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NESTING BEHAVIOR OF THE CLARK NUTCRACKER

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In March and April of 1947, near Missoula, Montana, detailed observations were made of the nesting activities of a pair of Clark Nutcrackers, *Nucifraga columbiana*. A few additional data were obtained from three other nests in 1947 and one nest in 1948, all near Missoula, and from one nest in 1952 in Stevens County, Washington. Since plans to supplement the 1947 findings with further detailed observations have not materialized, it seems wise to present the material on hand at this time.

Bendire (1889) first found nesting Clark Nutcrackers in 1876 in the Blue Mountains of Oregon. His account and those of Bradbury (1917) and of Dixon (1934) include observations on nesting behavior. Briefer accounts of nesting include those of Pyfer (1897), Parker (1900), Johnson (1900 and 1902), Silloway (1903), Saunders (1910), Skinner (1916), Racey (1926), Bee and Hutchings (1942), Mewaldt (1948 and 1954), and LaFave (1954).

Nesting activities of the Thick-billed Nutcracker, *Nucifraga caryocatactes caryocatactes* of northeastern and eastern Europe are but little better known than those of the Clark Nutcracker. Among the more important accounts on the European species are those of Vogel (1873), Bartels and Bartels (1929), and Steinfatt (1944). A significant study of the Thick-billed Nutcracker is being made in Sweden by P. O. Swanberg (1951 and personal communication). Except for two accounts (Formosof, 1933, and Grote, 1947), information on the Slender-billed Nutcracker, *Nucifraga caryocatactes macrorhynchos* of the USSR is generally less available. Other subspecies of *Nucifraga caryocatactes*, widely distributed in Asia, are less well known.

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METHODS

The nesting study is one portion of a life history study of the Clark Nutcracker conducted from October 1946 to May 1948 and continued on a more limited basis through 1952. Most of the observations reported here were made in western Montana, on Marshall Mountain near Missoula in Missoula County and in the Bitterroot Mountains of Ravalli County. The nests were situated between 4000 and 5000 feet in elevation, or from 500 to 1500 feet above the valley floors of the Missoula and Bitterroot



Fig. 1. Valley of the Clark's Fork (Missoula) River a few miles east of Missoula, Montana. Photograph taken on March 11, 1947, from vicinity of nest 1 of Clark Nutcracker.

rivers. Although predominately forested with relatively open stands of yellow pines (*Pinus ponderosa*) at these elevations, slopes less subject to desiccation are occupied by Douglas firs (*Pseudotsuga taxifolia*). A few of the later observations were made in eastern Washington and northern Idaho. Some reference will be made to information obtained from 439 specimens collected for studies on reproduction and molt. The results of these later studies will appear in separate papers.

Nests are numbered in the order in which they were found beginning on March 11, 1947. Early during the period of incubation an elevated blind was constructed about twelve feet from nest 1, where most of the observations were made. The distance from the observation port of the blind to the nest was gradually reduced to six feet. At this distance, the nutcrackers apparently completely ignored the occupied blind as well as shutter noises of still and motion picture cameras. Observations on the activities of the nutcrackers and other vertebrates at and in the vicinity of the nest were recorded continuously during the hours the blind was occupied. Air temperature and other weather data were recorded at least hourly.

On the first day that observations were made from the blind, April 1, one of the adults was captured by hand on the nest and banded with an aluminum band. After the young left the nest this adult was collected and found to be the female of the pair. Especially because of this band, no difficulty was encountered in distinguishing between the individual adult birds of nest 1. Eggs in nests 1 and 2 were numbered with ink as laid, and the young in both nests were ink-marked to permit individual identification. At about ten days of age, the nestlings were banded. Daily or bidaily weights to the nearest tenth of a gram were obtained with a laboratory balance after detectable fecal sacs had been eliminated.

VOICE

The Clark Nutcracker uses a considerable variety of calls which vary with the stimulus, season of the year, age, and perhaps sex. In the spring of 1949, recordings were made of many of the calls of two adults kept in an outdoor aviary at Pullman, Washington. These birds had been live trapped in the Cascade Mountains of southern Oregon a few months earlier. I sent one of these recordings to P. O. Swanberg of Skara, Sweden. He comments in a personal communication that all of the calls except one are similar to those of the Thick-billed Nutcracker of Sweden and that the variety of notes is suggestive of those used by the European bird at morning gatherings in late summer and early spring (see Swanberg, 1951).

For use in the discussions of behavior, names have been assigned to nine of the types of calls most commonly heard.

1. *Regular call*. Described variously as *khaaa* or *khraa* (Peterson, 1941), *chaar*, *char-r-r*, *chur-r-r*, *kra-a-a*, or *kar-r-r-r-ack* (Bent, 1946), and *kar'r'r'r* (Bailey, 1918), this harsh call is the one most frequently uttered by both sexes and is heard during all months of the year. Under favorable conditions it may be heard at distances of more than a mile. Usually given in series of three's, it may also be given only once, or many times in succession when the bird is excited. When used by juvenal birds, there is a squalling quality to the call.

2. *Musical call*. Similar in some respects to the foregoing, this call is comparatively liquid and soft. Its carrying quality is not great. I have heard it most often, but by no means exclusively, during the late winter and spring months when both sexes use it during the pre-nesting and nesting periods.

3. *Shrill call*. This high pitched and penetrating screech, described by Dawson (1923) as *meack*, or *mearrk*, is given by both males and females. Generally given during apparent excitement, this call may be heard during all months of the year. A metallic variation of the *shrill call* may be designated the *trumpet call*.

4. *Squalling call*. This call uttered during periods of apparent excitement is best described as a squalling prolongation of the *regular call*. It may be uttered by either sex of all ages during any month.

5. *Bullfrog call*. Heard only from December to June, this peculiar call, a comparatively slow rattle, sounding much like the "croaking" (see LaFave, 1954) of a frog, is given by both sexes of adults and by at least first-year females.

6. *Crackle and whistle call*. The alternating crackles and wheezing whistles are scarcely audible at 75 feet. The bird uttering this call does considerable bowing and neck stretching in contrast to the more or less conventional posture maintained when other calls are given. Heard on several occasions by birds of both sexes during only March and April, it would seem that this call is associated with the nesting period.

7. *Hunger call*. Much like the hunger calls of young crows (*Corvus brachyrhynchos*), these squalling notes, similar in quality to the *squalling call*, are given by juvenal birds during the spring and summer months (as late as August 10 in 1947) when they "beg" for food. Female nutcrackers occasionally use this call during courtship.

8. *Conversational squalling*. During the first few days after the young of nest 1 had hatched, the adults, when both were present at the nest, engaged in subdued musical squalling, similar in quality to the *musical call*.

