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## NOTES ON A NESTING COLONY OF WESTERN CROWS

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THE WESTERN CROW (*Corvus brachyrhynchos hesperis*) is a gregarious bird even during the nesting season. In California, occupied nests are rarely built in adjoining trees, but several dozen or more pairs often breed together in a loose association in an orchard or grove. Such a "breeding colony" has been present on the Straloch Farm, 3 miles west of Davis, Yolo County, California for several years. Observations on nest construction, laying, incubation and growth of nestlings were made in this colony during the spring of 1942. The study, as initiated, was incidental to the collecting of eggs for experimental use, and consequently was not planned in the most suitable manner for a life-history investigation. Certain statistical information on crow nesting, however, was obtained which seems worthy of record. A total of about 140 hours was spent in the colony on 55 visits between April 7 and June 13. Nine additional visits were made in late June and July. Notes on the condition and contents of each of 111 nests were made at appropriate intervals with an average of 9.6 visits per nest. Direct observations on courtship and breeding behavior were not attempted.

The colony site was a 108 acre orchard of English walnuts on black walnut stock. The trees, 11 to 17 years old and generally from 20 to 30 feet in height, were spaced in rows 30 feet apart or thinned to form diagonal rows  $42\frac{1}{2}$  feet apart (fig. 1). An avenue of large black walnuts, paralleling highway U. S. 99, bounded the orchard on the north; open fields lay to the east and west and a young peach orchard to the south. Most of the surrounding country was in grain and field crops.

A total breeding population of about 60 pairs of crows inhabited this orchard during the nesting season of 1942. The 111 occupied nests found probably represent about 95% of the actual total. This large number of nests, almost two per pair, was in part due to egg-robbing by the observer and the consequent frequency of

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FIG. 1.—Distribution of crow nests on Straloch Farm—Spring, 1942.

- Early nests (started before leaves fully out.)
- Later nests (mostly second nestings).
- ⊙ Early nests used for a second nesting.
- Shade trees along highway.
- /// Roosting areas.
- ⋯ Spacing of orchard trees.
- Orchard boundaries.

