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Seasonal Variation in the Population of Indian Black Ibis *Pseudibis papillosa,* Inhabiting the Arid Zone of Rajasthan, India

K.C. Soni[1*], A.N. Sharma[2] and V.C. Soni[3]

[1]*Department of Zoology, Lohia P.G. College, Churu, Rajasthan-331001, India*
[2]*Principal, Tilak Mahavidyalaya, Bassi, Jaipur, Rajasthan, India*
[3]*Department of Bioscience, Saurastra University, Rajkot, Gujarat, India*
[*]E-mail: *kcsibis@yahoo.com*

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Abstract

The population of Black ibis (*Pseudibis papillosa*) inhabiting rural and urban area of Churu city, Rajasthan was seasonally determined by the direct count method. The counting of the Black ibis was made at roosting sites of Churu city (28°15′N and 74°55′E, 286 msl) and it's out skirts area of 400 km^2. Total 35 roosting sites were identified in the study area of which 19 were located in the urban area and 16 in the rural areas. It was found that number was relatively higher from June to August in 2003, 2004 and 2005. However, the number was highest from June 2004 to August 2004 and lowest from June 2006 to August 2006. The maximum number of adult was noticed in the rainy months of every year. A sharp decline in the juvenile population was observed from January 2004 to April 2004. Maximum 17 juvenile birds were observed in the months of May and June 2004 and October 2005 while the minimum 4 juveniles were observed in January 2005. An average 40.08±3.62 and 35.33±4.61 in 2003, 42.5±4.81 and 43.16±8.69 in 2004, 42.16±4.23 and 38.33±4.47 in 2005 and 36.25±3.81 and 34.91±4.52 in 2006 ibises were recorded in rural and urban areas, respectively. The maximum number of ibis i.e. 101 individuals, occurred in the month of June, 2004. But in general, the population remained more or less constant with seasonal variations involving dispersion during the monsoons and aggregation during the winters. The winter season adversely affects the population of Black ibis in the study area because of the non availability of preferential food, particularly insects.

***Key words*:** Seasonal variation, population, Black ibis, arid zone, Rajasthan, India

Introduction

It is important to know the population size of a species for ecological studies. Counts of birds are used for many purposes in a variety of field studies. Simple presence or absence information suffices to study avian biogeography, but indices of abundance are needed to track the changing mix of species population associated with plant succession. Still other studies, as of trophic dynamics, require knowledge of population densities.

There are several methods to census the terrestrial birds (Ralf and Scott, 1981; Davis, 1982). However, any census technique is not absolutely perfect for population estimation of diverse avian species, because each census technique has

advantages and disadvantages (Pyke and Recher, 1984; 1985; Pyke, 1986). Some methods are accurate, some are fast, some are fun and some bird census techniques pose special methodological problems (Bull, 1981; Dawson, 1981). Many factors could influence applicability of census method, such as habitat type, weather condition, time of census, effect of observer, and behaviour of species (Conant *et al*., 1981; Robbins, 1981; Skirvin, 1981; Verner, 1985; Koen, 1988; Soni, 2008).

Many Indian bird species roost communally (Gadgil and Ali, 1975). Since the Ibis is fairly large size bird, it is easy to count individuals at roost sites when the species aggregates as per its communal roosting habit (Salimkumar, 1982). A tendency of the bird to return in fairly equal numbers from one night to the following at the selected site was noticed during the pilot study. This behaviour was considered in designing the study method to cover all located and identified roost sites monthly to perform a population census, including individuals scattered in the study area. According to Chavda (1988), aggregations of the Ibis are larger and more stable at the roosts than on the feeding grounds. Referring to this method, it is more reliable to carry out a census at roost sites than on the foraging ground, though the Ibis is a flocking feeder.

Ward and Zahavi (1973) reported that the birds which feed together usually roost together. The birds select as their roost sites locations nearest to their feeding sites (Gadgil and Ali, 1975).Hence it was deliberated that for flock feeding Ibis, direct counts obtained at roosts might give a most reliable census result. This method was earlier applied by Davis (1982), Salimkumar (1982), Sykes (1983), Sheshukumar (1984), Chavda (1988) and Lathigara (1989). In present study, the method was standardized and census was carried out for long period to understand the trends in population fluctuation.

