

HURRICANE FIFI AND THE 1974 AUTUMN MIGRATION IN EL SALVADOR

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ABSTRACT.—In the autumn of 1974 the migration pattern in El Salvador had several unusual features, too many to have been merely coincidental: 1) delayed arrival of certain early migrants whose appearance overlapped with that of later migrants; 2) unprecedented numbers of a few species; 3) the appearance of several rarely seen or previously unreported species; 4) extension of winter ranges of a few species which was maintained for several years after. These events were closely associated with Hurricane Fifi (17–20 September) and to a lesser extent with Hurricane Carmen (1–6 September). I attribute the unusual features of the 1974 migration to Hurricane Fifi (possibly augmented by Carmen) after comparison of routes and schedules of early migrants with the route, dates, wind directions, and velocities of Fifi. I suggest that other hurricanes have affected and will affect migration through Middle America but that serious disruptions are probably rare and unpredictable.

In the course of my 10 years of netting and banding birds in El Salvador, Central America, the fall of 1974 was exceptional for the early migration pattern and for the arrival of several uncommon and previously unreported species. These events aroused my interest but I did not note their conjuncture with Hurricane Fifi until almost three years later. Then in 1977, I encountered an unprecedented wave of Canada Warblers (*Wilsonia canadensis*) and learned that Hurricane Anita had crossed the Gulf of Mexico shortly before.

Storms are known to affect bird movements. Hurricanes moving northward along North America's eastern seaboard force south-bound migrants and sea birds far inland (Pettingill 1970:271). Lowery (1946:192) and Mayhew (1949:403) described instances of birds caught in hurricanes. Bagg (1967:87–121) showed how severe storms over the North Atlantic brought spectacular numbers of Eurasian Lapwings (*Vanellus vanellus*) to North America in 1927 and 1966. Raffaele and Roby (1977:338–342) credited the 1960 Hurricane Donna with introducing the Lesser Antillean Bullfinch (*Loxigilla noctis*) into the Virgin Islands. Fisk (1979:226) associated 1969 Hurricane Gerda with an exceptional wave of migrants at her banding station in south Florida. I propose that Hurricane Fifi was responsible for the unusual features of the 1974 fall migration in El Salvador and that such storms can and do affect migration patterns in Middle America.

METHODS AND SOURCES OF DATA

From my field notes and netting records I selected data which show the unusual nature of the 1974 migration. For comparison I summarized relevant information for other years as given by my notes and the literature. My field notes extend from 1966, my netting records from 1969. I have operated banding stations for about one month a quarter, each station for 12–14 days, using 15–20 nets. One station at Cerro Verde (13°50'N, 89°38'W; 2,000 m elevation) has been used regularly once a quarter; the others were used less regularly and for only two to four years. Since 1969 I have maintained one lowland station to complement Cerro Verde.

Dickey and van Rossem (1938) provided almost all that is known about migrants in El Salvador before 1966. Van Rossem collected for 20 months in 1912 and 1925–27. His data were not strictly comparable to netting data but he was a dedicated observer who annotated richly his impressions of abundance. Of other visiting ornithologists, only Marshall (1943) added information pertinent to this paper.

The U.S. National Oceanic and Atmospheric Administration provided general information on cyclonic storms, details of Hurricanes Carmen, Fifi, and Anita, and surface maps for the periods of these hurricanes.

MIGRATION PATTERNS IN NORTHERN MIDDLE AMERICA

Lack of band recoveries limits understanding of migration patterns in Middle America. Approximate routes can be inferred from species accounts in regional summaries, e.g. Miller et al. (1957), Paynter (1955), Russell (1964), Land (1970), and Monroe (1968). Knowledge of migration schedules is in general limited to earliest recorded dates in species accounts in Bent (1949, 1950, 1953, 1958, 1968), Russell (1964), Land (1970), and Monroe (1968); these dates may not represent normal arrival dates.

