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Digging and Clipping Behaviour of Indian Crested Porcupine, *Hystrix indica* Kerr, 1792 in a Green Belt of Islamabad, Pakistan

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ABSTRACT

We studied the landscape impact of digging and clipping of vegetation by Indian crested porcupine *Hystrix indica* in an undulating topography in Islamabad. We recorded that the porcupine excavates and consumes subterranean organs of Johnson grass (*Sorghum halepense)*, purple nutsedge (*Cyperus rotundus*), stumps of shisham *(Dalbergia sissoo*) and clipping of its saplings. Porcupine fresh digs varied in size according to depth of subsurface plant organs. The mean values of dig's depth of Johnson grass were 27.71 ± 6.99 cm with maximum and minimum values of 48.00 and 14.00 cm, respectively. The density of digs was less than one dig^{m2}, while the maximum number recorded was three (3) digs^{m2}. In case of purple nutsedge, the mean of depth was 6.49 cm, ± 2.72 SD, with a maximum of 18 cm; the difference between the depth of digs was highly significant (t = 2.72, P = 0.007). The clipping of shisham saplings was caused at different heights from the ground level. The maximum height recorded was 27.5 cm, while the minimum was 2.00 cm with a mean of 7.98 cm ± 5.67 SD. The average depth of digs of shisham stumps was 11.15±2.24 cm. Digs are temporary pocket like structures that trap soil, water, organic matter, and seeds which help in the germination and growth of annual plants including porcupine forage species, *e.g.*, groundnut *Arachis hypogeal*, guar *Cyamopsis tetragonolaba*, field bindweed *Convolvulus arvensis*, and puncture vine *Tribulus terrestris*. Loose soil dug out by porcupines instantly becomes a part of the runoff thus enhancing ecosystem flows of water, soil, and nutrients.

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AAK designed the study. AAK and MM conducted the field experiments and wrote the article. AMG analyzed the data.

Key words
Feeding habits. *Hystrix indica*, landscape disturbance, nutrient pockets, subterranean plant organs.

INTRODUCTION

Indian crested porcupine (*Hystrix indica* Kerr, 1972), a generalist herbivore, with wide environmental tolerance, is widely distributed in south – central Asia from the Mediterranean to Pacific, including the Indian sub-continent (Corbet, 1978). In Pakistan, it is distributed in almost all the agro-ecological zones (Greaves and Khan, 1978; Roberts, 1997; Khan *et al*., 2000, 2007). It commonly inhabits man-made forest plantations, natural forests, scrub and thorn vegetation, agricultural landscape, sandy deserts, undulating plateaus, mountainous valleys and steppe mountain regions of Balochistan up to 2750 m elevation. It has also been recorded from the moist deciduous forests of Machiara National Park (Azad Jammu and Kashmir) at 3200 m elevation; the highest point so far recorded for its distribution range (Awan *et al*., 2004). The Indian crested porcupine has been identified as a serious vertebrate pest of economic importance in agro-forestry systems of Pakistan (Ahmad and Chaudhry, 1977; Greaves and Khan, 1978; Khan *et al*., 2000, 2007; Mian *et al*., 2007). The Indian crested porcupine is a generalist forager and exploits a wide variety of cultivated crops, trees, nursery stocks and wild vegetation, consuming above-ground and subterranean plant tissues (Greaves and Khan, 1978; Gutterman, 1982; Alkon and Saltz, 1985; Alkon, 1999; Khan *et al*., 2000). The most economically important porcupine damage, however, occurs in man-made irrigated forest plantations and reforested watershed areas of Tarbela and Mangla reservoirs (Nawaz and Ahmad, 1974; Ahmad and Chaudhry, 1977; Greaves and Khan, 1978; Khan *et al*., 2000; Hussain, 2004; Mian *et al*., 2007). The porcupine utilizes plant tissues (bark, roots, tubers, bulbs, corms, rhizomes) either by up-ground debarkation, clipping or by digging the subterranean parts. The vegetation, thus affected, includes shrubs, geophytes, hemi- cryptophytes, and annuals. The porcupine meets food and water requirements through these activities. Digging by the porcupine is a unique ecological process in an environment, where surface disturbance is made for the purpose of exploring subterranean plant organs as its food material (Gutterman, 1982, 1987; Gutterman *et al*., 1990; Alkon, 1999; Khan *et al*., 2000). During this activity, some plant species are totally consumed but later on germinate in the digs and plant species partially consumed get renewed vegetatively. Thomson (1974) suggested that the African porcupine, *Hystrix africaeaustralis* is an accelerator

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factor in the long term vegetation succession along the Nuanetsi River in south – east Rhodesia.