Population of Black ibis is also estimated every year at various aquatic habitats in India and abroad as a part of Asian Waterfowl Census (AWC) conducted by Asian Wetland Bureau (AWB). In the present study, seasonal variations in the populations of the Black ibis were studied. Comparison was made between the population estimated by the direct count method at terrestrial habitats and counts at aquatic habitats. The counting of the Black ibis in and around Churu city of arid zone of Rajasthan was carried out by using various methods as mentioned in material and methods.

Materials and methods

The study was carried out in and around Churu city, Rajasthan, India covering 400 Km^2 area (29°N and 75°E, rainfall 325 mm, altitude 286 msl). The study area was surveyed and roost sites located either by following the flocks of Black ibis returning from their feeding grounds to night roost or by listening to their calls from roost sites early in the morning, and by gathering information from the local people. Observations were made with the help of a binocular (Olympus, 10×50) at the distance of about 40 m from the roosts to avoid interruption of the birds behaviour. All observations were made in clear weather. Data on rainfall, temperature and humidity were collected from the Meteorological Department of Churu to seek any affect inclement weather may have on the population's fluctuation. The population of the Black ibis was decided by using

counting at roosting site method. Other methods like nest counting method, point counting method and transect counting method were considered improper due to specific size and behaviour of the Black ibis. Based on a pilot study of consecutive 7 days counts of the ibis at the roost sites selected, it was henceforth assumed that the average number of ibis at any one roost remains more or less constant for a period of at least three week. Each census was carried out during first two weeks of the month. It was assumed no radical overlap of individuals among the different roosts in the study area. Numbers of ibis at roosts were counted either during late evenings or early mornings. Evening counts were started about 2 hours before sunset with no birds in roosts, and continued until dark. Morning counts were started before sunrise when all night roosters were present. Each ibis lacking red warts and the prominent yellow iris was considered to be a juvenile bird so it was possible to census the population of young individuals separately from the mature birds (Ali and Ripley, 1983). The numbers of ibis at all active roosts were recorded every month and the total of the roosts was treated as a population.

Results

Total 35 roost sites were identified in the study area of which 19 were located in the urban area and 16 in the rural area. All of the sites were monitored once a month to record the number of birds at each site. Birds were counted at roosting on khejadi tree during day time. They were also counted at roosting on Neem, Peepal and Bargad trees during night. It was found that number was relatively higher from June to August in 2003, 2004 and 2005 (Table 1). However, the number was highest from June, 2004 to August, 2004 and lowest from June, 2006 to August, 2006 (Figure 1).

Figure 2 highlight the population trend of juvenile and adult ibis during the study period. The maximum number of adult was noticed in the rainy months of every year. A sharp decline in the juvenile population was observed from January, 2004 to April, 2004. Maximum 17 juvenile birds were observed in the month of May, 2004; June, 2004 and October, 2005 while the minimum 4 juveniles were observed in January, 2005. There was not a single month when we did not find juvenile ibis.

Figure 3 highlight a positive relationship between the size of the ibis population and rainfall during rainy season. The population of the ibis attained maximum average 85.66±11.53 during 2004 when the study area received 343 mm of rain, whereas population was found to lower average of 71.16±1.52 in 2006 when the study area received only 223 mm of rain. In 2005, rainfall was 522 mm and above the average, but population was 79.66±5.89 and noticeably lowers in comparison to previous year 2004 (Table 2). An average of 77.97±8.74 ibis were recorded during the study period of 48 months from January, 2003 to December, 2006 with slightly lower number averaging 77.54±6.00 during high rainfall in 2003 and 2005 and slightly higher but consistent number averaging 78.41±10.93 during low rainfall year of 2004 and 2006..

Table 3 depicts that an average 40.08±3.62 and 35.33±4.61 ibises in 2003, 42.5±4.81 and 43.16±8.69 in 2004, 42.16±4.23 and 38.33±4.47 in 2005 and 36.25±3.81 and 34.91±4.52 in 2006 were recorded in rural and urban areas respectively. The bird showed a strong preference for the rural area for roosting in

2003, 2005 and 2006 while in 2004 bird showed preference for roosting in urban area. However, there was no much great difference in preference for rural and urban area during the study period of 2003 to 2006. An average 40.25±4.73 and 37.93±6.57 ibis were recorded in rural and urban area respectively during the study period of January, 2003 to December, 2006.

