



## Breeding and Mortality of African Lion (*Panthera leo leo* Linnaeus 1758) at Bahawalpur Zoo, Punjab, Pakistan



CrossMark

Sheikh Muhammad Azam<sup>1,6</sup>, Ahmad Ali<sup>2</sup>, Nisar Ahmad<sup>3</sup>, Muhammad Zubair Hussain<sup>4</sup>, Muhammad Khalid<sup>4</sup> and Muhammad Ejaz<sup>5</sup>

<sup>1</sup>Department of Zoology, Division of Science & Technology, University of Education Lahore, Pakistan

<sup>2</sup>Department of Zoology, Islamia University, Bahawalpur, Pakistan

<sup>3</sup>Department of Zoology, University of Jhang, Punjab, Pakistan

<sup>4</sup>Department of Zoology, Emerson University Multan, Pakistan

<sup>5</sup>Department of Statistics, Bahaudin Zakariya University Multan, Pakistan

<sup>6</sup>Bahawalpur Zoological Garden Bahawalpur Punjab, Pakistan

**P**RESENT study was conducted in order to estimate the breeding potential and mortality of African lion (*Panthera leo leo*, Linnaeus 1758) in captivity. Recorded data by the experts of zoo management for the period 2003 to 2011 and by research worker for the period 2012 through 2015 was included in the study. During study period, a total of 29 cubs were produced including 12 males and 17 females. During this period, 12 animals died including 7 males and 5 females. Among these, 2 were adults and 10 were young ones. The number of breeding animals (pairs) varied during this period. Estrus cycle in lioness ranged from 4-7 days and gestation period lasted for 110 days. Old age with related ailments was the cause of death in adults. Premature and underweight births, avoidance of females to adapt offspring, infanticide, and bacterial infections were the causes of infant mortality. As the observations during study period showed a good breeding outcome of African lion in the form of 29 cubs with a maxima of 6 cubs per annum and the mortality rate is less than that, therefore, it is rational to conclude that big cats like *Panthera leo leo* can breed successfully in captivity. It is concluded from this study that African lion in captivity has optimal breeding potential and the conservation status of this highly threatened species could be improved.

**Keywords:** African lion, Captivity, Breeding, Mortality, Reproductive potential, Infanticide, Bahawalpur Zoo.

### Introduction

Big cats that belong to genus *Panthera* of the order Carnivora are the most threatened and endangered mammalian species on earth, and hence are the subject of various conservation and reintroduction strategies [1]. The lion is one of the five big cat species in the genus *Panthera* [2]. Two subspecies of the lion are recognized on the basis of genetic analysis i.e. *Panthera leo leo* (African lion) and *Panthera leo persica* (Asiatic lion)

[3, 4]. *Panthera leo* is considered vulnerable in IUCN red list published in 2012 [5] (IUCN 2012). Until 1850, lions were spread across the India, and were found in MathyaPardesh, UtharPardesh, Gujrat, Rajasthan and Punjab [6]. In early 1900s, the Asian subspecies was considerably reduced and become confined to western India in the Gir Sanctuary of Gujrat state [7]. African lions are bred in captivity on commercial farms across country and often have close contact with workers may responsible for risk for disease and

threat for conservation [8] as the introduction of pathogenic *Mycobacterium* sp. Which cause threat to genetic diversity [9]. The lion is an iconic resident of zoos and wild animal parks throughout the world. Regular assessment of the morbidity of captive lions is necessary to address wellness concerns and improve the healthcare and management of this vulnerable species [10].

In the natural habitat, males usually do not have any chance to reproduce till the fifth year of their life [11]. There have been several studies on estrus cycle, ovulation [12], conception rate [13] and gestation period [10, 13, 14] in lioness. Food is a limiting factor in lion productivity. Four cub litters survive best in the abundance of prey, and survival reduces with the reduction of prey [15] Generation length about 7 year [16]. 27% of offspring mortality is also related to periods of prey shortage and infanticide by male lions [17, 18, 19]. Lioness has lived a maximum age of seventeen years in captivity; however mortality of lioness declines at 3-4 years and then increases rapidly. Maximum age of male noticed 16 years and an average of 12 years [10, 20].

There exists no evidence for the occurrence of lion in natural habitat in Pakistan. The last specimen of lion recorded within Pakistan territory was an animal shot in Sindh near KotDiji in 1810 [7]. The Asiatic lion was supposed to have been hunted at the beginning of the nineteenth century [21]. There has been no previous study in Pakistan on breeding and mortality of this big cat in captivity. The present study aimed to evaluate status of breeding and mortality of the *Panthera leo leo* in captivity.

