

JOURNAL OF FIELD ORNITHOLOGY

Published by
Association of Field Ornithologists

VOL. 60, No. 4

AUTUMN 1989

PAGES 421-565

J. Field Ornithol., 60(4):421-430

EPIZOOTIC LESIONS OF HOUSE FINCHES IN VENTURA COUNTY, CALIFORNIA

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Abstract.—Lesions or sequelae attributed to avian-pox virus were found among 11,082 House Finches (*Carpodacus mexicanus*) handled 21,642 times between March 1977 and June 1987 at Camarillo in Ventura County, southern California, in both urban and rural environments. The number of infections was greatest during winter in both environments. Where the birds were concentrated about feeders in town about one-third of them became infected during their lifetimes. Infection was seen less often in rural environments. Lesions were present most often on the feet, but also occurred on the mandibles and about the eyes. The infection attacked both sexes and all ages and was recurrent at long intervals.

LESIONES ATRIBUIDAS A LA VIRUELA AVÍCOLA EN GORRIONES (*CARPODACUS MEXICANUS*) ESTUDIADO EN EL CONDADO DE VENTURA, CALIFORNIA

Resumen.—Lesiones o secuelas atribuidas a la viruela avícola fueron estudiadas en 11,082 individuos del gorrión *Carpodacus mexicanus* que fueron examinados entre marzo del 1977 y junio de 1987. El estudio se llevó a cabo tanto en áreas rurales como urbanas de Camarillo en el Condado de Ventura, California. El número de aves con lesiones varió a través del año y durante los diferentes años que cubrió el estudio, siendo mayor durante el invierno en ambos tipos de áreas. En áreas urbanas donde las aves se concentraban en los alrededores de comederos, una tercera parte de estos se infectó en algún momento de su vida. Aves infectadas se observaron con menos frecuencia en áreas rurales. Las lesiones aparecieron con mayor frecuencia en las patas, aunque también se encontraron en las mandíbulas y en los alrededores de los ojos. La viruela atacó a aves de todas las edades y sexos, y resultó ser recurrente a largos intervalos.

During the last half century, House Finches (*Carpodacus mexicanus*) with crippling lesions have been noted over much of their western range (Table 1). Warner (1968) found that nearly half of the introduced House Finches in Hawaii had such lesions. Although most authors of these reports have attributed the lesions to avian-pox virus, only Docherty and Long (1986) isolated and identified the pox organism from finches in Boise, Idaho.

While bird banding at Camarillo, Ventura County, California, I noticed that House Finches suffered from an epizootic disease that produced lesions resulting in loss of toes, damaged mandibles, blindness, and death.

TABLE 1. Distribution of pox-like lesions among House Finches in western United States.

Place	Year	Source
Hawaii	1968	Warner
Washington, Aberdeen	1979	Hasen (pers. comm.)
Oregon, Eugene	1979	Payne (pers. comm.)
Arizona, Tucson	1979	Burke (pers. comm.)
Nevada, Reno	1987	Molde (pers. comm.)
California, Pasadena	1936	Michener and Michener
California, Hollywood	1958	Bleitz
California, Bakersfield	1962	McClure
California, Santa Barbara	1976	Power and Human
California, Santa Barbara	1979	Rothstein (pers. comm.)
California, San Jose	1979	Mewaldt (pers. comm.)
California, Modesto	1979	Elms (pers. comm.)
California, Modesto	1979	Feltes (pers. comm.)
California, Long Beach	1979	Collins (pers. comm.)
Idaho, Boise	1986	Docherty and Long

This report explores the seasonality of this epizootic and its effects on survival of infected individuals.

LOCALITY

Observations were made in two environments: the house, an urban habitat in Camarillo around the author's house and garden, and the park, a rural habitat with more than 10 ha of open oak woods and coastal chaparral 7 km east of town in the Conejo Uplands. Observations at the house continued from March 1977 through June 1987. During this time all the citrus and avocado groves in its vicinity were bulldozed and replaced by single family homes.

