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COMPARATIVE STUDIES IN THE GROWTH OF YOUNG RAPTORES WITH TWENTY-ONE ILLUSTRATIONS

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During the year 1927 I had under my observation one nest each of the Golden Eagle (*Aquila chrysaetos*) and the Southern California Screech Owl (*Otus asio quercinus*). The young birds were weighed and photographed at regular intervals, and notes were taken regarding their general development. Several facts of particular interest were observed, chief among them being an actual loss of weight suffered by every bird without exception just before leaving the nest. Accordingly, during 1928, I have undertaken a more extended series of observations, with the view to verifying these results, of which the present paper is a brief summary.

The species whose nests have been visited are as follows: Cooper Hawk (*Accipiter cooperii*), one nest; Western Red-tailed Hawk (*Buteo borealis calurus*), two nests; Golden Eagle, same nest on two successive seasons; Desert Sparrow Hawk (*Falco sparverius phalaena*), one nest; Barn Owl (*Tyto a'ba pratincola*), two nests; Long-eared Owl (*Asio wilsonianus*), one nest; Southern California Screech Owl, same nest on two successive seasons; Pacific Horned Owl (*Bubo virginianus pacificus*), two nests. In order to avoid unnecessary repetition only one brood will be considered for each species, except for those few cases where the other brood has presented features not observed in the first.

COOPER HAWK

April 21, 1928. The female flushed from six fresh eggs and was immediately joined by the male. Both birds were bold, darting under the trees and perching within thirty feet of me while they continually uttered their high-pitched scolding cry. The nest is thirty feet up in an oak tree (*Quercus agrifolia*), and is composed of oak twigs and small sticks. The lining is entirely of twigs and pieces of oak bark, with no sign of leaf or dry grass, giving the nest a peculiarly clean and dry appearance.

May 14. Actions of parents as before. Four young have hatched. They whimper softly, and at the approach of my finger open their beaks and redouble their cries. Eyes open, iris brown. Upper mandible black; lower mandible flesh color, becoming lighter at the tip; "egg tooth" present. Claws and feet flesh color. Total length about 88 mm.

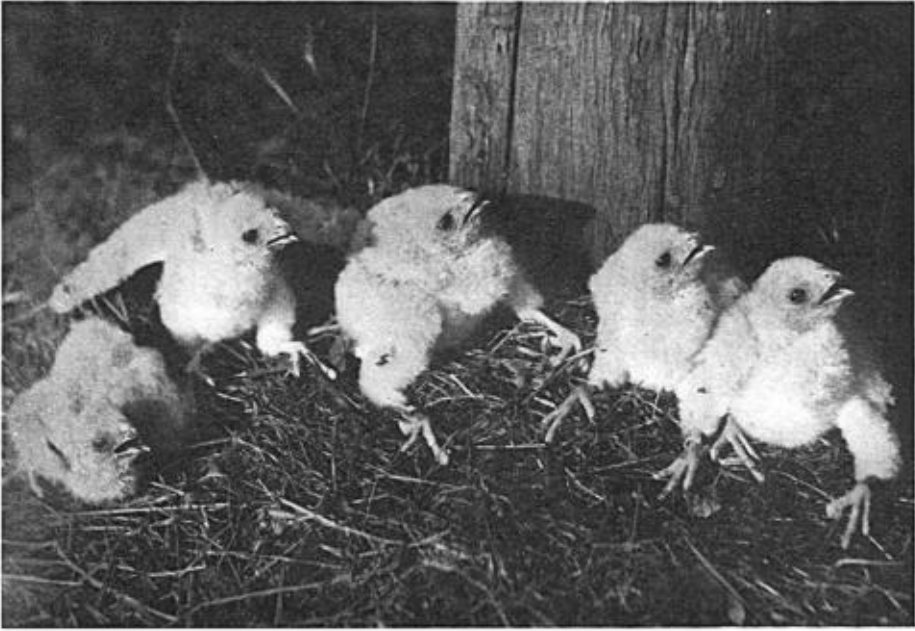


Fig. 32. YOUNG OF COOPER HAWK, WHEN SOME FIFTEEN DAYS OLD, FOLLOWING MOTIONS OF OBSERVER'S HAND.



Fig. 33. YOUNG OF COOPER HAWK, WHEN SOME TWENTY-EIGHT DAYS OLD, LEARNING, WITH DIFFICULTY, TO PERCH.

May 20. Adults slightly more aggressive, swooping by me continually and making the woods resound with their cries. Youngsters are quiet and undemonstrative. At intervals they chirp in low tones and occasionally stand up and look about stupidly, but for the most part they are content to lie prone upon the ground with half-closed eyes. Egg tooth still present, but in the case of one bird it scaled off when picked at with my finger nail. Oil gland about 1.6 mm. long. The sixth egg is infertile.

May 27. Only one adult present. It was much less hostile than usual, contenting itself with but one or two sallies in my direction. Youngsters as undemonstrative as ever (fig. 32). At my first appearance they raised their heads, with open beaks, but soon became quiet once more, their protests when handled being confined to a few faint chirps. Egg tooth absent. Oil gland about 10 mm. long. The crops of all are distended with food, but there are no indications about the nest as to its nature.

June 3. As before, the female was less in evidence than usual. Young birds somewhat more lively than on the previous visit. When I reached the nest they stood up, with open beaks and upraised wings, and struck at me feebly with their talons.

Table 1. COOPER HAWK, Summary of Development

Bird	Weight (grams)					
	April 21	May 14	May 20	May 27	June 3	June 9
<i>a</i>	29.7 (egg)	25.1	93.6	223.8	272.8	.....
<i>b</i>	29.8 (egg)	21.7	93.3	225.4	271.6	282.9
<i>c</i>	29.0 (egg)	29.3	84.4	208.7	283.9	288.5
<i>d</i>	29.5 (egg)	24.3	73.4	203.7	267.9	284.2
<i>e</i>	29.0 (egg)	24.1 (pipping)	52.4	171.6	302.3	375.1
	29.0 (egg)	(infertile egg)				
Total length (millimeters)						
<i>a</i>			140	203		.....
<i>b</i>			140	203		311
<i>c</i>			130	191		292
<i>d</i>			133	184		311
<i>e</i>			117	171		292
Fifth primary—ratio of total length to portion which has burst from the enveloping sheath						
<i>a</i>					84 : 41	.....
<i>b</i>					87 : 41	121 : 86
<i>c</i>					81 : 38	116 : 79
<i>d</i>					78 : 38	111 : 75
<i>e</i>					59 : 19	100 : 57
Left deck (tail) feather—ratio of total length to portion which has burst from enveloping sheath						
<i>a</i>					61 : 36	.....
<i>b</i>					70 : 40	106 : 67
<i>c</i>					61 : 32	98 : 64
<i>d</i>					57 : 32	95 : 60
<i>e</i>					40 : 13	78 : 43
Total wing spread						
<i>b</i>						616
<i>c</i>						565
<i>d</i>						568
<i>e</i>						572

On the ground they moved about haltingly in search of cover, chirping occasionally in low tones; but for the most part they were willing to remain wherever placed and offered hardly any resistance. Oil gland about 10 mm. long; skin at base of bill greenish yellow; feet flesh color. Bill and claws black. Iris slate gray. One of the birds uttered a series of feeble, scolding notes similar to the cries of the parents.