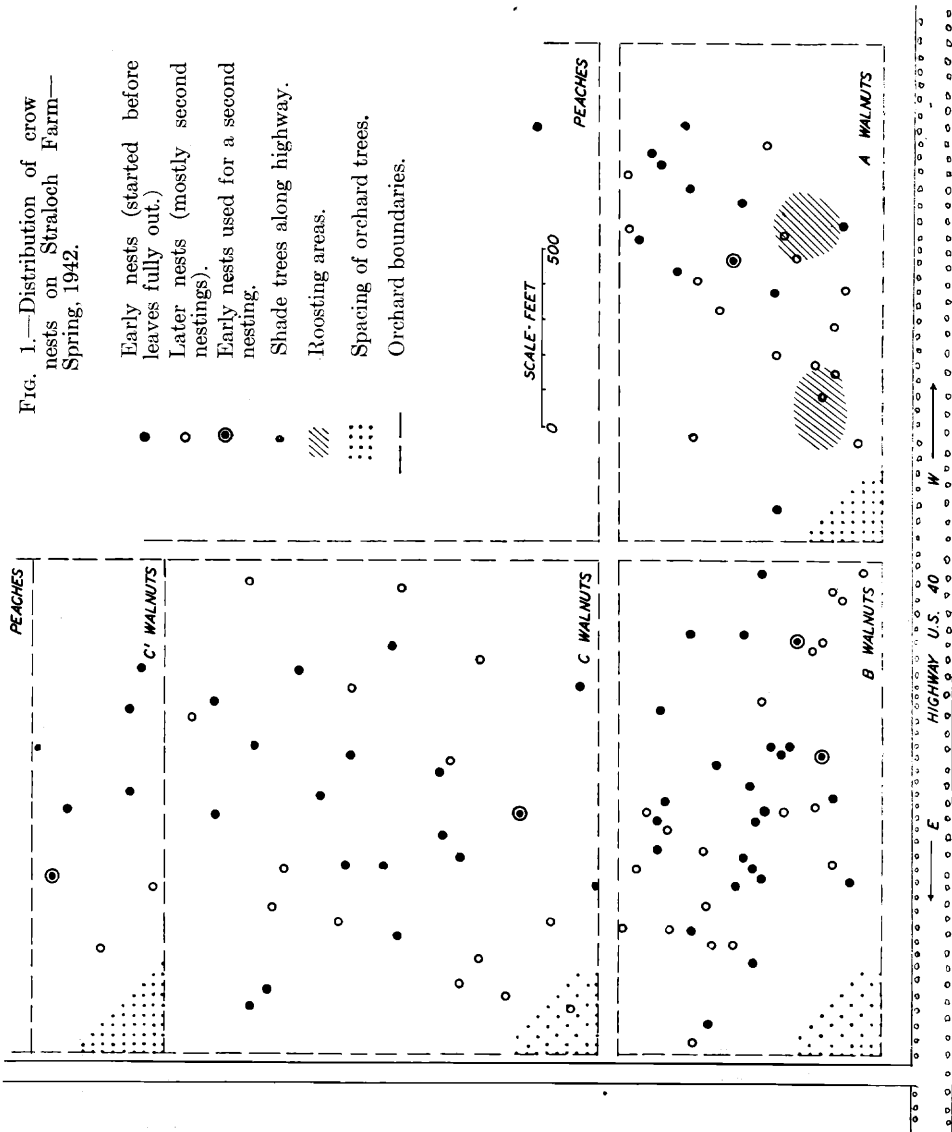


TABLE 1  
EXPERIMENTS WITH REMOVING AND ADDING EGGS DURING THE  
LAYING PERIOD IN 36 MANIPULATED CROW NESTS  
WHICH SURVIVED INTO THE INCUBATION STAGE

Nest Number	Days of Laying Period on Which Eggs were Laid (*) and on Which Removals (-) or Additions (+) were Made						Total Eggs Laid	Eggs in Nest at End of Laying
	1st	2nd	3rd	4th	5th	6th		
2	*	*	*	*-2	*-1	....	5	2
6B	*	*-1	*-1	*-1	*-1	....	5	1
8	*	*-1	*	*	*-2	....	5	2
9	*	*	*-2	*-1	*-1	....	5	1
10	*	*-1	*-1	*-1	....	....	4	1
11	*	*	*	*-4	*	*	6	2
19	*	*-1	*-1	*-1	....	....	4	1
23	*	*	*	*	-3	*	5	2
29	*	*	*	*-3	*	....	5	2
33	*	*	*	*-3	*	....	5	2
36	*	*-1	*-1	*-1	....	....	4	1
38	*	*	*-1	*-1	....	....	4	2
40	*	*	*-2	....	....	....	3	1
47	*	*-1	*	*-1	....	....	4	2
51	*	*	-1	*-1	*-1	*-1	5	1
59	*	*-1	*-1	*-1	*-1	....	5	1
61	*	*-1	*-1	*-1	....	....	4	1
62	*	*-1	*-1	*-1	*	....	5	2
63	*	*-1	*-1	*-1	*-1	....	5	1
65	*	*-1	*	-1	*	....	4	2
67	*	*-1	*-1	*-1	*	*	6	3
70	*	*-1	*-1	*-1	*-1	....	5	1
72	*	*-1	*-1	*-1	*-1	....	5	1
73	*	....	*-1	*-1	*-1	*-1	5	1
75	*	*-1	*-1	*-1	....	....	4	1
76	*	*-1	*-1	....	*-1	....	4	1
81	*	*-1	*-1	....	....	....	3	1
82	*	*-1	*-1	*-1	*-1	....	5	1
85	*	*-1	*	*-2	....	*-1	5	1
86	*	*-1	*-1	*-1	*-1	....	5	1
96	*	*-1	*	*-2	*	....	5	2
32	*	*-1	*-1	*-1	+4	*	5	6
77	*+3	*	*	*	....	....	4	7
78	*+1	*+1	*	*	....	*	5	7
91	*+4	*+1	*	*	....	....	4	9
94	*+4	*	*	*	....	....	4	8

second nestings. Nests were widely scattered through the orchard. Early nests, constructed before the leaves had fully opened, were somewhat more centrally located in the orchard (mean of 12.2 trees from edge) than later nests (mean of 8.8 trees from edge). Concurrently occupied nests averaged about 250 feet apart, but in seven instances were only 80 to 90 feet apart.

