

FORAGING HABITS OF RUBY-CROWNED AND GOLDEN-CROWNED KINGLETS IN AN ARIZONA MONTANE FOREST

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ABSTRACT.—Foraging behaviors of breeding Ruby-crowned (*Regulus calendula*) and Golden-crowned kinglets (*R. satrapa*) in an Arizona mixed-coniferous forest were compared to assess foraging similarity and the use of available habitat components. The species were not significantly different in five of the eight foraging variables examined. Foraging behavior was significantly different (Chi-square test, $P < 0.02$), for three variables: method of prey attack (Ruby-crowned Kinglet hovered more, Golden-crowned gleaned more), tree species selection (Golden-crowned was more restricted to certain tree species), and relative foraging location (Ruby-crowned used the upper thirds of the trees more frequently). Mean foraging height was similar. Both kinglets differed from a random distribution of use when compared to resource availability for all foraging variables tested (distance from branch tip, selection of tree species, tree height use, foraging height, and relative location).

Foraging repertoires of these similar congeners were strikingly alike. Niche theory predicts that two such similar species will modify their foraging behavior to partition the habitat and minimize potential competition. In the case of the kinglets, limited environmental subdivision was demonstrated. Under less favorable habitat conditions, competitive influences may be more important in modifying the foraging behavior of these species.

Ecological theory predicts that similar sympatric species will act in such a way as to reduce the overlap in niche foraging characteristics. Studies suggest that habitats can be partitioned either through differential use of vertical or horizontal portions of the vegetation (e.g., Hartley 1953, Balda 1969, Morse 1980), or through differences in foraging substrate preferences such as perch types or sizes (e.g., Hartley 1953, Morse 1967a, b), or plant species (Balda 1969, Jackson 1970, Willson 1970, Franzreb 1978, Holmes and Robinson 1981, and others).

Ruby-crowned Kinglets (*Regulus calendula*) and Golden-crowned Kinglets (*R. satrapa*) may coexist during the breeding season. They are similar morphologically and in body size, although the Golden-crowned Kinglet is slightly smaller (see the Appendix for morphometric and weight data). Their diets also are similar, consisting primarily of animal prey (insects, spiders), and to a much lesser extent, plant matter (fruits, seeds; Beal 1907, Laurenzi et al. 1982).

The primary objective of my study was to determine if breeding Ruby-crowned and Golden-crowned kinglets foraged randomly in a mixed-coniferous forest, and if not, to determine their preferences. Secondly, I wished to assess the similarity of foraging behaviors between the two kinglets in order to ascertain the extent of habitat partitioning. I anticipated

finding clear differences in food habits that minimized potential competition.

STUDY AREA

I conducted this study in the Willow Creek watershed, White Mountains, Greenlee County, Arizona. Willow Creek is approximately 80 km south of Springerville, in the Apache-Sitgreaves National Forest. Elevation of the watershed ranges from 2,682–2,805 m. The watershed is covered by a mixed-coniferous forest composed primarily of Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), and southwestern white pine (*Pinus strobiformis*).

METHODS

VEGETATION ANALYSIS

A 15.5-ha study plot was established using nine parallel, flagged transect lines 390 m in length and 50 m apart. Vegetation was sampled using the plotless point-quarter method (Cottam and Curtis 1956); 400 trees (diameter at breast height ≥ 7.6 cm) were sampled. Basal area served as the basis for dominance determinations. Relative density, relative frequency, and relative dominance values were computed for each tree species and for snags (dead trees); these values were summed to derive importance values. Tree heights were estimated using a clinometer and subsequently classified

into 3-m categories (i.e., trees ≤ 3 m in height, those $> 3 \leq 6$ m, etc.). The habitat and additional details of the methods used in the vegetation analysis including determining volume of foliage are described more fully in Franzreb (1978) and Franzreb and Ohmart (1978). Plant nomenclature follows the Soil Conservation Service (1982).

FORAGING BEHAVIOR

I obtained foraging data daily on kinglets from mid-May through August in 1973 and 1974 by systematically traversing the transect lines. Observations were taken under skies that were generally clear to less than 30% overcast and wind conditions that varied from no wind to light wind (Beaufort scale 0 to 2). Although data were collected throughout the day, the majority of observations were taken during morning hours (06:00–10:00).

