barytes). Hardness is 3. The associated minerals are quartz, calcite, pyrite, malachite, pyrite and chalcopyrite. $BaSO_4$ content is highest in white barytes (94%) and lowest in brown barytes (47.7%).

Barytes has been reported from many geological environments (P. C. Avadich, unpublished). Various occurrences of barytes can be broadly classified into hydrothermal vein and cavity filling, bedded deposits and residual deposits.

In the present area of investigation, the occurrence of barytes has the following characteristics:

(i) It occurs in various types of veins crisscrossing the rocks.

(ii) The veins show various structures of cavity-filling massive veins, crustified veins, chambered veins, and linked veins.

(iii) It is hosted by a number of rock types, i.e. not confined to only one lithology. The host rocks are biotite–chlorite schist, greywacke and granites.

(iv) The contacts with enclosing rocks are generally sharp. The wall rock alteration of propylitic nature is associated with epithermal deposits[4].

On the basis of the above observations, it can be concluded that the barytes in Babarmal area is epigenetic hydrothermal vein and cavity filling type deposits.

The hydrothermal solution itself can carry the barium and sulphur ions. Barium ions along with ions of other metals, e.g. copper and iron, are transported as complex ions. Sulphur (H_2S, HS^-, S^{2-}) can be transported in the same solutions as metals[6,7]. The solubility of mineral species is controlled by a combination of pH and E_h, sulphur fugacity, temperature, pressure and halide concentration.

In the present area of investigation, the possible source of hydrothermal solutions could be Salumbar Granite. The mineralizing solutions have been derived as the last phase of igneous intrusion. Barium with other metal ions and sulphur ions has been carried in solution. Only low activity of sulphate ions (SO_4^{-2}) would permit the transportation of barium along with sulphur species.

While moving along various openings in the rocks, this hydrothermal solution mixed with other circulating fluids (meteoric, connate waters, etc.) has been oxidized. The reduced form of sulphur (H_2S, HS^-, S^{-2}) changed into sulphate ions (SO_4^{-2}). The barium and sulphate ions combined to form barium sulphate. Upon reaching the solubility limit it precipitated as barium sulphate, i.e. barytes in the veins and other openings available in different rocks of the area, along with other associated minerals. The present configuration of barytes mineralization is the result of various post-depositional tectonic and metamorphic episodes in the area.

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Breeding success of Oriental White Ibis (*Threskiornis melanocephalus* Latham) in captivity

Oriental White Ibis, also referred to as Indian White Ibis (*Threskiornis melanocephalus* Latham), is a nomadic, ciconiiformes water bird that gregariously frequents shallow wetland habitats in India[1–3]. Its breeding season is June to August in North India, November to February in South India[4] and late June to October in Saurashtra region, Gujarat, depending on the onset of monsoon[5]. Except for the reports of Gadhvi and Soni[6] from Bhavnagar region and Tiwari and Rahmani[7] from Kutch in Gujarat, reports on breeding of White Ibis from western India are scanty. Although a commonly sighted bird in the wetlands of Gujarat[8], a recent report from South India refers to White Ibis as a near threatened species[9]. The nesting colonies of Ciconiiformes and Pelecaniformes, popularly known as heronries or egretries[1], require extensive foraging areas for breeding[10]. Predators selectively attack the nesting colonies in unmanned areas, rendering late nesters more susceptible to predatory loss of nestlings[11] and forcing them to form nesting colonies near human habitations[12]. The nesting of White Ibis in crowded urban environs[13] is a result of its adaptability towards choice of nesting site and limited foraging range. The nest of Oriental White Ibis is a platform of twigs and sticks, usually unlined but built on tops of bamboo, emergent shrubs and moderate to tall-sized trees such as *Prosopis*, *Acacia*, and various species of *Ficus* that stand in or near water[4,5,14]. Breeding of White Ibis in captivity has not been documented in detail. A single pair of White Ibis had bred at Arignar Anna Zoological Park, Vandalur, after a decade of efforts by zookeepers and officials[15]. Another report by Dash and Mohanty[16] from Nandankanan Zoological Park is among the only few recent records of its breeding in captivity. However, factors affecting the captive breeding score of Threskiornids remain grossly unclear because such reports fail to elaborate the details of seasonal breeding cycle, type of artificial nest and nesting material required for successful breeding in captivity. Since its reproductive success in captivity has never been systematically documented, this inventory is an effort to study its breeding in captive environs. It is well acknowledged that failure to protect at-risk species is likely to result in an accelerated loss of biodiversity at a regional perspective[17]. The information generated herein can be important in management of this species for conservation purposes.