Boeken *et al*. (1995) observed that the porcupine foraging and digging generates a net-work of direct and indirect impacts on ecological systems. Diggings become micro-habitats in which water and organic matter accumulates, resulting in to nutrient rich sites and improving conditions for the germination of trapped seeds, seedling establishment and plant growth (Gutterman and Herr, 1981). They recorded that the number and survival of seedlings within the diggings of Indian crested porcupine was higher than the surrounding areas. Gutterman *et al*. (1990) found that within porcupine diggings changes took place over time in terms of species richness, plant density and plant biomass. Garkaklis *et al*. (2000) suggested that the vertebrate diggings in which surface litter and organic debris become trapped can provide a site for the development of sub-surface water repellence and sinks of critical environmental resources at many ecological levels (Alkon, 1999). Also, some data suggest that perturbation by mammals, such as porcupines; can be an important force in paedogenesis, in structuring landscapes, and in maintaining heterogeneity in ecosystems (Whitford and Kay, 1999; Wilby *et al.*, 2001).

MATERIALS AND METHODS

The research reported in this paper was conducted in undulating landscape in the green belt of H – 10 Sector of Islamabad, running parallel to the Kashmir Highway (33º 66´ N, 73º 01´ E). Three patches of vegetation, of various sizes, were selected for data collection. On these patches porcupine digs and clipping of plants were observed which were scattered in groups. These patches consisted of purple nutsedge (*Cyperus rotundus*) (100 x 50 m); Johnson grass (*Sorghum halepense*) (25 x 10 m); shisham (*Dalbergia sissoo*) clipped stumps (70 x 32 m). On the Johnson grass patch the soil was very hard and almost having no moisture content. On the other two patches where shisham and purple netsedge were examined, the soil surface was grassy and contained organic matter and sufficient moisture. Depth and width of the digs were taken in centimeters with an accuracy of 0.01 cm. In case of clipping of shisham radius of the stump was taken with vernier calliper with an accuracy of 0.05 mm; while the clipping part of the plant was measured from the ground level. Jhonson grass is a creeping perennial weed, the tubers and rhizomes of which are 1 – 2 m deep in the soil. purple netsedge is a geophyte, the corms of which are formed 2 – 8 cm deep in the soil. Other species of the vegetation in the study area are toot/mulberry *Morus alba*, phulai *Acacia modesta*, mullah *Zizyphus nummularia*, anjeer *Ficus carica*, and paper mulberry *Broussonetia papyrifera.*

Descriptive statistics, the mean, the number of observations, measures of variations, the range and standard deviation (SD) were used for analysis of the data. Student `t' test was also used to compare the statistical difference between two means of respective variables over two patches of Johnson's grass diggings.

RESULTS AND DISCUSSION

Foraging porcupines of the genus *Hystrix* dig soil with their nailed forepaws, resulting into elliptical digs that are narrow and deep at the anterior end, and wider and shallow posteriorly. The soil dirt removed is piled up outside the distal end of the dig. Transverse sections of four representative digs of *purple nutsedge*, Johnson's grass, and shisham stump are shown schematically in Figure 1a,b. Investigatory sniffing of vegetation is a major behaviour of the porcupine for subterranean food search. However, crested porcupine olfactory capabilities have not been searched, and mechanisms of food detection are conjectural (Alkon, 1999). In areas where drinking water is seasonally scarce or not available, exploitation of sub-surface plant biomass by the porcupine is a key to its welfare and survival.

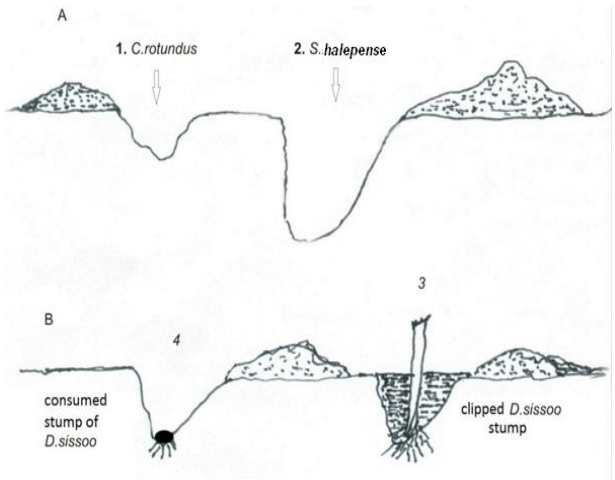

Fig. 1. Schematic transverse section of porcupine digs in flat terrain (A and B), digs of *C. rotundus* and *Shalepense* (A1,2), clipped and consumed stump of *D. dissoo* (B3,4)

Morphometric measurements of fresh digs (n=63) of Johnson's grass showed that the means of width and depth of the digs of subterranean plant organs as 20.77±2.87 and 27.71±6.99 cm respectively. Maximum (30 cm) and minimum (14 cm) values of width, and

maximum (48 cm) and minimum (14 cm) values of depth indicated high variability in the behaviour of the porcupine in excavating the digs and the depth of subterranean plant organs. Co-efficient of variation (CV) for depth values was 13.84, while it was 25.24 for depth values. Boeken *et al*. (1995) recorded 150 cm deep and 15-20 cm wide digs of the porcupine in the Negev desert in Israel but they did not mention the plant species having been dug out. The results clearly indicated that porcupine digs for Johnson's grass varied in size according to depth of forage and substrate (Alkon and Olsvig-Whittakar, 1989; Alkon, 1999). Johnson's grass dig densities varied from less than one dig / m^2 to three digs per m^2.