Figure 4 depicts that in overall study period of 48 months from January, 2003 to December, 2006 the bird preferred rural roosting sites in 26 months and urban roosting sites in 21 months and in one month rural and urban preference was same.

The maximum number of ibis i.e. 101 individuals, occurred in the month of June, 2004. But in general, the population remained more or less constant with seasonal variations involving dispersion during the monsoons and aggregation during the winters (Figure 1).

Maximum 17 juvenile birds were found in the month of May, June, 2004 and in October, 2005. The lowest number of juveniles occurred in the month of March, 2003 and January, 2004.

Discussion

The population of the birds follows fluctuations as per climatic changes, so also the Black ibis. The population count of this bird at roosting sites shows seasonal variation. The number of the bird was more during rainy season and less in winter and summer seasons. The reason of comparatively more number during rainy season may be due to high prey availability. Kushlan (1976) also reported similar tendency of some wading birds to aggregate at sites of high prey availability in favourable season. It can be stated that the species would be expected to be more packed as environmental variation decreases, resulting in monophasia (May and MacArthur, 1972).

Data presented in Figure 1 shows that population of the Black ibis was maximum during the rainy seasons of 2003 to 2005 while it was comparatively low in the rainy season of 2006 due to low rainfall in this year. The population of this bird was medium during the summer seasons and low during the winter of 2003 to 2006. It may be due to low availability of food during these seasons.

Graphical presentation of data in Figure 2 depicts that the Juveniles numbers was more during post rainy months and pre winter months as the bird preferentially breeds during February to July i.e. pre monsoon season in this arid zone area.

Data of Figure 3 indicates that there is direct relationship between rainfall and the number of population of the Black ibis because good rainfall results in the availability of insects as food to the bird. However, low rainfall during 2006 could not improve the number of birds in the rainy season of this year. The diet of the Black ibis suggests the bird is largely a generalist, including, macro-invertebrates, and human garbage e.g. food scrapes etc. Similar observations have been made in Sacred ibis also (Clark, 1979; Kopij *et al*., 1996; Clergeau and Yesou, 2006; Williams and Ward, 2006). The generalist nature of the Black ibis in diet decides its population in different microhabitats in different seasons.

Data of Figure 4 show that there were some correlations between the availability of food in the rural and urban area of the study area and the population of the Black ibis. The number of ibis was comparatively more in rural area during winter and rainy seasons as the bird rends to feed in the sand

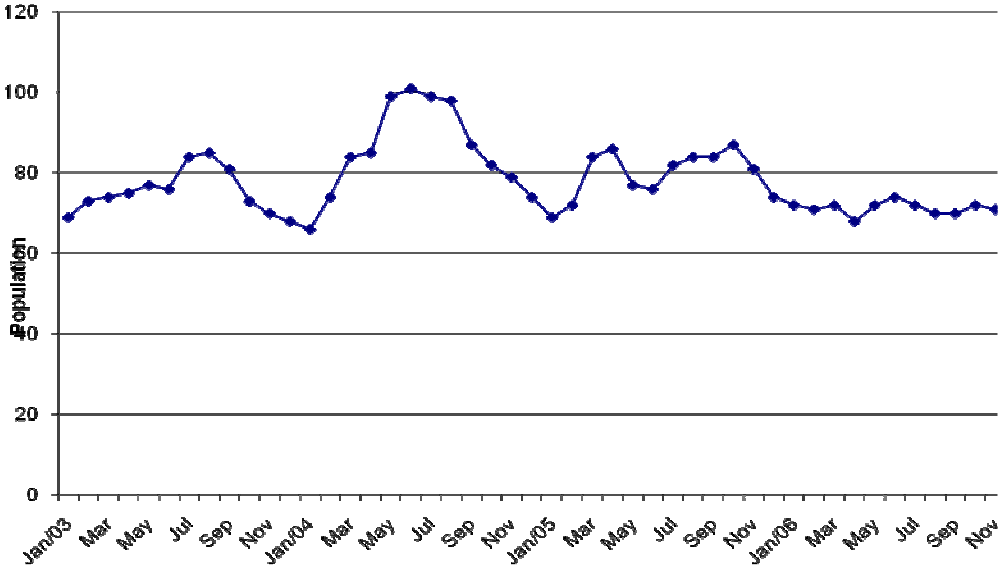

Figure 1. Monthlywise population trend of the Black Ibis from January 2003 to December 2006

