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Research Article

Studies on the Food and Feeding Habits of Swamp Deer (*Rucervus duvaucelii duvaucelii*) in Jhilmil Jheel Conservation Reserve, Haridwar, Uttarakhand, India

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Food habits of the swamp deer (*Rucervus duvaucelii duvaucelii*) were studied in and around Jhilmil Jheel Conservation Reserve (JJCR), Uttarakhand, for two years. This population (320 in number) was recently rediscovered in the state (2005) and warranted an ecological study because the habitat around this study area is heavily fragmented due to expansion of agriculture, habitation, and various other land use practices. Therefore, this study was initiated by the major objective of studying seasonal variation in food habits of swamp deer. Proportionate food consumption was studied using feeding quadrat method. The study reveals that the overall diet of swamp deer consisted mainly of graminoids (grasses and sedges) and herbs (terrestrial and aquatic). In the protected areas studied earlier, the swamp deer habitat was dominated by grasses, and hence they were reported to be predominantly a grazer who occasionally fed on aquatic plants (Schaller 1967 and others). In contrast, at Jhilmil, the area also has equal presence of other plant types namely, sedges and terrestrial herbs. This resulted in polyphagous feeding habit of animal here.

1. Introduction

Swamp deer (*Rucervus duvaucelii duvaucelii*) also known as the Barasingha lives in the swampy grasslands and flood-plains of Indian subcontinent [1]. It is currently found in isolated localities in north and central India and southwestern Nepal [2]. It eats mainly grasses and remains close to water all the time [1]. Barasingha is listed as Vulnerable C1 because the estimated population lies between 3,500 and 5,100 animals (not all of which will be mature individuals), and outside several key populations the protection status is not secure. The species range is now highly fragmented, and the total area of occupancy (AOO) possibly falls below 2,000 km^2. This species is reliant upon hands-on management in protected areas, and changes in management style could see a resumption of very rapid declines echoing those of the mid-twentieth century [3].

Studies on the food habits of swamp deer have been carried out in different habitats by a number of researchers. The earliest account available about forage species of swamp deer in Dudhwa was given by Schaller [1]. Later on, Singh [4], Qureshi et al. [5], and Khan and Ahmed [6] also studied the feeding habits of swamp deer in Dudhwa forest. Observations on food habits of barasingha in Kanha were made by Martin [7]. Swamp deer of Nepal were studied by Schaaf [8], Moe [9], Pokharel [10], Bhatta [11], and Wegge et al. [12]. Jhilmil Jheel happens to be the last refuge of swamp deer in western most portion of its distribution range [13]. The present study was undertaken with an aim to identify the plant species consumed by swamp deer and their feeding habits in different seasons.

2. Materials and Methods

2.1. Study Area. Jhilmil Jheel is a saucer shaped wetland located between Haridwar-Najimabad highway and the River Ganges, in Chidiyapur Range of Haridwar Division, Uttarakhand, covering an area of 37.83 km^2 of Reserve Forest and

elevation ranging from 200 to 250 meters above MSL [14]. The spectacular *terai* landscape of the study area is a mosaic of short and tall grasslands, tropical mixed moist deciduous forests, and secondary scrub (Figure 1). Throughout the landscape, shifting of river channels over time has left behind many old channels where numerous seasonal and perennial swamps ("*tals*") or wetlands occur. The central swamp zone represents one of the above swamps such-oxbow-lake formed along the eastern bank of River Ganges. Surrounding areas get submerged during the monsoon. A number of small rivulets (total 32 in number) emerge from the woodland and discharge into Jhilmil Jheel, which finally drain into the Ganges. Most of them provide water throughout the year, while some dry up for about 6-7 months. The reserve area also receives water from the Shivaliks formations of Chidiyapur and the adjacent ranges such as underground streams, locally called "*Choyas*." The area experiences subtropical climate. Annual rainfall averages about 1300 mm (recorded between 1997 and 2007) and is most prominent during June–September (monsoon). Temperature soars up to 44°C in May and drops to 2°C in January. The texture of the soil varies from fine sand to clay loam. The area is rich in faunal and floral diversity, including spotted deer, elephant, blue bull, wild boar, monkey, *langur*, mongoose, hare, common leopard and occasionally tiger, jungle cat, otter, porcupine, *sambar*, barking deer, and hog deer that are also seen in the area. The dominant vegetation types include *Typha elephantina, Phragmites karka, Imperata cylindrica, Vetiveria zizanioides, Ziziphus mauritiana, and Salix tetrasperma*. The local inhabitants of Tantwala Village, adjacent to Jhilmil Jheel, consist of 146 households. They are of different communities, namely, Punjabis, Sainis, Garhwalis, and Gujjars who settled here in the early 1950s. Before the enforcement of Wildlife (Protection) Act of 1972, limited wildlife shooting was permitted here. The working plans in the initial 70–80 years of the management history (1896–1973) aimed only at obtaining more revenue out of the forest wealth. Later 1973 onward from there was a shift with the inclusion of wildlife conservation initiatives in the working plans (B.K.P. Sinha plan of 1973–89). On August 5, 2005, the government of Uttarakhand declared the area as a Conservation Reserve. Before this declaration, people (villagers and illegally settled nomads, "*gujjars*") were freely grazing their livestock in the grasslands of Jhilmil Jheel area. Later, *gujjars* were rehabilitated outside Conservation Reserve area (in adjoining forest divisions) along Rawasan River (Figure 1).