#### **Material and Methods**

The Bahawalpur zoological garden was established in 1942 at Bahawalpur city (29.3956°N, 71.6836°E) that is situated in Cholistan desert, south of Sutlej River. The zoological garden covers an area of 25 acres, inhabiting nearly fifty five species with several rare wildlife species including *Gazella gazelle*, *Antilope cervicapra* and *Boselaphus tragocamelus*. It is also unique in terms of the breeding of the lions (*Panthera leo leo*) in Pakistan. Zoological garden also lion house, zoological museum and aviary. The design of cages / pens of zoological garden have been designed keeping in view the natural habitat and requirements of animals.

Administration of zoological garden is committed to ensure record keeping of data including breeding, husbandry and mortality in befitting manner. During pregnancy, female's behavior was monitored. At last month of pregnancy female was separated. It is assured that only one keeper should be attending the female to reduce the disturbance level. Gestation period was recorded in days. To study the congenital defects, the morphology of neonates was keenly observed. Dying cubs or adults were examined by postmortem examination with the help of veterinarian to evaluate the major cause of death. To understand the breeding, congenital defects and mortality of lion (*Panthera leo leo*) in Bahawalpur Zoological Garden, data was collected from 2003 to 2015. Study period comprises of two years (i.e. 01 July 2012 to 30 June 2014). We had collected data ourself during the study period and the previous data was obtained from the management of Bahawalpur Zoological Garden Bahawalpur since 2003 to 2012 & 2015.

#### **Results and Discussion**

During the study period from 2003 to 2015, a total of 29 cubs were born. Study period comprises of two years (i.e 01 July 2012 to 30 June 2014). we had collected data ourself during the study period and the previous data was obtained from the management of Bahawalpur Zoological Garden Bahawalpur since 2003 to 2012 & 2015. While the number of breeding pairs were varied (Table 1). Maximum breeding of lion was recorded in the years 2003 and 2004, with a litter size of six cubs. Whereas, year 2013 and 2015 were also highly prolific with a litter size of five cubs (Table 1). However, in several years i.e. 2009, 2011 and 2012, 2015 no breeding was recorded (Table 1). Lions breed throughout the year, however most births are noticed between April and March in captivity [8]. Food is a limiting factor in lion productivity (usually determined in number of surviving offspring). Four cub litters survive best in the abundance of prey, and survival reduces with the reduction of prey [15].

Out of 29 cubs, 12 were males and 17 were females, thus demonstrating a ratio of 1:1.5 between males and female. In a previous study, 1:1 gender ratio at the time of delivery has been reported [9]. In 2003 one male and five females were borne while in 2004 three males and three females were borne. In 2013, three males and two

females were born; while in 2014, two males and three females were born (Table 1). During the study period, estrus in lioness was recorded to occur between ranges from 5 to 7 days. This is in agreement with previous report of Rudnai (1973) who stated estrus period in lioness to last for 4 to 7 days [9]. Similarly gestation period of lioness lasted for 110 days in this study, also reported by other workers [10, 14].

Mortality was observed for adult lions and the cubs. Several reasons were recorded to cause mortality in adult lions and cubs (Table 1). These include old age with consequent paralysis for adult lions. Old age with associated health complications has also been identified as a major cause of death in adult lions in another study conducted in India [22]. The age limit for mortality in adult lions ranged from 2 days to 24 years. *Escherichia coli* infection, acute enteritis, impaction of stomach, premature births, underweight and infanticide were the causes of mortality for cubs. A high incidence of miscarriage, still births and premature births has been reported in captive carnivores [23]. Due to premature development, cubs are not able to survive and die soon after birth

[23]. Infant mortality can also be affected by birth weight [24]. The under weightiness and abnormal morphology may pose a problem for mother in adapting these pre mature cubs. Moreover, they have less immunity and environmental factors may negatively affect cubs [24].

In case of neglect of mother, the young ones die because of hunger, hypothermia or may be killed by mother by means of direct action, such as biting or by removing young from the nest. In case of pre mature born cubs which are not adopted by mother, the young ones die due to starvation as there was no lactation provided by mother or due to hypothermia as female did not provide the heat of lap [25]. Parental infanticide has different causes and benefits [26]. In extreme conditions, such as threat of predation, mammals may respond by reabsorbing litters or abortion, or eating them after birth. Depending upon the capacity of parents, they may produce another litter in the same season. It has been observed that after the episode of infanticide female come into estrus just after an interval of two weeks [26].