I recorded observations of an individual for as long as it was visible, often for several minutes. When birds are foraging, some individuals may be more detectable in certain portions of the habitat (e.g., more open branches on pines), thus biasing the results toward more conspicuous perches. Taking repeated observations while following one bird may reduce bias for the more conspicuous foraging locations. To test for this bias, I compared the data for first observations to those subsequent observations of an individual during a given foraging bout for each species using a Chi-square contingency table for each foraging variable (this and all subsequent Chi-square tests were performed on actual data, not percentages); none was significantly different at the $P < 0.05$ level. These results suggest that the use of the first observations was not biased by conspicuousness. However, it may also be argued that both first observations and subsequent ones are biased by conspicuousness; this possibility can not be evaluated. I also assumed that foraging Ruby-crowned and Golden-crowned kinglets were equally detectable. If this assumption is correct, the effects of any detectability bias in comparing the two species should be negligible. For statistical purposes, use of first observations is preferable because observations should be independent. Because first observations did not appear to be biased by conspicuousness of birds in particular locations, data provided herein represent first observations.

Data were collected for eight foraging variables: method of prey attack, perch type, perch diameter, distance from the branch tip to the perch site, tree species selected, tree height selected, foraging height, and the relative foraging location (upper, middle, or lower third

of the tree). All heights of birds were estimated using a clinometer.

“Method of prey attack” referred to the manner in which the individual attempted to acquire food. Methods used by the birds were defined following Holmes et al. (1979) and included: glean, hover, hawk, and peck-probe. The substrate (e.g., trunk, branch, cone, etc.) on which the bird perched was denoted as perch type. Each observation of birds using branches/twigs as a foraging substrate was further categorized by perch diameter. Observations of individuals foraging on branches/twigs were segregated relative to the bird’s position from the branch tip by subdividing the branch into thirds with “0 to 33% from tip” representing the distal portion of the branch. For each foraging observation, I recorded the tree species (or snag) and the tree height. Foraging height denoted the estimated height of the bird in the tree relative to the ground. Observations were segregated into those occurring in the upper, middle, or lower third of the tree.

I constructed Chi-square contingency tables (Zar 1974) (species \times foraging variable) to test for significant differences in probabilities of each foraging variable between the two kinglets. Tree species preferences, tree height selection, foraging height and relative location were evaluated using Chi-square goodness of fit tests. An expected distribution of foraging data for tree species use was derived from the importance value of each tree species as determined from the point-quarter vegetation analysis; foraging data were compared with the expected values. Expected frequencies were estimated for foraging in trees of each height interval; these were based upon the frequency of such tree heights. The expected distribution pattern for foraging height was based on the proportion of foliage volume available in each height interval (see Franzreb 1978 for details). The expected values for relative location were derived by assuming that each third of the tree should constitute one-third of the observations if the birds were using the vertical substrate randomly. This assumption does not consider that foliage volume is unevenly distributed, with more foliage located in the lower portions of the trees. Hence, any overuse of the upper portions would be even more apparent had foliage volume data been used in the evaluation. A significant Chi-square value indicated that the kinglets foraged non-randomly, preferring certain portions of the habitat. Some individuals undoubtedly were observed more than once, hence, the data may not represent a truly independent sample. To compensate for this, I used a significance level of $P < 0.02$ unless otherwise noted.

Niche overlap was determined using the formula $O_{rg} = 1 - \frac{1}{2} \sum |P_{ri} - P_{gi}|$ (modified from Schoener 1968) where P_{ri} and P_{gi} are the proportions of observations in resource state i by Ruby-crowned (r) and Golden-crowned (g) kinglets, respectively, in each foraging category; O_{rg} represents the extent of niche overlap between Ruby-crowned and Golden-crowned kinglets. Values range from 0 to 1 with higher values indicating greater overlap and more similarity between the species.