This study was carried out from October 2003 to September 2004 at Sakkarbaug Zoo Aviary in Junagadh city, Gujarat, India. Junagadh town (021°31′N lat., 070°49′E lon., +05:30 time zone, 82 to 92 m a msl, rainfall 35–40 in) is located in Saurashtra region, Gujarat. Sakkarbaug Zoo is the largest in Gujarat and the third oldest zoo in India that attracts thousands of tourists every year. White Ibises were housed in an aviary (51 × 32 × 20 ft) made of wire mesh and iron angles. The aviary had an artificial pond (33.70 × 18.80 × 1 ft) and feeding tray (3.25 × 2.25 ft). Birds were fed tilapia fish (*Tilapia mosambica*) and beef khima (minced beef) *ad libitum* daily at 1100 and 1600 h. Five artificial nesting platforms (ANPs) (4 ft × 2.50 ft × 5 in) made of iron frame and iron mesh were located at a height of 12.9 ft from the ground level and 13.8 ft apart (Figure 1). These ANPs were welded to the vertical grill (wall) of the aviary. The design of ANPs was based on pilot observations of nesting behaviour of White Ibises in aviary and literature survey[18,19]. Diameter of nests made on ANPs was measured as mentioned by Sykes[20]. A binocular (7 × 21, 'Olympus', Japan) was used for daily observations, and manual handling of eggs, nests or birds was avoided during the breeding season.

Aviary houses like neem (*Azadarachta indica*), banyan (*Ficus bengalensis*) and goras amli (*Pithecolobium dulce*) trees provided partial protection to ANPs from direct sunlight and wind. The pilot observations of nidification activities revealed that the birds were most active during morning and evening. Initially, nest-building behaviour of one pair of ibis was studied by monitoring the activities continuously for 15 min with a gap of 15 min, daily from 0800 to 1000 h in the morning and from 1600 to 1800 h in the evening. Observations revealed that fresh leaves and dry twigs of plants inside the aviary were inadequate. Hence, birds were supplied randomly assorted dry twigs (1 to 2.5 ft long) daily to ensure abundant availability of nesting material. The average diameter of the nest of White Ibis was 20 in, whereas the 'cup' measured 6 in in diameter and 3 in deep. The aviary housed 19 adult White Ibises, out of which eight breeding pairs were observed to be actively involved in courtship display. Three ANPs were used for nest-building, whereas the remaining two ANPs were used for perching or occasional courtship rituals. The breeding pairs made nine nests at different time intervals. Each of the ANPs had three nests. Eight nests were used for egg-laying, whereas one nest was discarded. The same or a different pair of White Ibis reused the nests during subsequent breeding cycles. Each breeding pair was seen to make some minor corrections/alterations by putting a few fresh/dry twigs before reusing the nest for its next breeding cycle. Both male and female birds contributed to nest-building. Stealing of nesting material from the neighbouring nest was a common feature. The remaining three sub-adult birds were seen feeding independently and did not participate in courtship behaviour during the period of study. Hence, they have not been considered for calculating the overall reproductive success.

Figure 1. Nesting of Oriental White Ibis (*Threskiomis melanocephalus*) in zoo aviary. Note the artificial nesting platforms.

The entire period of study was divided into four phases for the sake of convenience (phases I–IV as detailed below). Observations recorded during different phases include the total number eggs laid by the breeding pairs, number of eggs hatched, not hatched, broken and the mortality and natality of chicks (Table 1). The % value and the mean value were calculated for each of the parameters mentioned above.

Phase I (October to December 2003): Totally 21 eggs were laid during this phase over a period of three months. Two eggs were broken and were removed from the nest by either of the parents. Out of the remaining 19 eggs, 13 hatched whereas the rest failed to hatch. Except for one, the remaining 12 chicks survived till the end of the study.

Phase II (January to March 2004): Fifteen eggs were laid during this phase, of which two were broken during incubation. Four eggs were hatched, whereas nine failed to hatch. One of the chicks died and the remaining three survived till the end of study.

Phase III (April to June 2004): During this phase, twenty eggs were recorded. Four eggs were broken during incubation and 10 failed to hatch. The remaining six eggs hatched and the chicks survived till the end of study.

Phase IV (July to September 2004): During this phase, 24 eggs were laid, seven hatched, whereas 17 failed to hatch. One of the chicks died, whereas the remaining six survived till the end of study.

It was interesting to note that either the same or a different pair of ibis reused the nests during subsequent breeding cycle. Each bird laid 2–4 eggs per nest. The average incubation time in captivity was observed to be 27–29 days. Observations indicate that breeding season of Oriental White Ibis extends throughout the year in captivity, keeping in view that egg-laying occurred in all the four phases of study. Lack of natural predator in captivity environs and plenty of food and water can be the reason for a prolonged breeding season spanning virtually throughout the year. Extrinsic factors like good rainfall[21] and familiarity of foraging areas[22] are known to have a positive effect on the reproduction of White Ibis in its natural habitat. Natural predators, mainly birds of prey, play an important role in the survival of chicks of ibises in heronries[9].