Nest no longer retains its original, cleanly appearance, being covered with down and littered with pellets, the latter containing many small bird feathers. As with certain other hawks, green material is present, in the shape of freshly plucked oak branches.

June 9. Female shy; male not seen. Young more active than hitherto. When I reached the nest the three largest ran out along the branches to the outermost twigs and clung there so tightly that it was difficult to dislodge them; the remaining two reared back and struck at me feebly with their claws. On the ground they ran about rapidly with half opened wings when disturbed, chirping in high pitched, excited tones; but if not handled, they gradually became quiet and were content to perch upon whatever branch they were placed on (fig. 33). While I was engaged with the others, no. 362869 escaped and could not be found. Tongue slate color. Oil gland 10 mm. long. The infertile egg still was present in the nest. The youngsters were given bands, numbers 362868 to 362872 inclusive.

In the accompanying tables, individuals in a brood are designated by the letters *a*, *b*, *c*, etc. The weights of the unhatched eggs are also included in these tables, for convenience, although it cannot be assumed that they have been placed with the corresponding youngster in every instance. It was, of course, impossible to allocate them in this way in those cases where they had all hatched between visits.

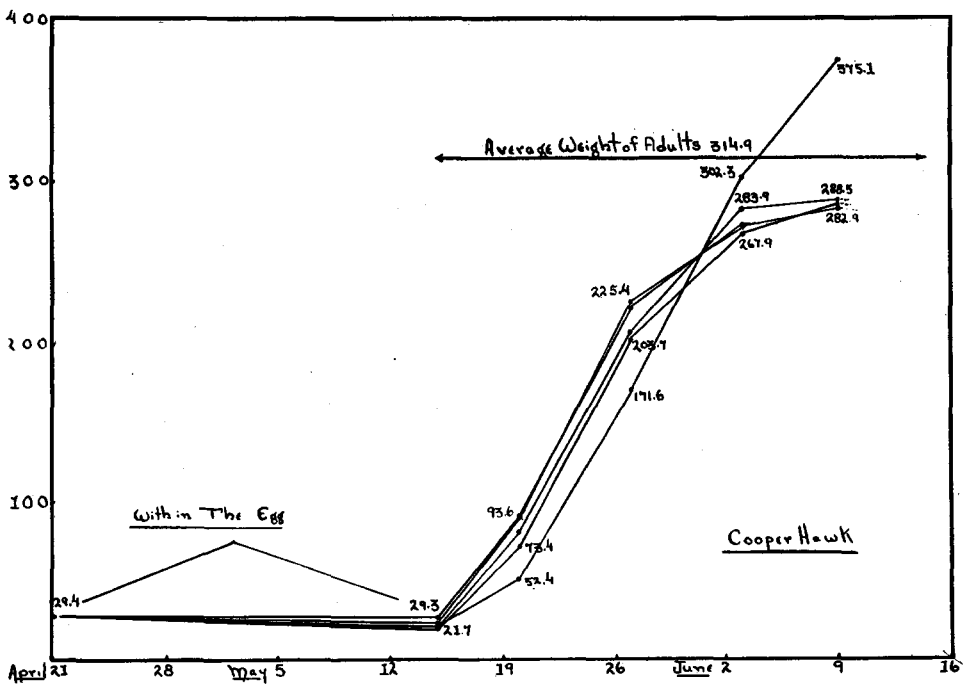


Fig. 34. GRAPH SHOWING INCREASE IN WEIGHT (GRAMS), WITH ADVANCING AGE, OF YOUNG COOPER HAWKS.

WESTERN RED-TAIL

March 17, 1928. The female flushed from three eggs whose incubation was estimated at from seven to ten days. Both adults circled about high in the air, screaming, and occasionally swooping to within fifty feet of me. The nest is fifty feet up in a medium sized sycamore (*Platanus racemosa*) growing in a small gully at the base of a brush-covered slope (fig. 35).

April 10. Female flushed at a distance of 100 yards; actions of adults as before. Youngsters have hatched but are as yet very feeble. They chirp softly and can stand up for a brief moment, although quickly tiring. Eyes open; iris brown. Bill black; claws slate color. Skin at base of bill yellow; feet flesh color. Egg tooth present. The crops of all are full.

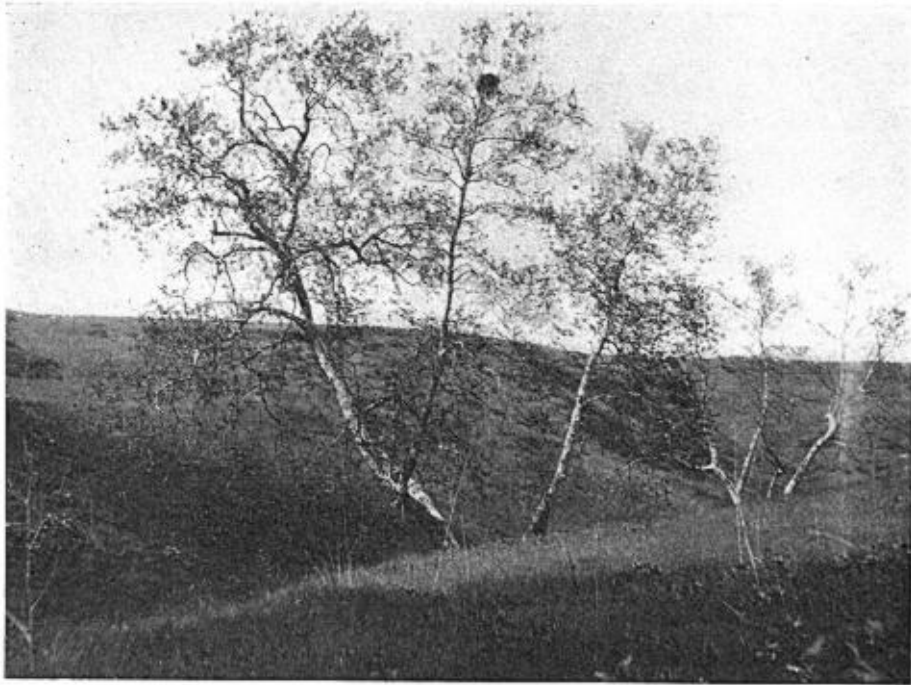


Fig. 35. HOME SITE OF THE WESTERN RED-TAILS WHICH HAVE BEEN MADE SUBJECTS OF THE STUDY DETAILED IN THE ACCOMPANYING TEXT. SHOWS ROLLING NATURE OF COUNTRY, WHERE MOST OF THESE STUDIES WERE MADE.