9. *Nestling calls*. Within 24 hours after hatching, the young of nest 1 began *peeping*. This continued almost constantly during at least the daylight hours of the first week. These *peeps*, heard at a rate of about 35 per minute from two 24-hour nestlings, were scarcely audible ten feet from the nest. This *peeping* continued during actual brooding and increased in tempo when feeding was in progress. After about one week the *peeping*

was gradually replaced by squealing and could be heard only during feedings. The pitch of this squealing became lower and finally became the squalling characteristic of the older nestling when being fed, or when being disturbed.

Generally speaking, the Clark Nutcracker is a noisy bird most easily located by its calls. In areas where the birds are present in some numbers, their calls may usually be heard throughout the daylight hours.

Although nutcrackers feeding on the ground are usually silent, they mount nearby trees or rocks at intervals and utter the *regular*, *shrill*, *musical*, or *bullfrog* calls. These frequent calls probably serve to preserve contact when two or more birds are moving in company while foraging. When engaged in fly-catching, nutcrackers are usually silent. Tree-foraging nutcrackers are usually noisy. Paired adults apparently use the *musical call*, as a means of communication. From October, 1947, through February, 1948, most birds observed were paired. These pairs were frequently discovered by their use of the *musical call*. On occasions when one of such a pair was collected, the other bird would leave as the shot was fired, but would frequently return to the area one or two minutes later uttering the *musical call*. In each such instance, when both were collected, one was later sexed as a male and the other a female. When harassing perched hawks or owls, the *regular call* is generally used while the nutcracker is 15 or more feet distant from the raptor, but as the nutcracker approaches more closely, it uses the *squalling call*. During aerial pursuits of flying hawks or eagles, I have heard nutcrackers uttering the *regular*, *squalling*, *shrill*, and *bullfrog* calls.

COURTSHIP

There is evidence that once paired, Thick-billed Nutcrackers of Europe remain paired for the life of both individuals. Steinfatt (1944) states that outside of the breeding season he has often seen pairs of these nutcrackers together and that it is increasingly evident that the species is a permanent resident of the Rominte Heide of northeast Poland (formerly East Prussia) and that individuals remain permanently paired as, for example, do magpies (*Pica*) and ravens (*Corvus*). Linsdale (1937) indicates that among American Magpies, mated pairs tend to remain together as long as both birds live. Swanberg (1951) finds that Thick-billed Nutcrackers "pair for life" (p. 551). During the fall and winter of 1947-48, when only Clark Nutcrackers two years old or older were present in the western Montana study areas, most nutcrackers were encountered in two's. In October and November of 1947, isolated pairs were collected on four occasions and in each instance, one was a male and the other a female. The extent to which the pair's bond is preserved by attachment of each individual to the same territory is difficult to ascertain.

Courtship is generally considered to include those activities which aid directly in bringing together males and females for reproduction of the species. In species such as the Clark Nutcracker, in which birds once mated tend to remain paired year after year, courtship or courtship-like activities may facilitate the synchronization of the male and female sexual cycles. How such activities may differ from those leading to the formation of new pairs is unknown to me. The histories of the individuals in the accounts which follow are unknown, except that all participants were probably two years old or older. Because of the variation in courtship behavior observed, none of these accounts can be considered typical.

On the morning of March 6, 1947, observations were made at about 5200 feet on a ridge near the junction of the Missoula and Bitterroot rivers. North-facing slopes were covered with a dense growth of Douglas firs, south-facing slopes with open stands of yellow pines, and the crests of the main and feeder ridges with mixed stands of both species. There were from three inches to three feet

of fresh and old snow on the ground, the sky was clear and the air temperature about 25°F. At 10:10 a.m., I heard and then saw three nutcrackers on the pine slope. At intervals one bird started in rapid flight and another followed an instant later. Staying about 50 feet above the ground, they flew about 200 yards up a feeder ridge and returned to the same or an adjacent tree. From 10:20 to 10:30 a.m., eight such flights were made. The third bird did not participate and disappeared from the area about 10:25. The two birds did not return from the ninth flight. When I found them on the main ridge at 10:35, they also saw me and took up positions on either side of me giving the *regular call* occasionally. At 10:40 another pair of nutcrackers appeared from up the ridge, the larger (probably a male) carrying a twig in its beak. Nine times between 10:40 and 10:50, the smaller bird, loudly uttering the *regular call*, proceeded in rapid flight about 150 yards over the Douglas fir covered slope and each time returned to the same tree. The larger nutcracker, with twig in beak, followed in equally rapid flight, but without calls audible to me. Although the first-mentioned pair remained silent, one of the birds (the same each time) twice joined in the last part of a flight. At 10:50 the first pair proceeded up the ridge and the second pair down the ridge. Upon following the second pair, I found the larger bird carrying a twig when nearly a half mile down the ridge. Three additional flights, similar to those last described, were observed before this pair also proceeded up the ridge toward higher country.

On February 25, 1947, at 4400 feet on the southwest facing slope of Mitouer Ridge on Marshall Mountain, in the same area where nests 1, 2, and 3 were later found, there were snow-free patches of ground under some of the larger pines. The air temperature was 27°F. and the sky was partly cloudy. At 1:45 p.m. a nutcracker with a twig in its beak constantly uttered the *musical call* as it flew from tree to tree and then to the snow-free ground below a pine where another nutcracker was standing. After a few seconds it flew to a large Douglas fir, broke off eight or ten dead twigs in fast succession, dropped each in turn, and then returned to the bird on the ground without a twig. During the next 25 minutes the two birds in company flew among large trees, clumps of young trees, and the ground, both almost constantly uttering the *musical call*. One of the birds kept a dead twig in its beak most of the time. At 2:20 one bird suddenly gave the *shrill call* (there was no indication that my presence had been detected), and they flew together up slope something over 200 yards.

Between 4:15 and 4:45 p.m. on April 8, 1947, the sky was overcast and occasional light rain fell. About 400 yards up Mitouer Ridge from nest 1, two adult nutcrackers were under continuous observation. Constantly squalling, the smaller of the two followed the larger from tree to tree and occasionally to the ground. Finally in the dead top of a pine, the larger bird approached and appeared to feed the smaller crouching bird, by placing its beak well into the smaller bird's mouth several times. The smaller bird then stopped its squalling and they moved together from tree to tree out of the area.

At 9:45 a.m. on April 17, 1947, while I was in the blind at nest 1, a performance similar to that noted on April 8 was observed to include five minutes of begging and then an apparent feeding. This occurred partly in the territory around nest 1. Both participants were adults, or possibly first-year birds. The male of nest 1 flew at and drove the two birds down slope from nest 1 just after the apparent feeding. On April 24, the adults of nest 1 were observed in this same begging-and-feeding routine within their territory five days before the young left the nest. I was unable to distinguish the roles taken by each bird.

At nest 1 the brooding adult was observed to crouch, droop its wings, open its beak, and usually squall on about half the occasions when its mate arrived to feed the young. These actions usually took place on the edge of the nest. The female, on one occasion, actually fed the male at the nest, while in all other instances the begging tactics were apparently ignored. No such behavior was observed during the period of incubation at nest 1.

