Minimum_Temprature(°C) | .534* | 1 | | | | |
| Difference_Temprature(°C) | -0.079 | -.885** | 1 | | | |
| Humidity(%) | -0.338 | -0.182 | 0.028 | 1 | | |
| Wind velocity (Kmph) | 0.044 | .683** | **-.781**** | 0.285 | 1 | |
| Sunbathing time in summer season | -.889** | -.633* | 0.256 | 0.08 | -0.163 | 1 |

Note - * = Correlation is significant at the 0.05 level (2 tailed); **= Correlation is significant at the 0.01 level (2 tailed).

**Table 7: Comparison of Mean, Standard Deviation Between Environmental Factors and Winter and Summer Season**

| Mean±Std. Deviation | Winter | Summer | p value |
|---|---|---|---|
| Maximum_Temprature(°C) | 27.11±2.88 | 39.35±2.1 | <0.0001 |
| Minimum_Temprature(°C) | 8.63±3.03 | 23.09±4.5 | <0.0001 |
| Difference_Temprature(°C) | 18.48±2.89 | 16.26±3.82 | 0.083 |
| Humidity(%) | 83.07±6.1 | 44.73±10.67 | <0.0001 |
| Wind velocity (Kmph) | 2.29±0.98 | 6.11±2.12 | <0.0001 |
| Sunbathinng time in different season (Second) | 680±95.65 | 516.07±68.6 | <0.0001 |

**Fig. 1: Thermoregulatory Behaviour in Long-Billed Vulture Inside Nest**

**Fig. 2: Thermoregulatory Behaviour in Long-Billed Vulture, Udaipur, Rajasthan**

**Fig. 3: Long-Billed Vulture Sitting on Rock, Udaipur Rajasthan**

**Fig. 4: Long-Billed Vulture Spreading Wing to Protect Nestling from Direct Exposure of Sun Light**

**Fig. 5: Stretching of Wing by Long-Billed Vulture in Nest**

**Fig. 6: Spreding of Wings by Long-Billed Vulture Nestling**

**Fig. 7: Thermoregulatory Behaviour in Long-Billed Vulture on Tree**

**Acknowledgment**

I ( Narayan Lal Choudhary)as research scholar is extremely thankful to CSIR-UGC for financial support. We want to thanks Principal Govt Meera Girls college, Udaipur for providing us infra structure and facility needed to carried out our research work. We sincerely thankful for Dr Satish sharma for their valuable suggestions. Last but not least Dr Nadim chishty (Assoc Professor) acknowledges to Commissionerate of College education-Jaipur Rajasthan for encouragement to do research work.

**Funding**

The author(s) received no financial support for the research, authorship, and/or publication of this article.

**Conflict of Interest**

The authors do not have any conflict of interest.

**References**

1. Kennedy, R.J. Sunbathing behaviour of Birds. *British Birds*. 1969; 62: 249-258.
2. Kennedy, R.J. Sunbathing behaviour of Birds. *British Birds.* 1969; 62: 249-258.
3. Heath, J.E... Temperature fluctuation in the turkey vulture. *Condor.* 1962; 64: 234-235.
4. Curry-Lindahl, K. Spread wing postures in Pelicaniformes and Ciconiiformes. *Auk.* 1970; 87: 371372.
5. Kushlan, J.A. Spread-wing posturing in cathartid vultures. *Auk.* 1973. 90: 899-890.
6. Tom J. Cade. Sun-Bathing as a thermo regulatory aid in birds. *The Condor.* 1973; 75: 106-133.
7. Slessers, M. Bathing behaviour of land birds, rhea. *Auk* 1970; 87: 91-99.
8. Clark, G.A. and Ohmart, R. D.. Spread-winged postures of turkey vultures: single or multiple functions. *Condor.* 1985; 87: 350-355.
9. Hamilton, W. J. and Heppner, F. H.. Radiant solar energy and the function of black homoeothermic pigmentation. *A hypothesis Science.* 1967; 155: 196197.
10. Lustick, S. Bird energetic: facts of artificial

radiation. *Science.* 1969; (1) 63: 387-390.

11. Marder, J..Body temperature regulation in the Brown-necked Raven (*Corvus coraxruficollis*)-II. Thermal changes in the plumage of ravens exposed to solar radiation. *Comparative Biochemistry Physiology journal.* 1973; 45: 431-440.
12. Walsberg, G.E., Campbell, G.S. and King, J.R. Animal coat colour and radiative heat gain: a-evaluation. *Journal of Comparative Physiology.* 1978; 126: 211-222.
13. Clark, G.A.. Spread- wing postures in pelicaniformes, Ciconiiformes, and Falconiformes. *Auk.* 1969; 86: 136-139.
14. Mueller, H.C. Sunbathing in Birds. Z. *Tier psychol.* 1992; 30: 253-258.
15. Schmidt-Nielsen K. Desert animals: Physiological problem of heat and water. Clarendon Press, Oxford.1964.
16. Scholander, P. F.. Evolution of climatic adaptation in homeotherms. *Evolution.* 1955; 9: 15-26.
17. Scholander P. F., Hock, R., Walters, V., Johnson, F. and Irving, L. . Heat regulation in some arctic and tropical mammals and birds. *Biology Bulletin.* 1955; 99: 237-258.
18. Irving, L., and Krog, H. Temperature of skin in the Arctic as a regulator of heat. *Journal of Applied Physiology.* 1955; 7: 355-364.
19. RCA Udaipur. Rajasthan meteorological department, Rajasthan College of Agriculture science Udaipur. *Annual weather forecasting report.* 2017 and 2018.
20. Sonika K. and Amita K. . Ecology of Vultures in and Around Orcha, Madhya Pradesh. *Asian journal of experimental biological science.* 2010; (1): 112-118.
21. Cade T. J., .Sun-Bathing as a thermoregulatory aid in birds. *The Condor* (1973); 75: 106-133.
22. James A. Mosher (1976). Raptor Energetic: A Review. *Journal of Raptor Research.* 1976; 10(4).
23. Hennemann, W.W. (1982).Energetic and spread winged behaviour in Anhinga in Florida. *Condor.* 1982; 84: 91-96.
24. Marsha A. S. Use of spread wing posture in Indian King Vulture (*Sarcogyps calvus* ). *Vulture News.* 1997; 36: 17-28.
25. Samson, A., Ramakrishanan, B., Renuka, S., Ravi, P. and Ramasubramanian, S. Bathing behaviour and waterhole importance of white rumped vulture conservation in the Sigur Plateau, Tamil Nadu, Southern India. *Journal of Applied Science And Research.* 2014; 2(5): 92-99.