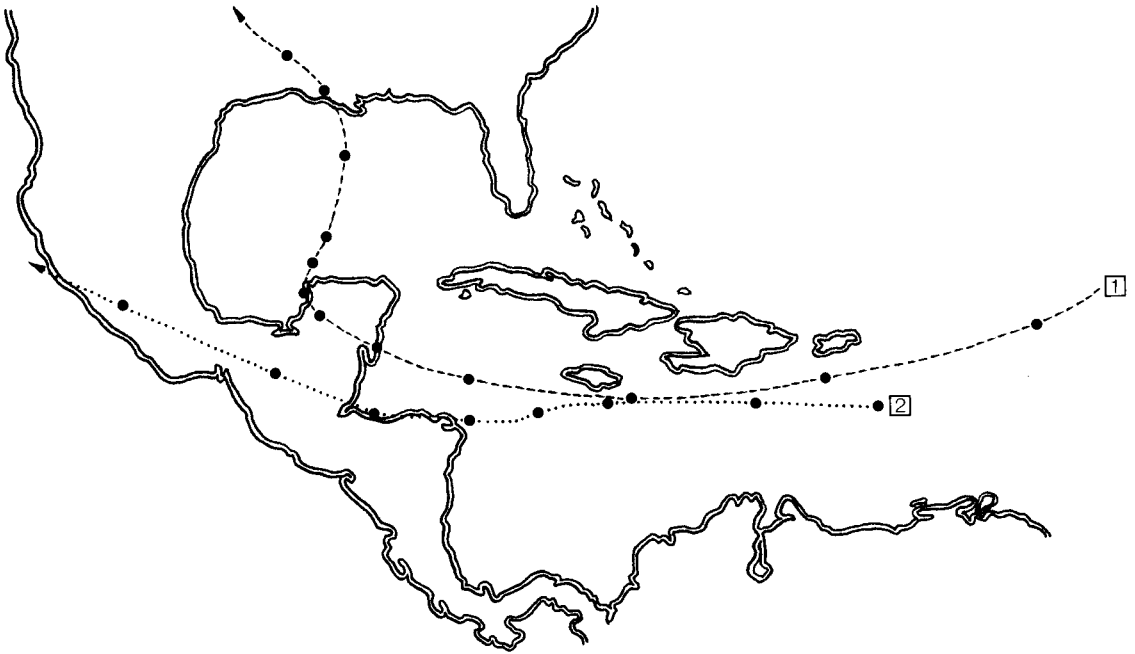


FIGURE 1. Tracks of Caribbean tropical cyclones, 1974: (1) Hurricane Carmen, 29 August–9 September; (2) Hurricane Fifi, 14–22 September. Solid circles mark positions at 07:00 E.S.T. (Adapted from J. Hope 1975: 9, Fig. 10.)

Passerines originating in western North America tend to migrate through western Mexico and the interior highlands. Those that arrive in Guatemala are usually at or near the southern limit of their winter range (Land 1970:18–19; see also Monroe 1968: 390). Western migrants are sheltered from the effect of most Caribbean hurricanes, but in 1974 Fifi crossed the isthmus and, although its intensity diminished after making landfall, it continued to cause devastation along its path.

Some eastern species of migrants follow the coast around Yucatan, some bypass Yucatan at the base of the peninsula, and some cross the Gulf of Mexico. The extent of trans-Gulf migration in autumn is uncertain although large-scale flights in spring are reported (Lowery 1951). Paynter (1951:113–114) provided limited direct evidence of south-bound crossings and inferences can be drawn from the presence of fall migrants on off-shore islands (see species accounts in Paynter 1955 and Miller et al. 1957). Many south-bound migrants continue along the Caribbean slope, some probably crossing the Gulf of Honduras (see Monroe 1968: 390). Other species spread out onto the Pacific slope upon reaching southern Mexico and Guatemala.

For passerines along the Atlantic, the fall migration season begins in late July and ear-

ly August, as judged by earliest recorded dates for Orchard Orioles (*Icterus spurius*) and Northern Orioles (*I. galbula*). Other passerines, e.g. Canada Warblers, begin to arrive at the Gulf of Mexico in mid-August. Migration seems to continue at least into late October and possibly into November in Central America.