Nearly half of the area at the park was dominated by old Coastal Oaks, *Quercus agrifolia*, and other shade trees. The park was bordered on the west by a large lemon grove and on the other three sides by more than 500 ha of coastal chaparral pasture. The hillsides and valleys of the pasture supported a light cover of annuals and sparse shrubs, including sage, *Ramona* spp., Lemonade Berry, *Rhus integrifolia*, Toyon, *Photina arbutifolia*, Wild Tobacco, *Nicotiana glauca*, and others. An intermittent stream, supplied by a small spring, flowed through the area during February, March, and April, if winter rains filled its aquifer. During 1978 through 1980 the surrounding pasture was ungrazed and abundant winter rain encouraged heavy plant growth. On 30 Oct. 1980 a brush fire destroyed the chaparral without entering the park. Annuals and shrubs were regenerating by the spring of 1981 when cattle, sheep, and goats were brought into the pasture. They further destroyed the plant cover until mid-1984 when they were removed. Lack of winter rains inhibited regeneration through the end of the study in 1987.

METHODS

At the house there were two feeding stations, each of which was supplied with an Irl Rogers 8-cell trap. Two 1-celled Potter Traps were placed by one of the feeders, thus bringing the total cells to 18. Grain was provided at these traps continuously. The traps were set one day each week, from dawn until dusk, usually a 10 h day; totalling 457 d by the end of the study. Their location and activation were not changed during the 11 yr.

At the park and pasture 8–10 mist nets, 6 or 12 m long, were extended at various locations depending upon the vegetation, movements of the birds, and disturbances by livestock or the public. The nets were placed within the park and up to 0.25 mi (about 0.5 km) into the pasture. They were extended once each week before dawn, removed at mid-day, and examined at half hour intervals to avoid disturbance by feral cats, livestock, and park visitors. Except for a few absences, weekly netting in the park was continuous from October 1978 through June 1987, a total of 351 netting days (over 2100 h).

Pasture netting lasted for 27 mo, September 1980 through November 1982. After April 1985 four small feeding stations were set up at the park. Grain was placed in them twice each week and on banding days a mist net was placed before each.

At both study locations each bird that was caught was banded with a standard U.S. Fish and Wildlife Service band, sexed, aged (where possible), weighed, examined for ectoparasites and lesions, and released at the site of its capture. Lesions or deformities were recorded as to location: right foot, toe 1, 2, 3, 4 (counted from the inside out, hind toe #4), left foot, toe 1, 2, 3, 4, wings and body. Injuries to the feet (metatarsals) were differentiated from those to the toes (digits) and facial injuries were separated from those about the eyes or mandible. Each time a bird was recaptured, its number was recorded and it received the same examination that was done initially. Although many individuals were retrapped repeatedly they were rarely retrapped more than once a month. In determining the monthly rate of infection in the population at the house those birds caught several times were considered as separate individuals.

RESULTS

A total of 9195 House Finches were banded at the house. Of these, 3463 (37.7%) repeated from one to 21 times, an average of 3.5 captures per bird (including the first capture) or 8657 recaptures, totalling 17,852 examinations over-all. At the park and pasture, 240 of 1887 finches (12.9%) were captured an average of 2.3 times, bringing the total examinations at the park to 2203. The information summarized here is drawn from the 20,055 examinations, but not all birds were considered in all studies, therefore the totals given in the text and tables will vary.

Because the virus is present in the environment for long periods, possibly the entire year, and because birds may be exposed at anytime or repeatedly,

the epizootic density of the disease in the population cannot be determined by a simple survey of banded birds. As the birds age and are recaptured, the number infected or showing the effects of previous infections increases (Table 2).

Information in Table 2 for birds at the house was taken from the first 5 yr of study. The longer the study continued (the remaining 5 yr) the greater opportunity for these birds to be recaptured. There were 4664 new House Finches captured and banded. Of these, 717 had lesions or sequelae from previous infections, 15.4%. However, 2906 of these 4664 birds did not repeat so there is no further information concerning them. Of the 1768 birds retrapped, 245 had developed infections or sequelae since their first handling, bringing the total infected birds to 962, 20.6% of the original number. However, this may underestimate the percentage of birds ultimately infected. During long term observations older birds will show new or recurrent infections. Probably one-third of the House Finches in this environment contract avian pox at least once during their lifetime.