TERRITORY

The Clark Nutcrackers nesting on Mitouer Ridge appeared to have well defined territories. Although I became familiar with territorial limits around nest 1 only, some defense of areas around nests 2 and 3 was observed. It is apparent that there are important differences between the observed territorial behavior of the Clark Nutcrackers nesting on Mitouer Ridge and the territorial behavior of the Thick-billed Nutcrackers nesting at Billingen in central Sweden (Swanberg, 1951). Swanberg writes (p. 550), "In spite of intensive studies of nutcrackers for many years, I have never observed any

true territorial fights or any consistent defense of the territory against intruders by means of sounds or posturing. Nevertheless, each pair obviously has its defined territory. As example, my nutcracker pair A are proved to have held the same territory for at least ten years. During this time I have found fourteen nests of A in it; but although A has always been surrounded by other pairs, other nutcrackers have never made any



Fig. 2. Nest of Clark Nutcracker situated 15 feet up in 25-foot Douglas fir indicated by arrow. Photograph taken March 11, as nest was being built.

attempt to nest in the same area. Broadly speaking, the areas are used only by their holders, but it is not unusual for other nutcrackers to trespass and rest in them without being attacked, and sometimes they may even pay friendly visits to each other, as during the ceremonial gatherings, which take place in the morning immediately before or during nest building." In contrast, the Clark Nutcrackers on Mitouer Ridge did defend their nest territories against other nutcrackers by sounds and pursuit. Trespassing nutcrackers were attacked and driven off the territory if the male was present and not incubating or brooding.

Because territorial conflicts at nest 1 were very similar, I will describe in some detail one from the 14th day of incubation. On April 1 at 9:38 a.m. I had been in the blind for 98 minutes. The female had been on the nest continuously during this time. Two nutcrackers entered the territory and perched in the upper portion of a dead topped pine about 50 feet east of the nest tree. As they settled, the male of nest 1 flew from one of his perches northwest of the nest to a high stump 40 feet east of the nest tree and a moment later flew up at one of the two trespassers. The attacker and the attacked squalled as they fluttered together toward the ground. Before reaching the ground they separated, each taking low perches about 40 feet apart on opposite sides of the nest tree. Almost immediately, the male of nest 1 uttered the *shrill call* and flew at the same bird. The two birds, alternately hopping and flying along the ground, and constantly squalling and fighting, passed below the blind and nest to a point about 30 feet east of the nest where they both took wing and disappeared from view over the edge of the ridge. The second trespasser had in the meantime disappeared. About a minute later the male of nest 1 returned to one of his east boundary perches and gave the *regular call* about ten

times. Throughout these proceedings, which took about four minutes, the female on nest 1 maintained an "alert" attitude.

In most cases, the male of nest 1 was definitely known to be the defender of the territory, whereas the female was not observed to make any such defense. The female was not easily excited; while incubating or brooding, she did not react to other nutcrackers on the territory unless her mate was actively in defense of territory and using his voice. The male, however, was constantly "alert" while incubating and reacted immediately to many more outside influences than did his mate; he turned in the direction of trespassing nutcrackers when they called, but did not leave the nest while he was incubating or brooding. In the case of the pair of nest 2, both birds pursued and drove off a nutcracker trespassing on their territory before they had successfully built a nest.

The territory surrounding nest 1 was about 2.1 acres in area as enclosed within seven boundary perches. These perches varied in ground distance, 33 to 89 yards from the nest tree and in most cases were in the only large trees (75 or more feet tall) between 25 and 100 yards of the nest tree in a given direction. Toward the northwest, where there were several apparently suitable perches, the ground distances to boundary perches were found to be 52 and 63 yards. Nest 2 was situated 415 yards southeast of nest 1 while nest 3 was in a tree only 144 yards northwest of nest 1. Other nutcrackers were frequently observed to pass and occasionally stop for several minutes between the territories of nests 1 and 2 without being attacked. The territory around nest 1 was less than one-tenth the size of the "territories" described by Swanberg (1951) for the Thick-billed Nutcracker in Sweden. It should be noted that Swanberg's nutcrackers used their territories for the storage of hazel-nuts (*Corylus avellana*) which they harvested and stored during the fall months for use during the winter months and during the following spring for both themselves and their young. Although I have since 1947 seen Clark Nutcrackers transporting and storing pine nuts (from *Pinus ponderosa*), I have no evidence to indicate that the birds nesting on Mitouer Ridge in 1947 used any such stores. The birds left their territory and apparently traveled some distance to favorable foraging areas to obtain pine nuts still available on trees and in litter on the ground. Dixon (1934) in California found that a large share of the food for the nestlings was secured from an area 400 feet lower in elevation than the nests and at least one-half mile distant in an air line.

During the periods when the incubating or brooding bird was alone on the territory, no defense was made. It appeared that the female was gone from the nest only long enough to feed. This left the male a considerable amount of time when he was observed to perch silently on the northwest (high) edge of his territory. Although precise data were not obtained, this male was "on guard" approximately one-half the daylight hours.

Nest materials for nests 1 and 2 were obtained, at least in part, from areas outside of the territories known to be defended during incubation and brooding. Many of the Douglas fir twigs used in nest 1 came from two partially dead trees approximately 40 yards beyond territorial limits. The pair building nest 2 crossed a gulch 400 feet deep to secure twigs from a slope more than 600 yards from the nest tree.

Other species of passerine birds were tolerated within the territorial limits of nest 1 without known exception. Species observed within 30 yards of the nest were *Cyanocitta stelleri*, *Pica pica*, *Parus atricapillus*, *Parus gambeli*, *Sitta carolinensis*, *Sitta canadensis*, *Sitta pygmaea*, *Turdus migratorius*, *Sialia currucoides*, *Regulus satrapa*, *Carpodacus cassinii*, *Loxia curvirostra*, and *Junco oreganus*. A male junco, whose territory overlapped the territory around nest 1, was apparently ignored by the incubating female nutcracker on two occasions when the junco sang from the top of the blind less than eight feet from nest 1.

Hairy Woodpeckers (*Dendrocopos villosus*) and Red-shafted Flickers (*Colaptes cafer*) were frequently in or near the territory around nest 1. Both adult nutcrackers, while incubating or brooding, assumed an "alert" attitude when a flicker would utter its *kee-yer* call within 50 or 75 yards of the nest, but no pursuit of a flicker was seen. On one occasion a Pygmy Owl (*Glaucidium gnoma*) called for about two minutes from a tree about 25 yards from nest 1. The incubating female appeared disturbed and turned her head in the direction of the sound, turning back to her former position only when the owl had stopped calling. The presence of a Red-tailed Hawk (*Buteo jamaicensis*) approximately 300 yards from nest 1 was sufficient in one instance to cause the male to leave his territory and attack in company with the nutcrackers of nest 2. This occurred during the period of incubation at nest 1 and the building of nest 2. The pursuing nutcrackers made repeated diving attacks toward the hawk's back causing it to swerve to the side as if to avoid being struck. On two other occasions the male of nest 1 remained on one of his territorial perches and gave the *regular call* in an excited manner while the two nutcrackers of nest 2 gave chase to a Red-tailed Hawk. The female, incubating on nest 1, assumed an "alert" attitude during these encounters.