Scattered about the edge of the nest, where the sitting bird could reach them, were the following: five pocket gophers (*Thomomys bottae pallescens*), six meadow mice (*Microtus californicus sanctidiegi*), and one white-footed mouse (*Peromyscus maniculatus gambelii*).

April 15. Age about 8 days. Female no longer on the nest; actions of both adults as before. Youngsters do not look altogether healthy, although they are able to stand up and walk about in search of cover. Their down is bedraggled and dirty, the skin shiny with a bluish tinge, and their eyes somewhat sunken. They dig frequently at themselves with their beaks as if troubled with mites. Claws black, becoming lighter at the tips. Skin at base of bill dull yellowish-green; feet flesh color,

also with a tinge of green. Egg tooth present. Oil gland very small. The crops of all are full. When handled, the young birds utter a soft whimper of protest, but for the most part they are silent and seem content to remain wherever placed. The remains of two pocket gophers are in the nest.

April 21. Age about 14 days. Female no longer on nest. The appearance of the young is still quite unlike that of the other brood under observation. Their bedraggled, unkempt look is quite in contrast with the alert, cleanly appearance of this other brood, and the difference between the two in color of the down is especially noticeable. Whereas the down of the other youngsters is almost pure white, in the brood under consideration it is a dirty smoky gray, as if the birds had been held over a smoking lamp chimney. There is no difference to be seen in behavior, however. None of the youngsters is very active, but the darker birds seem fully as strong and vigorous as the others. For the most part they are silent, and except when actually handled, make no effort to escape. Egg tooth still present. Oil gland small. The crops of all three are full. Posterior half of a pocket gopher, in the nest.

April 28. Age about 21 days. When I appeared at the edge of the nest all three youngsters reared up with open beaks. One of them struck at my hand with its claws, although in a feeble, undecided manner, and another uttered a thin, long drawn squeal similar to the scream of the parents who were circling about in great anxiety. After they had been handled for a moment, however, they became docile again, and offered no further resistance.

Egg tooth absent in one bird. Nest contained one gopher snake, one pocket gopher, and one brush rabbit (*Sylvilagus bachmani cinerascens*).

May 4. Age about 26 days. Young more lively and aggressive than on previous visits. When I reached the nest they all reared up, with upraised wings and open beaks, while one bird uttered a series of thin screams, as if in answer to the frantic cries of the parents. While I was holding them up by the feet one of the youngsters reached up and repeatedly bit my fingers; and when set down on its back another threw itself upon its back and struck at my hand with its talons. In a few moments they quieted down again, however, and made no attempt to escape even when handled (fig. 36). Egg tooth still present in one bird. Iris slaty brown. Nest contained one pocket gopher, much decayed. Birds given bands, numbers 320771 to 320773 inclusive.

May 14. Age about 37 days. As I reached the nest all three young jumped out and flapped awkwardly down the cañon. They flew for about 150 yards, descending lower all the



Fig. 36. YOUNG OF WESTERN RED-TAIL AT AN AGE OF ABOUT TWENTY-SIX DAYS. SHOWS CHARACTERISTIC DOCILITY OF THESE BIRDS; ALSO METHOD OF WEIGHING.

time, and finally lit in the dry grass, where their momentum tumbled them head over heels before they came to a stop. So well did they conceal themselves by simply flattening out upon the ground that I was unable to find more than two. The actions of these two birds were about as before. After the first attempts at resistance, they became comparatively docile, and with the exception of a single scream, uttered by one youngster while still in the air, they were silent throughout this visit.

Neither bird seemed able to take wing again, even when I tossed them up into the air, and in every case they tumbled to the ground in sprawling heaps. However, it was deemed useless to try to make them stay in the nest when once they had left, and so I left them in the long grass, with the hope that the parents could take care of them. Oil gland about 14 mm. long. Nest contained one gopher snake and two pocket gophers.

Judging from their relative sizes, no. 320773 should be a female and no. 320771 a male.

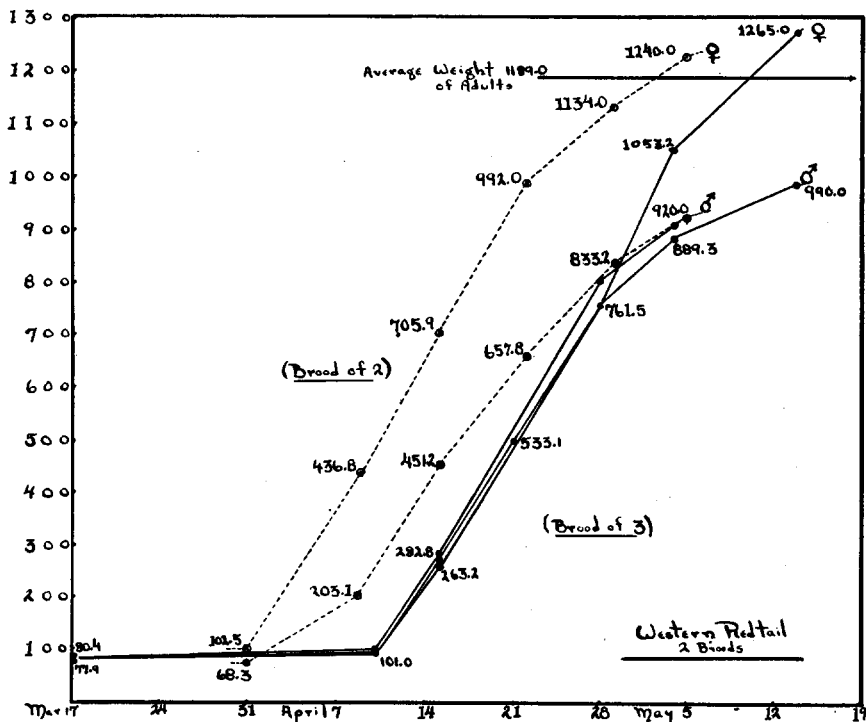


Fig. 37. GRAPH SHOWING INCREASE IN WEIGHT (GRAMS), WITH ADVANCING AGE, OF TWO BROODS OF WESTERN RED-TAILS.

May 20. Age about 43 days. Both parents present and showing their customary anxiety. Although I had left all three young on the ground at the end of the last visit, one of the youngsters was actually back in the nest. As I started up the tree it leaped out and sailed away with power and precision, alternately flapping and soaring after the manner of the adults. It came to rest in an oak about a fifth of a mile away, and was seen no further.

Whether this bird remained upon the ground until it had learned to fly and was now using the nest simply as a convenient feeding table, or whether the parents had carried it there after my departure of the preceding week, it is impossible to say. Wheelock (*Birds of California*, 1904, p. 148) gives an account of a Western Red-tail which picked up one of its young and returned it to the nest under exactly similar circumstances, indicating that further observations of this nature would be quite worthwhile.