Because of the smaller numbers involved, data presented for the park include birds retrapped over 9 yr. Of 1398 birds banded, 163 or 11.6% had lesions or sequelae. An additional 41 of the 180 birds that were retrapped (22.8%) had evidence of infection, bringing the total to 204 birds, 14.6% of the original birds examined. Nine birds had no sequelae following infection so would not appear in the tally of subsequent evidence of infection. This suggests a loss in identification of infection of at least 3.8%.

At the house 8.8% of the infected birds had healed completely by 1986. The total birds listed as infested in Table 2 can be only the minimum number, because 62% of the birds at the house and 87% of those at the park did not repeat, therefore any increase or decrease in infection among them is unknown. Even in a long term study, the indicated incidence of infection may be below that which is actually present.

Table 3 lists the locations on the birds commonly serving as the sites of infection and tumors. Bleeding tumors attributed to secondary bacterial invasion usually develop at the site of virus entry (Davis et al. 1971). These may remain small but may also become massive and life threatening. Most birds had more than one sequela following a pox episode, an average of 1.4 deformities per bird. The damage most commonly seen was to feet and toes. The middle toe of each foot was the site of the most injuries, 17.9% on the right and 19.8% on the left. There was no evidence that the birds were right or left footed since injuries were nearly equally divided.

Lesions around the base of the upper mandible afflicted 10% of the injured birds. When damage to the culmen resulted in growth retardation while the lower mandible continued to grow a "shovel-nosed" condition resulted. Tumors about the upper mandible often extended into the eyes. Birds with the "shovel-nosed" condition learned to turn the head in order to pick up food by the side of the mouth. Where food was plentiful they

TABLE 2. The number of House Finches in the Camarillo area exhibiting lesions or sequelae when first captured and at subsequent recaptures. Based upon the examination of 6062 birds.

Month	Lesions seen at the house				Lesions seen at the park							
	New birds banded	Infected birds	Percent infected	Additional birds infected when retrapped	Total infected	Percent infected	New birds banded	Infected birds	Percent infected	Additional birds infected when retrapped	Total infected	Percent infected
Jan.	328	70	21.3	37	107	32.6	98	25	25.5	2	27	27.5
Feb.	599	101	16.9	23	124	20.7	79	13	16.5	6	19	24.1
Mar.	635	114	17.9	33	147	23.1	50	5	10.0	1	6	12.0
Apr.	394	66	16.8	15	81	20.5	31	6	19.4	2	8	25.8
May	381	51	13.4	14	65	17.1	93	11	11.8	4	15	16.1
Jun.	498	40	8.0	11	51	10.2	266	18	6.7	5	23	8.6
Jul.	720	73	10.1	7	80	11.1	234	11	4.7	3	14	6.0
Aug.	292	26	8.9	6	32	10.9	143	7	4.9	4	11	7.7
Sep.	244	36	14.8	15	51	20.9	131	18	17.7	6	24	18.3
Oct.	131	22	16.8	26	48	36.6	106	12	11.3	5	17	16.0
Nov.	123	38	30.9	18	56	45.5	97	16	16.5	0	16	16.5
Dec.	319	80	25.1	40	120	37.6	70	21	30.0	3	24	34.3
Total	4664	717	15.4	245	962 ^a	20.6	1398	163	11.6	41	204 ^a	14.6

^a The actual number of injured birds may be greater than this since 62.3% of the birds at the house and 87.1% of those at the park were not recaptured.

TABLE 3. A 10 yr summary of the sites of injuries or sequelae on House Finches at Camarillo, California.

	New capture	Per-centage	Re-captures	Per-centage	Average percent
Birds examined					
Total birds	8227		7797		
Uninjured birds	6878	83.6	5896	75.6	79.7
Injured birds	1349	16.4	1901	24.4	20.3
Sites of injuries					
Right foot (other than toes)	170	12.6	256	13.5	13.1
Toe 1	58	4.3	104	5.4	5.0
Toe 2	259	19.2	322	16.9	17.9
Toe 3	125	9.3	173	9.1	9.2
Toe 4	110	8.1	170	8.9	8.6
Left foot (other than toes)	150	11.1	236	12.4	11.9
Toe 1	69	5.1	100	5.3	5.2
Toe 2	244	18.1	399	20.9	19.8
Toe 3	100	7.4	223	11.7	10.0
Toe 4	156	11.6	216	11.4	11.4
Head	82	6.1	107	5.6	5.8
Face	37	2.7	57	3.0	2.8
Upper mandible	133	9.8	191	10.0	10.0
Lower mandible	28	2.1	44	2.3	2.2
Right eye	55	4.1	90	4.7	4.5
Left eye	47	3.5	69	3.6	3.6
Wings	26	1.9	29	1.5	1.7
Abdomen	8	0.6	5	0.3	0.4
Number of injuries	1826		2733		
Injuries per bird	1.35		1.43		1.4