Species migrating along the Atlantic coast, especially those crossing the Gulfs of Mexico and Honduras, or flying offshore, are vulnerable to hurricanes that approach or skirt the coast. The season of tropical storms (winds 63–119 km/h) and hurricanes (over 119 km/h) extends from May to December but nearly all severe storms approaching Middle America have done so between mid-August and mid-October (Cry 1965:140–147, charts), a period which coincides with the autumn migration of many species. A severe cyclonic storm can affect migrants for three to seven days depending upon whether the routes intersect at right angles or tend to parallel each other.

The time and place where migrants may encounter severe storms vary. In the decade before Fifi (1964–1973) there were two seasons with no storms along the Atlantic coast of Middle America. In the other eight years there were six tropical storms and eight hurricanes in the western Gulf of Mexico. Yucatan was battered by six hurricanes and

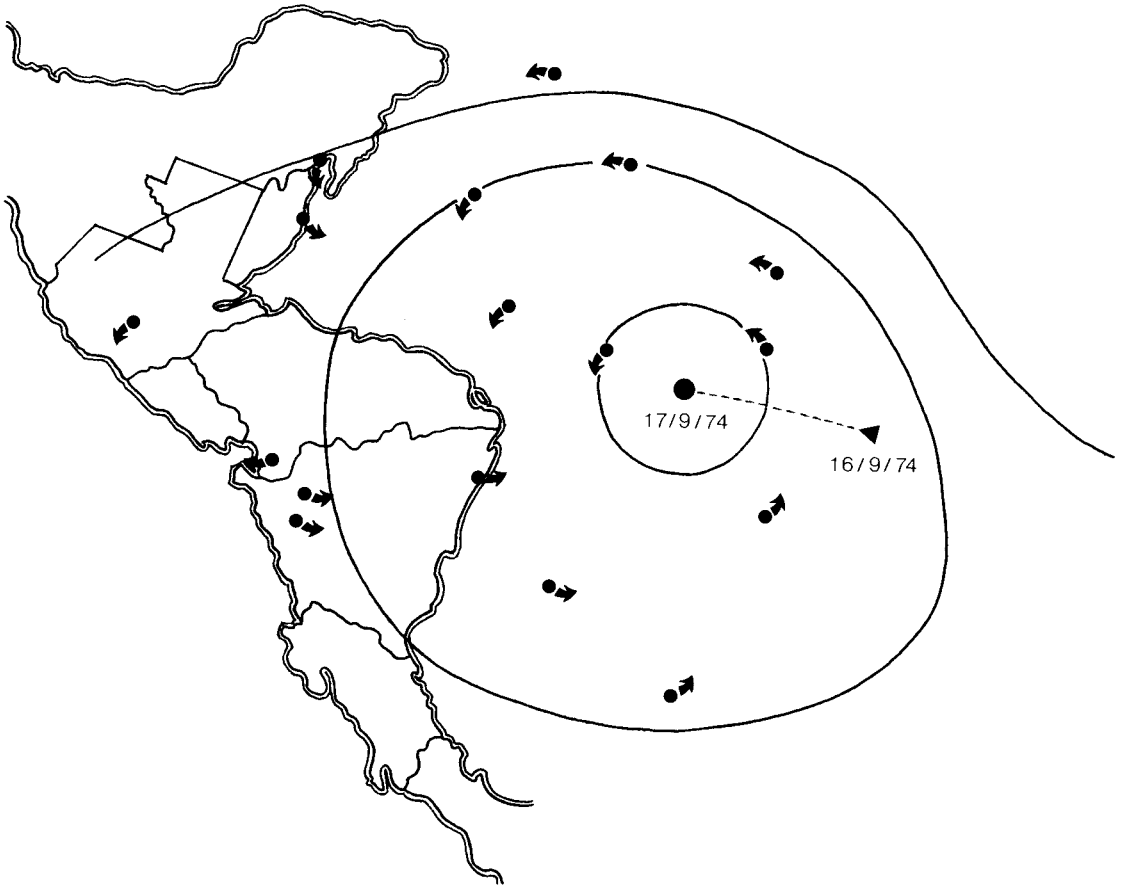


FIGURE 2. Isobars showing position of Hurricane Fifi at 07:30 E.S.T., 17 September 1974. Arrows, flying with the wind, give wind directions at reporting ships and land stations. (Adapted from Surface Analysis Map 12Z 17 September 1974, WMO Regional Center, Miami.)

eight tropical storms, including some of the above, which crossed it, brushed its tip, or paralleled its coasts. Farther south, three tropical storms passed the mouth of the Gulf of Honduras, one hurricane crossed it, and one hurricane travelled its length, the route followed later by Fifi but with less destruction. (Data from Cry 1965.)