Table 2. WESTERN RED-TAIL, Summary of Development
Weight

Bird	March 17	April 10	Weight				
			April 15 Age about 8 days	April 21 Age about 14 days	April 28 Age about 21 days	May 4 Age about 27 days	May 14 Age about 37 days
<i>a</i>	80.4 (egg)	.....	269.7	533.1	761.5	1053.2	1265.0
<i>b</i>	80.2 (egg)	105.1	282.8	.....	801.6	912.4	.....
<i>c</i>	77.9 (egg)	101.0	263.2	.....	761.7	889.3	990.0
	May 14	Total length		Total wing spread			
<i>a</i>		457		1117			
<i>c</i>		445		1003			

GOLDEN EAGLE

The observations for this species have been confined to a single pair which, however, has been studied for two successive seasons. Since the results of the second season have amounted to hardly more than a confirmation of the first year's findings, we shall give the facts which bear upon the present study in the briefest possible form.

In 1927, three eggs were laid—an unusual number with this species—and of this number two birds reached maturity, one male and one female. In 1928, there were only two eggs, and of these, but one bird survived, this one being a female. Parenthetically it may be remarked that contrary to what seems to be the usual custom, the parents of these young birds have occupied the same nest (fig. 38) for at least four years in succession; prior to that, the writer's knowledge of them does not extend. The following is a brief outline of the growth of the single eaglet for 1927.

Period of incubation: Regarding this point there seems to be a lack of definite information. I had supposed that incubation required about 30 days, and this had seemed to be confirmed by observations in 1926; on February 27, 1926, there were three eggs whose incubation was estimated at one week, and three weeks later they were found to be hatching. This was not at all corroborated in 1927. On February 12, the female flushed from the nest, and although we did not definitely ascertain it, in all likelihood she had begun to lay. The next week we climbed the tree and actually observed the two eggs, which were then judged to have been incubated eight or nine days. Nevertheless, the first egg did not hatch until March 25—six weeks from the first time that the parent was flushed, and five weeks from the time when the eggs were actually observed. I am unable to say whether my guess as to incubation of the year before was wrong by about ten days or whether the eggs were abnormally late in hatching in 1928. This second view might be substantiated by the fact that in 1928 only one egg hatched. On the other hand, the one surviving youngster has been fully as healthy and precocious as the two birds of the year before.

It is of interest to note that these eggs weighed 144.8 and 145.2 grams on February 19, but only 138.1 and 138.4 grams on March 4, two weeks later. This, of course, is quite normal, and to be expected.

March 25, 1928. Female flushed. Young bird recently hatched and still very feeble (fig. 40). It stands up with great difficulty, and takes but little notice of external objects. Beak black; claws flesh color. Egg tooth present. Freshly

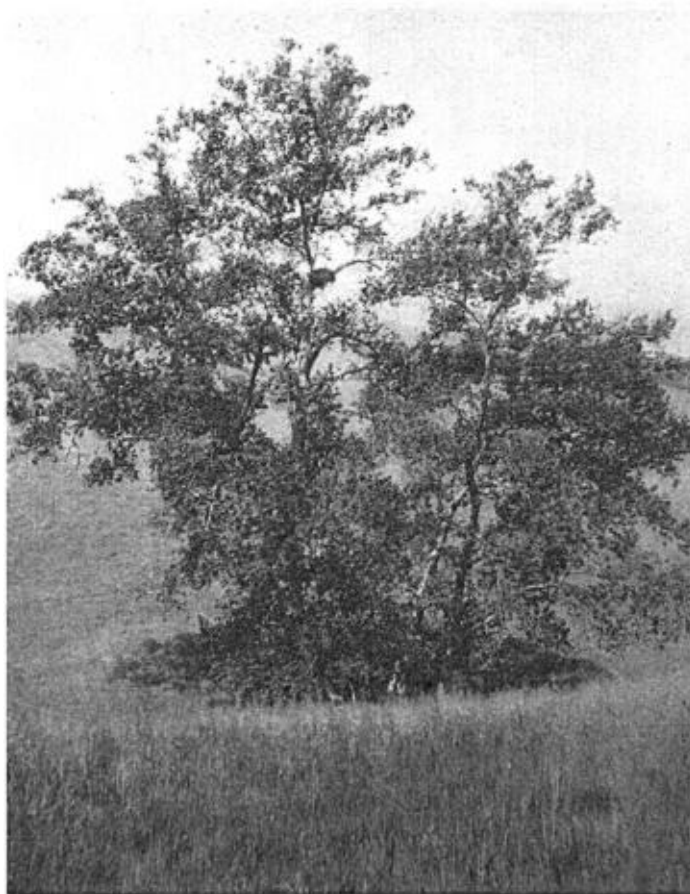


Fig. 38. HOME SITE OF THE GOLDEN EAGLES DESCRIBED IN THE TEXT. TREE IS ONE OF A LONG LINE OF SYCAMORES IN A SMALL CAÑON IN LOW ROLLING HILL COUNTRY.

plucked branches of the elderberry (*Sambucus glauca*) in the nest, as well as remains of the following mammals, all quite fresh: Fisher ground squirrel (*Citellus beecheyi fisheri*), pocket gopher, and long-eared woodrat (*Neotoma fuscipes macrotis*). Second egg unhatched.

April 1. Age about one week. Bird is more lively, being able to stand up and take bits of ground squirrel meat which are offered it. It chirps intermittently,



Fig. 39. CLOSE-UP SHOWING LINING OF NEST, WITH EGGS, OF THE GOLDEN EAGLE. THE LEAVES AND TWIGS ARE CHIEFLY THOSE OF ELDERBERRY.



Fig. 40. YOUNG GOLDEN EAGLE RECENTLY HATCHED. PORTIONS OF EGG SHELL VISIBLE IN THE NEST.

and seems as yet to be devoid of all fear. Eyes open; iris brown. Egg tooth still present. Posterior portions of five ground squirrels in the nest. The second egg is no longer present.

April 8. Age about two weeks. Beak black; claws now slate gray. Egg tooth present. Remains of three ground squirrels in the nest.

April 15. Age three weeks. As I appeared at the nest the youngster reared up and hissed softly. When handled it protests with shrill squealing whimpers, but offers no other resistance. Claws black. Egg tooth present. Skin at base of bill



Fig. 41. YOUNG GOLDEN EAGLE AT NINE WEEKS OF AGE
STANDING IN POSITION CHARACTERISTIC OF LATE NEST-LIFE.

yellowish; feet yellowish flesh color. A large amount of fresh green material present—oak and elderberry branches—as well as portions of a ground squirrel.

April 22. Age four weeks. Actions of the eaglet are much as before, its peculiarly vacuous expression and ridiculously infantile voice being quite in keeping with the rest of its behavior. Spread of talons (front to rear) 152 mm. Oil gland very small. The usual amount of green branches in the nest, and in addition, a

large quantity of dry barley hay, gathered from a newly mown hillside nearby. The posterior halves of two cottontails (*Sylvilagus audubonii sanctidiegi*) also present.