To determine a species' niche breadth for a particular foraging behavior (e.g., tree species use), I calculated a proportional similarity index (PSI) (Feinsinger et al. 1981) using $PSI = 1 - \frac{1}{2} \sum |p_i - q_i|$ where p_i is the proportion of the units in state i used by a species and q_i is the proportion of i units available. Niche breadth (PSI) values were calculated for each species and only for those variables for which food availability could be quantified (distance from branch tip, tree species use, tree height selection, foraging height, and relative location). Values range from 0 to 1 with higher values indicating greater generalization in that particular variable. The asymptotic variance (V_A) for each PSI value was estimated using the "delta method" outlined in Smith (1982). Estimates of niche breadth for these variables were compared using the procedures described by Smith (1982, eq. 18) to determine if kinglets were similar in niche breadth.

For foraging variables whose category availability could not be quantified, I estimated a niche breadth value using Levin's (1968) formula whereby $1/B = \sum p_i^2$ where B is foraging niche breadth and p_i is the proportion of observations occurring in the i^{th} resource state (e.g., for method, resource states are glean, hover, hawk, peck-probe). Higher values indicate a more generalized response in that foraging behavior and a wider niche breadth.

RESULTS

The kinglets differed significantly ($\chi^2 = 16.7$, $df = 3$, $P < 0.001$) in method of prey attack. Ruby-crowned Kinglets hovered more (18.2% vs. 11.2%) and gleaned less (80.3% vs. 86.9%) than Golden-crowned Kinglets (Fig. 1).

Kinglets selected similar ($\chi^2 = 2.1$, $df = 2$, NS) types of foraging perches; both species foraged almost exclusively from branches/twigs (97.0% Ruby-crowned, 98.3% Golden-crowned). Kinglets infrequently used the categories: trunk, cone, ground, or logs. Niche breadth (B) for perch selection was 1.06 and 1.04 for Ruby-crowned and Golden-crowned kinglets, respectively. Niche overlap for perch type was the highest of any foraging variable (0.99).

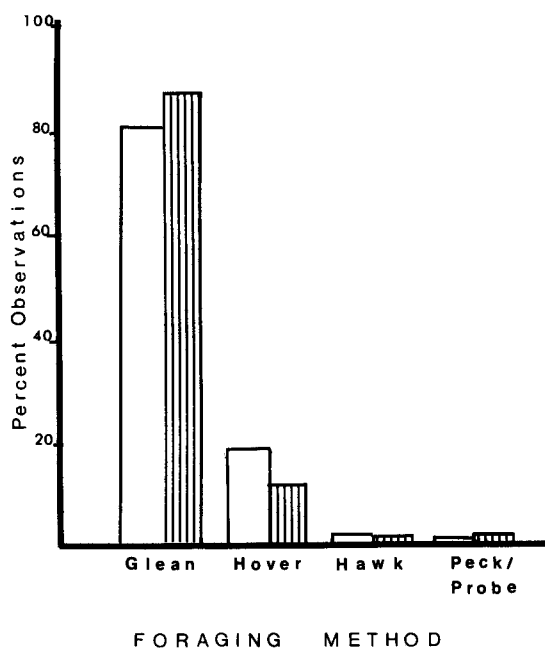


FIGURE 1. Method of foraging by Ruby-crowned and Golden-crowned kinglets during the nesting season. Open columns = Ruby-crowned Kinglet ($n = 775$), striped columns = Golden-crowned Kinglet ($n = 436$). Niche breadth for Ruby-crowned Kinglet = 1.47, Golden-crowned Kinglet = 1.28. Niche overlap = 0.92. Significant difference between the species in foraging method ($\chi^2 = 16.7$, $df = 3$, $P < 0.001$).

There was no significant difference in diameter of perches used by the kinglets ($\chi^2 = 1.3$, $df = 3$, NS); both foraged most frequently on the smallest branches/twigs (those ≤ 1.3 cm in diameter) (Ruby-crowned 80.6%, Golden-crowned 79.6%). Niche overlap for the perch diameter variable was high (0.98). The kinglets were also similar in niche breadth (Ruby-crowned $B = 1.50$, Golden-crowned $B = 1.52$).

Both kinglets generally foraged near branch tips and were not significantly different in this regard (Table 1). However, each species foraged in a non-random way in relation to distance from the branch tip ($P < 0.001$).