2.2. Methods. Sampling sites in different habitats covering moist deciduous, secondary scrub, dry grassland, swamp, and cropland habitats, an area of 6 km^2, were selected for the present study. Observation was done on foot. A year-round study was carried out for two years. Three methods were employed for studying food habits: (i) direct observation, (ii) quantification of feeding, and (iii) faecal analysis.

2.2.1. Direct Observation. To study the food habits of swamp deer, a scan sampling method [15] was employed. Observations were made from selected vantage points in the area using a pair of 8 × 40 binoculars and 15 × 45 spotting scope. Since the animals were observed in groups, a scan was taken once in 15 minutes. Study time was for two years and was divided into four-month period corresponding to summer, monsoon, and winter. A total of 100 hours of observation per season were compared. The diurnal cycle was divided into 5 periods: (1) 0700–0900, (2) 0900–1100, (3) 1100–1300, (4) 1300–1500, and (5) 1500–1700 hours. The number of individuals and age-sex composition of groups of swamp deer were also recorded. Individuals in the group were classified into different age and sex classes following Martin [7] with appropriate modifications. Over 250 detections of swamp deer groups were made. Chi-square test was performed to see the variation in frequency distribution of different food plants selected among different age and sex categories and among seasons within categories.

2.2.2. Quantification of Feeding. The feeding sites were examined, after the animal left the location, for plants with fresh feeding signs. Identification of plants in the field was done with the help of floras, research papers, and reports (e.g., [16–21]). Proportionate food consumption was estimated through feeding quadrat method [22, 23]. The plots (1 × 1 m for grass and herbs and 5 × 5 m for shrubs) were laid at random, and the number varied depending upon the size of the area used by the animal at the time of observation. The numbers of food species, the percentage cover of each species, and the phenology of available and utilized species were recorded. The principal food was worked out for grass, herb, and sedge, separately.

2.2.3. Faecal Analysis. The method involves two major steps: first, the preparation of reference material of the food plant species; second, the microhistological examination of faecal material to estimate the frequency of fragments of various plant species [24]. Identification of plant fragments was based on keys given by Satakopan [25] and Johnson et al. [26]. The results were compared with field observations.

3. Results

Age and sex categories as a whole and across seasons showed no significant variation in feeding habits. Yearling and fawn showed significant differences in feeding habits across seasons ($\chi^2 = 14.646$, $P = 0.023$ and $\chi^2 = 1.190$, $P = 0.551$, resp.). Swamp deer in Jhilmil was observed to feed on 42 species of plants belonging to 15 families. More than 75% of the food species were of the families Poaceae (16 species), Cyperaceae (5 species), Fabaceae (5 species), Asteraceae (4 species), and Typhaceae (2 species) (Table 1, Figure 2). Aerial parts, chiefly comprising leaves, were fed. Root stock of *Typha* spp. was fed throughout monsoon, while its fresh sprout was fed in winter and new leaves in summer. Percentage contribution of the food types, namely, grasses, aquatic flora, sedges, and herbs, to the overall diet and in individual seasons is presented in Figure 3. A lesser number of food plant species were identified by faecal analysis, when compared to the direct observations. The reason was that monocot faecal fragments