One hundred thirty one fresh digs of purple nutsedge were measured; the results showed variability in size as it appeared in the case of Johnson's grass. The mean width was 9.05 cm ± 2.75 SD and the difference between them was non-significant (t value = 0.43; P value = 0.66). The mean depth was 6.49 cm ± 2.72 SD and the difference between them was highly significant (t value 2.72; P value = 0.007). Maximum (16 cm) and minimum (5 cm) values of width and maximum (18) and minimum (2.5) values of depth of digs indicated varied degree of depth of subterranean plant organs which Indian crested porcupine utilized as food material. The digs per m^2 density varied, average being two per m^2, while the maximum number was more than seven digs per m^2 but less than nine per m^2.

On the third patch of vegetation, 102 clipped saplings of shisham were observed. The maximum (2.9 cm) and minimum (0.5 cm) radius of plants was recorded with a mean of 1.06 cm. The clipped part of the saplings was measured from the ground / surface level that greatly varied. The maximum height of the clipped part from ground level recorded was 27.5 cm while the minimum was 2.0 cm. The mean of all measurements of this parameter was 7.98 cm. Among these, 22 clipped stumps of shisham were dug out for consumption by porcupine to meet water requirements. The means and SD of width and depth of the digs around these stumps were 15.57±1.89 and 11.15±2.24 cm, respectively. The CV values were 12.16 and 20.10 respectively. The less value of standard deviation for depth indicated more consistent digging behaviour of porcupine.

The digging and clipping behaviour of Indian crested porcupine has been less studied in the sub-continent. Preliminary studies conducted by Idris and Rana (2001) reported clipping of seedlings of neem *Azadiracta indica* 5 -7 cm above ground level in Aravalli hills near Jodhpur, India. Khan *et al*. (2000) reported 30 - 95% (x = 60%) complete clipping of chir pine *Pinus roxburghii* transplants and 42% of honey locust *Robinia pseudoacacia* in the Tarbela Watershed areas of Khyber Pakhtunkhwa, Pakistan. A similar study in Himachal Pradesh, India, reported 54.4% mortality of chir pine (Sheikher, 1988). Hussain (2004) reported 38.1% clipping damage to less than one year transplants and 24% to one to six years old transplants. Assuming an average of 40% mortality of chir pine, based upon the studies of Khan *et al*. (2000) and Hussain (2004), the economic losses come to about US $ 58 per hectare. In the irrigated forest plantations of Punjab, Pakistan, nursery stocks of shisham and dharek *Melia azedarach* are severely damaged through cutting by the Indian crested porcupine. Chaudhry and Ahmad (1975) observed devastation of shisham seedlings cut off at the collar level. Ahmad and Chaudhry (1977) reported that in a four hectare plot, six month old shisham nursery at Kundian, 75% cutting of seedlings was recorded. A similar damage was observed by Greaves and Khan (1978) to Dharek in a nursery at Chichawatni with more than 90% of the seedlings destroyed through clipping. Mian *et al*. (2007) recorded 20.36% clipping of shisham seedlings in a nursery plot at Kundian.

Various authors have reported porcupine digging and damage to commercial crops and grasses of grazing importance in Pakistan, and elsewhere. Brooks *et al*. (1988) observed that a porcupine can uproot through digging as many as 30 groundnut plants at pod stage during a night. Khan *et al*. (2000) reported 15 – 20 digs per night and removing the bulbs of saffron *Crocus sativus* at an experimental plot near Mastung, Balochistan, through diggings; the estimated loss being approximately US $ 20-40 / hectare/season. A similar kind of damage to Gladioli was observed in one of the floriculture orchard of Islamabad, where the estimated damage to bulbs ranged from 50 to 70% per season (Khan *et al*., 2000). Again, Khan *et al*. (2000) estimated damage to potato, two weeks before the harvest and calculated 17.6% loss of the total production from 2.5 hectare potato field, near Taxila, district Rawalpindi, Punjab. Similar damage to irrigated potato fields has been reported by Alkon and Saltz (1985) in the Negev desert of the southern Israel. They estimated potato damage by porcupine at 1.3 ton / hectare or 0.6% of the crop production. Khan *et al*. (2000) recorded that five species of grasses, *e.g.*, desert grass *Pennisetum* spp., dhamann grass *Cenchrus ciliaris*, bhabbar *Elionurus hirsutus*, khawi *Cymbopogan jwarancusa* and Jhonson's grass *Sorghum halepense* were severely damaged by porcupine diggings as it consumed the subterranean organs of the grasses, and thus affected the grazing capacity of range lands.

The digging and clipping by the porcupine cause severe economic loss to crops, tree nursery stocks, transplants and grasses of grazing importance. Further

studies on the role of porcupine diggings as a model of vegetation disturbance and recovery over time in terms of species richness, plant density and plant biomass are suggested. Also additional research is needed to better define and predict porcupine digging impacts at several ecological levels and as a basis for realistic management of the habitats and landscapes.

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