maintained their weight, but were unable to preen effectively. Consequently, they were soon infested heavily with feather mites *Proctophyllodidae* (*Proctophyllodes pinnatus*) and Mallophaga (*Myrsidea* spp.). Moulting was also difficult because the primary sheaths could not be cleaned away and each feather took longer to open. Individuals with a "shovel-nose" survived up to 4 yr at the house.

Damage to the lower mandible was less often seen. Only 2.2% of the birds were afflicted with this "parrot-bill" syndrome. They also became heavily parasitized with mites and Mallophaga and did not survive as long as the "shovel-nose," only up to 3 yr at the house.

Eight percent of the injured birds had damaged eyes. Where both eyes were impaired, the bird quickly succumbed (starvation or predation) and few were seen beyond the initial stages of eye injury. Single blind eyes were about equally distributed left and right, and if the bird learned to cope with its condition, it could survive (up to 38 mo).

Very few wing injuries were noted. A swelling or tumor at the bend of a wing would incapacitate a bird, which would quickly succumb to the loss of flight.

The over-all percentage of affected birds varied little from year to year. The lowest was 17.1% in 1981 and the highest 23.5% in 1986. Among infected birds the fewest right limb deformities were noted in 1978 (34.1%); the most in 1979 (75.4%). Fewest left limb injuries were seen in 1977 (48.1%), the most in 1979 (65.9%). Fewest eye injuries were seen in 1979 (3.2%) and the most in 1986 (10.9%).

Table 4 summarizes 10 yr of monthly numbers of birds with injuries and deformities within the population; males, females and juveniles. When first captured there was little difference in the numbers of injured males and females; 18.5% and 20.4% respectively. The number of infections increased in both sexes when retrapped at an older age; 22.8% and 28.3% respectively. The monthly figures given in Table 4 suggest that females were subject to infection while nesting. Until juveniles had been exposed to the epizootic peak of infection during their first winter they were less heavily afflicted than the adults. Monthly percentages of the numbers of birds with infection as shown in Tables 2 and 4 and based on different segments of the birds under observation indicate that the virus reaches its greatest virulence and dispersal in the population during the winter months in this habitat.

DISCUSSION

Lesions caused by avian-pox virus or its associated secondary bacteria have been described by other authors (Davis et al. 1971; Herman, Locke, and Clark 1962; Worth 1956). As demonstrated by Davis et al. (1971), the pox virus is transmitted by contact and is apparently long lived free of its hosts. Once having entered the host it produces swellings at the site of entry and the infection may become systemic with swellings that break out on the limbs, wings or over the body. The initial lesions are invaded by bacteria that produce massive bleeding spongy tumors. If the bird does not die at this stage, the tumors dry up and break away. Those about the limbs and bill destroy the normal circulation of blood. Consequently, the birds lose toes or feet and the normal growth of the culmen is inhibited.

No attempt was made to isolate the infectious agent or agents from the injured birds. However I attempted to follow the progress of the disease in wild individuals as they were recaptured. Forty-six percent of repeating birds were recaptured only once, 22.7% were captured twice with descending numbers to one individual that was recaptured 21 times. The time interval between recaptures was as great as 5 yr. From a sample of 100 individuals captured while the infection was fulminating with bleeding ulcers the infection was still purulent when the bird was recaptured 1 mo later, 48% of the time. At 2 mo, 22% of the infections were still active, and 10 of the 100 were still active at 3 mo. Although lesions were still fulminating at 4, 5, and 6 mo in some individuals, it was possible that these were new infections or recurrence of the disease.

