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Brood parasitism of Greater Sage-Grouse by California Quail in Idaho

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Abstract.—We describe a case of brood parasitism of a Greater Sage-Grouse (*Centrocercus urophasianus*; hereafter, sage-grouse) nest by California Quail (*Callipepla californica*; hereafter, quail) in southwestern Idaho during 2019. We observed one quail egg in the parasitized nest; the egg partially hatched, but the chick was dead upon the final nest check. Of the 6 sage-grouse eggs in the nest, only 2 hatched, although the eggs contained chicks that appeared nearly completely developed. Identification of the quail chick was confirmed using mitochondrial DNA. Additional monitoring and documentation of this behavioral interaction is warranted to better understand its prevalence and any reproductive consequences for sage-grouse.

Resumen.—Se describe un caso de parasitismo de puesta del urogallo de las artemisas o gallo de salvia (*Centrocercus urophasianus*) de aquí en adelante se mencionará como urogallo, el nido del colín de California o codorniz californiana (*Callipepla californica*) que la llamaremos codorniz, en el sur del estado de Idaho a partir de 2019. Se observó un huevo de codorniz en el nido con parásitos; el huevo se encontraba parcialmente roto del cascarón, mientras que el polluelo estaba muerto durante la última revisión del nido. De los 6 huevos del urogallo en el nido, solamente dos habían roto el cascarón, aun cuando los huevos tenían polluelos que parecían estar completamente desarrollados. La identificación de la codorniz fue realizada a través del ADN mitrocondrial. Se garantizó monitoreo y documentación adicionales de esta interacción de comportamiento para entender mejor su prevalencia y cualquier consecuencia reproductiva para el urogallo.

Brood parasitism occurs when a hen lays her eggs in the nest of another hen (of either the same or another species) and is reported for several species within Galliformes, although interspecific brood parasitism in this group is thought to be uncommon (Krakauer and Kimball 2009). However, the extent to which galliforms engage in interspecific brood parasitism is unclear because of the presumed rarity of the behavior and bias in reporting such events (Krakauer and Kimball 2009). To date, the only published case of interspecific brood parasitism of Greater Sage-Grouse (*Centrocercus urophasianus*) occurred in Nevada in 2011; in this event the sage-grouse nest was parasitized by a Chukar (*Alectoris chukar*; Fearon and Coates 2014). Because brood parasitism may have consequences for sage-grouse hens or broods, and because sage-grouse populations are declining in many parts of the species' range (WAFWA 2015, Conover and Roberts 2016), it is important to improve our understanding of the prevalence and geographic extent of this behavior. To that end, we describe a new case of a sage-grouse nest parasitized by California Quail (*Callipepla californica*) in Idaho during 2019 (Fig. 1). This case was observed by chance during a study of demography and habitat selection of Greater Sage-Grouse in relation to western juniper; the objective of this study was not to estimate the rate of parasitism of sage-grouse.

Our study area is located in the Owyhee Mountains of southwestern Idaho, approximately 34 km southwest of the town of Grandview. Land was primarily managed by the Bureau of Land Management (BLM), with interspersed sections owned privately or by the U.S. Forest Service or the state of Idaho. Land use primarily consisted of livestock grazing, hunting, camping, and localized off-road

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Fig. 1. Greater Sage-Grouse (*Centrocercus urophasianus*) nest containing a California Quail (*Callipepla californica*) egg in the Owyhee Mountains of southwestern Idaho in 2019. Photo by E. Heldt.

vehicle recreation (Owyhee County 2009). Elevation varied from 1200 to 2900 m, mean annual precipitation ranged from 16 to 51 cm, and average high temperature from low to high elevations was 4 °C to −2 °C, respectively, in January and 31 °C to 21 °C in July (NRCS 2017, NOAA 2018).

We captured female sage-grouse at roost locations during nighttime hours (20:00–05:00) using spotlighting and netting techniques in March–May 2019 (Wakkinen et al. 1992). All hens received a 22-g necklace-style very high frequency (VHF) radio transmitter equipped with a mortality sensor (model A4060, Advanced Telemetry Systems, Isanti, MN; <3% body mass) to identify use locations following release. All sage-grouse were captured, marked, and monitored in accordance with approved protocols (Western Ecological Research Center 2015-02, Idaho Department of Fish and Game permits #161213 and #180205 and University of Idaho Institutional Animal Care and Use Committee protocol 2016-58).