No apparent notice was taken by the nutcrackers of nest 1 on two occasions when mule deer (*Odocoileus hemionus*) passed within 25 yards of the nest. The chatter of a chipmunk (*Eutamias*), which occupied a stump less than ten yards from the nest, caused both incubating nutcrackers to assume an "alert" attitude.

My presence on the territory was not protested unless I flushed one of the adults from the nest. Upon my entry to the blind, the female never flushed from the nest. The male, however, did flush while brooding, the only time he was on the nest as I entered the blind. When the young were being weighed, the female of nest 1 frequently came within ten feet of me to "protest" my presence. However, the male of nest 1, as well as both adults of nest 2, made no obvious "protest" when their young were handled.

NEST CONSTRUCTION

I have found six occupied nests of the Clark Nutcracker as well as several old nests. The observations reported here are based on four occupied nests studied in considerable detail in early 1947. The other nests exhibited no essential differences in placement or construction (see Mewaldt, 1954).

Nest 1.—Found on March 11, probably the second day of construction, at 4600 feet on a south-east facing slope near the crest of Mitouer Ridge near Missoula, Montana. It was 12 feet above the ground, supported by small lateral branches and flush with the east face of the main trunk of a 25-foot Douglas fir. The nest tree protruded somewhat into a small clearing which was surrounded on all sides, except on the east, by firs similar in size to the nest tree.

Nest 2.—Found on April 1, the first day of construction, at 4200 feet on the south-facing slope of Mitouer Ridge about 415 yards south-southeast of nest 1. It was six feet above the ground near the end of a heavily foliated branch of an isolated 25-foot Douglas fir.

Nest 3.—Found on April 15, the first day of construction, at 4700 feet on the crest of Mitouer Ridge about 145 yards northwest of nest 1. It was placed in the heavily foliated terminal portion of a southwest lateral branch about 80 feet above the ground in a 125-foot yellow pine.

Nest 4.—Found on April 27, when the one remaining young nutcracker was about 20 days old, the nest was at 4300 feet on a southeast-facing slope in the Bitterroot Mountains near Florence, Montana. It was placed four feet out on a south lateral branch and about 25 feet above the ground in a 50-foot yellow pine.

All nests seen were similar in composition and structure, except that bowls of old nests were somewhat broader and shallower as a result of occupancy. Nests 1 and 2 were measured early in the incubation period and later collected for examination of their component parts. Outside diameters of nests 1 and 2 varied from 11 to 13 inches. Nest 1

was seven inches high and nest 2 was six inches high. The nest bowls were about four inches in diameter and about three inches deep. The floor and outer walls of nest 1 contained 247 dead Douglas fir twigs and eight twigs from deciduous shrubs making up a dry weight (255 twigs) of 256 grams. The outer wall and thinner base of nest 2 contained 193 Douglas fir twigs with a dry weight of 144 grams. Diameters of twigs varied from one-sixteenth to three-sixteenths of an inch. Lengths of twigs were up to 12 inches with eight- to nine-inch twigs being most common. Twigs in nest 1 were generally larger than those in nest 2. The outer portion of each bowl was composed of rotten wood pulp and the inner lining of dried grass and fine strips of the inner bark from Douglas firs. In the base of each nest, between the wood pulp and the grass lining, there was a layer of mineral soil about one-half inch thick. This mineral soil was carried to the nests in damp pellets between one-quarter and three-eighths of an inch in diameter. Eight such pellets were found on the incomplete floor of nest 1 on March 15.

Except for the layer of mineral soil and differences in source plants for nest material, these nests compare well with nests of the Clark Nutcracker described by Bendire (1895) and Dixon (1934), and with those of the Thick-billed Nutcracker of Europe described by Steinfatt (1944). However, Bartels and Bartels (1929) detected in the floor of a nest of the latter species a layer of "arable" soil which was in the same relative position as the soil layer in nests 1 and 2. No evidence of the "landing platform" described by Dixon (p. 233) was found associated with any of my nests.

Although both members of the pairs building nests 1, 2, and 3 shared about equally the collection of nest material, the females accomplished most of the actual construction. While a female adjusted and arranged the freshly collected material, the male would usually fly to a nearby lookout perch where he would remain for 30 to 90 seconds before making another trip for material. This sex distinction (at nests 1 and 3 only) was based on my familiarity with the individual birds of nest 1 and on an observed size difference between the birds of nest 3. Weights of the adults of nest 3 eight days after the nest-building was begun were 122 grams for the female and 151 grams for the male.

Nest 1 was found during a heavy snowfall at 10:10 a.m. on March 11. There were four to six inches of fresh snow on the ground in addition to old snow up to three feet deep within a few feet of the nest tree. One of the birds carrying a twig into the nest tree revealed the presence of the nest. During 85 minutes of nest building observation time, of which 40 were on March 11 (10:20 to 11:00 a.m., temperature 32°F.) and 45 on March 12 (9:35 to 10:20 a.m., 34°F.), 44 individual trips to the nest were made with material. Each bird arrived at the nest tree with a twig about every fourth minute. Five times (ten trips) the birds flew together from the material gathering area (about 100 yards from the nest). Entrances into and exits from the nest tree were made in nearly every possible direction by both nutcrackers. The *musical call* was occasionally uttered by both birds especially while they were carrying twigs in their beaks. The male gave the *regular call* three to six times on each of four times he mounted a lookout perch between trips. The *bullfrog call* and the *shrill call* were uttered by both birds on several occasions, especially in the vicinity of the trees where the twigs were gathered. Once upon my approach to the nest, the female repeated the *crackle and whistle call* several times before retreating into the Douglas fir thicket adjacent to the nest tree. Snow fell continuously during both periods of observation.

Data were gathered for 75 minutes during the first hours of construction of nest 3 during the early afternoon of April 15. The weather was mostly clear with the air temperature about 50°F. Some 51 trips with nest material were observed. In 20 cases (40 trips) the two birds flew together from the material trees. Each bird made a trip to the nest with material about once each three minutes.

Nest 2 was found on April 1 at 7:25 a.m. (weather mostly cloudy and temperature 30°F.) when each of the two nutcrackers was seen to enter the nest tree with a twig. Whereas material for nests 1 and 3 was obtained within 125 yards of the nests, at least some of the material used in nest 2 was carried a distance of more than 600 yards. The two birds stayed together from the time they left the nest area until they returned to the nest tree on each of the six trips observed.

