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Behavioral ecology of Red-backed Hawks in central Chile.—The Red-backed Hawk (*Buteo polyosoma*) is found in South America from Colombia to Tierra del Fuego, along both sides of the Andes, in the Juan Fernández Archipelago off the coast of Chile, and in the Falkland Islands off the Argentine coast (Vaurie 1962, Johnson 1965, Jaksic and Jiménez 1986). The species has been studied little except for its diet and food-niche relationships (Schlatter et al. 1980, Jaksic et al. 1981). Here we report on the behavioral ecology of the Red-backed Hawk, based on a one-year study in central Chile, and draw comparisons with a similar and simultaneous study of the Grey Eagle-Buzzard (*Geranoaetus melanoleucus*) by Jiménez and Jaksic (1989).

Methods.—The study site is described in Jiménez and Jaksic (1989). San Carlos de Apoquindo (33°23'S, 70°31'W, referred to as Los Dominicos in Paynter (1988) is a rugged area 20 km east of Santiago in the Andean foothills, with elevations ranging from 1050 to 1915 m. The physiography includes both flat areas and numerous ridges dissected by deep ravines. The climate is Mediterranean, with cool and rainy winters and dry and hot summers. The wind blows westwardly from the valley to the mountains during the daytime. The predominant vegetation is evergreen scrub that changes physiognomically depending on topography and orientation.

For each Red-backed Hawk we recorded: (1) time and duration of observation, (2) activity type, and (3) habitat beneath the bird. We recognized the following activity types (see Jiménez and Jaksic 1989): (1) thermal soaring, (2) wind soaring, (3) cruising, (4) hovering, (5) harassing, (6) perching, and (7) miscellaneous behavior. We recognized the following habitat types (Jiménez and Jaksic 1989): flatlands, ravines, ridgetops, and slopes (east-, west-, south-, and north-facing). We mapped these habitats and calculated their surface areas (slope-corrected) with a digital planimeter from a high-resolution aerial photograph. The vegetative cover of each habitat type, as represented by trees, shrubs, herbs, bare ground, and rocks was documented by Jiménez and Jaksic (1989), who also estimated prey numbers in these different habitats.

Observations were made from sunrise to sunset, with the day arbitrarily divided into six equal intervals. We made observations every other week between 1 August 1984 and 1 August 1985. We divided a total of 1730 min of observations into four seasons: spring (1

TABLE 1
ABSOLUTE (MIN) AND RELATIVE (%) TIME SPENT BY RED-BACKED HAWKS IN DIFFERENT
ACTIVITIES IN CENTRAL CHILE

Activity	Spring*	Summer	Fall	Winter
Thermal soaring	22.7 ± 16.5 (14) ^b	21.1 ± 7.0 (12)	11.3 ± 7.3 (6)	2.6 ± 3.4 (4)
% time	48.3	31.2	30.6	27.4
Wind soaring	8.7 ± 8.5 (14)	24.4 ± 12.4 (12)	6.1 ± 3.9 (6)	0.5 ± 1.0 (4)
% time	18.5	36.0	16.5	5.3
Perching	12.7 ± 8.6 (14)	14.3 ± 11.5 (12)	16.2 ± 10.2 (6)	5.6 ± 6.5 (4)
% time	27.0	21.1	43.9	58.8
Cruising	1.0 ± 0.6 (14)	1.8 ± 1.1 (12)	0.4 ± 0.7 (6)	0.7 ± 1.5 (4)
% time	2.1	2.7	1.1	7.4
Hovering	1.3 ± 0.8 (14)	4.3 ± 3.2 (12)	2.4 ± 3.5 (6)	0.0 ± 0.0 (4)
% time	2.8	6.4	6.5	0.0
Harassing	0.4 ± 0.5 (14)	1.0 ± 0.7 (12)	0.2 ± 0.2 (6)	0.1 ± 0.1 (4)
% time	0.9	1.5	0.5	1.1
Other	0.2 ± 0.2 (14)	0.8 ± 0.5 (12)	0.3 ± 0.4 (6)	0.0 ± 0.0 (4)
% time	0.4	1.1	0.9	0.0
Total time	47.0 ± 28.8 (14)	67.7 ± 23.1 (12)	36.9 ± 16.7 (6)	9.5 ± 10.7 (4)

* See Methods section for periods involved.

^b Mean number of min this activity was observed per day ± two standard errors (number of days observed).