No direct observations were made on social or territorial behavior, but the spacing of nests suggested territory recognition. Community

relationships were demonstrated by the flocking and general excitement of from four to forty crows whenever an unusual disturbance occurred. Most of the birds roosted together at night in a group of about forty trees in the colony. On June 3 the roost site was shifted 500 feet to the west but still within the colony confines. Other crows from the neighborhood joined this roost during late May and June, swelling the nightly assemblage to about 300. Several occupied nests were located within the roosting areas; the distribution of droppings on the ground indicated that roosting birds avoided the immediate vicinity of a nest but often perched on the opposite side of the same tree.

*Laying season.*—The first eggs of the season were deposited on April 6. Laying reached a peak between April 17 and 20, then declined, the last set found being laid June 2 to 4. Authors generally agree that a crow raises only one brood a year, but often renests after the destruction of the first set of eggs. In the present study, most of the laying after April 29 probably represented renesting (fig. 2). A new nest was usually built for the second set, but in five instances the same nest was re-used after an interval of 10 to 12 days (ave. 11.6 days). Three of these five nests had been completely emptied of the first set by the collector, one retained one egg and the other, three eggs. None of these first sets had been incubated. A comparison of nest records and eggs suggests that new nests for second sets were sometimes built within 200 feet of the first nest with an interval of from 10 to 15 days between the completion of the first set and the starting of the second set, but as individual birds were not marked for definite identification, more accurate information is not available.

*Nests and nest building.*—Eighty percent of the nests were 16 to 24 feet above the ground and about  $\frac{3}{4}$ ths of the height of the tree in which they were placed. The highest nests were 28 to 29 feet from the ground, the lowest only  $6\frac{1}{2}$  feet. About one third of the nests were in basal crotches or on branches more than two inches in diameter. Most of the nests constructed after the leaves had opened were "peripheral," often in small terminal branches.

Old nests or nest platforms of previous seasons formed the foundation for 13 and possibly 17 of the 111 nests. Such nests were supplemented with new rims, mud floors and linings.

New nests varied in structure and size. Most of the early ones had basal platforms and frames of stout sticks mixed, in varying degrees, with fine twigs and grasses. In later nests the foundations were often entirely composed of fine twigs and grasses. Mud was used in most of the early nests, forming a hard firm floor which, during spring rains, proved to be quite impervious to water. Later nests generally contained little or no mud, possibly because it was

then not available locally. A lining of bark shreds, fine grasses, wool, hair, etc. was present in all but four of the nests.

The progress of nest construction was arbitrarily divided by the observer into seven stages of approximately equal duration, identified on the following basis: (1) handful of twigs or grasses; (2) loose platform; (3) loose cup; (4) completed cup with traces of mud; (5) mud floor completed; (6) lining material added; (7) lining completed and smoothed. Most of the early nests could be traced through these seven stages, but later nests frequently omitted stages 4 and 5, and in four instances, stages 6 and 7. The elapsed time from the beginning of stage 1 until the laying of the first egg varied from about 7 to more than 17 days. The entire construction from stage 1 to stage 7 was followed in only six nests, all first nestings; these required from 11 to 17 days (ave. 13.0 days). Nests completed before April 30 (excluding one, quite definitely a second nest) progressed at the average rate of one stage in every 1.86 days, suggesting a total construction period of about thirteen days for first nestings. Nests completed on or after April 30 (excluding one started before April 13) advanced one stage every 1.27 days suggesting a total average construction period of about nine days for second nestings. Eggs appeared before the nest had been completed in three instances and in one of these nest building continued for three days. Building activity ceased with the laying of the first egg in all other nests and apparently was not resumed even when the structures were falling apart.