Table 1
Initial Stages of Nesting in 1947

Nest	Found	Begun	Completed	First egg	Probable construction time
1	March 11	March 10 ¹	March 17	March 19	8 days
2	April 1	April 1	April 5	April 7	5 days
3	April 15	April 15	April 19 ²	April 21 ²	5 days ²

¹ An estimate based on the rates of construction of nests 2 and 3.

² Female contained three freshly ruptured ovarian follicles when collected at 4:50 p.m. on April 23.

It is highly probable that nests 2 and 3 were found on the day construction began, while nest 1 was likely found on the second day of its construction. Nest 2 consisted of about 20 twigs at 7:25 a.m. on April 1, and was already a well shaped nest at 6:20 that evening. Nest 3 was so thin at 2:05 p.m. on April 15 that the sky could be seen through its center from about 80 feet below. Nest 1 was less advanced at 11 a.m. on March 11 than nest 2 at 6:20 p.m. on its first day of construction (see table 1).

Work on nests 1 and 2 continued until, but apparently not including, the day before the first egg was laid. Because of the inaccessibility of nest 3, the incubating female was collected on the eighth day after the nest was begun. At autopsy she contained three freshly ruptured follicles in her ovary, there was no egg in the oviduct, and all other follicles were relatively small. Efforts to recover the nest were not successful.

AN INSTANCE OF ABERRANT NEST-BUILDING BEHAVIOR

At 9:10 a.m. on March 24, 1947, a pair of Clark Nutcrackers, thought to be the same pair which on April 1 began construction on nest 2, were seen carrying twigs to a pine about 140 yards north-northeast of their later successful nest. The twigs were placed on a comparatively open fork of a lateral branch about 10 feet above the ground. During the following week this pair spent many, if not most, of the daylight hours carrying material to this location. At no time were more than 10 or 12 twigs observed at a time on this fork and usually only 2 or 3 remained in position. Although partially obscured by fresh snow, there were several hundred freshly broken twigs on the ground below this branch on March 24. Shortly after the snow had disappeared a count disclosed more than 2500 Douglas fir twigs in this pile, plus some strips of shredded bark. About 20 twigs were accumulated on a stump about 12 feet from the larger pile.

During an hour of observation (9-10 a.m.) on March 25, only the smaller bird, presumed to be the female, concerned itself with arranging the twigs. Trips for material were always made together whether to nearby trees or across Mitouer Gulch where material was later collected for nest 2. Upon their return the presumed male would leave his twig on the branch and quickly fly to a lookout perch nearby. The other bird would spend 30 to 90 seconds arranging the 10 to 12 twigs. As this bird crouched and turned about, as though shaping a nest, one or more of the twigs would fall to the pile below the tree. Once when a twig fell, the bird flew down to the pile, picked up a twig, and

returned to the fork where it again proceeded to arrange the material. On one return trip, the presumed male flew past the "nest tree" to a lookout perch, where he dropped his twig.

A nutcracker which came near the "nest tree" was pursued by both members of the pair in five or six circles about 100 yards in diameter before the intruder left the area in direct flight. The three birds were silent except about once in each circuit when they dipped near the ground and engaged in considerable fluttering, fighting, and squalling. This episode consumed about five minutes. Immediately after the third bird disappeared up the slope toward nest 1, the pair resumed gathering twigs.



Fig. 3. Nest and eggs of Clark Nutcracker, April 13, 1948, 20 feet up in yellow pine in Bitterroot Mountains, Ravalli County, Montana.

Nice (1943) cites several instances in which various species of birds collected nesting material in excess to that needed for a given nest. In this instance, however, the female was unable to arrange the twigs so they would remain in position. It is possible that the precise site chosen did not have the requisite physical configuration to support the base of a nest. It was apparent on April 1 that little effort was wasted in the construction of the outer shell of nest 2 in the new location.

EGG-LAYING AND INCUBATION

Three eggs were laid in nest 1 and in nest 2, and probably also in nest 3. Nest 5, found on April 13, 1948, in the Bitterroot Mountains near Stevensville, Ravalli County, Montana, contained three eggs in an advanced stage of incubation. Nest 4 held one nearly fledged young on April 27, 1947, and nest 6 contained three young about 14 days old when found on April 6, 1952, near TumTum, Stevens County, Washington (Me-

waldt, 1954). According to Bent (1946), the Clark Nutcracker lays usually two or three eggs, but often four and occasionally as many as five or even six. Of six nests of the Thick-billed Nutcracker of Europe observed by Vogel (1873), five contained four eggs each and one contained three eggs.

Although the eggs were almost certainly covered by the adults from the time that the first egg was laid, actual incubation probably did not begin until the last egg was laid (see Swanberg, 1951). The mean temperature for March (1892-1946) at Missoula, about 1500 feet lower in elevation than nest 1, was about 2°C., and the mean minimum about -4°C. In order not to be frozen, the eggs must not only be covered but must also receive some warmth from the bird on the nest during the pre-incubation period.

By taking the time elapsing between the laying of the last egg and the hatching of that egg (Swanberg, 1950; Nice, 1954), the period of incubation was found to be 18 days (table 2). I have assumed that intervals of approximately 24 hours elapsed between the depositions of eggs in each of nests 1 and 2 (Miller, 1931; Nice, 1937; and Bent, 1946) and that the young probably hatched during daylight hours (Miller, 1931).

Table 2
Egg Laying and Hatching Times

Egg	Egg laid between	Probable laying time	Young hatched between	Probable hatching time	Days from laying to hatching	Incubation period
Nest 1						
A	1:00 p.m. March 17	a.m.	4:30 p.m. April 6 ¹	a.m.		
	2:35 p.m. March 19	March 19	6:55 p.m. April 7	April 7	19	18
B	10:00 a.m. March 20	a.m.	6:55 p.m.	6:55 p.m.		
	8:55 a.m. March 21	March 20	April 7 ²	April 7 ²	19	18
C	9:25 a.m.-6:50 p.m. March 21	a.m.	3:15 p.m.	3:15 p.m.		
		March 21	April 8 ²	April 8 ²	18	18
Nest 2						
D	5:00 p.m. April 6	a.m.	7:15 p.m. April 26 ³	a.m.		
	6:35 p.m. April 7	April 7	7:10 p.m. April 27	April 27	20	18
E	7:00 a.m.-5:00 p.m. April 8	a.m.	do	do	19	18
F	5:00 p.m. April 8	a.m.	do	do		
	6:45 p.m. April 9	April 9			18	18

¹ Egg not pipped.

² Hatching time.

³ Egg pipped.