Table 1. Breeding score of White Ibises in captivity (actual values and % are represented)

	Phase of study				
	Phase I (Oct. 2003 to Dec. 2003)	Phase II (Jan. to Mar. 2004)	Phase III (Apr. to June 2004)	Phase IV (July to Sept. 2004)	Overall (Mean ± SE)
Total eggs laid	21	15	20	24	20.00 ± 1.87
Total eggs broken	2 (9.52%)	2 (13.33%)	4 (20%)	0	2.00 ± 0.81
Total eggs not hatched	6 (28.57%)	9 (60%)	10 (50%)	17 (70.83%)	8.00 ± 0.91
Total hatchability	13 (61.90%)	4 (26.66%)	6 (30%)	7 (29.16%)	7.50 ± 1.93
Total mortality of chicks	1 (7.69%)	1 (25%)	0	1 (14.28%)	0.75 ± 0.25
Total natality of chicks	12 (92.3%)	3 (75%)	6 (100%)	6 (90%)	6.75 ± 1.88

n = 8 pairs; % breakage of eggs and % eggs hatched/not-hatched are calculated based on total number of eggs in the respective phases, whereas % mortality and natality are calculated taking into account the total hatchability in each phase.

Overall, low percentage mortality (0.75) observed in the present study can be attributed to the absence of natural predators in captivity. Also, reports on nesting Reef heron (*Egretta gularis*) in crowded city areas[23] and of White Ibis in busy suburban areas[13] indicate adaptability of wetland birds and selection of nesting sites. This adaptation is comparable to the present context, wherein White Ibises in zoo aviary were oblivious to noisy tourists and showed acceptance towards ANPs and nesting material available/provided. Also, the preference of building three nests on one ANP corroborates the idea of a crowded nesting colony as seen in its natural habitats[4]. Major environmental changes (such as in captivity) demand major behavioural changes such as shortened futile flights symbolizing foraging and stealing of nesting material, in spite of its relative abundance inside the aviary. These adaptations with respect to its nesting behaviour are a definite shift from its conventional choice that often is near isolated water bodies[4] or islands[24]. The number of eggs laid during each phase of study ranged from 15 to 24, with a marginal decline during phase II. The breeding season of White Ibises recorded in Saurashtra region, Gujarat was from April to October[6]. Results of the present study, however, indicate that maximum percentage hatchability of eggs and percentage natality was during phase I. The reason for a shift in its peak breeding season is hard to interpret, but reproductive success during this period can be attributed to high percentage hatchability of eggs. This shift can be attributed to obliging artificial conditions that fulfilled *in situ* requirements of White Ibises during this phase. Although phases III and IV recorded higher number of eggs, the percentage of eggs that failed to hatch was also the highest (Table 1). The poor percentage hatchability observed in phases III and IV requires further scrutiny. Studies on breeding of White Ibis in western India have shown that its longest breeding season has been from January to August (2001) due to good rainfall, followed by a poor breeding score as a result of decreased reproductive efficiency[6]. Hence, it may be assumed that the poor hatchability in phases III and IV may be due to testicular exhaustion or drastic changes in endocrine milieu. The reason for high percentage of unhatched eggs can be attributed to high hatchability rate and higher percentage natality in the preceding phases of study. These facts, however, need to be ascertained by hormone assays. The low mean mortality and high mean natality number can be attributed to favourable conditions in captivity, that enable eight breeding pairs of White Ibises to successfully rear 27 chicks in captivity, amounting to 2.68 times increase in the existing number of birds (i.e. from 16 to 43) during one year of the present investigation.

A variety of anthropogenic alterations have made most of the wetland habitats vulnerable, whereas their further degradation fails to provide the quality-feeding habitat for wetland birds[25]. Local population of birds is critically vulnerable to loss of breeding habitat and nomadic species pose special management and conservation challenges due to the large area they occupy and their unique population dynamics[24]. Studies on captive breeding of wetland birds, especially White Ibises, are mandatory since their numbers contribute greatly in determining the avian density and biodiversity index of any of the wetlands in India[6]. Under these circumstances, Sakkarbaug Zoo and other zoos in India and South Asia can play a pivotal role in generating first-hand information regarding specialist captive breeding programmes of zoo animals. White Ibises are important wetland birds and are categorized as schedule IV species under the Indian Wildlife Protection Act (1972). Detailed information pertaining to scientific management of its captive environs and subsequent behavioural changes culminating in a successful breeding programme have academic and applicative value, as it can be of interest to avian biologists and wildlife managers.

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MEETINGS/SYMPOSIA/SEMINARS

National Workshop on Bioassays in Plant Cells for the Improvement of Ecosystem

Date: 13–16 February 2006
Place: Kolkata

The training programme will mainly focus on the techniques to biomonitor environmental genotoxins with an emphasis on plant bioassays. Single cell gel electrophoresis or Comet assay techniques will be covered in addition to CA, MN and SCE.

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National Symposium on Computational Biology (NSCB2006)

Date: 23–25 January
Place: Changanacherry

Topics include: Molecular modeling, Artificial intelligence, *Ab initio* protein structure prediction, Neural networking, Drug target development using genome bioinformatics and medicine, Cluster computing, Many other topics in computational biology, biology and computer science.

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