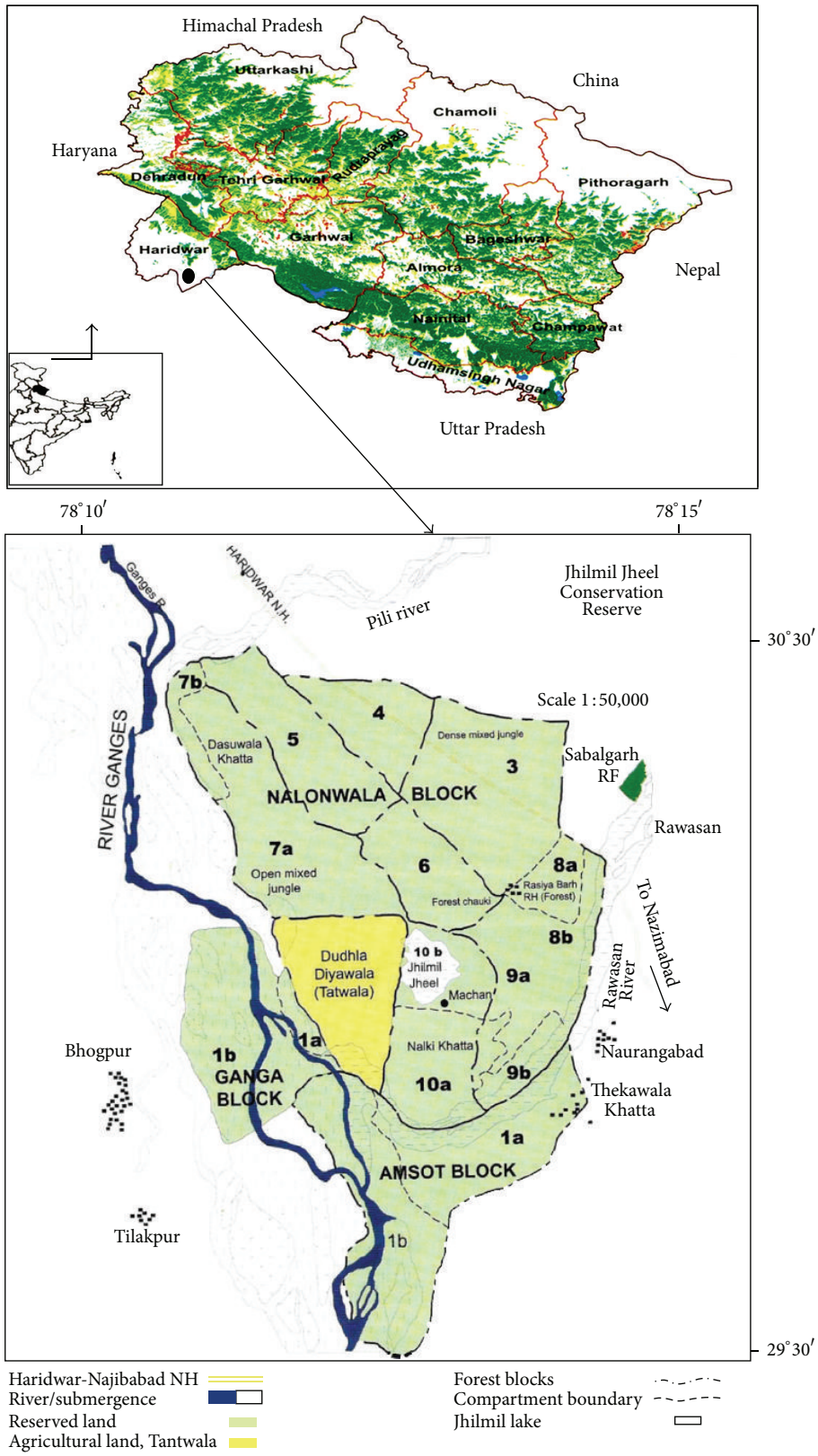

Figure 1: Location map of Jhilmil Jheel Conservation Reserve. Source: anonymous 2005 [14].

