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# SEED MANIPULATION BY CLARK'S NUTCRACKER

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Seed harvesting and caching by Clark's Nutcracker (*Nucifraga columbiana*) have been well described in recent years (Vander Wall and Balda 1977, Tomback 1978, Lanner and Vander Wall 1980, Tomback and Kramer 1980, Tomback 1982), but the birds' manner of handling and opening seeds is little known. We investigated stereotyped patterns of seed-opening and the use of the feet in this process. Because nutcrackers prefer to feed on the large seeds of the genus *Pinus* (Vander Wall and Balda 1977, Tomback 1978), and they probably coevolved with several species of pines (Lanner 1980; Tomback, in press), their feeding behaviors are of evolutionary and ecological interest.

Three nutcrackers were captured between 4 and 7 February 1981 in Rocky Mountain National Park, Colorado, ca. 2,950 m elevation. From 1 March to 15 May 1981, we used them for seed caching-recovery experiments conducted in an aviary with an adjoining observation booth and one-way glass window. During these experiments, we also collected data on piñon seed (*Pinus edulis*) manipulation and the use of the feet as nutcrackers opened seeds. Observation periods each lasted 1 h and totalled 18 h. Nutcrackers opened seeds while standing on either a perch or the edge of a nursery flat. Seed manipulation was similar for both sites, and no distinction will be made in the following behavior descriptions:

The experimental nutcrackers opened seeds by either: (1) positioning a seed along the posterior third of the tomium between the upper and lower mandibles and applying pressure or, (2) holding a seed by one or both feet (which also grasped the perch) and striking the seed with the bill tip. All three birds preferred the first method, using the second method in 5, 10, or 30% of the cases. In this method, a bird held each seed on its side and repeatedly struck the exposed lateral seam, which bears seed wings in some pine species. We confirmed the effectiveness of this technique ourselves by pressing on the seam; this split the seed coat in half and left the contents intact for easy extraction.

When using both feet to position a seed, the hind toe (hallux) of one foot and both inner (second) toes held the seed, leaving a seam exposed (Fig. 1a). When one foot was used, the seed was held between the second and third toes (Fig. 1b), exposing the seam.

All three nutcrackers preferred one foot to the other while manipulating seeds. When both feet were used to position a seed, we determined foot preference by noting which foot held the seed and which was used as a support (Fig. 1a). Two birds used only the right foot for handling seeds (Bird 1, 33 times and Bird 2, 93 times). Bird 3 used the left foot exclusively 9 times. Foot preference has been noted during substrate scratching, string pulling, feeding, or handling nesting material in 26 avian species representing six families (Columbidae, Falconidae, Strigidae, Psittacidae, Paridae, and Fringillidae; Friedman and Davis 1938, Allen 1939, Fisher 1957a, b, Vince 1964, Newton 1967, McNeil et al. 1971, Smith 1972, Clark 1973, Baptista 1976).

Our observations suggest that individual nutcrackers are consistently either "left-" or "right-footed" when handling seeds, and that seed-holding behavior is highly stereotyped. Whether foot preference and seed manipulation patterns are learned or inherent remains to be determined.

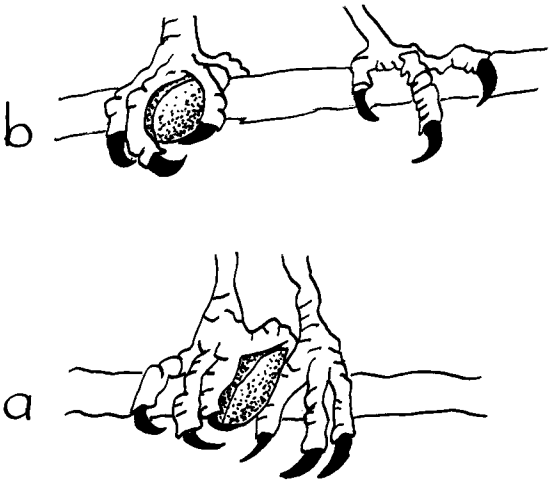


FIGURE 1. Stereotyped positions of nutcracker feet during seed opening: a. two-footed manipulation. b. one-footed manipulation.