The kinglets differed significantly in their choice of tree species ($P < 0.001$; Table 2). Neither species used the available tree species randomly. Both kinglets strongly preferred Engelmann spruce (*Picea engelmannii*), Douglas-fir, and blue spruce (*P. pungens*); they appeared to avoid the pines and snags. The Ruby-crowned Kinglet was considerably more generalized in tree species selection than the Golden-crowned Kinglet as indicated by the PSI (0.58 Ruby-crowned, 0.44 Golden-crowned). This was the only variable for which PSI values were significantly different [$P(Z = 2.551) < 0.0054$]. Niche overlap for tree

TABLE 1. Distance from the branch tip used while foraging by Ruby-crowned and Golden-crowned kinglets.

Distance from tip ^a	Percent (%)	
	Ruby-crowned Kinglet	Golden-crowned Kinglet
0-33%	46.9%	44.3%
>33-66%	30.3%	31.8%
>66%	22.8%	23.9%
Total	100.0%	100.0%
Sample size	689	418
PSI ^{b,c}	0.87	0.89
Niche overlap	0.97	

^a No significant difference between Ruby-crowned and Golden-crowned kinglets ($\chi^2 = 0.76$, $df = 2$, NS). Significant difference in comparing use to availability for both species: RCK ($\chi^2 = 62.7$, $df = 2$, $P < 0.001$), GCK ($\chi^2 = 26.4$, $df = 2$, $P < 0.001$).

^b PSI = Proportional similarity index.

^c Variance estimates and Z values: RCK $V_n(\widehat{PSI}) = 0.0015$, GCK $V_n(\widehat{PSI}) = 0.0024$, $Z = 0.324$, NS.

species selection (0.81) was the lowest of any foraging variable.

Both species foraged in tall trees (≥ 27 m) considerably more frequently than expected (Table 3). Selection of trees by height for foraging purposes was not random and for each kinglet was significantly different ($P < 0.001$) from the predicted pattern of use. Patterns of tree height use for both species were similar ($\chi^2 = 11.5$, $df = 4$, NS).

The kinglets did not differ significantly in pattern of foraging height ($\chi^2 = 7.6$, $df = 3$, NS; Table 3). Overall mean foraging height was 10.9 m (SE = 7.1) for the Ruby-crowned and 10.4 m (SE = 6.7) for the Golden-crowned. For both species, foraging height differed significantly ($P < 0.001$ for each species) from the random use of available foliage volume within the vegetation profile.

Kinglets differed significantly ($\chi^2 = 9.0$, $df = 2$, $P = 0.01$) in relative foraging location (up-

TABLE 2. Tree species selection by Ruby-crowned Kinglets and Golden-crowned Kinglets while foraging.

Tree species ^a	(I.V.)/3 ^b	Percent (%)	
		Ruby-crowned Kinglet	Golden-crowned Kinglet
Ponderosa pine	22.6%	4.9%	2.9%
Southwestern white pine	15.6%	6.3%	2.4%
Douglas-fir	30.8%	28.9%	25.8%
Alpine fir (<i>Abies lasiocarpa</i>)	0.5%	2.4%	11.9%
White fir (<i>A. concolor</i>)	8.1%	6.8%	5.9%
Blue spruce	1.7%	7.2%	16.8%
Engelmann spruce	4.4%	39.1%	34.1%
Quaking aspen (<i>Populus tremuloides</i>)	6.7%	4.0%	0
Snag (dead tree)	9.6%	0.4%	0.2%
Total	100.0%	100.0%	100.0%
Sample size		843	511
PSI ^{c,d,e}		0.58	0.44
Niche overlap		0.81	

^a Significant difference in tree use of Ruby-crowned vs. Golden-crowned kinglets ($\chi^2 = 113.8$, $df = 8$, $P < 0.001$). Significant difference in use vs. availability for both kinglets: Ruby-crowned ($\chi^2 = 2,794.0$, $df = 8$, $P < 0.001$), Golden-crowned ($\chi^2 = 3,006.0$, $df = 8$, $P < 0.001$).

^b Importance value of each tree species (expressed as %) divided by 3 = (relative density + relative dominance + relative frequency)/3.

^c PSI = Proportional similarity index.

^d Computation based on availability as denoted by importance values.

^e RCK $V_n(\widehat{PSI}) = 0.0012$, GCK $V_n(\widehat{PSI}) = 0.0018$, $P(Z = 2.552) < 0.0054$.

per, middle, or lower third of the tree; Fig. 2). Ruby-crowned Kinglets preferred the upper one-third of trees, whereas Golden-crowned Kinglets more frequently selected the middle portions.