Table 1: The principal food plant species, in which habitat it occurs, and major categories of food plants of swamp deer in Jhilmil Jheel Conservation Reserve.

Food plant species	Family	Type of food plant	Habitat category
Coix lachryma-jobi	Poaceae	Grass	Swamp
Cynodon dactylon	Poaceae	Grass	Dry grassland
Cyrtococcum accrescens	Poaceae	Grass	Swamp
Echinochloa colona	Poaceae	Grass	Cropland
Imperata cylindrica	Poaceae	Grass	Dry grassland
Oplismenus compositus	Poaceae	Grass	Moist deciduous forest
Oryza sativa	Poaceae	Grass	Cropland
Paspalidium flavidum	Poaceae	Grass	Moist deciduous forest
Paspalum conjugatum	Poaceae	Grass	Cropland
Paspalum scrobiculatum	Poaceae	Grass	Swamp
Phragmites karka	Poaceae	Grass	Swamp
Polypogon fugax	Poaceae	Grass	Cropland
Saccharum officinarum	Poaceae	Grass	Cropland
Saccharum spontaneum	Poaceae	Grass	Secondary scrub
Setaria glauca	Poaceae	Grass	Dry grassland
Vetiveria zizanioides	Poaceae	Grass	Dry grassland
Carex myosurus	Cyperaceae	Sedge	Swamp
Cyperus brevifolius	Cyperaceae	Sedge	Swamp
Cyperus cyperoides	Cyperaceae	Sedge	Swamp
Fimbristylis dichotoma	Cyperaceae	Sedge	Swamp
Fimbristylis miliacea	Cyperaceae	Sedge	Swamp
Desmodium triflorum	Fabaceae	Herb	Secondary scrub
Medicago lupulina	Fabaceae	Herb	Secondary scrub
Melilotus indica	Fabaceae	Herb	Cropland
Trifolium alexandrinum	Fabaceae	Herb	Cropland
Trifolium tomentosum	Fabaceae	Herb	Cropland
Blainvillea acmella	Asteraceae	Herb	Swamp
Parthenium hysterophorus	Asteraceae	Herb	Moist deciduous forest
Silybum marianum	Asteraceae	Herb	Moist deciduous forest
Xanthium strumarium	Asteraceae	Herb	Swamp
Typha angustifolia	Typhaceae	Aquatic flora	Swamp
Typha elephantina	Typhaceae	Aquatic flora	Swamp

could not be differentiated to species level that's why named as similar species. While 13 plant species were identified from faecal fragments in summer, 8 in monsoon and 12 in winter.

4. Discussion

The variation in feeding habits of yearling and fawn categories across seasons was probably an outcome of low sampling intensity (fewer sightings). We have observed that swamp deer have proportionally more of grasses and aquatic plants in their diet. These observations are in agreement with the reports of Schaller 1967, Martin 1977, Schaff 1978, Singh 1984, Moe 1994, Qureshi et al. 1995, Pokharel 1996, Khan et al. 2004, and Bhatta 2004 who reported that swamp deer is primarily a grazer who largely fed on grasses and aquatic plants. In contrast, a study on dry-season diet of swamp deer in Nepal [12] showed that swamp deer diet had a proportion of woody plants as well (12.5%). However, dominance of forage species and its distribution pattern in a certain locality have a great deal to do with its proportionate consumption [7]. At Jhilmil, the area also has equal presence of other plant types, namely, sedges and terrestrial herbs. This resulted in polyphagous feeding habit of the animals there (Table 2). Higher consumption for a particular food type showed seasonal variation. Swamp deer (mixed feeders though) commonly concentrated on grasses during high-rainfall periods and high rate of grass growth. The proportion of terrestrial and aquatic herbs in diet increased gradually in winter and summer.

Swamp deer showed shifts in their diet to specific part (root stock) of *Typha* spp. in monsoon for physiological requirement. This is presumed to be a way to supplement calcium intake [27]. In summer, there is an equal choice for both new leaves of *Typha* spp. and sedges. This can be attributed to their almost equal availability and palatability. In this study site, the overall principal diet of swamp deer

Table 2: Food plants of swamp deer reported in previous and present study.