*Eggs and egg laying.*—In 14 undisturbed nests the average number of eggs laid was 4.50; in 43 nests partially robbed or otherwise manipulated but allowed to advance into the incubation stage, the average was 4.40 eggs. In this total of 57 nests one had 2 eggs, six had 3 eggs, nineteen had 4 eggs, twenty-nine had 5 eggs, and two had 6 eggs. Twenty-eight sets started before April 30 (excluding one probably a second nesting) averaged 4.39 eggs, whereas twenty-nine sets started on or after that date averaged 4.52 eggs. Two very late sets started May 26 and June 2, possibly third nestings, contained 3 eggs each.

Eggs varied in color from almost immaculate sky blue to heavily blotched dark green, and in shape from blunt, 2.81 mm. x 3.64 mm. to elongate, 2.73 mm. x 4.18 mm. Weights of 157 fresh eggs ranged from 12.5 grams to 21.3 grams and averaged 16.6 grams. Eggs of a set usually resembled each other in color, shape, and size, although the last of a set was generally somewhat smaller and less heavily pigmented. In ten sets for which complete weight data were recorded the first egg averaged 17.1 grams and the last 15.7 grams; in only two sets was the last egg larger than the first. Eggs of first and second settings were about equal in size. Ninety eggs from nests where laying started before April 30 averaged 16.6 grams; sixty-seven eggs