August–30 October), summer (1 November–31 January), fall (1 February–30 April), and winter (1 May–31 July). We used one- or two-way ANOVAs for unequal sample sizes (Sokal and Rohlf 1981:210, 360), with PROC GLM in SAS (1985) and the Student-Newman-Keuls test (SAS 1985:444) for *a-posteriori* contrasts. For analyzing frequency data, we used the *G* statistic (Sokal and Rohlf 1981:695).

Results.—Red-backed Hawks were observed throughout the day with no clear peaks of activity in any interval of the day. Although activity levels (measured in absolute time) did not differ among times of the day ($F = 1.57$, $df = 5$, $P > 0.17$), they did vary with season ($F = 5.39$, $df = 3$, $P < 0.002$); there was no significant interaction between these variables ($F = 1.57$, $df = 15$, $P > 0.08$). Red-backed Hawks were most active in summer, intermediately active in spring and fall, and least active in winter (SNK *a-posteriori* test, $P < 0.05$ in all cases). Thermal soaring was the most common flight mode throughout the year, ranging from a spring high of 48% to a winter low of 27% of the observed time (Table 1). Wind soaring was the second most prevalent flight mode, accounting for a high of 36% in summer to a low of 5% in winter. Red-backed Hawks perched from 59% (winter) to 21% (summer) of the time; the remaining activity categories (Table 1) accounted for less than 12% of the daily activity period.

Activity levels (absolute time) differed both among habitat types ($F = 24.27$, $df = 6$, $P < 0.0001$) and among seasons ($F = 31.92$, $df = 3$, $P < 0.0001$); there was a significant interaction between these variables ($F = 2.26$, $df = 18$, $P < 0.002$). Throughout the year, Red-backed Hawks flew more often over ridgetops (from a high of 76% in spring to a low of 3% in winter), north-facing slopes (from 46% in winter to 17% in spring), and west-facing

TABLE 2
ABSOLUTE (MIN) AND RELATIVE (%) TIME SPENT BY RED-BACKED HAWKS ON SEVEN
HABITAT TYPES IN CENTRAL CHILE

Habitat type	Spring ^a	Summer	Fall	Winter
Flatland	0.1 ± 0.1 (14) ^b	0.2 ± 0.2 (12)	0.1 ± 0.1 (6)	0.0 ± 0.0 (4)
% time	0.2	0.3	0.3	0.0
Ravine	0.7 ± 0.8 (14)	7.7 ± 5.4 (12)	0.2 ± 0.3 (6)	0.0 ± 0.0 (4)
% time	1.5	11.4	0.5	0.0
Ridgetop	35.6 ± 27.7 (14)	19.9 ± 8.6 (12)	16.5 ± 10.7 (6)	0.3 ± 0.2 (4)
% time	75.7	29.4	44.7	3.2
North slope	7.9 ± 5.1 (14)	21.6 ± 12.0 (12)	15.3 ± 12.1 (6)	4.4 ± 5.6 (4)
% time	16.8	31.8	41.5	46.3
South slope	0.0 ± 0.0 (14)	4.1 ± 2.6 (12)	1.5 ± 2.6 (6)	0.0 ± 0.0 (4)
% time	0.0	6.1	4.1	0.0
East slope	0.4 ± 0.4 (14)	1.3 ± 1.4 (12)	2.3 ± 2.2 (6)	0.1 ± 0.2 (4)
% time	0.9	1.9	6.2	1.1
West slope	2.3 ± 1.7 (14)	12.9 ± 9.0 (12)	1.0 ± 1.0 (6)	4.7 ± 5.8 (4)
% time	4.9	19.1	2.7	49.4
Total time	47.0 ± 28.8 (14)	67.7 ± 23.2 (12)	36.9 ± 38.9 (6)	9.5 ± 10.7 (4)

^a See Methods section for periods involved.

^b Mean number of min this activity was observed per day ± two standard errors (number of days observed).

slopes (from 49% in winter to 3% in fall) than over other habitats (Table 2). Except for ridgetops and north-facing slopes, there were seasonal shifts in the use of the remaining habitat types (SNK *a-posteriori* test, $P < 0.05$ in all cases). West-facing slopes, for example, were used more during winter than in other seasons (Table 2).