The age limit for mortality in cubs ranged from two to seventeen days and nine months

**TABLE 1. Breeding and mortality in African Lion (*Panthera leo leo*) in captivity during 2003-2015 at Bahawalpur Zoo, Bahawalpur, Punjab, Pakistan.**

Year	Number of breeding animals (M+F)	Litter size			Mortality rate			Age at Death	Cause of death	Shifting Status
		Male	Female	Total	Male	Female	Total			
2003	05+15	1	5	6	0	1	1	9 months	Unknown cause	6 adults, Lahore Zoo
2004	04+11	3	3	6	2	0	2	15, 17 days	Unknown cause	3 adults, Lahore Zoo
2005	02+10	0	1	1	0	0	0	No death	No mortality	3 adults, Lahore Zoo
2006	02+07	1	0	1	0	0	0	No death	No mortality	
2007	03+07	1	0	1	1	0	1	12 days	<i>E. coli</i> infection/Acute enteritis	2 adults, Lahore Zoo
2008	02+06	1	1	2	1	1	2	03, 03 days	Impaction of stomach	1 adult, Lahore Zoo
2009	02+05	0	0	0	0	0	0	No death	No mortality	2 adults, Lahore Zoo
2010	01+04	0	2	2	0	0	0	No death	No mortality	
2011	01+05	0	0	0	0	0	0	No death	No mortality	2 adults, Lahore Zoo
2012	01+03	0	0	0	0	0	0	No death	No mortality	
2013	02+02	3	2	5	1	1	2	2 days, 24 years,	Premature birth & mother infanticide, Hindquarter paralysis due to old age	-
2014	02+02	2	3	5	2	2	4	3, 9 days	Underweight cubs, not adopted by mother/mother infanticide	-
2015	02+02	0	0	0	0	0	0	No death	No mortality	4 adults, Lahore Zoo
Total		12	17	29	7	5	12	-	-	-

(Table 1). The highest mortality i.e. 4 cubs, was observed during the years 2014. No mortality was observed during the year 2005, 2006 and 2010. Lioness has lived a maximum age of seventeen years in captivity; however mortality of lioness declines at 3-4 years and then increases rapidly. Maximum age of male noticed 16 years and an average of 12 years [10, 20]. 27% of offspring mortality is also related to periods of prey shortage and infanticide by male lions [16- 19]. Juvenile endurance is unaltered by maternal survival or following reproduction; however cub's survival is dependent on maternal survival.

During present study period, infant mortality was also noticed to be related with inappropriate behavior symptoms of mother's. This finding is supported by the study of Edwards and Hawes (1997) who reported that most institutions leave the mother to raise her cubs, and follow the policy of very little interruption when the young's are being cared by the mother [27]. He argued that it is essential to separate the cub for hand rearing, usually after the episode of the aggressive behavior by the mother of cubs. The management decision of Bahawalpur Zoological Garden was to leave the cubs at the mercy of mother to adopt and feed them while concerning with some wildlife experts of Pakistan. But the display of mother's behavior was not appropriate at all. So they should be isolated and nursed by mechanism of hand feeding. More than rational trust on the mercy of mother may prove fatal for the cubs and their crying may pose a bad impact on mother's behavior which ultimately leads to the episode of infanticide. Than the remainder cubs were separated from the mother for purpose of hand rearing but they were also not survived and died soon after separation.

As the observations during study period showed a good breeding outcome of African lion in the form of 29 cubs with maxima of 6 cubs per annum and the mortality rate is less than that, therefore, it is rational to conclude that big cats like *Panthera leo* can breed successfully in captivity.

#### Acknowledgements

We are thankful to the Dr. Masood ul Haq Chuhdary for always being available for us and providing valuable suggestion regarding *Egypt. J. Vet. Sci.* **Vol. 54**, No. 2 (2023)

management of Lions in the captivity. We are also thankful to the Mr. Muhammad Nadeem Qureshi & Mr. Mujahid Kalim Ex- Curators of the Bahawalpur Zoo for their cooperation.

#### Conflict of interest

Authors have declared no conflict of interest.

#### References

1. Peixoto, K.V. Factors affecting breeding in captive carnivore. Thesis submitted in fulfilment of the requirements for degree of Doctor of Philosophy at the Univ. of Oxford (2003).
2. Murphy, J.W. and Ligang-davis., W.B. Supermatrix and species tree methods resolve phylogenetic relationships with big cats, *Panthera* (Carnivora: Felidae). *Mol. Phylogenet. Evol.*, **56**, 64-76(2010).
3. O'Brien, S.J. Biochemical genetic variation in geographical isolates of African and Asiatic Lions. *Natn. Geogr. Res.*, **3**,114-124(1987).
4. Dubach, J., Patterson, B.D. and Briggs, M.B. Molecular genetic variation across the southern and eastern geographic ranges of the African lion, *Pantheraleo*. *Conserv. Genet.*, **6**,15-24 (2005).
5. IUCN, 2012. <<http://www.iucnredlist.org/details/15951/0>>accessed 5 December 2013.
6. Chellam, R. and Johnsingh, A.J.T. Management of Asiatic lions in the Gir Forest, India. *Symposia of the Zoologi. Soci. of London*, **65**,409-424(1993).
7. Kinnear, N.B. The past and present distribution of the lion in south-eastern Asia. *J. Bombay Nat. Histor. Soci.*, **27**, 33-39 (1920).
8. Green, J., Jakins, C., Asfaw, E., Bruschi, N., Parker, A., de Waal, L. and D'Cruze, N. African Lions and Zoonotic Diseases: Implications for Commercial Lion Farms in South Africa. *Animals: an open access journal from MDPI*, **10**(9),1692( 2020).
9. Molenaar, F. M., Burr, P. D., Swift, B., Rees, C. and Masters, N. Conservation Challenges: The Limitations Of Antemortem Tuberculosis Testing In Captive Asiatic Lions (*Panthera leo*). *Journal of Zoo and Wildlife Medicine: Official publication of the American Association of Zoo Veterinarians*, **51**(2), 426-432(2020). <https://doi.org/10.1638/2019-0084>