DISCUSSION

Both kinglet species were specialized in their use of certain aspects of the habitat. They subdivided the habitat through differences in method of prey attack, tree species selection,

TABLE 3. Tree height selection and foraging height of Ruby-crowned (RCK) and Golden-crowned (GCK) kinglets.

Tree height ^a or distance from ground ^b	Tree height frequency ^d	Tree height use			Foraging height	
		RCK	GCK	Foliage volume ^d	RCK	GCK
≤ 9 m	30.0%	23.4%	23.3%	33.8%	56.1%	56.3%
>9-18 m	38.8%	31.6%	37.5%	39.8%	29.1%	33.2%
>18-27 m	23.0%	24.2%	23.6%	23.5%	13.2%	8.5%
>27-36 m	6.5%	11.1%	10.6%	2.6%	1.6%	2.0%
>36 m	1.7%	9.7%	5.0%	0.3%	0	0
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Sample size		806	480		814	494
PSI ^e		0.86 ^{d,e}	0.92 ^{d,e}		0.77 ^f	0.78 ^f
Niche overlap		0.94			0.95	

^a No significant difference in use by RCK vs. GCK: ($\chi^2 = 11.5$, $df = 4$, NS). Significant difference in use vs. availability: RCK ($\chi^2 = 341.8$, $df = 4$, $P < 0.001$), GCK ($\chi^2 = 52.3$, $df = 4$, $P < 0.001$).

^b No significant difference in comparison of foraging height of RCK vs. GCK ($\chi^2 = 7.6$, $df = 3$, NS). Significant difference in comparison of use vs. availability for both species: RCK ($\chi^2 = 185.8$, $df = 3$, $P < 0.001$), GCK ($\chi^2 = 140.5$, $df = 3$, $P < 0.001$).

^c PSI = Proportional similarity index.

^d Based on vegetation analysis.

^e RCK $V_n(\widehat{PSI}) = 0.0012$, GCK $V_n(\widehat{PSI}) = 0.0020$, $Z = 1.058$, NS.

^f RCK $V_n(\widehat{PSI}) = 0.0012$, GCK $V_n(\widehat{PSI}) = 0.0007$, $Z = 0.23$, NS.

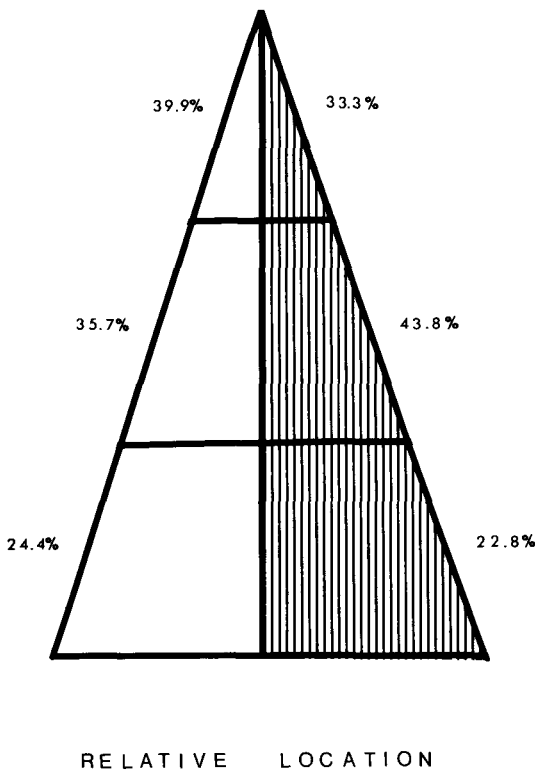


FIGURE 2. Relative location of foraging Ruby-crowned and Golden-crowned kinglets with respect to the top, middle, and bottom thirds of trees. Open area = Ruby-crowned Kinglet ($n = 782$), striped area = Golden-crowned Kinglet ($n = 493$). Proportional similarity index for Ruby-crowned Kinglet = 0.91, $V_r(\text{PSI}) = 0.0009$; Golden-crowned Kinglet = 0.89, $V_r(\text{PSI}) = 0.0014$; $Z = 0.4106$, NS. Niche overlap = 0.92. Significant difference in use of Ruby-crowned vs. Golden-crowned ($\chi^2 = 9.0$, $df = 2$, $P = 0.012$). Significant difference in use vs. availability for each species: Ruby-crowned ($\chi^2 = 29.8$, $df = 2$, $P < 0.001$), Golden-crowned ($\chi^2 = 33.0$, $df = 2$, $P < 0.001$).

and relative location. However, high overlap values (0.90 or higher) for all but one of the foraging variables, indicated that the kinglets were quite similar in their overall foraging habits.