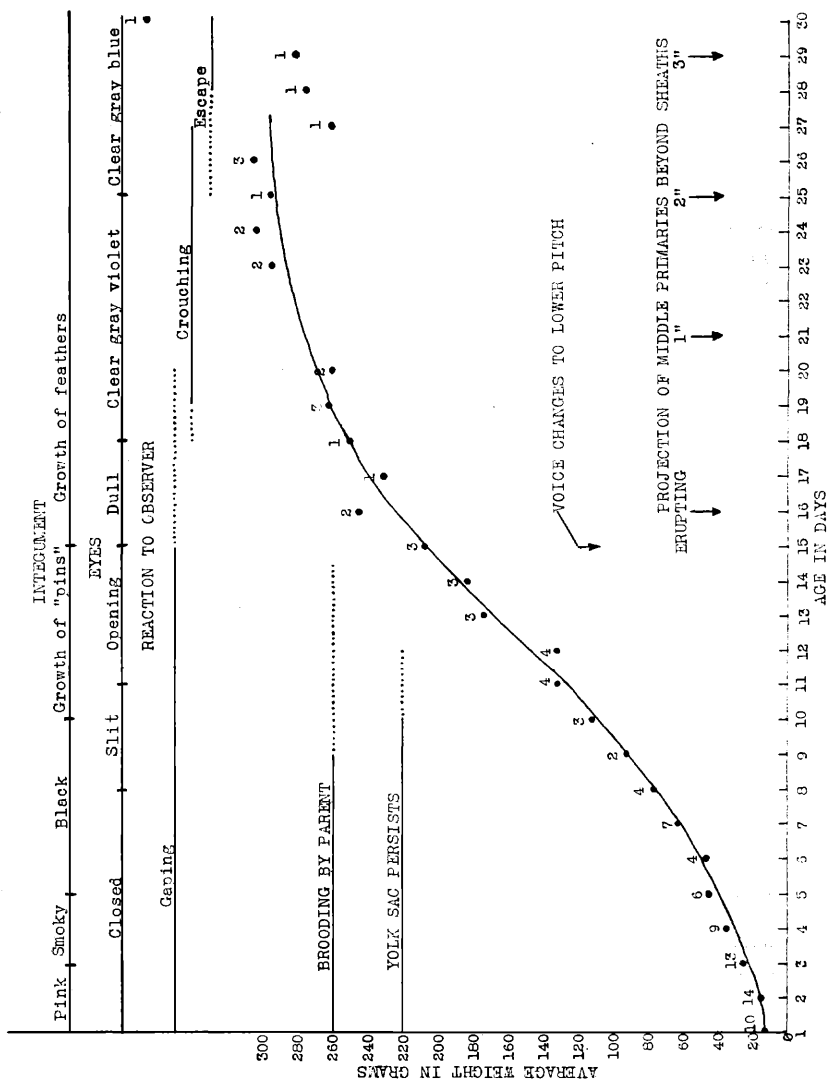


FIG. 3. Development of nesting crows. Figures over weight records indicate number of measurements included. Weights of inaccurately aged birds and of strongly aberrant individuals are not included.

from later nests also averaged 16.6 grams. Eggs in small sets were slightly heavier than those in large sets. Three 3-egg sets averaged 51.2 grams or 17.1 grams per egg; ten 4-egg sets averaged 66.7 grams or 16.7 grams per egg; three 5-egg sets averaged 82.4 grams or 16.5 grams per egg.

In 43 nests the eggs were laid at the rate of one per day; in 14 nests an extra day intervened, generally (ten instances) just preceding the last egg. Most of the eggs were laid in the latter part of the morning.

Removal or addition of eggs in the nest during laying had little or no effect on the duration of the laying period or the number of eggs

TABLE 2  
FATE OF 18 BROODS OF CROWS WHICH FAILED TO SURVIVE THE NESTLING STAGE

Nest No.	Nest Contents		Approx. Age of Nestlings	Con- dition of Nestlings	Fate	Corollary Conditions	Presumed Cause
	Yg.	Eggs					
108*	1	0	7-9 days	poor	Yg. disappeared	Nest exposed to direct sun	Deserted by parents
60*	1	1	8-10 "	"	"	Faulty nest (re-inforced)	"
	2	1	18 "	"	Yg. dead in nest	Nest environs disturbed	"
78	2	3	3 "	good?	Yg. disappeared	"	"
104	2	0	18 "	"	"	"	"
97	4	0	3 "	"	"	"	"
65*	1	0	10 "	"	"	"	"
111*	2	0	21 "	fair, poor	"	shooting in colony	"
98*	2	0	18 "	good?	"	"	"
102	1	0	18 "	"	"	"	"
105*	2	0	16 "	fair	"	"	"
110	3	0	10 "	good?	"	"	"
109	2	1	2 "	"	"	"	"
15*	2	0	32 "	"	Yg. half eaten in nest	Tethered to nest for 11 days	Predator (parents?)
89	5	0	6 "	"	Yg. disappeared	A low nest	Predator (terrestrial?)
100	5	0	2 "	"	"	"	"
14	5	0	4 "	"	"	"	"
101	2	0	15 "	"	"	"	Predator (human?)

\* One or more young lost previous to final destruction of brood—see table 3.

laid. Of 56 nests subjected to consistent egg-robbing experiments, 32 advanced into the incubation stage despite the reduced nest contents, the birds having laid 3 to 6, or an average of 4.35 eggs (table 1). In 14 of these nests from which eggs were removed daily

except for the first day, the number of eggs laid averaged 4.5. Nest robbing may possibly have stimulated further laying in two nests, Nos. 11 and 67 where 6 eggs were produced. In nests Nos. 32, 77, 78, 91 and 94 where as many as 5 eggs were experimentally added during laying a normal clutch of 4 or 5 eggs was laid despite the resultant crowding.

Twenty-four eggs collected on the day of laying or the following day failed to show any development in an incubator after being stored for 6 to 7 days in a standard egg-storage room at 55 degrees F. Another batch of 72 eggs kept for 1 to 4 days in the storage room and then packed and shipped for about 4 days more in insulated boxes, similarly failed to develop when set in an incubator. Of 13 eggs returned to nests for incubation after 4 to 6 days in the egg room, 3 were viable. Of 29 eggs returned to incubating crows after 9 to 23 days of storage only one was viable. The embryo in this egg, placed in an incubated nest on the 11th day, developed to about the 72 hour stage but adhered to the egg membranes.