At 6:55 p.m. on April 7 the sparse, but conspicuous, white down was dry on nestling A of nest 1 and its egg shell was not in the nest; nestling B was not yet free from one-half of its egg shell and the other half remained in the nest; and egg C was not yet pipped. On April 8 continuous observations were made from the blind from 7:40 a.m. to 4:05 p.m. Between 11:00 a.m. and 1:10 p.m. the female pecked egg C on several occasions. Upon flushing her at 1:10 p.m., I found the egg slightly pipped, and in line with this pip at the large end of the egg was a ring of indentations apparently pecked there by the female. She returned to the nest less than one minute after I returned to the blind. At 3:08 p.m. the female backed to the edge of the nest and pecked at egg C for four minutes, at the end of which time nestling C was free of its shell. Immediately thereafter the female proceeded to break off portions of the shell about one-eighth inch in diameter and swallow them. She then settled back to brooding at 3:16 p.m. without removing the remainder of the shell from the nest.

That both male and female Clark Nutcrackers incubate the eggs and brood the young has been reported by Bendire (1895), Skinner (1916), and Dixon (1934). My findings are consistent with these reports (table 3). In this regard it is significant to note that incubating male Clark Nutcrackers have incubation patches which are fully as well developed as those of females (Mewaldt, 1952). The relative roles in incubation and brooding of the sexes of the Thick-billed Nutcracker of Europe have not as yet been clarified in publication.

During 20 hours of daylight observation in the period of incubation, the adults were attentive 99.5 per cent of the time. The female was attentive 79.5 per cent and the male 20 per cent of the 20 hours. From the time that nest 1 was completed, until the first two eggs had hatched, the adults were not seen together at the nest. Incubation changes were apparently usually made on signal by the off-nest partner as it approached the nest tree from a westerly direction. Five different calls were used by the adults in making nine incubation duty changes. The male in five approaches used the *regular call* twice, the *musical call* once, and was silent twice; the female in four approaches uttered the *musical call* twice, the *bullfrog call* once, and was silent once. On being relieved four times, the male gave the *regular call* twice, the *shrill call* once, and was silent once; the female on being relieved five times uttered the *musical call* twice, *regular call* once, *bullfrog call* once, and a weak whining call once. Calls were repeated from one to seven times at each exchange. At 5:21 p.m. on April 3, after 272 minutes of continuous incubation, the female gave the *musical call* six times in succession and was answered by the male giving the *regular call* four or five times from near the edge of the territory. At his answer she left the nest and the male appeared at the nest about thirty seconds later, gave the *regular call* twice, and settled on the nest. On three different occasions the female, after having been on the nest for more than two hours (149, 180, and 260 minutes) without relief, seemed to call to the male. On each occasion the male was in the territory and had been calling shortly before. She used the *musical call* each time (12, 4, and 8 times, respectively), but apparently did not get the desired response, for she remained on the nest. Twice this happened 12 minutes and once 14 minutes before she was relieved, in each instance after another exchange of calls immediately prior to the change.

The very high percentage (99.5) of attentiveness and the efficiency in exchange of incubation duties has positive survival value when freezing and near-freezing temperatures are the rule, rather than the exception, during the February to April nesting season. The apparent feeding of the incubating female Clark Nutcracker by its mate reported by Dixon (1934) and suggested similar behavior in the Thick-billed Nutcracker of Europe (Vogel, 1873; Bartels and Bartels, 1929) was not observed at nest 1.

The eggs were left uncovered 0.1 to 2.5 minutes at incubation changes. It took 2.5 minutes to complete one transfer because just as the female left the nest at the usual exchange of calls, the male became involved in a short territorial dispute with a trespassing nutcracker. On arriving at the nest the male remained more than usually "alert" for the next 3.5 minutes, although I did not hear any other nutcrackers during the first five minutes after his arrival at the nest.

When the female flushed from nest 1, she would return to and settle on the nest within one or two minutes, but the male after being flushed from the nest never returned while I was still in the vicinity. The male at nest 1 seemed to be an unusually nervous bird. At nest 2, where the individual adults were not differentiated, the nest was usually covered within two minutes after I left the nest tree. Whenever I approached an incubating or brooding bird on nest 1 or 2, it would open its beak in a wide gape (observed and photographed by Dixon, 1934) but would not take an otherwise menacing

Table 3

Summary of Attentiveness and Inattentiveness during Incubation and Brooding at Clark Nutcracker Nest 1

	April 1 14th day incubation	April 3 16th day incubation	April 8 2nd day brooding	April 11 5th day brooding	April 17 11th day brooding	April 24 18th day brooding
Time of day	8 a.m.-6 p.m.	7:15 a.m.-5:30 p.m.	7:45 a.m.-3:45 p.m.	6:50-11:30 a.m.	8-11 a.m.	9 a.m.-4 p.m.
Total time	10 hours	10 hrs. 15 min.	8 hours	4 hrs. 40 min.	3 hrs.	7 hrs.
Air temperature (°F.):						
Beginning and end	31-39	32-38	.....	28-39	40-52	37-40
Low and high	31-53	32-46	.....	28-39	40-52	37-51
Hourly mean	43	40	.....	33	46	42
Wind velocity (est.)	0 to 15 m.p.h.	10 to 35 m.p.h.	0 to 10 m.p.h.	5 to 10 m.p.h.	0 to 5 m.p.h.	0 to 15 m.p.h.
Per cent sunshine	10%	40%	75%	5%	50%	30%
Snow at nest tree	0 to 18 in.	0 to 18 in.	0 to 12 in.	1 to 10 in.	0 to 8 in.	0 to 5 in.
Precipitation (% time)	20% rain and snow	15% snow	None	15% snow	None	20% rain and snow
Attentive periods, ♀ ♂	5	6	9	5	3	6
Lengths in minutes	(118) ¹ , 69, 161, 61, (190)	(30), 51, 194, 55, 272, (8)	(21), 25, 43, 37, 158, 25, 90, 20, (61)	(3), 87, 58, 121, (11)	(25), 1, 2	1, 1, 1, 1, 1, 1
Per cent of total time	99.89%	99.19%	99.96%	99.88%	15.56%	1.19%
Inattentive periods, ♀ ♂	4	5	1	1	3	7
Lengths in minutes	0.08, 0.25, 0.25, 0.08	0.25, 0.25, 2.50, 1.50, 0.50	0.17	0.33	40, 99, (13)	(35), 139, 22, 65, 9, 81, (64)
Percent of total time	0.11%	0.81%	0.04%	0.12%	84.44%	98.81%
Attentive periods, ♀	3	3	5	2	3	4
Lengths in minutes	(118), 161, (190)	(30), 194, 272	(21, 43, 158, 90, (61)	87, 121	(25), 1, 2	1, 1, 1, 1
Per cent of total time	78.20%	80.65%	77.67%	74.17%	15.56%	0.83%
Attentive periods, ♂	2	3	4	3	None	2
Lengths in minutes	69, 61	51, 55, (8)	25, 37, 25, 20	(3), 58, (11)	None	1, 1
Per cent of total time	21.69%	18.54%	22.29%	25.71%	None	0.36%

¹ Periods in parentheses were not completely clocked because of the arrival or departure of the observer. Arrival and departure had no apparent effect on attentiveness or inattentiveness, as reported here.

attitude. When I remained motionless near the nest, or disappeared into the blind at nest 1, the bird would almost immediately close its beak and apparently ignore my presence. The Heinroths' (1926) observed this unusual gaping behavior in the Thick-billed Nutcracker of Europe and, strangely enough, in the phylogenetically distinct Starling, *Sturnus vulgaris*.