Present study	Schaller 1967 [1], Qureshi et al. 2004 [2]	Singh 1984 [4]	Khan and Ahmed 2004 [6]	Martin 1977 [7]	Schaaf 1978 [8], Moe 1994 [9], Pokharel 1996 [10], Bhatta 2004 [11]	Wegge et al. 2006 [12]
Typha spp.	*Hydrilla* spp.	*Arundo donax*	*I. cylindrica*	Grasses	*Brachiaria* spp.	*A. donax*
Grasses	*Hygroryza* spp.	*I. cylindrica*			*Corchorus capsularis*	*Colebrookia oppositifolia*
Sedges	*Imperata cylindrica*	*N. porphyrocoma*			*Cynodon dactylon*	*Cymbopogon* spp.
	Narenga porphyrocoma	*S. spontaneum*			*Cyperus rotundus*	*Dalbergia sissoo*
	Oryza rufipogon	*Themeda* spp.			*Desmostachya bipinnata*	*I. cylindrica*
	Phragmites karka	*Ziziphus mauritiana*			*Grewia sapida*	*N. porphyrocoma*
	Saccharum spontaneum				*I. cylindrica*	*P. karka*
					P. karka	*Phoenix humilis*
					Saccharum munja	*S.spontaneum*
					S. spontaneum	*Themeda* spp.
						Vetiveria zizanoides
						Z. mauritiana

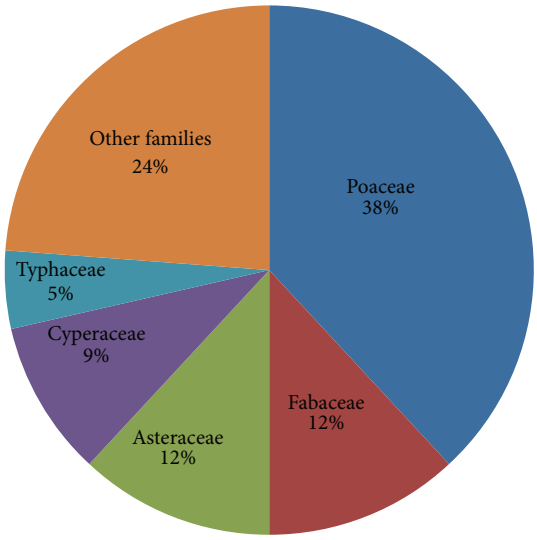

Figure 2: Percentage relationships among the principal families of the food species of swamp deer in JJCR.

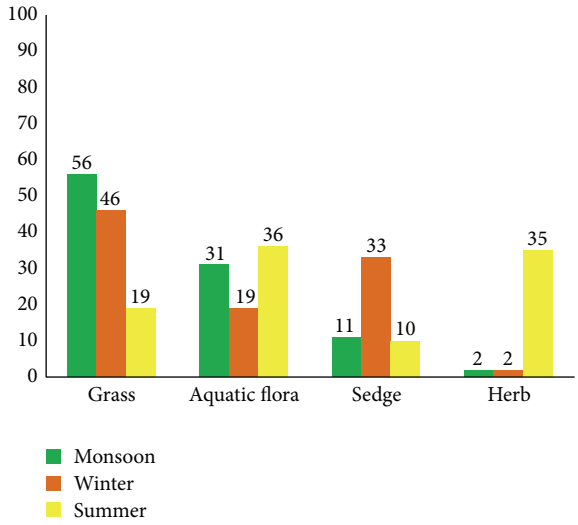

Figure 3: Percentage contribution of the food types to the overall diet of swamp deer and their seasonal ranking.

consists of *Typha* spp. in contrast to *Imperata cylindrica* reported by all the authors in past. The reason is *Typha*'s availability (in prime swamp deer habitat) and proportion area covered in comparison to those of *Imperata* grasslands.

5. Conclusion

The swamp deer is a mixed feeder, consuming a wide variety of food types, and diet composition may vary according to season and food availability. They are selective only in monsoon, the time of abundant food supply, and are nonselective or opportunistic feeders in summer when food is limited. Long-term survival and conservation of herbivores depend on the availability of suitable habitats; hence, protection of the plant species utilized by herbivores is a significant factor in conservation biology.

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