HURRICANES AND MIGRANTS

CHARACTERISTICS OF HURRICANE FIFI

In 1974 two hurricanes made landfall in Middle America; Hurricane Carmen approached and crossed Yucatan between 1 and 6 September, and Hurricane Fifi approached and entered Central America between 17 and 20 September (Fig. 1). The dates and routes suggest that Fifi was the more closely associated with the unusual wave of early migrants at Cerro Verde but two hurricanes close together may have had a cumulative effect.

Fifi, moving in from the Atlantic, was classified as a tropical storm on 16 Septem-

ber and as a hurricane on the 17th (Fig. 2). Its center entered the Gulf of Honduras on 18 September, made landfall in Guatemala on the 19th, and crossed to the Pacific, renamed Orlene. The maximum sustained wind velocity was 176 km/h, attained in the Gulf. Among the highest velocities reported on land were 213 km/h on Isla de Guanaja, 158 km/h at La Ceiba, Honduras, and gusts up to 185 km/h in Belize. Heavy rains, up to 50 cm, fell for more than two days in Honduras, El Salvador, Guatemala, and Belize. (Data from Hope 1975:15–16, Table 5.)

Typical of all Caribbean cyclonic storms, the winds of Fifi spiraled inward counter-clockwise (Fig. 2). Birds in the northern and northwestern sectors encountered winds which tended to push them inland; birds in the western sector were pushed southward. The center of such a storm need not actually intersect a migration route to affect migrants; the winds sweep a wide belt. Fifi may have been affecting migrants before noon on 17 September when a ship 125 km east of Yucatan (the northernmost reporting

station in Fig. 2) reported winds of 111 km/h from the northeast (Hope 1965).

Most of the birds driven by Fifi into the forests of Mexico and Belize would have been grounded immediately by the high winds and succeeding torrential rains (see Sutton 1945:603–606). Probably the birds then required several days to recuperate from the stresses endured, especially because heavy rains severely reduce available food and make feeding difficult (Leck 1972:846, Foster 1974:723). After the normal subtropical high pressure system was reestablished, the birds were able to continue southward; being west of their traditional routes some of them might have arrived in El Salvador.

THE 1974 AUTUMN MIGRATION IN EL SALVADOR

The first migrants recorded at Cerro Verde were a few Townsend's Warblers (*Dendroica townsendi*) on 29 September at the end of one week of clear, calm weather; this species is usually common at Cerro Verde in mid-September (earliest date 2 September).

Late on 1 October began a four-day period of violent winds, dense clouds with mountain fog, and heavy downpours. That night a major wave of migrants arrived which included: many Townsend's Warblers, 19 netted; Wilson's Warblers (*Wilsonia pusilla*), usually common in mid-September (earliest date 2 September), 34 netted; Tennessee Warblers (*Vermivora peregrina*), about on schedule and in usual numbers (earliest date 25 September), 15 netted; MacGillivray's Warblers (*Oporornis tolmiei*), about on schedule (earliest date 25 September) but in increased numbers, 16 netted; Canada Warblers, an irregular transient usually in small numbers, if present at all, in early September (earliest date 4 September), this wave peaking 6 October, very late for the species, (10-year record: one netted 1972; 23 netted and many seen at Cerro Verde, others elsewhere, 1974; one netted 1976; 30 netted and large numbers seen 1977; four netted 1978). Accompanying these were: one Summer Tanager (*Piranga rubra*), usually in the lowlands (earliest date 2 October); one Golden-winged Warbler (*Vermivora chrysoptera*) recorded twice before in El Salvador (B. Monroe, Jr., pers. comm.; pers. observ.); one Chestnut-sided Warbler (*Dendroica pensylvanica*) not previously recorded for the country.