April 29. Age five weeks. Egg tooth now absent. Bird given band no. 320769. Nest contained a freshly killed ground squirrel, half grown, and with the blood not yet congealed.

May 6. Age six weeks. Oil gland 25 mm. long. Hind portion of cottontail in the nest, and a headless gopher snake, as well as the usual amount of green material.

May 13. Age seven weeks. Bird slightly more aggressive. When I appeared at the nest it reared up with open beak and struck at me several times with its



Fig. 42. YOUNG GOLDEN EAGLE WHICH HAS JUST LEFT THE NEST, WHEN AT THE AGE OF TEN WEEKS. IT IS SHOWING ITS FIRST SIGN OF HOSTILITY TOWARD THE OBSERVER.

extended wings. It soon tired, however, and except when actually handled, offered no further resistance. Once or twice it uttered a long drawn note in a tone much lower than the usual high-pitched squeal, but for the most part it was silent, and remained standing in a dejected attitude with half open wings while it stupidly eyed the camera. Claws and beak smeared with blood, indicating that the youngster has been feeding on a ground squirrel, which appears to have just been torn open.

May 20. Age eight weeks. Oil gland 25 mm. long. Head golden brown. Rump with upper tail coverts white at the bases; rest of body plumage dark brownish black. There is a patch of white on the under side of the wings formed by the white bases of the 7th, 8th, 9th, and 10th primaries. Nest empty of animal remains and with very little green material.

May 27. Age nine weeks (fig. 41). Actions of young bird as mild and spiritless as ever although it is as large as the adults. Once or twice it ventured to nip my arm when handled, but the attempt seemed only half-hearted and scarcely left a mark. It still utters the same ridiculously feeble squeal of protest when picked up—rarely giving any deeper tone, and never the deep rasping croak observed on the previous year. There has been an actual loss in weight from the previous week, the youngster now weighing only 4250.0 grams. This is a decrease of only 3 per cent as compared with losses of 11 and 12 per cent on the previous year, and occurs during the ninth week instead of the eighth as with the other two eaglets. This phenomenon will be more fully discussed later.

June 2. Age ten weeks. Adults not seen. Appearance of youngster much as before. It moved about restlessly when I threw stones up at it, but did not fly until I had gained the nest. Then it leaped out and sailed unsteadily down the cañon until it came to earth in a sprawling heap some 300 yards away. This youngster, unlike the young Red-tails, did its best to escape, running awkwardly but swiftly up the slope, and then, when hard pressed, spreading its wings, and after a few vigorous kicks, gaining the air long enough to sail down into another cañon. On being cornered it threw itself upon its back and struck out sharply with those huge talons; a single chance blow left a six-inch rip in my shirt sleeve although it failed to strike any deeper (fig. 42). When finally released, the bird flew for a quarter of a mile before alighting.

The bird now weighs only 4150.0 grams, and in contrast to the eaglets of the previous season it has shown no tendency to make up for this loss during the final week of nest life.

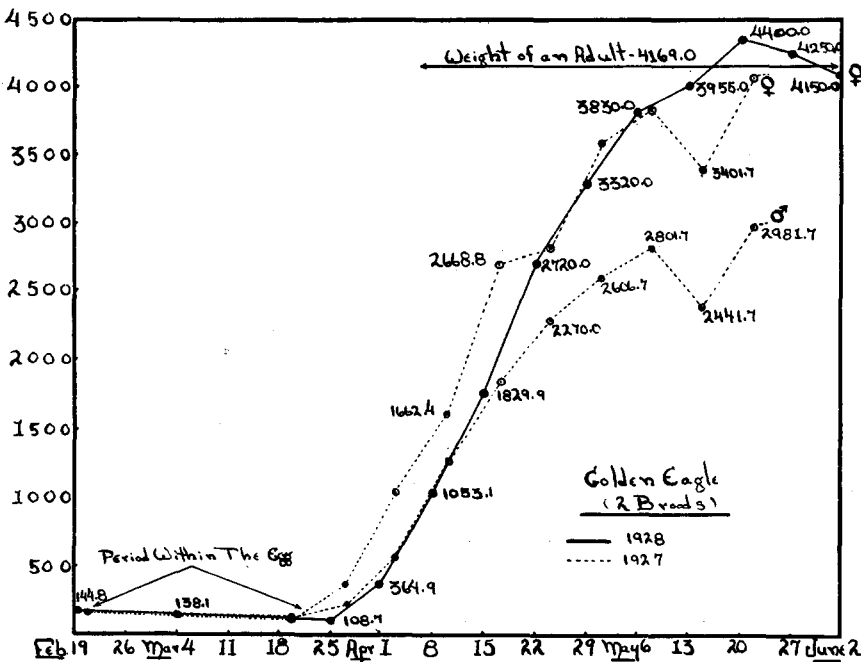


Fig. 43. GRAPH SHOWING FLUCTUATIONS IN WEIGHT (GRAMS) OF THREE YOUNG GOLDEN EAGLES OBSERVED DURING 1927 AND 1928.

Table 3. GOLDEN EAGLE, Summary of Development

Weight													
Feb. 19	Mar. 4	Mar. 25	Apr. 1	Apr. 8	Apr. 15	Apr. 22	Apr. 29	May 6	May 13	May 20	May 27	June 2	
			Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	
			Week	Weeks	Weeks	Weeks	Weeks	Weeks	Weeks	Weeks	Weeks	Weeks	
144.8 (egg)	138.1 (egg)	108.7	364.9	1053.1	1829.9	2720.0	3320.0	3830.0	3955.0	4400.0	4250.0	4150.0	
Total Length													
			April 15	April 22			May 6			May 20			
			387	438			610			686			
Fifth primary—ratio of total length to portion which has burst from the sheath													
			May 6				May 13				May 20		
			183:105				246:140				289:184		
Left deck feather—ratio of total length to the portion burst from the sheath.													
			130:64				173:92				208:149		

SPARROW HAWK

April 22, 1928. Female flushed from the nest cavity and disappeared. The nest is a natural hollow about a foot in depth and about 30 feet up in a large red willow (*Salix laevigata*) and has been used for a number of years.

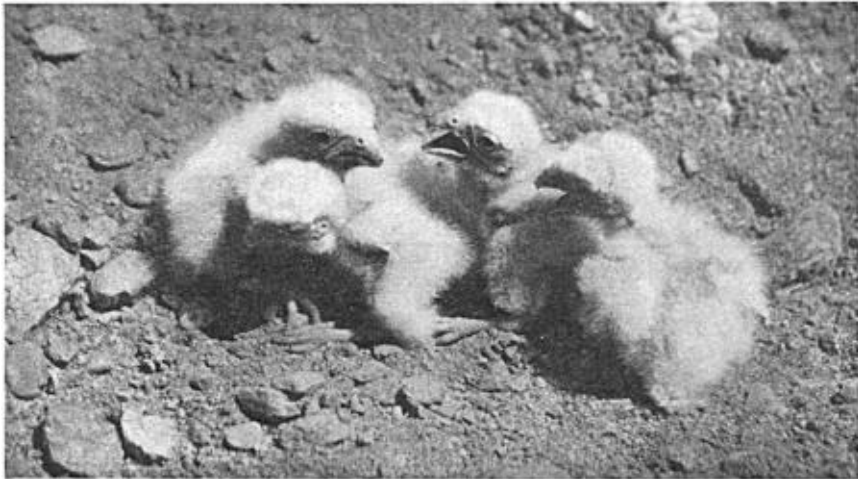


Fig. 44. YOUNG OF THE DESERT SPARROW HAWK, AT THREE DAYS OF AGE, SHOWING CHARACTERISTIC, ALERT, INQUIRING ATTITUDE.

