J. Raptor Res. 25(4):127–131

HUNTING TECHNIQUES AND SUCCESS RATES OF URBAN MERLINS (*Falco columbarius*)

NAVJOT S. SODHI
Department of Biology, University of Saskatchewan, Saskatoon, SK, Canada S7N 0W0

IAN G. WARKENTIN
Department of Zoological Research, National Zoological Park, Smithsonian Institution, Washington D.C., 20008-2598

LYNN W. OLIPHANT
Department of Veterinary Anatomy, Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, SK, Canada S7N 0W0

ABSTRACT.—Hunting techniques and success rates are described for urban Merlins (*Falco columbarius*). Attack from a perch was the most common technique (58% during breeding, 95% during winter) and cruising flights the second most common (37% and 5%, respectively). Hunting success of breeding Merlins was significantly higher (28%) than wintering birds (11%).

Modalidades de caza y sus proporciones de éxito en los halcones de la especie *Falco columbarius*

EXTRACTO.—Describimos las modalidades de caza y sus correspondientes proporciones de éxito en los halcones de la especie *Falco columbarius*. El ataque desde una percha fue la modalidad más frecuente (58% durante la época de reproducción y 95% durante el invierno). En segundo lugar se observó la cacería al vuelo (37% y 5% respectivamente). Estos halcones tuvieron más éxito en sus cacerías durante la época de reproducción (28%) que durante el invierno (11%).

[Traducción de Eudoxio Paredes-Ruiz]

The hunting techniques used by raptors depend upon the type of prey, habitat, weather, and characteristics of the hunting bird such as age, sex and experience (Balgooyen 1976, Wakeley 1978, Cade 1982). Merlins (*Falco columbarius*) feed primarily on small birds (Oliphant and McTaggart 1977, Becker 1985, James and Smith 1987, Sodhi et al. 1990). Most published information on hunting techniques of this species has been obtained from migrating or wintering birds (Rudebeck 1951, Page and Whitacre 1975, Boyce 1985, Buchanan et al. 1988, Dekker 1988, Warkentin and Oliphant 1990). Similar data obtained during the breeding season are generally based on few observations (Armitage 1932, Craighead and Craighead 1940, Roberts 1962, Kermott 1981). Here, we describe the hunting techniques and success rates of Merlins from an intensively studied urban breeding population in Saskatoon, Saskatchewan (Oliphant and Haug 1985, James 1988) and make comparisons to the hunting behavior of Merlins wintering there.

METHODS

Breeding Merlins (*F. c. richardsonii*) were trapped at their nests in Saskatoon and fitted with radiotransmitters Between May and July 1987–90, observations of hunting behavior were made on 16 males and 11 females that were tracked for a total of 1200 hr. Only one bird was tracked at a time, generally for 4-hr periods during the first and last four daylight hours. The methodology employed in radio tracking is presented by Sodhi et al. (1991).

From 1983–88, Merlins were trapped each winter. Most of the wintering Merlins at Saskatoon are derived from the local breeding population (Warkentin et al. 1990). Individuals were fitted with radiotransmitters and detailed information was gathered throughout the day from six females and three males during 542 hr of direct visual contact. A detailed description of methodology for the collection of data in winter is presented by Warkentin and Oliphant (1990).

In addition, we present other observations of hunting Merlins, made on an urban wintering population of Black Merlins (*F. c. suckleyi*) in Seattle, Washington, from 1968–70 and on the Saskatoon population (both breeding and wintering) from 1971–90. These observations are difficult to quantify in terms of hours but conservatively represent about 200 separate attacks on prey. Generally only in-

Table 1. Hunting techniques used by breeding Merlins in Saskatoon, Canada. Most data (n = 73) were collected from 26 radio-tagged adults. Data are presented as number of hunting attempts made. Hunting success rate on species on which ≥3 attempts were observed is also reported. AP = attack from perch, CF = cruising flights, and OHF = other hunting flights.

Species	AP	CF	OHF	Total	Successful	% Success[a]
House Sparrow (*Passer domesticus*)	16	7	—	23	13	56
American Robin (*Turdus migratorius*)	6	2	—	8	1	11
Brewer's Blackbird (*Euphagus cyanocephalus*)	4	—	1	5	1	20
Horned Lark (*Eremophila alpestris*)	—	2	1	3	1	33
Cedar Waxwing (*B. cedrorum*)	1	—	1	2	0	0
Chipping Sparrow (*Spizella passerina*)	4	—	—	4	2	50
Tree Swallow (*Tachycineta bicolor*)	—	1	—	1	0	0
Common Grackle (*Quiscalus quiscula*)	1	—	—	1	0	0
Eastern Kingbird (*Tyrannus tyrannus*)	—	2	—	2	0	0
Unidentified	14	16	1	31	3	30
Total	46	30	4	80	21	28

[a] Values are based on hunting attempts of known outcome only.

stances where kills were observed were recorded, making it impossible to generate success rates from these observations. Observations were also recorded of the hunting flights of seven falconry-trained Merlins.