If Red-backed Hawks used habitat types in proportion to their relative representation in the study area, activity levels should follow the sequence: north-facing slope > south-facing slope > ridgetop > west-facing slope > flatland > ravine > east-facing slope (Jiménez and Jaksić 1989). Instead (Table 2), activity levels in north-facing slopes and ridgetops were significantly higher than those on west-facing slopes and ravines, which in turn were used more than east- and south-facing slopes; activity in flatlands was significantly lower than in all other habitat types (SNK *a-posteriori* test, $P < 0.05$ in all cases). North-facing slopes and ridgetops received more direct solar radiation, and probably generated more thermal drafts, while west-facing slopes received radiation from the setting sun and were swept by the prevailing westerly wind (Jiménez and Jaksić 1989). In contrast, Red-backed Hawks flew infrequently over south-facing slopes (from 6% in summer to 0% in both winter and spring), which were the second most common type of slope in area; they received relatively low amounts of incident radiation and were sheltered from prevailing winds.

The amount of perching in different habitats was not related to their relative availability ($G = 53.1$, $df = 5$, $P < 0.001$). In 43% of 53 sightings, hawks were perched in north-facing slopes, 36% were perched in ridgetops, 13% in west-facing slopes, and 8% in south-facing slopes. Red-backed Hawks were never seen perching in flatlands, ravines, or east-facing slopes. Thus, habitat types most often used for perching were the same as those used for soaring. Perhaps Red-backed Hawks prefer these perching sites because they afford easy

access to updrafts. Perch substrates were not used homogeneously ($G = 64.4$, $df = 8$, $P < 0.001$). In decreasing order, perch substrates used were live trees (*Quillaja saponaria*, 32%), standing dead bromeliads (25%), standing dead trees (21%), boulders (13%), and live trees (*Kageneckia oblonga*, 6%), and (*Porlieria chilensis*, 3%). All these structures were above the general level of the scrub canopy and likely provided good visibility and easy access to updrafts for hawks.

Aggressive encounters (harassment), which occurred at a consistent level throughout the year, comprised less than 2% of the Red-backed Hawks' time (Table 1). Red-backed Hawks originated 53 attacks, Grey Eagle-Buzzards 49 attacks (Jiménez and Jaksić 1989). Red-backed Hawks, however, were the second most common victims (48 attacks), after Grey Eagle-Buzzards (recipient of 62 attacks). The relative importance of intra- and interspecific harassment may be assessed by computing the percentage of conspecific, or conversely, allospecific attacks received (Jiménez and Jaksić 1989). Red-backed Hawks were more frequently harassed by other species than by conspecifics (55% allospecific attacks), unlike Grey Eagle-Buzzards (49%), which were about as frequently harassed by conspecifics as by other species. None of these agonistic encounters involved prey, unlike the situation reported by Bildstein (1987) for Red-tailed Hawks (*Buteo jamaicensis*) and Rough-legged Hawks (*B. lagopus*) in south-central Ohio.

Discussion.—Red-backed Hawks did not show any clear daily peaks in activity, but did show clear seasonal pulses (highest activity during summer, lowest during winter). These findings are unlike those reported for Grey Eagle-Buzzards, which showed a clear bimodal pattern of daily activity without seasonal changes (Jiménez and Jaksić 1989). We have no explanation for these species differences. In most other features studied, Red-backed Hawks behaved almost identically to Grey Eagle-Buzzards: (1) their most frequent flight modes were thermal and wind soaring, (2) they flew most often over ridgetops, north- and west-facing slopes, habitats that offered the best atmospheric conditions for soaring, (3) they perched primarily in ridgetops, north- and west-facing slopes, (4) they most frequently perched on live trees of *Q. saponaria*, dead bromeliads, dead trees, and boulders, and (5) they were by far the most aggressive among eight local raptor species (Jiménez and Jaksić 1989).

The similarities in flight activity over the same topographic features may be explained by the favorable updraft conditions afforded by ridgetops, north- and west-facing slopes (Jiménez and Jaksić 1989). As shown by Preston (1981) for Red-tailed Hawks in Arkansas, raptors readily respond to reduced relative humidity and cloud cover, and to increased wind velocity and solar illumination, with more extended soaring. Consequently, we invoke microclimatic conditions as the main determinant of habitat use by Red-backed Hawks (see also Barnard 1986, 1987). But at least two other explanations exist: differences in prey abundance or in prey vulnerability (Wakeley 1978, Bildstein 1987). These alternative hypotheses were evaluated by Jiménez and Jaksić (1989) with regard to Grey Eagle-Buzzards in a study conducted simultaneously at the same site.