May 4. Age about 3 days. Four downy young have hatched, while of the fifth egg there is no trace. These birds are markedly different, even at this early age, from the species previously mentioned. Like the adults they already show that nervous, aggressive temperament which is so characteristic of falcons. They crawl about nimbly, chirping in low "conversational" tones (fig. 44); and when I offer my finger, they stand up and nibble eagerly at it. Gradually, if not disturbed, they relax their alert, inquiring attitude and sink down upon the ground in a doze. As yet there is no indication of fear or hostility in their actions. Eyes open; iris brown. Bill grayish flesh color; claws light gray; feet flesh color. Egg tooth present. Oil gland appears as a small upthrust nob about 1.6 mm. long.

May 12. Age about 11 days. When I reached into the nest the youngsters turned upon their backs and siezed my fingers feebly with their claws. They are very lively; when placed upon the ground they retreat before my advancing finger, backing up rapidly, with open beaks and bodies reared straight up. At times, even

when not molested, they stand up and scream in excited tones, usually evoking an answering cry from one of the parents. Bill and claws gray. Egg tooth absent, oil gland about 3 mm. long.

May 19. Age about 18 days. Young more aggressive than on previous visit, throwing themselves upon their backs and screaming vociferously when approached (fig. 45). They grip my outstretched finger with a nervous, frightened sort of ferocity, but are not as yet able to inflict any injury. Oil gland about 11 mm. long. The cavity is becoming quite foul. Birds given bands, numbers 362861, 362862, 295324 and 295325.

May 27. Age about 26 days. The birds had left the nest and were perched among the branches, two within the immediate vicinity and a third in the top of the tree, the fourth being invisible. They kept up an almost continual screaming,

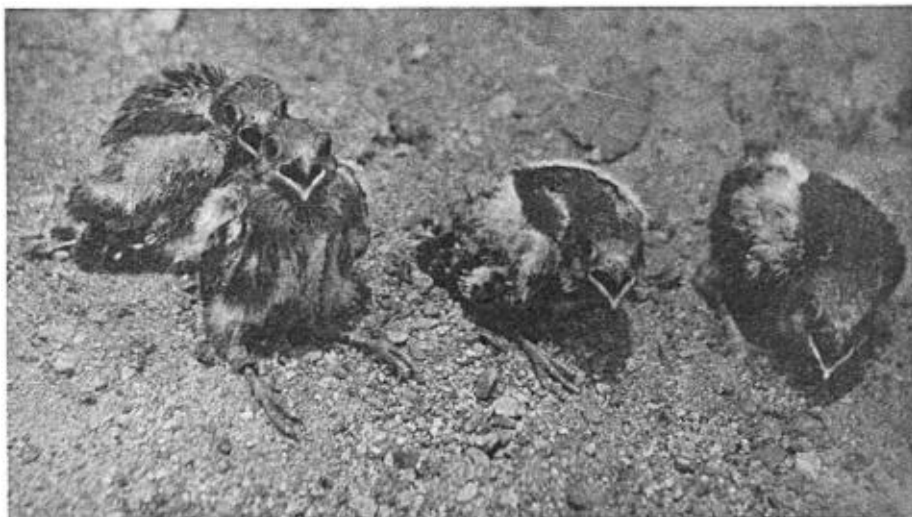


Fig. 45. YOUNG OF THE DESERT SPARROW HAWK WHEN EIGHTEEN DAYS OLD. BIRDS ARE SCREAMING AND SHOW THE HOSTILITY CHARACTERISTIC OF LATE STAGE OF DEVELOPMENT.

which was answered by the parents. The two near the nest hole were easily caught, and proved unable as yet to fly, although more fiery than ever. When cornered they used both beak and claws to good effect, while screaming shrilly in protest. When I tossed them back into the branches, however, they became comparatively quiet and after much frantic struggling, finally gained positions of equilibrium and security once more. Oil gland about 8 mm. long.

A study of the weights of these birds, particularly toward the close of the nest life, shows two items of interest. One is the greater size of the females, and the other is the loss of weight suffered by those birds which, on the last visit, I had the opportunity to weigh. In view of the losses experienced with the Golden Eagles previously discussed, and of facts presently to be considered, it is safe to say that the other two members of the brood exhibited a like condition.

To illustrate that the Sparrow Hawk is not altogether a model neighbor, from the point of view of other birds which may be rearing families, I submit an extract from my notes on the other brood under observation:

“May 20, 1928. While standing in the tree I saw the female fly rapidly past

with a fledgling, still struggling, in her claws, and closely pursued by three other birds. One of these was a Western Kingbird (*Tyrannus verticalis*), but the rapidity of their motions made it hard to identify the other two. One seemed to be a California Linnet (*Carpodacus mexicanus frontalis*). After circling swiftly about a neighboring tree, still hotly pursued, the hawk came to rest in a nearby sycamore, at which the other birds dispersed. Judging from the excited alarm cries which two linnets kept up without intermission for ten minutes thereafter, the fledgling must have been a juvenile *Carpodacus*."

Table 4. SPARROW HAWK, Summary of Development

Bird	Weight				
	April 22	May 4 Age about 3 days	May 12 Age about 11 days	May 19 Age about 18 days	May 27 Age about 26 days
a	14.0 (egg)	42.7	116.9	140.0	.....
b	14.1 (egg)	32.4	96.7	126.2	84.9
c	14.8 (egg)	34.0	93.8	111.9	.....
d	14.3 (egg)	32.2	80.7	105.7	86.9
	15.5 (egg)				
Total length					
a		96	146		.....
b		96	133		197
c		96	127		.....
d		96	140		191
Fifth primary—ratio of total length to portion burst from sheath					
a			22	67 : 33	.....
b			22	57 : 29	95 : 73
c			22	59 : 32	.....
d			17	52 : 33	90 : 67
Left deck feather—ratio of total length to portion burst from sheath					
a			9	38 : 17	.....
b			6	30 : 11	57 : 36
c			8	33 : 16	.....
d			5	25 : 13	54 : 36