A hunting attempt was considered as one or more strikes at potential prey (Page and Whitacre 1975, Dekker 1988, Warkentin and Oliphant 1990). Even when the bird disappeared from view, radiotracking facilitated, based on radio signal amplitude, in determining whether it had changed the hunting technique when out of view.

Results

Description of Hunting Techniques. Merlins used three main hunting techniques which are listed separately below although they were at times used in conjunction.

Attack from perch (AP). Merlins often (58% in summer and 95% in winter; Tables 1 and 2) initiated attacks directly from perches such as conifers, utility poles, deciduous trees, and even the ground. When hunting from high perches, prey sighted at considerable distances were attacked by strong direct flights. The falcon at times initially glided down to near ground level from the perch, which may allow greater acceleration and provide concealment when approaching potential prey. The final approach toward prey was often a fixed-wing glide.

Ground perches were used by Merlins while hunting in open country. These perches possibly made Merlins less detectable and enabled them to attack flying birds from below, forcing the prey away from cover. On one occasion, we observed a Merlin landing in a spruce tree that had House Sparrows in it, about 1 m from the ground. The falcon started hopping down until it chased the sparrows out and then it followed them. Out of 45 attacks of known outcome initiated from a perch, 12 (27%) were successful in summer. In winter, Merlins were successful in 30 (11%) of 273 attempts from a perch.

Cruising flights (CF). This was the second most common hunting technique used (37% in summer and 5% in winter; Tables 1 and 2). The hunting Merlins flew at high speed and at varying altitudes, close to the ground or just over or below the canopy in wooded areas. Birds already in flight or flushed at the approach of the Merlin were attacked. Low fast flights were frequently used while hunting in open country. This behavior was efficient in capturing prey such as Horned Larks that flushed from ground cover. In urban areas, Merlins often used streets as relatively open paths along which they flew at high speed below the arched canopy of trees. House Sparrows that flushed from beside or under parked vehicles were particularly vulnerable to attack. Birds such as Bohemian Waxwings (*Bombycilla garrulus*) and Cedar Waxwings were caught after flushing ahead of the Merlin, or were taken directly off their perches.

On one occasion, we observed a flying Merlin attack a blackbird that had been flushed by a Swainson's Hawk (*Buteo swainsoni*). On another occasion, a Merlin took a quarry flushed by a dog. We also observed one attack on a nest of an Eastern Kingbird. The Merlin took a nestling from the nest while

Table 2. Hunting techniques used by wintering Merlins in Saskatoon, Canada. Data presented were collected from radio-tagged birds. For abbreviations of hunting techniques see Table 1.

SPECIES	AP	CF	TOTAL	SUCCESSFUL	% SUCCESS
House Sparrow	260	11	271	25	9.2
Waxwings	12	2	14	5	35.7
Common Redpoll (*Carduelis flammea*)	1	0	1	1	—
Total	273	13	286	—	—

passing over, without landing. Of 28 cruising attacks of known outcome during the breeding season, six (21%) were successful. In winter, only one of 13 (8%) attempts were successful using this technique.

Other hunting flights (OHF). Merlins also used three other types of hunting flights (5% in summer and 0% in winter; Tables 1 and 2) to capture their prey. Some of these behaviors were not used by radio-tracked birds.

a) Ringing flights. Certain prey species (e.g., Horned Lark and Bohemian Waxwing) attempted to outfly attacking Merlins resulting in rising aerial chases. The term "ringing" denotes the tendency for both prey and pursuer to fly in circles as they climbed. Typically, the quarry flew in tighter circles as was described by Williamson and Williamson (1953). Merlins climbed in larger circles, often at such a distance that it was not always evident that it was actually in pursuit. If the Merlin succeeded in outclimbing its prey, it then stooped; forcing its quarry to do likewise to avoid being caught. Prey were typically taken after one or more stoops or were able to successfully find cover. Both flocks and solitary birds were attacked by this technique.

b) Straight aerial pursuit. Birds such as swallows attempted to outfly the Merlin by sheer speed and maneuverability. These flights consisted of a series of rapid, short stoops and direct aerial chases over a relatively long period of time but did not vary much in altitude.