*Incubation and hatching.*—As judged by egg warmth tested on the observer's face at each visit, incubation generally started with the laying of the last egg. Forty-six percent of the nests so tested had warm eggs when visited on the next to last day of laying; 78 percent had warm eggs on the day of laying the last egg, and 91 percent had warm eggs when visited during the first 5 days of incubation. Egg warmth was probably a fair indicator of a sitting bird for in several tests, made on moderately warm days, eggs had cooled markedly fifteen minutes after the incubating bird was flushed.

The incubation period, as calculated from the laying of the last egg to the first hatching, was 16 days in three nests, 17 days in eight nests, and 18 days in one nest. Nestlings were brooded an additional 9 to 14 days. Birds incubating sterile eggs sat as long as 21, 22, 24, 26, 26, 28 and 32 days before abandoning them. One bird, after seven days of sitting, fed and raised a nestling which hatched from an introduced egg.

Fourteen eggs disappeared from eight nests during incubation; six of these, however, were in three artificially supplemented and hence overcrowded nests. Slightly cracked eggs were tolerated in two nests for 3 and 4 days respectively, then removed, apparently by the parents. Three nests with broken eggs were abandoned. Of 77 undisturbed eggs which completed incubation in 22 nests, 68 (88%) hatched. Depressions in the shell near the "pipping line" in two unhatched eggs in two nests suggested abortive attempts at assistance from parent birds. Shells disappeared from nests within a few hours of hatching. Unhatched eggs remained in nests for 10 to 18 days after the hatching of nestlings, disappearing soonest in crowded nests. The invariable absence of shells or other remains



beneath the nests pointed to a removal of these eggs by the parents rather than by the growing nestlings.

The interval between hatching of the first and last young was generally three days in 4- and 5-egg sets. It was four days in one 4-egg set and one 5-egg set, and five days in one 4-egg (2 hatched) set.

*Nestlings.*—Young on the day of hatching weighed from 10 to 13 grams and averaged 12.3 grams. The weight increased about 3.4 grams the first day, and about 10 grams per day from the 2nd to the 7th day; it accelerated to about 18 grams per day after the 7th day to reach 250 grams or 20 times the hatching weight on the 18th day. Growth then retarded to roughly three grams per day until fledging on about the 35th day (fig. 3). The period of rapid growth between the 8th and 18th days coincided with the opening of the eyes. The retardation in growth after the 18th day coincided with the acquisition of clear bright eyes and a crouching (fear) reaction. The escape reaction was detected in two birds on the 25th day but did not become definite until the 28th day. Young birds reaching this age were either tethered to the nest or removed for other studies, but it is estimated on the basis of behavior that departure from the nest would not normally occur before the 32nd day and probably not until the 35th.

Pin feathers appeared on about the tenth day and feather tips about five days later. By the 19th day the crown was well covered with feathers. The middle (5th to 7th) primaries, useful as indicators of age, protruded about one inch beyond their sheaths on the 21st day, two inches on the 25th day, three inches on the 29th day, four inches on the 33rd day, five inches on the 38th day, and six inches on the 44th day.

The yolk sac measured roughly 10 mm. by 8 mm. in a five-day nestling, 6 mm. by 3 mm. in a 10-day bird, and was not found in a 14-day individual.

*Nestling survival.*—Of 88 nestlings which hatched in 31 nests, only 20 in 13 nests survived to the 30th day, a nestling mortality of 77 percent. Activities of the observer were probably a minor factor in this heavy mortality. Eighteen nests containing 43 young were abandoned or emptied during the nestling stage (table 2); in 14 of these the young were apparently deserted or removed by the parents following a disturbance, in four the loss was attributed to predators.