Although it is difficult to interpret niche overlap values as direct measures of competition (Colwell and Futuyma 1971), they may be used to indicate niche dimensions along which potential competition may exist. The distribution, abundance, and quality of food may influence the extent of foraging niche overlap (Hartley 1953, Willson 1970, Feinsinger 1976). However, I have no direct information on food resources for this study. The similar morphological features and comparable body size of these two kinglets may have permitted them to forage in a similar manner when food is not scarce. It is possible that the species' foraging behavior may differ seasonally and yearly, depending on food supplies.

Ruby-crowned Kinglet populations were considerably denser than those of Golden-crowned Kinglets during both summers (71.0 birds/40 ha vs. 26.3/40 ha in 1973, 74.4/40 ha vs. 30.8/40 ha in 1974, respectively) (Franzreb and Ohmart 1978). Mapping territories in 1973 and 1974 indicated that each Golden-crowned territory overlapped at least one, and frequently more than one, Ruby-crowned territory (Franzreb, unpubl. data). Estimated interspecific overlap in individual territories ranged from 60–85% in 1973 and from 20–90% in 1974. Mean overlap was estimated at 75% in 1973 and 47% in 1974 (Franzreb, unpubl. data). Considering the moderate-to-high densities of kinglets and extensive interspecific overlap in territories, the relative paucity of aggressive inter- or intraspecific interactions suggests that food supplies were not a limiting factor during the years of this study.

Nest site selection may also influence where a bird forages (Morse 1968, Williamson 1971). Both species build their nests in conifers; Golden-crowned Kinglets usually place nests 2–16 m from the ground, whereas Ruby-crowned Kinglets generally construct nests up to 33 m above ground (Bent 1949). Considering that Ruby-crowned Kinglets usually nest higher than Golden-crowned Kinglets, can be more aggressive (Morse 1970), and are morphologically very similar, I expected to find more habitat partitioning by means of vertical stratification.

Although differences between the kinglets in method of prey attack and relative location while foraging were statistically significant, their biological importance to the birds is probably much less than the differences observed for tree species selection. The kinglets' preference for spruces and firs (including Douglas-fir) has long been apparent (Bent 1949). The high needle-density in such trees provides protection against predators and good concealment of nests. Kinglets infrequently use the more open branches of pines, aspen, and snags. Foliage density appears to be highest in the upper portions of spruces and firs, which may account for the higher than expected use of the upper thirds of the trees by both kinglets. Thus, even though more overall foraging substrate was available in the lower areas, the birds did not feed there extensively. The distribution of prey and greater protection from predators provided by the denser upper vegetation may have compensated for the lesser volume of foliage.

Kinglets commonly nest, and males most often sing, in spruces and firs (Franzreb, pers. observ.). Optimal foraging theory predicts that

there would be a selective advantage, in terms of energetics, to sing, nest, and forage in the same trees. Hence, it is not surprising that most of my observations were in these trees.

I could not tell whether differences between kinglets in selection of trees were possibly the result of: 1) slight variations in tree species composition of territories, 2) a dominance hierarchy that restricted foraging by one species, or 3) the greater generalization of the Ruby-crowned Kinglet in tree species selection. However, because there was extensive interspecific overlap in territories, and few aggressive interactions were observed, the last alternative seemed most plausible.

My anticipated finding of significant differences between Ruby-crowned and Golden-crowned kinglets in most foraging traits was not fully substantiated. What habitat segregation that did occur was achieved primarily through differences in tree species selection. Competitive influences appeared to play minor roles in dictating the kinglets' manner of foraging. However, coexistence may be less harmonious and competitive pressures more important under harsher environmental conditions. Behavioral differences in foraging related to habitat segregation may be more pronounced during periods of food scarcity or adverse weather conditions.