Native sparrows (e.g., the Clay-colored Sparrow, *Spizella pallida*) and juncos that flushed from sparse cover were often capable of dodging several attacks by a pursuing Merlin. These attacks took the form of a series of twisting swoops in rapid succession, the Merlin rising less than 1 m above its quarry.

c) Attack from high soar. Similar to the hunting technique described by Walter (1979) for Eleonora's Falcon (*F. eleonorae*), soaring Merlins stooped at birds flying at considerable distance below. Soaring flights were observed near the height of spring migration when greater numbers of birds passed through at moderately high altitudes.

Hunting Success Rates. The success rate of the AP was slightly, but insignificantly higher than CF both in summer ($Z = 0.6$, $P > 0.05$) and winter ($Z = 0.4$, $P > 0.05$). Merlins were observed to attack nine and three species of passerines during summer and winter, respectively (Tables 1 and 2). The percent of successful hunting attempts was highest on House Sparrows during the breeding season. During winter, hunting Merlins were more successful when attacking waxwings. Overall, 28% (21/75) and 11% (31/286) of hunting attempts of known outcome (observed from start to finish) were successful during summer and winter respectively, a significant difference ($Z = 5.6$, $P < 0.05$).

DISCUSSION

Both wintering and breeding Merlins most frequently attacked prey from a perch. However, breeding Merlins more frequently attacked prey while in cruising flight than wintering Merlins ($\chi^2 = 66.8$, $P < 0.01$). While wintering Merlins made relatively more attacks from a perch. These differences may be dependent upon seasonal differences in prey behavior (e.g., flocking), prey species attacked, energetic constraints and habitat used by Merlins.

In contrast to our results, it has been documented previously that while hunting shorebirds, wintering Merlins use aerial attacks more frequently than other hunting techniques (Page and Whitacre 1975, Boyce 1985, Buchanan et al. 1988, Dekker 1988). It is possible that the urban setting may have made aerial attacks less feasible or that extended aerial chases are more conspicuous in rural settings and therefore more often recorded. These differences could

also be due the different prey species (e.g., shorebirds versus passerines).

The hunting success of Merlins during the breeding season was significantly higher than during winter in Saskatoon. These differences could be due to the fact that radio-tagged breeding Merlins were only observed when actively hunting. Other studies on wintering or migrating Merlins report hunting success rates between 5–22% for Merlins (Rudebeck 1951, Page and Whitacre 1975, Buchanan et al. 1988, Dekker 1988, Dickson 1988). Dekker (1988) reported a hunting success rate of 40% for breeding Merlins. Thus, the available information indicates that hunting success of Merlins during the breeding season is higher than in winter or migration. Some of the possible reasons for this include: a) only efficient foragers breed, b) prey vulnerability might be higher during the breeding season due to an influx of fledged birds in prey populations, and c) migrant and winter populations of Merlins include higher numbers of juvenile birds, which may be less experienced hunters.

Most hunting techniques reported here have been previously documented (Armitage 1932, de Lawrence 1949, Rudebeck 1951, Williamson and Williamson 1953, Roberts 1962, Sperber and Sperber 1963, Page and Whitacre 1975, Kermott 1981, Buchanan et al. 1988, Dekker 1988). However, Merlins landing in cover and then flushing and attacking prey, and attacking from high soar have not been reported earlier. Although Merlins have been observed attempting to capture prey flushed by other objects (both living and nonliving; Jenkins 1972, Bjorkman 1978, Cudworth and Massingham 1986, Dekker 1988), we document the first such hunting with prey flushed by a Swainson's Hawk and a dog. Some hunting behaviors previously reported in literature, were not observed by us (e.g., Haug 1985).

ACKNOWLEDGMENTS

We thank Paul C. James, Steve K. Sherrod, Marc J. Bechard, Daniel N. Gossett, Joseph B. Buchanan, and R. Wayne Nelson for making comments on an earlier draft of this manuscript. We also thank Geoff Peat, Joanna Freeland and Charanjit Sodhi for field assistance. Funding was provided by the Natural Sciences and Engineering Research Council of Canada (NSERC), the University Research Support Fund of the Canadian Wildlife Service, the Frank M. Chapman Fund of the American Museum of Natural History, the Canadian Plains Research Centre, and the University of Saskatchewan. I.G.W. held a NSERC postdoctoral fellowship while this manuscript was prepared.