10. Norton, B. B., Tunseth, D., Holder, K., Briggs, M., C Hayek, L. A. and Murray, S. Causes of morbidity in captive African lions (*Panthera leo*) in North America, 2001-2016. *Zoo Bio.*, **37**(5), 354–359 (2018). <https://doi.org/10.1002/zoo.21435>.
11. Smuts, G.L. 1982 (ed.). *Lion*. 1<sup>st</sup> Edn. Macmillan, South Africa.
12. Schramm, R.D., Briggs, M.B. and Reeves, J.J. Spontaneous and induced ovulation in the lion (*Panthera leo*). *Zoo Biol.*, **13**, 301–307 (1994).
13. Cooper, J. An exploratory study on African lions. *Compar. Psycho. Monog.*, **17**,1–48(1942).
14. Packer, C. and Pusey, A.E. Intra-sexual cooperation and the sex ratio in African lions. *Am. Nat.*, **130**,636–642 (1987).
15. Packer, C. and Pusey, A.E. The Lack clutch in a communal breeder: lion litter size is a mixed evolutionarily stable strategy. *Am. Nat.*, **145**, 833–841(1995).
16. Bauer, H., Packer, C., Funston, P.F., Henschel, P. and Nowell, K. *Panthera leo*. The IUCN red list of threatened species [Internet]. Version **2019** (1), e.T15951A97162455 (2016). [species assessed 2014 Jun 20; page accessed 2019 Apr 16]. <http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T15951A79929984.en>.
17. Schaller, G.B. *The Serengeti lion: a study of predator–prey relations*. Univ. of Chicago Press, Illinois(1972).
18. Van Orsdol, K., Hanby, J. and Bygott, J. Ecological correlates of lion social organization (*Pantheraleo*). *J. Zool. (London)*, **206**, 97–112(2009).
19. Whitman, K. and Packer, C. The effect of sport hunting on the social organization of the African lion (*Pantheraleo*).–In:Heerden,J. V. (ed.), *Proceedings of a symposium on lions and leopards as game ranch animals*. Wildlife Group of the South African Veterinary Association, Onderstepoort, Pretoria, South Africa. pp. 177–183 (1997).
20. Hanby, J. P. and Bygott, J. D. *Lions*.–In:Seidensticker, J and Lumpkin, S (Ed.),*Great cats*. Merehurst, London, United Kingdom, pp. 80–93 (1991).
21. Roberts, T. J. *The mammals of Pakistan*. Oxford Univ. press, Pakistan. pp. 152, 217, 221-222 (1997).
22. Pati, B.P., Hanif, B.M. and Pathak, B.J. Rescue and health status of big carnivores in and around gir protected area (GIR PA) Gujrat. pp. 1134. (2002).
23. Marker-krans, L. History of the cheetah, *Acinonyx jubatus*, in zoos, 1829-1994. *Intern. Zoo Yearbook*, **35**,27–43(1997).
24. O’Dongue, M. Early survival of juvenile snowshoe hares. *Ecology. Ecolog. Soci. of Am.*, **75**(6), 1582–1592 (1994).
25. Hayssen, V.D. Mammalian reproduction: constraints in the evolution of infanticide. – In:Hausfater, G and Hrdy S. B. (Ed.) *Infanticide, Comparative and Evolutionary Perspectives*. Aldine Press, New York, pp. 105–125 (1984).
26. Clutton-Brock, T.H. *The Evolution of Parental Care*. Princeton Univ. Press, Princeton, pp. 3521 (1991).
27. Edwards, M.S. and Hawes, J. An overview of small field hand rearing techniques and a case study for Mexican margay *Leopardus wiedii glaucula* at the Zoological Society of San Diego. *Intern. Zoo Yearbook*, **35**, 90–94 (1997).