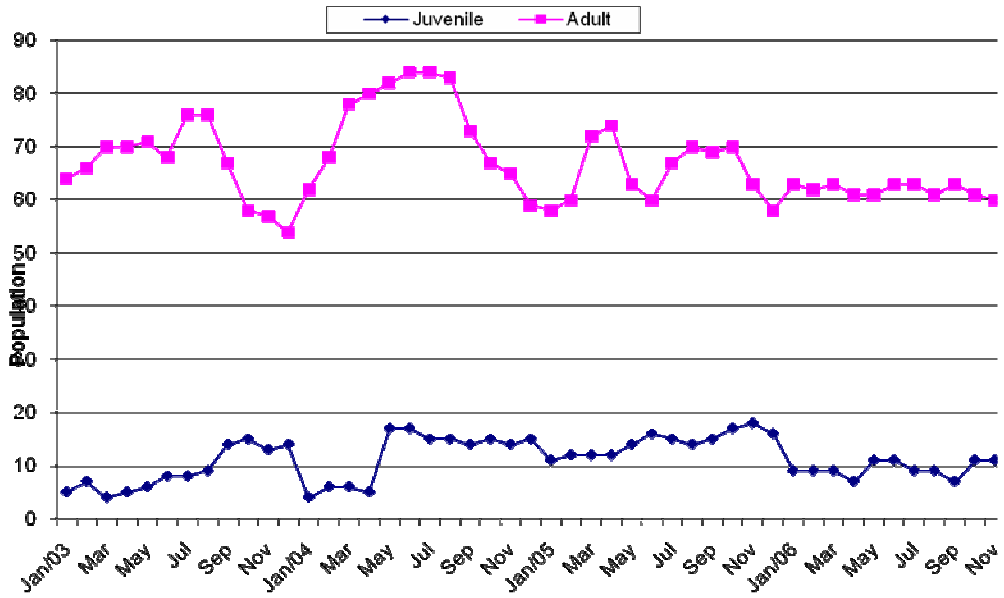

Figure 2. Monthwise population trend of Juvenile and adult Ibis from January 2003 to December 2006.