Total wing-spread May 27: b 445; d 432

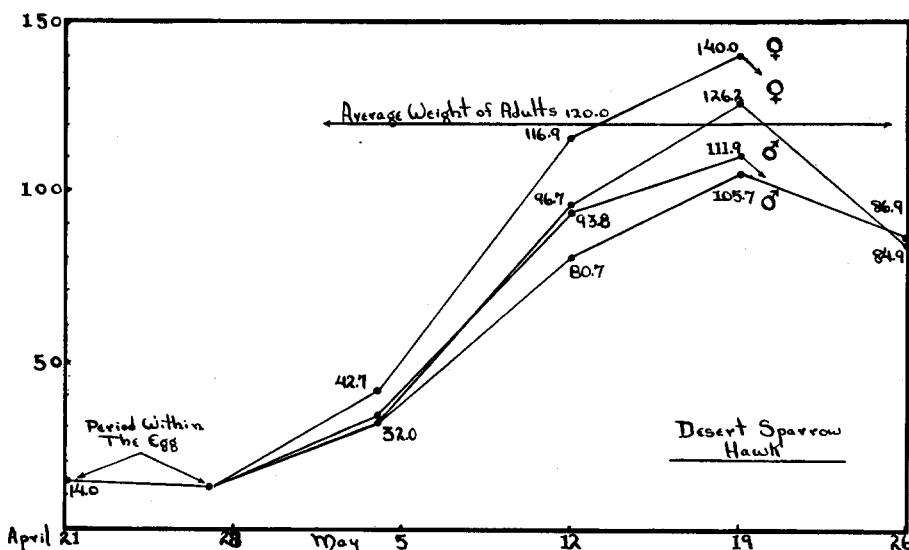


Fig. 46. GRAPH SHOWING FLUCTUATIONS IN WEIGHT (GRAMS), WITH ADVANCING AGE, OF YOUNG DESERT SPARROW HAWKS.

In passing from the hawks to the owls we enter a group whose characteristics of nest life are very nearly as different as are those of bodily structure. So, too, the reactions of a young owl and a juvenile hawk are as little alike as are their physical characteristics.

BARN OWL

February 18, 1928. Female flushed from eight eggs. The nest is a natural cavity in an oak growing in pasture land, and has been occupied for many years. In what follows, the birds are designated as *a*, *b*, *c*, etc., in order of hatching.

March 4. Female flushed, but returned as soon as I left the tree. Three young have hatched, eyes not yet open; beak and claws flesh color. Egg tooth present. All three whimper continually, in feeble tones. The oldest is able to stand up, although weakly and with nodding head. Three freshly killed pocket gophers in the nest.

March 10. Female flew away as I reached the cavity but returned after a short time and lit for a moment in the tree before again taking flight. Only two eggs remain unhatched. Egg tooth present. Eyes of *a* and *b* open; *a* whimpers continually, but *b* is less obstreperous. Remains of 2 pocket gophers, 1 meadow mouse, and 1 rabbit (*Sylvilagus* sp.) in nest.

March 17. Female no longer in the nest, but was observed moving restlessly about in a nearby eucalyptus. About a half hour later she flew directly for the entrance hole, but turned back when I moved my arms. Egg tooth absent in *a*, *b*, *c*, and *d*; *a* hisses harshly when handled, but is still quite docile. It stands up and walks about with ease. Bill grayish flesh color; claws gray as in adults.

Birds *a* to *f*, inclusive, have their eyes open. When I picked at the egg tooth of *f* with my finger nail it scaled off—a thing which does not often happen with any of the hawks. The egg tooth of *g* resisted all attempts at removal. This bird is as yet unable to stand up. One infertile egg. Four pocket gophers present in the nest.

March 26. Female still present in the nest. The youngsters are quite lively, even the smallest. When set down in the long grass they stand up to their fullest height and crane their necks in search of a hiding place. As yet, all the birds can be handled without danger. When disturbed, *a* and *b* hiss harshly and sway from side to side with heads lowered and extended wings inverted, after the manner of owls. If further provoked they throw themselves upon their backs and strike out with both feet. Of the remaining four, the rule is—the younger the less active; but all, even *g*, now have their eyes open.

March 31. Female not seen. Youngsters hiss harshly when handled, but are fairly quiet on this visit (fig. 47). The instinctive tendency to strike at any moving object when afraid causes them to attack each other viciously when placed side by side.

April 8. Young very aggressive. As soon as I reached into the nest their harsh hissing rose in chorus, and soon became almost unendurably loud. When placed on the ground they stand upright and sway from side to side with wings partly open and, if approached more closely, throw themselves upon their backs and strike out viciously with both feet. Their claws are by this time capable of inflicting painful scratches. Unlike the hawks, the oil gland in these owls is very prominent, varying from 13 mm. in *a* to 11 mm. in *g*, the youngest. The first five birds were given bands, numbers 543254 to 543258 inclusive, and the smallest two, bands 543270 and 543273.

April 16. Youngsters more active and aggressive than ever. When placed on

the ground they strike at each other, as well as at any other object that comes within range, and at times they even assume the offensive; running toward me with open beaks and upraised, inverted wings. If undisturbed they gradually cease their screaming hiss, and after a brief survey of the field, run rapidly in among the bushes, under which they crawl and become perfectly quiet. Not only their claws, but also their beaks are used in defense and I find it necessary to tie both wings and feet when weighing them, while the noise is simply deafening. During the time I was engaged with the others, no. 543256 escaped into the thick tangle of sage-brush and cactus nearby and could not be found.

April 22. Young more pugnacious than ever, rendering it difficult to pull them out of the nest cavity.



Fig. 47. YOUNG OF THE BARN OWL AT ABOUT THIRTY DAYS OF AGE. BIRDS HAVE JUST BEEN SET DOWN UPON THE GROUND, AND APPEAR TO BE LOOKING ABOUT FOR A PLACE TO HIDE.

April 27. Actions of young positively unprintable. It will be observed from the accompanying table that every bird, without exception, has lost weight since the preceding visit.

May 6. It is now necessary to tie the birds down to keep them from flying away. No. 543270 (*f*) no longer present. Three have gained in weight and two have lost.

May 13. Only four birds present.

May 20. Only two birds, *c* and *g* (the youngest), now remain. The latter bird is considerably browner than the rest, showing that, in this case, color variation has nothing to do with age; several others of the brood also exhibit shades intermediate between the darkest and the lightest.

May 27. Only the youngest left. Bird quiet, its only protest being a snapping of the bill. As yet it seems unable to fly properly. When I tossed it into the air it made off awkwardly, with legs hanging straight down, and lit sprawling among the lower branches of a near-by oak, where it was easily recaptured.