LITERATURE CITED

ARMITAGE, J. 1932. Merlins taking young from nests. *Brit. Birds* 25:303–304.

BALGOOYEN, T.G. 1976. Behavior and ecology of the American Kestrel (*Falco sparverius*) in the Sierra Nevada of California. *Univ. Calif. Publ. Zool.* 103:1–83.

BECKER, D.M. 1985. Food habits of Richardson's Merlin in southeastern Montana. *Wilson Bull.* 97:226–230.

BJORKMAN, G. 1978. Hunting association between Merlin, *Falco columbarius,* and Hen Harrier, *Circus cyaneus. Var Fagelvarld* 37:259.

BOYCE, D.A. 1985. Merlins and the behavior of wintering shorebirds. *Raptor Res.* 19:94–96.

BUCHANAN, J.B., C.T. SCHICK, L.A. BRENNAN AND S.G. HERMAN. 1988. Merlin predation on wintering Dunlins: hunting success and Dunlin escape tactics. *Wilson Bull.* 100:108–118.

CADE, T. 1982. The falcons of the World. Cornell University Press, Ithaca, New York.

CRAIGHEAD, J. AND F. CRAIGHEAD. 1940. Nesting Pigeon Hawks. *Wilson Bull.* 52:241–248.

CUDWORTH, J. AND C. MASSINGHAM. 1986. Hen Harrier and Merlin hunting together. *Brit. Birds* 79:340.

DEKKER, D. 1988. Pergerine Falcon and Merlin predation on small shorebirds and passerines in Alberta. *Can. J. Zool.* 66:925–928.

DICKSON, R.C. 1988. Habitat preferences and prey of Merlins in winter. *Brit. Birds* 81:269–273.

HAUG, E. 1985. Merlin feeding on road-kills. *Raptor Res.* 19:103.

JAMES, P.C. 1988. Urban Merlins in Canada. *Brit. Birds* 81:274–277.

——— AND A.R. SMITH. 1987. Food habits of urban-nesting Merlins, *Falco columbarius,* in Edmonton and Fort Saskatchewan, Alberta. *Can. Field-Nat.* 101:592–594.

JENKINS, M.A. 1972. Opportunistic hunting tactics of the Merlin. *Bird-Banding* 8:40–41.

KERMOTT, L.H. 1981. Merlins as nest predators. *Raptor Res.* 15:94–95.

DE LAWRENCE, L.K. 1949. Notes on nesting Pigeon Hawks on Pimisi Bay, Ontario. *Wilson Bull.* 61:15–25.

OLIPHANT, L.W. AND E. HAUG. 1985. Productivity, population density and rate of increase of an expanding Merlin population. *Raptor Res.* 19:56–59.

——— AND S. MCTAGGART. 1977. Prey utilized by urban Merlins. *Can. Field-Nat.* 91:190–192.

PAGE, G.W. AND D.F. WHITACRE. 1975. Raptor predation on wintering shorebirds. *Condor* 77:73–83.

ROBERTS, E.L. 1962. Merlins taking newly hatched passerines. *Scot. Birds* 2:245.

RUDEBECK, G. 1951. The choice of prey and modes of hunting of predatory birds with special reference to their selective effect. *Oikos* 3:200–231.

SODHI, N.S., A. DIDIUK AND L.W. OLIPHANT. 1990. Differences in bird abundance in relation to proximity of Merlin nests. *Can. J. Zool.* 68:852–854.

———, I.G. WARKENTIN, P.C. JAMES AND L.W. OLIPHANT. 1991. Effects of radiotagging on breeding Merlins. *J. Wildl. Manage.* 55:in press.

SPERBER, I. AND C. SPERBER. 1963. Notes on the food consumption of Merlins. *Zool. Bidrag. Uppsala* 35:263–268.

WAKELEY, J.S. 1978. Hunting methods and factors affecting their use by Ferruginous Hawk. *Condor* 80: 327–333.

WALTER, H. 1979. Eleonora's Falcon. University of Chicago Press, Chicago, IL.

WARKENTIN, I.G. AND L.W. OLIPHANT. 1990. Habitat use and foraging behavior of urban Merlins (*Falco columbarius*) in winter. *J. Zool., Lond.* 221:539–563.

———, P.C. JAMES AND L.W. OLIPHANT. 1990. Body morphometrics, age structure, and partial migration of urban Merlins. *Auk* 107:25–34.

WILLIAMSON, K. AND E. WILLIAMSON. 1953. Hoopoe pursued by a Merlin. *Scot. Nat.* 65:56–57.

Received 8 June 1991; accepted 9 September 1991