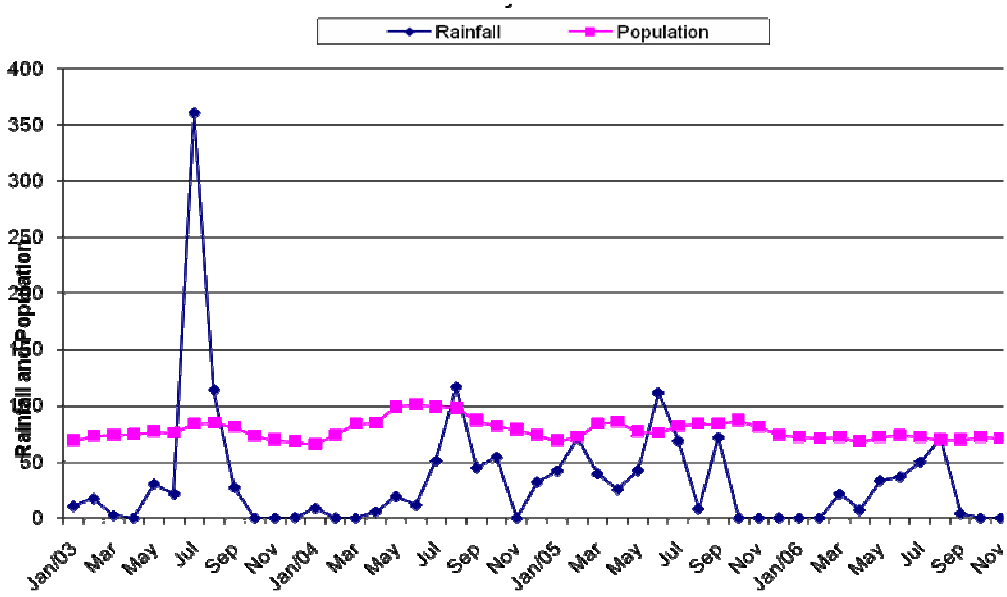

Figure 3. Graph showing correlation between rainfall and population of Black Ibis from January 2003 to December 2006

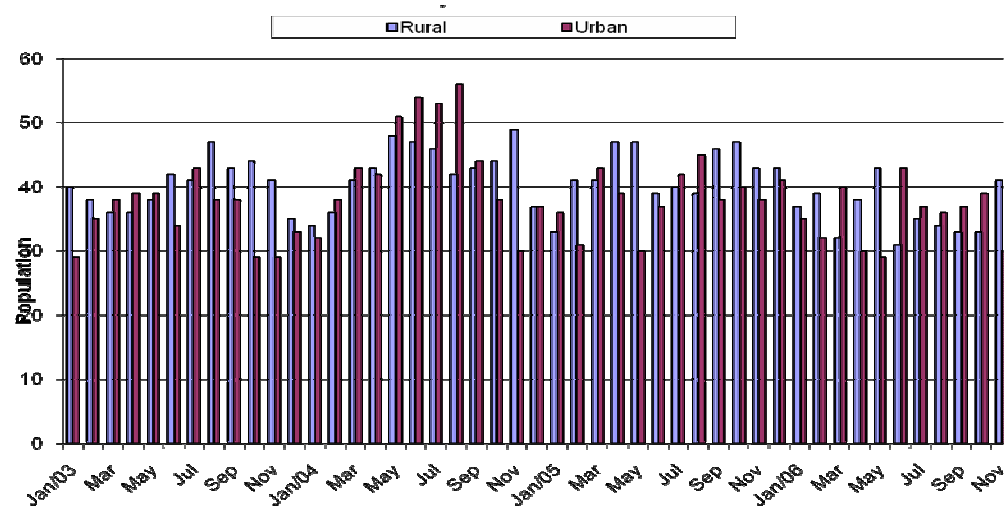

Figure 4. Monthwise population of the Ibis in rural and urban roost sites from January 2003 to December 2006.

dunes, grazing fields and agriculture fields in these seasons. In summer, the bird used to confine to the waste water bodies, Municipal garbage dumping stations in the nearby area of the city i.e. the urban area. The flock size of the Black ibis varies significantly with seasons. Similar correlation is also reported in Wooly necked

Table 1. Monthwise population of the Black ibis from January 2003 to December 2006 at roosting sites.

Year	**2003**			**2004**			**2005**			**2006**		
Month	Juvenile	Adult	Total	Juvenile	Adult	Total	Juvenile	Adult	Total	Juvenile	Adult	Total
January	5	64	69	4	62	66	11	58	69	9	63	72
February	7	66	73	6	68	74	12	60	72	9	62	71
March	4	70	74	6	78	84	12	72	84	9	63	72
April	5	70	75	5	80	85	12	74	86	7	61	68
May	6	71	77	17	82	99	14	63	77	11	61	72
June	8	68	76	17	84	101	16	60	76	11	63	74
July	8	76	84	15	84	99	15	67	82	9	63	72
August	9	76	85	15	83	98	14	70	84	9	61	70
September	14	67	81	14	73	87	15	69	84	7	63	70
October	15	58	73	15	67	82	17	70	87	11	61	72
November	13	57	70	14	65	79	18	63	81	11	60	71
December	14	54	68	15	59	74	16	58	74	9	61	70
Total	108	797	**905**	143	885	**1028**	172	784	**956**	112	742	**854**
Average monthly population	9 ±3.97	66.41 ±7.08	75.41 ±5.50	11.91 ±5.03	73.75 ±9.20	85.66 ±11.53	14.33 ±2.22	65.33 ±5.67	79.66 ±5.89	9.33 ±1.43	61.83 ±1.11	71.16 ±1.52

Table 2. Annual population of the ibis recorded at the study area and occurrence of rainfall during the same period.