During succeeding days of good weather, 6–11 October, the following appeared: Ruby-throated Hummingbirds (*Archilochus*

colubris), about on schedule (earliest date 23 September) and in usual numbers; Swainson's Thrushes (*Catharus ustulatus*), about on schedule (earliest date 26 September), one netted and a few seen; *Empidonax* flycatchers (probably *E. minimus* and *E. traillii/alnorum*), which usually pass through in mid-September (earliest date 3 September); Black-and-white Warblers (*Mniotilta varia*), nine netted, this a regular migrant arriving as early as 5 August but usually dispersed and rarely over one or two taken at one site during a single period. Accompanying the above were species seen rarely or not at all at Cerro Verde: four Mourning Warblers (*Oporornis philadelphia*) which winter occasionally in the lowlands (earliest date 27 September); one Northern Oriole, abundant in the lowlands (earliest date 26 September); one Indigo Bunting (*Passerina cyanea*), abundant in the lowlands but recorded only once before at Cerro Verde (earliest date 9 October); an American Kestrel (*Falco sparverius*, usually in the lowlands but an occasional visitor to Cerro Verde in mid-October); two Olive-sided Flycatchers (*Nuttallornis borealis*), single individuals previously recorded in 1912, 1926, and 1972 (Dickey and van Rossem 1938:371; pers. observ.).

Unusual migrants were not limited to Cerro Verde. At the next station (Las Minas de San Cristóbal, 13°35'N, 88°05'W, 300 m elevation) I netted: another Golden-winged Warbler; three Canada Warblers 18–23 October, very late; one Hooded Warbler (*Wilsonia citrina*), previously recorded once in 1925 and again in 1926 (Dickey and van Rossem 1938:502). In the meantime, A. Sermeño (pers. comm.) collected a Kentucky Warbler (*Oporornis formosus*) on 30 October near Cerro Verde, one previous record in 1925 (Dickey and van Rossem 1938:498) and I added a third record in 1979 following Hurricanes David and Frederick. At a highland station (Los Planes de Montecristo, 14°26'N, 89°22'W, 1,850 m elevation) I recorded: Lincoln's Sparrows (*Melospiza lincolni*), common, eight netted, one previous record in 1927 (Dickey and van Rossem 1938:570) and three collected in 1942 (Marshall 1943:33); Nashville Warblers (*Vermivora ruficapilla*), common, 13 netted, previously unreported in El Salvador. Back again at Cerro Verde in January 1975 I netted: six Nashville Warblers of many seen; two Lincoln's Sparrows, no others seen; three Hermit Thrushes (*Catharus guttatus*) of 6–10 seen, not previously reported for the country.

In summary, during the early season at

Cerro Verde, mid-September to mid-October, I saw: five species delayed two or more weeks; three species in greater numbers than usual (except for Canada Warblers after Hurricane Anita in 1977); four lowland species rarely seen at Cerro Verde; two species reported only a few times in El Salvador; one species not previously recorded for the country. Appearing elsewhere that autumn: three species each reported only one to three times before; two species not previously recorded.

AFTERMATH OF FIFI

A curious aspect of the 1974 autumn migration has been the return of some of the unusual species in succeeding years. Nashville Warblers, previously unreported, reappeared in the winter of 1975–76, the fall of 1976, and one bird banded in October 1975 was retaken in March 1978. Hermit Thrushes, previously unreported, were present again in the winter of 1975–76 and the autumn of 1977. Lincoln's Sparrows, reported a few times in 1920 and 1942, and not seen previously at my banding stations, reappeared in considerable numbers in 1975–76. A banded Hooded Warbler, reported only twice in the 1920's, was recaptured in autumn 1976.

HURRICANE ANITA

I mention this 1977 hurricane because of its relevancy to the following discussion. Anita was identified as a tropical depression on 29 August south-southwest of New Orleans. Moving westward it intensified rapidly, reaching hurricane strength just prior to making landfall on the Mexican coast on 2 September. Anita is ranked as the fourth most intense storm ever in the Gulf; surface winds attained 280 km/h. (Data from Lawrence 1978:81–82, Table 2.) Beginning on 4 September and peaking on the 9th at Cerro Verde came the largest wave of Canada Warblers in my experience; they were truly abundant and I netted 30. No other unusual migrants were recorded.