During 965 minutes of incubation the female was observed to rise and shift position (other than to leave the nest) a total of 53 times, or about once every 18 minutes. Similarly, during 244 minutes of incubation, the male shifted position 14 times, or about once every 17 minutes. These periods of restlessness varied in duration from about five seconds to about two minutes and occurred at intervals of from 1 to 62 minutes. Restlessness did not appear to be correlated with the amount of time the bird had been incubating. During periods of restlessness, the most common activity was to rise off the eggs, back toward the edge of the nest, probe into the nest among and around the eggs, and then moving from side to side, settle back on the eggs facing in the same or a slightly different direction. It is probable that the eggs were turned and shifted in position by the bird with its beak on these occasions. It was noted that each time the relieving bird arrived at the nest its beak was glossy black, but after the first probing into the floor of the nest, it was a dusty gray, indicating that the mineral soil in the floor of the nest was dry and not a caked layer of mud. The calls of other nutcrackers, of Red-shafted Flickers, a Pygmy Owl, and a chipmunk caused the incubating bird to become more "alert," but not to shift position. During a snow squall at 7:30 a.m. on April 3, the incubating female, without rising from the nest, snapped at and seemed to catch about ten falling snow flakes.

BROODING AND FEEDING

Observations were made from the blind at nest 1 on the second, fifth, eleventh, and eighteenth days of the altricial period (table 3). Observations made on the ninth day were interrupted and are not included in the summaries. Attentiveness through the ninth day of brooding was nearly 100 per cent. During 664 minutes of observation on the second and fifth days, the female was attentive 75.2 per cent of the time, and the male 24.8 per cent of the time. On the eleventh and eighteenth days, the female was brooding when I arrived at the nest but did not return to the nest except for feeding after she was flushed. On the eighteenth day, when continuous observations were made from 9 a.m. to 4 p.m., neither adult was at the nest except to feed the young and clean the nest. At nest 2, to which 12 weighing visits were made in the 19 days of the altricial period, one or the other of the adults was flushed from the nest through the ninth day, but not from the tenth day onward. Steinfatt (1944) found that brooding duties were shared by the adult Thick-billed Nutcrackers in the German Alps in the early days of the altricial period.

Whereas during incubation the adults were never observed at the nest together, the adults were frequently at the nest simultaneously during about the first half of the altricial period. For the record, times when both adults were at the nest together are assigned to the bird remaining to brood. Feedings on the second and fifth days were usually signaled by the off-nest bird, which uttered the *musical call* as it approached the nest tree. Immediately after the arriving bird reached the nest, the brooding bird would move to one edge of the nest and assume a begging attitude with its wings fluttering. Ignoring its begging mate, the adult just arrived would feed one or more of the nestlings by inserting its beak well into the open mouths of one or more young at least two or three times each. The feeding bird's throat quivered as it reached the nest and feedings were made by regurgitating the shelled, partially broken-up, and well lubricated pon-

derosa pine nuts deep into the throats of the young birds. Then, with subdued squalling, both adults would probe among the young birds, where they would pick up and then swallow spilled food and freshly voided fecal sacs. One of the adults would then leave the nest and the other would settle over the young with its breast feathers well fluffed. This feeding procedure was much the same whichever bird arrived with food.

On the second day of the altricial period, the female upon arriving at nest 1, fed the begging male before she fed the young. This was the only instance observed at nest 1 wherein one adult responded to the begging of the other by feeding it. Later that same morning the male arrived at the nest, apparently ignored the begging female, and pro-



Fig. 4. Adult Clark Nutcrackers at nest 1 on April 11, the fifth day of brooding-feeding.

ceeded to feed the young. As he was feeding the nestlings, the female began working her throat muscles and also fed one of the young. She had arrived at the nest 18 minutes before, had fed the young at that time, but had not picked up any fecal sacs. This retention of food in the crop was demonstrated by the male shortly after noon the same day. Twenty minutes after he had relieved the female without feeding the young, he backed to the edge of the nest, regurgitated a quantity of shelled, partially broken-up, and well lubricated pine nuts on the edge of the nest. He then re-ate the nuts and settled back onto the nest. When the female arrived five minutes later and proceeded to feed the young, the male also fed them.

At 6:53 a.m. on the fifth day of the altricial period the male was on nest 1 when the female arrived to feed the young. While still covering the nestlings, the male squalled and fluttered his wings as though begging to be fed. When the female did not feed him, he backed to the edge of the nest, and on this singular occasion left the nest while the female was still feeding the young.

Each of the six times the female arrived at nest 1 during the observations of the

second and fifth days of the altricial period, she fed the nestlings and relieved the brooding male. During this time, the male made nine trips to the nest. On four trips he fed the young and relieved the female, on three trips he fed the young but did not relieve the female, and on two trips he relieved the female without feeding the young.

After daytime brooding ceased, the feedings followed basically the same procedure, except that the excitement apparently provoked by the presence of both birds at the nest simultaneously, was absent. Actions of the adults seemed more deliberate and they consumed less time.

Of 22 feedings observed at nest 1 during 22 hours and 40 minutes of the altricial period, 12 were made by the female and 10 by the male. Eight clocked intervals between feedings by the female were 80, 88, 92, 100, 110, 140, 145, and 183 minutes for an average of 117 minutes between feedings. Similarly, seven clocked intervals between feedings by the male were 50, 54, 75, 90, 115, 123, and 179 minutes for an average of 98 minutes. Clocked intervals between feedings by either bird varied from 10 to 140 minutes with an average of 64 minutes. Recorded intervals between feedings early and late in the altricial period did not vary significantly, but a tendency to increase with nestling age is suggested. In the case of half-grown Thick-billed Nutcrackers, Steinfatt (1944), during 20 hours of observation, found that intervals between feedings varied from 17 to 110 minutes with the average interval about 45 minutes.

During the first few days, apparently being uncovered by the brooding adult was sufficient stimulus to cause the young to open their mouths for food. After daytime brooding ceased, almost any loud noise, shock, or sudden movement near the nest, seemed sufficient to induce them to open their mouths. However, at 1:23 p.m. on the eighteenth day of the altricial period, the two young remained crouched low in the nest, apparently asleep, when the female arrived on the edge of the nest. She remained perched a few seconds and then gave the *musical call*. This caused the young to raise their heads for feeding. It had been 65 minutes since the previous feeding.