Year of observation	**Population**	**Rainfall(mm)**
2003, N=12	X:75.4, SD±5.10	583
2004, N=12	X:92.6, SD±6.83	343
2005, N=12	X:85.58, SD±2.99	522
2006, N=12	X:81.7, SD±1.65	223

N= number of observations per year, X= average number of the ibis.

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Table 3. Monthwise population of the Black ibis from January 2003 to December 2006 in rural and urban area.

Year	2003			2004			2005			2006		
Month	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
January	40	29	69	34	32	66	33	36	69	37	35	72
February	38	35	73	36	38	74	41	31	72	39	32	71
March	36	38	74	41	43	84	41	43	84	32	40	72
April	36	39	75	43	42	85	47	39	86	38	30	68
May	38	39	77	48	51	99	47	30	77	43	29	72
June	42	34	76	47	54	101	39	37	76	31	43	74
July	41	43	84	46	53	99	40	42	82	35	37	72
August	47	38	85	42	56	98	39	45	84	34	36	70
September	43	38	81	43	44	87	46	38	84	33	37	70
October	44	29	73	44	38	82	47	40	87	33	39	72
November	41	29	70	49	30	79	43	38	81	41	30	71
December	35	33	68	37	37	74	43	41	74	39	31	70
Total	481	424	**905**	510	518	**1028**	506	450	**956**	435	419	**854**
Average monthly population	40.08 ±3.62	35.33 ±4.61	75.41 ±5.50	42.5 ±4.81	43.16 ±8.69	85.66 ±11.53	42.16 ±4.23	38.33 ±4.47	79.66 ±5.89	36.25 ±3.81	34.91 ±4.52	71.16 ±1.52

storks and Black headed ibis (Gopisundar, 2006).

The ability to exploit diverse feeding grounds enables the ibis to traverse both natural and man-made microhabitats. The scattered form of flocking during a normal rainfall year would allow the birds to forage in a variety of grounds, such as grazing field, agricultural farm houses and waste water bodies. An exact opposite situation occurs in the drought period. A phenomenon of the normal rainfall results in unlimited food supply, which leads to provincial emigration. However, lower rainfall restricts the useable foraging grounds, leading to the utility of limited resources, such as municipal garbage dumping station, waste water bodies, sand dunes, and animal dead bodies dumping station in rural area. That is why higher numbers of individuals prefers roosts in close proximity of feeding sites in the rural area. Even distribution of the birds supports this hypothesis that aggregation or dispersion is related to the availability of food resources and species would be expected to be more packed as environmental variation decreases, resulting in monophasia (May and MacArthur, 1972). Thus conclusion can be drawn that the dispersal of the ibis depends upon climatic conditions affecting food availability.

As breeding virtually ceases in winters, solitary breeding pairs tend to aggregate at communal roosts with their offspring's, which increases the strength of flock size. Stead (1932) recorded aggregation of the Australian harrier at certain roost sites just after the breeding season. This behaviour plays a potential role in the learning and social structure for the juveniles. They can follow the search and exploitation techniques of the adults during the period of potential limited resources in the shorter days of winter.

Post winter is a beginning of the breeding season for the majority of the avifaunal species all over the world. Besides heat regulation and its antipredation mechanism, a communal roost influences pair formation and pair bonding for the following breeding season. Observations by Gurr (1968) on the courtship behaviour of the Australian harrier on the roost supports the probable fact of communal roosting provides better mate selection and flow of stronger genes in future generations.

During good rainfall years, insect fauna and aquatic habitat flourish well. Apparently such situations encourage breeding dispersion during the pre and post winter periods, and with the normal bumps and busts the recruitment of young ibises at communal roosts during the winter. And finally, by and large conservative practices, religious attitude of multimillionaire people of the area and biodiversity of the Rajasthan state supports continuance of a substantive number of the ibis in both its urban and rural areas with periodically internal variations depending on climatic changes, food availability, and breeding strategies.

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