Because the pattern of habitat use by Red-backed Hawks is essentially the same as that of Grey Eagle-Buzzards, conclusions drawn for the latter species should hold for the former, given that their diets are very similar (Schlatter et al. 1980). Jiménez and Jaksić (1989) showed that north- and west-facing slopes and ridgetops, where the two raptor species demonstrated the highest activity, had the lowest prey densities (accounting for about 5, 10, and 4% of the mammals captured, respectively). Prey were most dense in ravines, flatlands, east- and south-facing slopes (accounting for about 22, 21, 19, and 19%, respectively, of the mammals captured), but Red-backed Hawks infrequently flew over these habitats.

The other explanation is that Red-backed Hawks hunted on areas with sparse vegetative cover, where prey were more vulnerable, rather than on areas with high prey abundance

(e.g., Wakeley 1978, Baker and Brooks 1981, Bechard 1982, Bildstein 1987). Jiménez and Jaksic (1989) showed that the habitats with the most sparse vegetation were north-facing slopes (most sparse), ridgetops, east-facing slopes, flatlands, west- and south-facing slopes (least sparse). As noted above, east-facing slopes and flatlands were seldom used by Red-backed Hawks, whereas west-facing slopes were frequently visited by them, unlike south-facing slopes. These data indicate that relative habitat use by Red-backed Hawks is not linked closely with relative amounts of sparse vegetation in different habitat types.

It appears that Red-backed Hawks key on habitat types due to updrafts rather than prey density or vulnerability as reflected in the degree of vegetational sparseness. This conclusion concurs with that of Barnard (1986, 1987) for three South African raptors, and of Jiménez and Jaksic (1989) for Grey Eagle-Buzzards at the same site in central Chile. However, this conclusion does not appear to hold for North American buteos (Wakeley 1978, Baker and Brooks 1981, Bechard 1982), probably because the North American studies were done in flat or rolling terrain with a relative scarcity of updrafts.

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Poult adoption in Merriam's Wild Turkeys.—There are few documented cases of gallinaceous birds caring for offspring other than their own. Willow Ptarmigan (*Lagopus lagopus*) usually mate monogamously, with pairs remaining together throughout the breeding season, but they occasionally are polygynous (Hannon 1984, Martin and Cooke 1987, Martin 1989). If males are removed from monogamous pairs after breeding, replacement males may fill the openings and adopt the brood (Martin 1989). We observed four cases of apparent adoption by Merriam's Wild Turkeys (*Meleagris gallopavo merriami*) during 1987, 1988, and 1989 while collecting data to determine dispersion and habitat selection patterns in a ponderosa pine (*Pinus ponderosa*) ecosystem in the central Black Hills of South Dakota. Adoption by Merriam's Wild Turkeys, to our knowledge, has not been documented previously. Merriam's Wild Turkeys are polygynous, and the young are cared for and reared by hens.

On July 25, 1987, a radio-fitted hen was observed with five poults. In the week that followed, she was located twice with another radio-collared hen, which had four poults. On August 3, 1987, the first hen was observed brooding alone with two poults, and the second hen was observed with seven poults. The second hen appeared to have adopted, at least temporarily, three poults from the first hen. The nearest possible relationship between these two hens was estimated to be half-siblings.

On June 13, 1988, four days post-hatch, a hen with a radio transmitter was flushed from a ground roost. No other hens were in the vicinity. The poults scattered throughout the vegetation except for one which flew approximately 30 m into a ponderosa pine tree. Some turkey poults are capable of flying 1-2 m when they are 8 days old and are strong flyers by 18 days (Bailey and Rinell 1968, Williams 1974). Based on the size of this poult and its flight capability, we believe this poult was obtained from another brood.

On June 27, 1988, a different radio-collared hen was observed brooding two poults 19 days after certain complete loss of her brood. These apparently adopted poults had an estimated age of two weeks, and we observed this hen three times (once on roost) with these poults when no other hens or poults were in the immediate vicinity. The hen was observed alone a week later and we do not know the fate of the poults.

The fourth observation occurred on June 5, 1989. A radio-equipped hen was observed brooding two poults one day after only two of eight eggs in her clutch had hatched. Nine days later, this hen was observed with four poults; no other hens were in the vicinity. The hen appeared to have adopted two poults. The hen was observed with three to four poults on several occasions during the next four weeks. One poult remained until joining two other hens and their poults.

Plausible explanations for adoption by turkeys may include the following. Prolonged close association between the parents and offspring bring the young into intimate contact with subsequent broods of the parent birds (Skutch 1961). The adopter may benefit by gaining