Thirteen broods were reduced by the loss of one or more nestlings without (or before) being completely destroyed (table 3). Of the 25 young involved, 19 were thought to have succumbed to competition from larger and stronger nest-mates. In nine of these the victim was the smallest member of the brood, and in six a weight loss was noted several days before death.

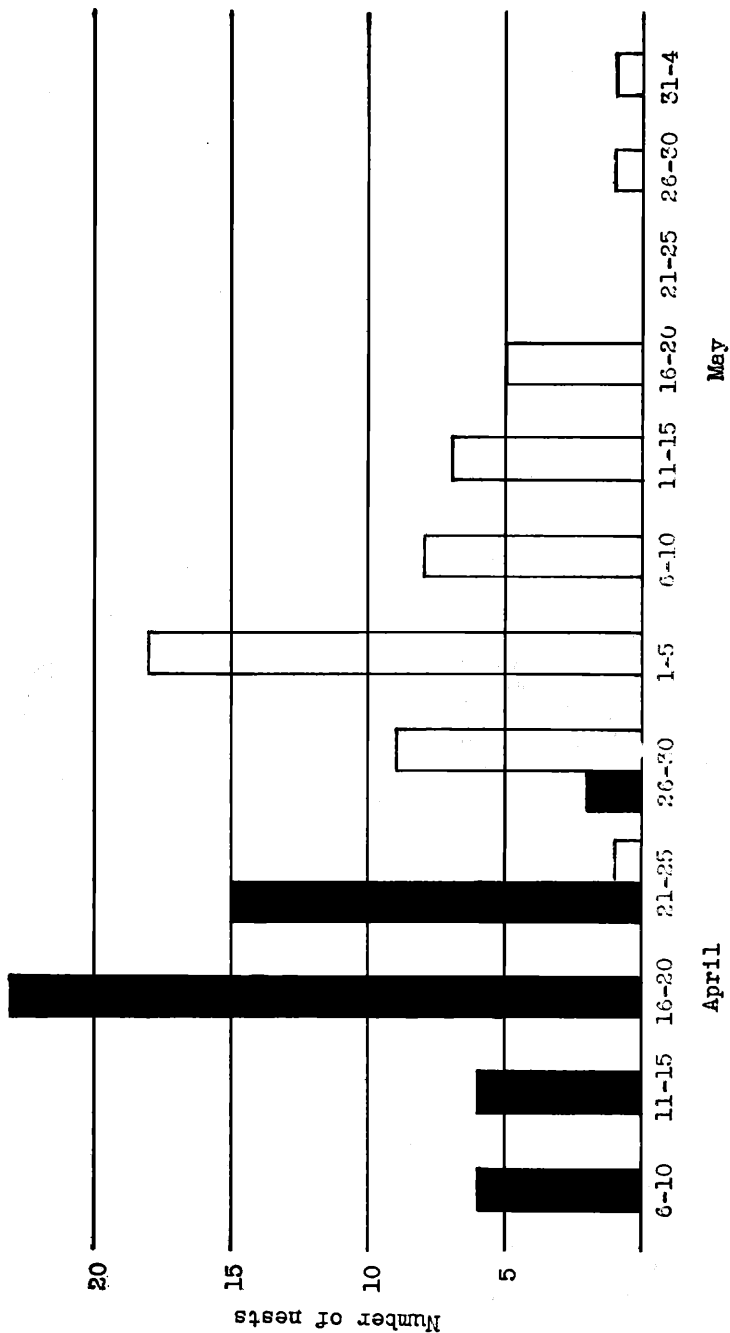


FIG.2. Date of the first egg in 102 crow nests at Davis, California in 1942. Solid bars indicate first nestings; open bars indicate nests interpreted as renestings. Renesting was stimulated by extensive egg-robbing in first nests.

Only six nests were completely successful in that all the young which hatched were fledged. Five of these contained only one young bird, the sixth had three. This last was the only nest which held more than two nestlings after the 15th day; all other nests with 3, 4, or 5 young at hatching, were reduced during the first two weeks to one or two birds (table 3).