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APPENDIX. Ruby-crowned (RCK) and Golden-crowned (GCK) kinglet dimensions (average values) from Ridgway (1904) and weights.¹

	Length (mm)	Wing (mm)	Tail (mm)	Exposed culmen (mm)	Tarsus (mm)	Middle toe (mm)	Weight (g) ± SE
RCK (Male)	102	60.5	45.7	8.4	18.7	9.1	6.30 ± 0.71
RCK (Female)	100	57.2	43.5	7.3	18.4	8.9	6.11 ± 0.48
GCK (Male)	94	54.9	40.8	7.0	17.3	8.5	5.70 ± 0.43
GCK (Female)	93	53.5	39.7	7.9	16.8	8.6	5.55 ± 0.38

¹ Weight values represent mean weights of specimens in: Museum of Vertebrate Zoology, University of California, Berkeley; Museum of Wildlife and Fisheries, University of California-Davis; and Museum, California State University-Sacramento. *N* values for dimensions: male RCK *n* = 10, female RCK *n* = 10, male GCK *n* = 17, female GCK *n* = 17; for weights: male RCK *n* = 52, female RCK *n* = 22, male GCK *n* = 24, female GCK *n* = 9.

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RECENT PUBLICATIONS

Costa Rican Natural History.—Edited by Daniel H. Janzen. 1983. University of Chicago Press. 815 p. Paper cover. \$30.00. Perhaps the most comprehensive introduction to Central American natural history since Skutch's *Life Histories of Central American Birds*, this volume is a superb compendium of ecological and life history studies of Neotropical species. Six introductory chapters provide brief but synthetic coverage of paleogeography, climate, geology, soil and agricultural patterns in Costa Rica. Chapters 7 through 11 provide more comprehensive introductions to and checklists of Costa Rican plants, insects, mammals, reptiles and birds. Gary Stiles' introduction to Chapter 10 on birds is an expert treatment of the ecological diversity of the country's avifauna, zoogeography, including historical and contemporary distribution, distribution by altitude, habitat and season, the range of social systems and available bibliography. Species accounts, compiled by 174 field workers with extensive knowledge of their subjects, give the volume a depth to equal its biotic breadth. A uniquely valuable book for Neotropical biologists.—M. F. Lawton.

Once A River: Bird Life and Habitat Changes on the Middle Gila.—Amadeo M. Rea. 1983. University of Arizona Press, Tucson. 285 p. \$24.50. This ethnoecological study of the desertification of riparian forests in the southwestern United States is jarring and ingenious. In addition to ornithological reports dating from the turn of the century, Rea, Curator of Birds and Mammals at the San Diego Natural History Museum, employs accounts of Spanish explorers, the oral history of the Pima Indians and two decades of careful field and museum work to document

changes in the avifauna of the Middle Gila River. In detailed and complete treatment of species present, he presents ethnographic accounts, including Pima information and nomenclature dating back over 300 years, scientific accounts from historic records and accounts of modern species' status. Well illustrated with maps, habitat and air photographs, this is an unusual and thought-provoking book.—M. F. Lawton.

A Natural History of British Birds.—Eric Simms. Illustrated by Robert Gillmor. 1983. J. M. Dent & Sons, Ltd., London. 367 p. \$24.95. Source: J. M. Dent & Sons, % Biblio Distribution Center, 81 Adams Drive, Totowa, New Jersey 07512. This is a book about birds and birding, aimed for birders and other lay naturalists in Britain. Contrary to what the title suggests, it does not go into detail about each species but uses British birds as familiar examples for introducing ornithology. The usual aspects of avian biology (e.g., evolution, classification, morphology, food habits, breeding habits, voice) are followed by considerations of birds in human affairs, which lead into instructions about where and how to watch birds. Although the treatment is clear, highly informative, and nontechnical, it tends to be a rather dry array of facts, lacking spark from the author's ideas or experiences. The book is attractively illustrated with many line drawings and 16 color plates. In closing, it gives a list of the birds of Britain and Ireland plus a selected bibliography. Overall, it is fine work for its intended audience but does not appear to offer any advantages to novice bird students in North America over books such as those by Pasquier (noted in *The Condor* 79:397) and Kress (noted in *The Condor* 83:309).