From another sample of 100 birds in which the infection had healed by the first recapture, the time interval was again noted. Seventeen percent had healed within 1 mo; 14% were healed by 2 mo; while another 22%

TABLE 4. A 10 yr summary of injuries by sex and age among House Finches at Camarillo, California.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Males													
New birds	455	543	501	359	288	161	151	112	153	136	102	249	3211
Number injured	90	104	88	48	55	29	30	10	17	22	34	72	599
Percent injured	19.8	19.2	17.6	13.4	19.0	18.0	19.9	8.9	11.1	16.2	33.3	23.9	18.6
Number recaptured	499	611	621	431	270	217	169	109	182	153	171	372	3805
Number injured	137	133	119	85	42	46	29	12	40	44	59	123	869
Percent injured	27.5	21.8	19.2	19.7	15.6	21.2	17.2	11.0	22.0	28.8	34.5	33.1	22.8
Females													
New birds	441	538	490	210	161	136	212	95	154	129	99	243	2908
Number injured	95	106	96	52	28	26	28	11	23	26	27	75	593
Percent injured	21.5	19.7	19.6	24.8	17.4	19.1	13.2	11.6	14.9	20.2	27.3	30.9	20.4
Number recaptured	530	572	581	321	255	151	138	68	152	153	171	397	3489
Number injured	173	158	151	70	75	36	38	11	35	49	68	125	989
Percent injured	32.6	27.6	26.0	21.8	29.4	23.8	27.5	16.2	23.0	32.0	39.8	31.7	28.3
Percent infection among adults based upon new and repeat birds													
	25.7	22.1	20.7	19.3	20.4	20.6	18.7	11.5	17.9	24.7	34.6	31.3	22.7
Juveniles													
New birds					396	678	738	252	108	22			2094
Number injured					10	24	57	20	22	11			144
Percent injured					4.0	3.5	7.7	7.4	20.4	50.0			6.8
Number recaptured					34	163	132	59	25	6			419
Number injured					3	13	16	4	7	5			48
Percent injured					8.8	8.0	12.1	6.8	28.0	83.3			11.4

had healed when the birds were recaptured 3–5 mo after the first capture. These observations suggest that the infected bird is shedding virus or bacteria for intervals up to 6 mo or more. Musselman (1928) showed survival of the virus for several months in the Chipping Sparrow (*Spizella passerina*); Kossack and Hanson (1954) for 82 d in a Mourning Dove (*Zenaid macroura*); Kirmse (1966 (cited in Davis et al. 1971)) for 81 d in a Dark-eyed Junco (*Junco hyemalis*) and 13 mo in a Northern Flicker (*Colaptes auratus*); and Hood (cited in Davis et al. 1971) for 109 d in a Dark-eyed Junco.

Those finches in the present study that were still infected after 5–6 mo were possibly in relapse or suffering from a new infection. Davis et al. (1971), who referred to several strains of the pox virus, indicated that those birds still (or again) infected after 6 mo or more may have been suffering from another strain. He reports laboratory tests demonstrating the development of antibodies to some strains. Possibly finches infected after a year or more could have lost their immunity to a given strain and been reinfected, or may have been challenged by a strain to which they were not immune. An age-related immunity is doubtful, although some birds did not contract the disease until quite old and a few individuals that overcame the infection were again afflicted at a later date.

Competition at feeders affected incapacitated finches to the extent that individuals with massive infection or sequelae had to come early before other birds arrived or return late after most had left. At the park the sick birds did not have this opportunity and would seek food in the surrounding pastures. Once feeders were placed there, an increase in the number of injured birds retaken suggested that here, too, they remained close to a known food supply. The density of birds in the area was assumed to be reflected in the number captured. However, the number captured is affected by the experience of the individuals, the availability of food away from the feeder as well as at it, the weather, the abundance of active predators (e.g., Sharp-shinned Hawks (*Accipiter striatus*)), the age and health of the birds and their breeding activities and duties.

ACKNOWLEDGMENTS

I wish to thank Dr. Richard Mewaldt and Dr. L. Jeannette Davis for constructive criticism and evaluation of the manuscript.

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Received 4 Nov. 1987; accepted 22 May 1989.

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