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# DIURNAL ACTIVITY AND SOCIAL DISPLAYS OF RHINOCEROS AUKLETS ON TEURI ISLAND, JAPAN

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The distribution of the Rhinoceros Auklet or Horn-billed Puffin (*Cerorhinca monocerata*) arches the north Pacific Basin, with large populations on the coast of North America, Japan, and the adjacent coasts of the Okhotsk Sea (Udvardy 1963). Sowls et al. (1978) and Vermeer (1979), summarized the nesting requirements and distributions of known colonies on the west coast of North America and reported that the largest of them ranged from 50,000 to 100,000 breeding pairs. Worldwide, the largest known breeding colony of Rhinoceros Auklets is in northern Japan, located off the coast of Hokkaido on Teuri Island, where there are nearly 400,000 pairs (Environmental Agency Report 1973).

The breeding biology of Rhinoceros Auklets has been studied (Richardson 1961, Leschner 1976, Wilson 1978, Vermeer 1979, 1980, Vermeer and Cullen 1979). Wehle (1980) enhanced and summarized our knowledge of the sexual and social behavioral displays of other species of puffins but little comparative information was available to him for the Rhinoceros Auklet, perhaps because of its usually nocturnal habits. The sexual behavior of this species remains unknown.

Since the species is crepuscular as well as nocturnal on Teuri Island, I was able to observe some social displays and report them here for their comparative value. The auklets' crepuscular habits and their relationship to predation are also discussed.

## STUDY AREA AND METHODS

Teuri Island, a Japanese National Monument for Seabirds, is about 38 km west of Haboro, Hokkaido, Japan (44°4′N, 141°3′E). The avifauna of the island has been described in the Japanese literature (Kuroda 1963, Environmental Agency Report 1973). Approximately 3 km of a total of 12 km of coastline is comprised of rocky cliffs up to 100 m in height. On the shoulders, slopes and more level terrain at the crest of the island, dense stands of fescue (*Fescus rubra*), dock (*Rumex longifolius*), meadow grass (*Poa macrocalyx*), and bell flower (*Adenophora triphylla*), reach heights of more than 1 m. These areas are heavily undermined by burrows of Rhinoceros Auklets.

I made observations daily between 4 June and 1 August 1981. Binoculars were used to watch undisturbed birds in the evening and early morning hours from a campsite at the base of the cliffs, where 15 to 30 individuals could usually be seen near their burrow entrances. Occasionally observations were also made from the cliff-tops.

## OBSERVATIONS AND DISCUSSION

*Chronological and daily activity patterns.* Rhinoceros Auklets come to Teuri in late February, lay eggs in mid-April, begin hatching eggs during the last week of May, and fledge young in July. Most have left by mid-August (Kuroda 1963). When I arrived on Teuri on 4 June, the birds were feeding young and by 15 July their numbers had waned considerably.

Thousands of adult auklets gathered on the sea beginning as early as 2 h before sunset. During June the birds came to land in large numbers, flying at cliff-top height, an hour or more before sunset; they streamed in and out, continuing into the night. The auklets began leaving the island at dawn, although every day I saw individuals departing in mid-afternoon; on dull, foggy days many birds came and went until mid-morning. On Protection Island, Washington, Rhinoceros Auklets arrive at the colony 1 h after sunset (Richardson 1961).

The usual nocturnal habits of the Rhinoceros Auklet are generally thought to be a way of avoiding predators (Cody 1973, Scott et al. 1974, Vermeer 1979). Diurnal land activity has been reported for the species at several places along the North American coast (Thoresen 1980) and has usually been explained by the lack of predation by gulls (Scott et al. 1974). Wehle (1980) suggested that their nesting habitat may partially account for their diurnal activity in the Sea Lion Caves in Oregon, where darkness of the caves excludes gulls. This does not explain, however, their diurnal and crepuscular habits on Teuri, where 20,000 pairs of Black-tailed Gulls (*Larus crassirostris*) aggressively preyed upon the auklets carrying fish to their nests at dusk. Often 10 or more gulls would dive after each arriving auklet that carried fish. The gulls skillfully snatched fish from flying auklets, especially if the auklet slowed down or turned to leave again.

Plant cover on Teuri protected an auklet from predators only if a bird carrying fish flew directly to its hole under the vegetation. Wehle (1980) hypothesized that Rhinoceros Auklets can use heavily vegetated terrain because of their nocturnal avoidance of predators. He suggested that darkness allows them to land in an open area and walk to their burrows under the vegetation. On Teuri, however, it was the vegetation that enabled the auklets to avoid the gulls in daylight. The adaptive value of the nocturnal/diurnal habits of these birds remains unsettled.

*Social displays.* At dawn thousands of Rhinoceros Auklets departed by rocketing down from the cliffs with their wings swept backward, creating a sound of roaring wind.