DISCUSSION

COINCIDENCE OR CAUSE-EFFECT?

Was the near conjuncture of Hurricane Fifi and the abnormal 1974 migration mere coincidence? That migration was not a single event but an aggregate of many events—the arrival of thousands of birds (Emlen 1975: 130). Quantification of probabilities must be limited to crude estimates such as: the probability that a first wave of Wilson's Warblers might be delayed over two weeks (1 in 10

on the basis of my 10 years' experience); that Canada Warblers might arrive at all (5 in 10), in increased numbers (2 in 10 with one instance following Anita), and one month late (1 in 10); that Nashville Warblers might extend their range into El Salvador (less than 1 in 10); that a Chestnut-sided Warbler might wander in from the Caribbean slope (less than 1 in 10); and so on for an additional 15 or so events.

The probability P_0 that all these events, including Hurricane Fifi, might occur at about the same time is the product of the individual probabilities: $P_0 = P_1 \cdot P_2 \cdot P_3 \dots P_m$ where m is the m th event considered, obviously a vanishingly small value.

With coincidence ruled out, one may search for a cause-effect relationship, either among the events being considered or by considering some previously unmentioned factor. In the interests of parsimony I invoke the winds of Hurricane Fifi as the common cause of the other events. The remainder of the discussion will be based on the assumption that Fifi was responsible for the unusual features of the 1974 migration in El Salvador.

DISRUPTED MIGRATION PATTERNS IN 1974

At Cerro Verde the first waves of Townsend's Warblers and Wilson's Warblers were delayed two to three weeks, *Empidonax* flycatchers almost a month. Townsend's Warblers migrate along the Pacific slopes (Miller et al. 1957:250–251). Western races of Wilson's Warblers migrate through western Mexico (Miller et al. 1957:266–267). *Empidonax* species migrate along either the Pacific or Atlantic or both (Miller et al. 1957:86–89). Birds on the Pacific slopes were not necessarily deflected by Fifi but may have been delayed by the inclement weather and the need to recuperate afterwards. Possibly *Empidonax* flycatchers were delayed the longest because of difficulty in finding flying insects after heavy rains; in El Salvador these birds feed exclusively by sallying, whereas Townsend's Warblers feed also by gleaning and Wilson's Warblers chiefly by gleaning (pers. observ.).

Canada Warblers arrived at Cerro Verde in increased numbers three to four weeks later than usual. This species migrates along the Atlantic slopes of Mexico including Yucatan and off-shore islands (Miller et al. 1957:267). Bent (1953:655–656) gave 18–19 August as early dates of arrival in south Texas; a bird flying over the Gulf was taken 30 August (Paynter 1951:113). These dates suggest that migrating Canada Warblers

could have encountered Carmen. Probably the birds' delay in arriving at Cerro Verde was due to being grounded by Carmen and/or Fifi. Their increased numbers may have been the result of additional birds being pushed into routes that lead to El Salvador, and/or grounded birds accumulating at sheltered places from which they resumed flight simultaneously. (A similar explanation may apply to the concentration of this species following Anita in 1977.)

Of the species that appeared unexpectedly in El Salvador in 1974, the following migrate chiefly or exclusively along the Atlantic slopes: Golden-winged Warblers (Miller et al. 1957:238, Land 1970:282, Monroe 1968:324); Chestnut-sided Warblers (Miller et al. 1957:254, Land 1970:293, Monroe 1968:333); Kentucky Warblers (Miller et al. 1957:258, Land 1970:296-297, Monroe 1968:336); Hooded Warblers (Miller et al. 1957:266, Monroe 1968:340). Individuals of these species caught in the northern or northwestern sectors of Fifi would have been driven inland and, if they resumed a southward course, some would have arrived in El Salvador.