TABLE 3  
FATE OF 25 NESTLINGS LOST IN 13 PARTIALLY DESTROYED BROODS

Nest- ling No.	Nest Contents		Approx. Age at Death	Con- dition Before Death	Fate	Corollary Conditions	Presumed Cause
	Yg.	Eggs					
15a	3	1	2 days	?	dead in nest	smallest of 3 yg.	neglected or crowded
68a	4	1	3 "	?	"	" " 4 "	"
b	3	1	10 "	poor	"	" " 3 "	"
111a	3	0	10 "	"	"	" " 3 "	"
103a	5	0	5 "	fair	"	" " 5 "	"
b	}	4	0	8-12 "	?	disappeared	"
c							
d							
105a	5	0	5 "	?	"	"	"
b	}	4	0	6-15 "	?	"	"
c							
34Ba	3	1	5 "	?	"	" " 3 "	"
98a	3	0	8-15 "	?	"	" " 3 "	"
106a	4	1	4-8 "	?	"	"	"
b	3	0	15 "	poor	"	" " 3 "	"
39Bb	1	0	2 "	good?	"	had a 6-day-old nest mate	"
88a	}	5	0	3-5 "	poor?	"	poorly attended nest
b							
c							
d							
	2	0	31 "	poor	killed in fall from nest	frightened by observer	human interference
60a	2	1	4 "	"	disappeared	faulty nest	nest obstacle
108a	}	4	0	3-6 "	"	"	nest exposed to direct sun
b							
c							
65a	2	0	4 "	good	dead in nest	"	?

#### SUMMARY

1. Observations were made on 111 crow nests in a walnut orchard near Davis, California.
2. A community roost was located within the colony.
3. Nests were generally well spaced, the closest being 80 feet apart.
4. Nest building required about 13 days for first nestings and about 9 days for renestings.

5. First sets were laid between April 6 and April 29; second sets, following removal of the first, were laid in the same nest after an interval of 10 to 12 days (five instances) or in a new nest.

6. The number of eggs in a clutch varied from 2 to 6 and averaged 4.4. Second sets were slightly larger than first sets.

7. Eggs weighed from 12.5 to 21.3 grams and averaged 16.6 grams. The first egg in a clutch was generally heavier than the last. Eggs in first and second nestings were equal in size. Eggs in small sets were slightly heavier than those in large sets.

8. Eggs were generally laid at the rate of one per day.

9. Experimental removal or addition of eggs during laying had little or no effect on the duration of the laying period or the number of eggs laid.

10. Eggs held in storage at 55 degrees F. for 5 to 7 days, failed to develop when placed in an incubator; 4 of 42 stored eggs developed when returned to incubating crows.

11. The incubation period was 16 to 18 days. Birds sat on sterile eggs as long as 32 days.

12. Eighty-eight percent of undisturbed eggs hatched.

13. Nestlings averaged 12.3 grams at hatching, grew slowly at first, then rapidly, then slowly to reach approximately 300 grams at fledging on about the 35th day. The development of the fear reaction on about the 18th day coincided with the acquisition of clear bright eyes.

14. Nestling mortality was 77%. Greatest losses occurred through desertion of nests by parents and through competition between nestlings in crowded nests. Only one nest held more than two young after the 15th day.

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## A COMPARISON OF TWO CHICKADEE SEASONS

By EUGENE P. ODUM

BETWEEN September 1939 and September 1940 the Black-capped Chickadee (*Penthestes atricapillus*) population on the Edmund Niles Huyck Preserve was kept under continuous observation. An analysis of this annual cycle has been published (Odum, 1941a, b, 1942). Opportunity was provided for a study of at least a portion of a second breeding season when the writer returned to the area during June and July 1941. In 1940 nearly all the adults on the 375 land acres of the Preserve, a number in adjacent areas, and 31 nestlings were color-banded. In 1941 few new birds were banded but every effort was made to locate and study all birds, banded or unbanded, within the same study area and to locate banded birds