Beginning on 1 April, we located hens via radiotelemetry in order to identify nesting attempts by homing in on collar signals with a 3-element Yagi antenna and a receiver (model R2000, Advanced Telemetry Systems, Isanti, MN; model R-1000, Communications Specialists, Orange, CA). We found nests (n = 17 in 2019) by observing localized movements of hens between consecutive tracking events and visually confirming incubating hens (Connelly et al. 1993, Kolada et al. 2009). At a subset of nests (n = 11 in 2019), we installed a microvideo camera that was 30 mm diameter × 76 mm long with 8 light-emitting diodes producing 950-nm infrared illumination (model ENC-100, EZSpy Cam, Los Angeles, CA) on the nest. The camera was connected to a digital video recorder (DVR; model MDVR14, Super-Circuits, Austin, TX; model SSC-773V2, Advanced Security, Swansea, IL) that was camouflaged and placed about 30 m from the nest. We monitored hens on nests 2–3 times per week until we determined a nest fate. We located hens with successful nests beginning 10 d after hatch to determine whether hens were accompanied by chicks (Casazza et al. 2011).

We observed the parasitized nest while we were installing a camera and DVR system. The hen was discovered nesting via telemetry on 22 May, but the nest was not observed directly until the camera was installed on 29 May; the quail egg was observed at this first visit to the nest (Fig. 1). The hen was visited 6 more times via telemetry during incubation until a nest fate was determined on 17 June. The nest successfully hatched 2 of 6 sage-grouse eggs; the quail chick did not completely hatch and was found dead in the nest bowl with the unhatched sage-grouse eggs (Fig. 1). Upon reviewing the video, we observed the hen leading only 2 sage-grouse chicks away from the nest. A mortality signal was detected from the hen's collar prior to the first brood count on day 10, but the collar could not be recovered, and we were ultimately unable to confidently determine a fate for the brood.

Egg size may be used to discriminate among eggs from different species and can help identify potential parasitism events. Sage-grouse eggs average 5.45–5.82 cm × 3.76–3.87 cm and are approximately 46 g (Schroeder et al. 1999). We measured the partially hatched quail egg; its dimensions (3.16 cm × 2.24 cm) were more similar to the average size of quail eggs (Calkins et al. 2020), and an intact sage-grouse egg from the same clutch was substantially larger in size (5.57 cm × 3.78 cm). We collected the egg and chick for genetic confirmation of the species. Genetic analysis was conducted by the Laboratory for Ecological, Evolutionary, and Conservation Genetics at the University of Idaho and returned a 479-bp fragment of cytochrome b. Comparison of the sequence to the GenBank website (https://www.ncbi.nlm.nih.gov/genbank) was a match to a California Quail at all but one base, and the DNA sequences overlapped 100%. We cannot exclude the possibility that the chick is a quail hybrid; however, this is unlikely because there are no sympatric quail species at our study area.

Researchers should increase vigilance for future parasitism events to improve awareness of outcomes for sage-grouse, especially events that directly cause nest or egg failure. Because sage-grouse hens do not directly feed their chicks and must leave the nest shortly after egg hatch to lead chicks to food sources (Starck and Ricklefs 1998, Schroeder et al. 1999), brood parasitism may cause reproductive failure of sage-grouse via the abandonment of their own eggs if quail eggs were to hatch first. The length of incubation for quail eggs is shorter than sage-grouse eggs (22 vs. 28 d; Schroeder et al. 1999, Calkins et al. 2020), which makes it possible for quail eggs to hatch prior to sage-grouse eggs, depending on the timing of laying. Indeed, we observed low hatching success for sage-grouse eggs in the parasitized nest. Two of 6 grouse eggs in the parasitized nest hatched (33%), whereas mean hatching success for all nests that hatched at least one egg in 2019 was 91% (range 28.6% to 100%). However, we do not have direct evidence that this low success rate was caused by the presence of the quail egg. Field studies conducted on sage-grouse populations that are sympatric with other galliforms should monitor and document parasitized nests to aid in understanding the prevalence of interspecific brood parasitism, the conditions under which it occurs, and whether brood parasitism influences the survival of sage-grouse nests or chicks. Studies that use nest videography, measurements of egg morphology, and genetics would be especially useful.

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