After Fifi, two species wintered beyond their usual range, Hermit Thrushes and Nashville Warblers, both normally wintering to Guatemala (Land 1970:261, 284). The Hermit Thrushes are of the Rocky Mountain race, *C. g. auduboni*, as judged by measurements and photos. A Nashville Warbler collected was assigned to the western race, *V. r. ridgwayi*, by J. Farrand, Jr. (E. Eisenmann, pers. comm.). Another species, the Lincoln's Sparrow, usually wintering to Guatemala (Land 1970:349) and Honduras (Monroe 1968:385), seems to have extended its range back into El Salvador after being absent for some years. Van Rossem (Dickey and van Rossem 1938:570) and Marshall (1943:33) collected a western race of this species (*M. l. alticola*) in El Salvador. These three races migrate through western and central Mexico (Miller et al. 1957:188-189, 240, 398). Had individuals arrived in western Guatemala just before Fifi made landfall, they would have encountered strong winds in Fifi's western sector and could have been swept southward beyond their usual limits into El Salvador.

WINTER RANGE EXTENSIONS

Data are too few to allow more than speculation about the causes for the unexpected reappearance of Hermit Thrushes, Nashville Warblers, Lincoln's Sparrows, and one Hooded Warbler in years subsequent to

Fifi. In the cases of a Nashville Warbler banded at Cerro Verde and retaken there a season later, and a Hooded Warbler banded at Las Minas de San Cristobal and retaken there two seasons later, there is little likelihood that they returned by chance. The probability that a banded bird might chance again on the banding site is $1/n$ where n is the total number of suitable sites within the bird's range; $1/n$ is obviously an insignificant value.

To account for the return of individuals of the four species, I propose that a hypothesis formulated by Schwartz (1963:481-484) is applicable. Schwartz, in Venezuela, transported banded Northern Waterthrushes (*Seiurus noveboracensis*) 10-25 km away from the capture sites on their wintering grounds. Four of four "old" residents (birds present at least one previous season) returned to their former wintering grounds. Fourteen of 14 "new" winter residents failed to do so. Schwartz concluded, "What the bird learns on its first trip south does not enable it to orient to its new winter home if artificially removed from it; but once having flown north from the winter territory, the bird—even if artificially removed—is thereafter able to return to this winter home."

Ralph and Mewaldt (1975:698-705), using migratory *Zonotrichia* sparrows in California, released about 400 adults and 400 subadults far from the capture stations. The following year none of the adults was recaptured at the release sites and 17% were retaken at the original capture sites. About 3% of the subadults were recaptured at the release sites and 8% at the original capture sites. Ralph and Mewaldt suggested a form of learning, "site fixation." Their data suggest that the sparrows had some means of relocating specific sites, the original wintering grounds of the adults, the new wintering grounds of some of the subadults.

Ralph (1978:243) invoked learning to explain the different age compositions of south-bound migrants moving inland and along the coast of eastern North America—35% adults inland vs. 10% adults along the coast. He considered that those young "disoriented" birds surviving the many hazards of offshore flight during their first migration do not "repeat the mistake" and thereafter migrate inland.

The migrants that found their way back to El Salvador (two individuals with pinpoint accuracy) must have learned how to orient themselves towards their new wintering grounds. To me, it seems more probable

that their orientation was learned during the northward flight, as Schwartz suggested, than during their first arrival under the severe stresses of the hurricane which brought them.

CONCLUSIONS

The effects of Hurricane Fifi, augmented perhaps by Carmen, were to delay the passage of certain species, cause local concentrations of migrants, deflect individuals from their normal routes, and bring about at least temporary extensions of winter ranges. Probably migrants through Middle America have long been and will continue to be so affected by severe storms. The effects are unpredictable because of the marked irregularity of these storms and the minor irregularities of migration patterns. Probably large scale disruption rarely occurs, only when an especially severe storm intersects a major wave or series of waves of migrants. The extensions of winter ranges of a few species into El Salvador, should these prove permanent, will show that cyclonic storms can have a lasting effect on the distribution of migrants, introducing species into areas that have become suitable for wintering. Undoubtedly tropical cyclonic storms have had a long-lasting effect on regional lists and distribution maps by adding accidentals which could not be recognized as such by compilers for lack of comparative data; these records will be corrected eventually but, meanwhile, investigators should interpret such lists and maps with caution.

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