Fecal sacs were usually voided by the nestlings immediately after a feeding, when the adults would promptly pick them up and either swallow them or carry them away. This prompt voiding of the fecal sacs was observed by Steinfatt (1944) in nestling Thick-billed Nutcrackers in Europe. At nest 1, during 22 hours and 40 minutes of observation during the altricial period, the female removed fecal sacs nine times (15 sacs) and the male removed them six times (10 sacs). In each of the nests observed by me, the fecal sacs were removed throughout the altricial period. They were not permitted to accumulate on the edge of the nest as is common in some passerine species such as *Sturnus vulgaris* and *Carpodacus mexicanus*.

Food for the young at nest 1 consisted almost entirely of shelled ponderosa pine nuts, although some insect material was included in feedings on April 24. The importance of vegetable food for nestling *Nucifraga* has been reported by several workers including Vogel (1873), Bendire (1895), Skinner (1916), Bradbury (1917), Steinfatt (1944), and Swanberg (1951). The general unavailability of insect food during the nesting season in the areas inhabited makes this ability to utilize vegetable food an important factor in survival. There is abundant evidence in the literature, and in my findings (unpublished data), that the incidence of nesting of Clark Nutcrackers in areas they inhabit is largely dependent on the previous year's pine-nut crop in that area. This is apparently true in the case of Old World nutcrackers, also (Lack, 1954).

DEVELOPMENT OF THE YOUNG

Daily or bidaily visits usually between 5 and 7 p.m. were made to each of nests 1 and 2 during the altricial period of about 20 days. Weights were taken to the closest

0.1 gram on a laboratory balance, after detectable fecal sacs had been eliminated. Each of the six nestlings was first marked with ink and later banded to assure correct identification. Because weights were taken late in the day and because four of the six subjects apparently hatched early in the day, the ages of the nestlings are given to the nearest 0.5 day (Lack and Silva, 1949; King, 1955).

A freshly hatched and unfed nestling weighed 7.1 grams, whereas three nestlings at 0.5 day of age weighed 7.5, 8.0, and 8.2 grams. The mean weight of the four surviving young was 95.3 grams at an age of 16.5 days. Mean daily increments were 5.5 grams from 0.5 to 16.5 days of age. Twelve additional daily increments and decrements up to 20.5 days of age have a positive mean value of only 0.2 grams. This indicates that weights tended to level off during the last few days in the nest.

One nestling in each brood failed to survive the altricial period. The last one to hatch in nest 1 failed to gain sufficient weight and died in the nest when 9 days old. It weighed 14.5 grams at death when its sibs weighed 50.2 and 62.3 grams. One young nutcracker in nest 2 kept pace with its sibs until 8.5 days of age. It then ceased making significant gains in weight up through 12.5 days of age and was gone from the nest on the fourteenth day. A diligent search failed to reveal its presence in the vicinity of the nest tree.

The newly hatched nutcrackers had a sparse covering of white down on their principal feather tracts. The white down became thicker until at 4.5 days dark pigmentation was first apparent in the feather papillae of the capital, dorsal, and alar tracks. On the eleventh day feathers had begun to break their sheaths and the white down was less noticeable. Feather development by 18.5 days was not yet sufficient to cover the apteria. However, when crouched in the nest in their usual position of resting, most dorsal apteria were covered, especially because the wings folded over the back.

Eyes of nestling Clark Nutcrackers began to open on the fifth day, but did not appear completely opened until the eleventh day. By their eighteenth day, the young birds spent some minutes at a time, several times during the day preening their feathers, shaking themselves, and at times flapping their wings.

The nestlings were silent while being handled for weighing until 8.5 days of age. The squealing at this age, as well as the lower-pitched squalling of the nestlings when several days older, stimulated the adults to approach the site of the weighing more closely than before the audible responses of the young were uttered.

No coordinated attempts at escape were exhibited until one of the two nestlings of nest 1 had to be replaced in the nest a second time after weights were taken when they were 20.5 days old.

Mouths of nestlings were observed to be bright salmon-red. At the time they left the nest they had gray eyes, gray feet, and the inside surfaces of their bills and mouths varied from pale salmon-red to white. Feathers were in growth (postnatal molt) in every tract except the capital tract. Usually primaries 1 to 9 were soft and growing, whereas primary 10 and the ten secondaries were fully grown and hard. The upper wing coverts were usually hard, with the exception of the marginal coverts, many of which were incompletely grown. The lower wing coverts were more than half grown. The rectrices were usually about one-half grown. Pitelka (1945) found young *Aphelocoma coerulescens* lacking lower wing coverts as late as the time of departure from the nest. In the young nutcrackers as they were leaving the nest, feathers in the central portions of most feather tracts on the body were fully grown, but those along the edges of the spinal and ventral tracts, and of the posterior portions of the humeral and femoral tracts were soft and only partially grown. The last traces of the postnatal molt appeared in the lateral portions of the dorsal region of the spinal tract.

During the postnatal molt the irises of the eyes gradually changed in color from gray to brown and the feet changed from gray to black. Black areas appeared in the white inside surfaces of the bill and mouth and gradually increased in size until well into the postjuvinal molt, when the inside of the bill and mouth of most specimens was black.

SUMMARY

Observations were made on the nesting activities of a pair of Clark Nutcrackers, *Nucifraga columbiana*, which nested in March and April of 1947 near Missoula, Montana. A few additional data were obtained from five other nests.

Nine calls most commonly heard are described and the circumstances incident to their use are discussed.

Considerable variation in courtship activities suggests that no simple set of behaviors can be cited as typical, even for the one population studied.

The territory around the most thoroughly studied nest contained at least 2.1 acres and was actively defended by the male against trespass by other nutcrackers. He used pursuit, body contact, and voice in territorial defense. At least some nest material and most of the food for the young was obtained beyond territorial limits.

Whereas both birds collected nest material, the female apparently did most of the actual building. Nest placement was highly variable, nests being found from 6 to 80 feet from the ground, in either *Pseudotsuga taxifolia* or *Pinus ponderosa*, the only suitable species of trees in the areas most intensively studied during the nesting season. Construction time on two nests was five days each and on one nest was eight days. An instance of aberrant nest building behavior is described.

The male Clark Nutcracker develops an incubation patch. During 20 daylight hours, a male was clocked incubating 20 per cent of the time. Better than 99 per cent attentiveness assured adequate protection to the eggs even during sub-freezing weather. The period of incubation was found to be 18 days.

Attentiveness of the adults was essentially 100 per cent during the first nine days of the altricial period. Thereafter the young were not covered during most of the daylight hours. The male was attentive 25 per cent of the time during 11 hours of observation on the second and fifth days of the altricial period. Intervals between feedings by either adult varied from 10 to 140 minutes with an average of 64 minutes.

Four nestlings in two nests gained an average of 5.5 grams per day during the first 16.5 days of about 20 days in the nest. Food for the nestlings consisted almost entirely of shelled nuts from *Pinus ponderosa* supplemented by some insects late in the altricial period.

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