Table 5. BARN OWL, Summary of Development

Bird	Weight													
	Feb. 18	Mar. 4	Mar. 10	Mar. 17	Mar. 26	Mar. 31	Apr. 8	Apr. 16	Apr. 22	Apr. 27	May 6	May 13	May 20	May 27
a	22.4 (egg)	57.0	146.4	291.5	444.8	490.3	482.4	495.5	520.0	450.0	480.0	440.0	.....	.....
b	21.6 (egg)	35.1	128.3	299.2	444.0	555.2	622.8	603.9	670.0	615.0	595.0	580.0	.....	.....
c	22.9 (egg)	20.9	94.6	211.0	384.5	492.1	586.6	.....	.....	.....	.....	.....	.....	.....
d	23.2 (egg)	22.3 (egg)	54.0	174.8	339.0	470.0	493.9	570.9	620.0	565.0	620.0	.....	.....	.....
e	24.7 (egg)	22.7 (egg)	32.0	140.3	296.3	428.6	502.6	552.6	600.0	590.0	540.0	520.0	565.0	.....
f	24.2 (egg)	22.4 (pipping)	18.4	80.8	191.0	321.3	402.9	467.1	550.0	500.0	.....	.....	.....	.....
g	26.1 (egg)	24.0 (egg)	21.7 (egg)	50.8	193.8	350.0	487.3	567.3	620.0	530.0	540.0	565.0	600.0	580.0
h	24.3 (egg)	22.6 (egg)	23.2 (pipping)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

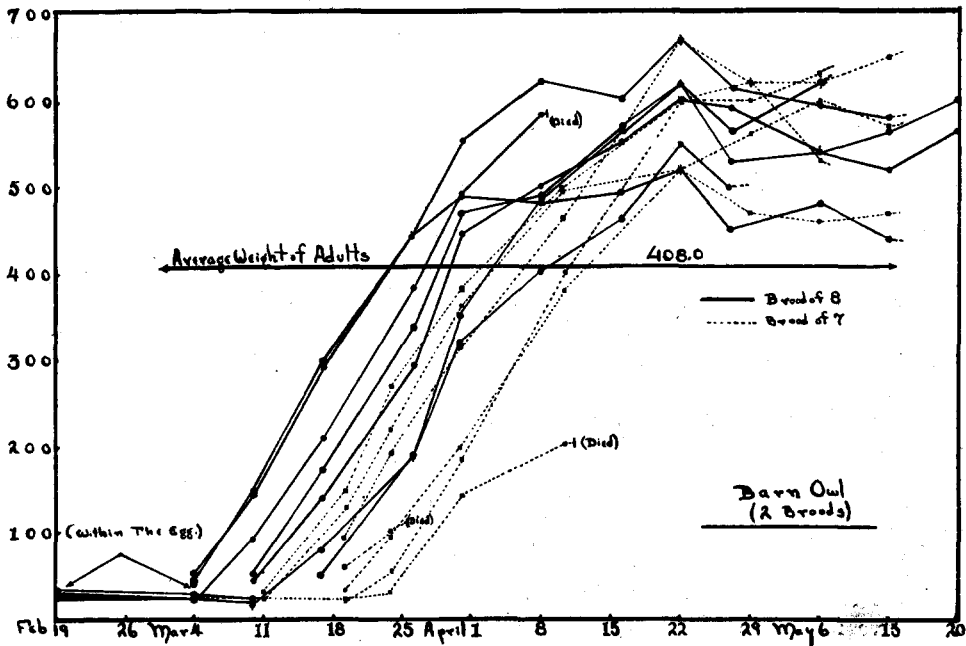


Fig. 48. GRAPH SHOWING FLUCTUATIONS IN WEIGHT (GRAMS), WITH ADVANCING AGE, OF TWO BROODS OF YOUNG BARN OWLS.

LONG-EARED OWL

These owls made use of a nest which had been occupied the previous year by the pair of Cooper Hawks mentioned at the first of this article. Indeed the hawks built their new nest only 75 feet from the owls' household. It is impossible to say whether the prior occupation by the owl family forced the Cooper Hawks to build another nest, or not; I have observed several instances of such robbery between Pacific Horned Owls and Western Red-tails. It is also impossible to make any

definite statements as to the fate of the young owls, so precariously near to the nest of the hawks, but that will be mentioned later.

February 25, 1928. Female flushed from three fresh eggs and was immediately joined by the male. They flew about restlessly but made no sound. Nest was not disturbed.

March 3. Female flushed and remained in the general vicinity. Once or twice she hooted in a subdued tone which was similar to the hoot of the Pacific Horned Owl. Six eggs present.

March 24. Male flushed within 40 feet of the nest. In leaving, the female kicked one youngster out of the nest, and by the time I had arrived it was breathing its last. Two other eggs also hatched, but as yet the birds have their eyes closed and are weak and lifeless in appearance. Individuals are designated by letters as with the Barn Owls; *a* whimpers feebly and is too weak to stand up. Bill and claws slate color. Egg tooth present, but scaled off when I picked at it; *b* similar, but beak and claws lighter. Egg tooth does not scale off.

March 30. The parents show considerable anxiety at my presence and utter a variety of sounds similar to those mentioned by Dawson (*Birds of California*, 1923, p. 1082). At times they hoot in tones similar to those of the Pacific Horned Owl, and frequently give forth a series of squeaks and whines. Several times, also, one of the birds fluttered down to the ground and uttered piercing cries like the screams of a small bird in distress, while it spasmodically beat the ground with its outstretched wings, as if to attract attention.

The young are all hatched but are very sluggish and inactive—a characteristic of juvenile Strigidæ as far as the writer's experience goes. Even *a*, the oldest, makes no protest other than a feeble hiss, and all the rest are silent. Eyes open (iris yellow), egg tooth absent, in both *a* and *b*.

April 10. Female flushed from nest; actions of both adults as before. The largest three youngsters are quite aggressive, standing up with outspread wings inverted and every feather erect, which gives them a deceptively bulky appearance. They snap viciously at my outstretched finger, and sway from side to side—a trait not exhibited by any of the hawks—but are as yet perfectly harmless. With the exception of the oldest, they make no noise other than a snapping of the bill; this bird uttered a number of loud shrill prolonged squeaks, similar to one of the notes uttered by the adults. Egg tooth absent. "Ears" prominent. Eyes of all are open. Oil gland 9 to 13 mm. long. Birds given bands, numbers 543274, 543275, 543278, 543280 and 543281.

April 15. There are only three owls in the nest, and since it is highly improbable that the two largest birds could have learned to fly, it would seem that they have fallen out of the nest. This is all the more indicated by the surprising lack of care with which the remaining young move about in the nest when I approach—entirely unlike the behavior of hawks. They raise their wings, snap their bills, and without the slightest hesitation back right off the nest. Bird *c* saved itself only by clinging desperately to the under side, where it could not have remained very long unaided. Bird *d* fell all the way to the ground, striking a large limb in its descent, and was unable to use its wings other than to break the force of the fall. This inability to remain in the nest until the power of flight is gained would appear to be a considerable liability to the species, especially because of the danger from predatory animals. The close proximity of the Cooper Hawk's nest must also be considered in this particular case. Remembering a similar experience with another nest of this owl, I searched everywhere in the scant cover of the

vicinity, but just as on this other occasion, there was no trace of the missing birds. Perhaps the old birds led them to a place of safety and protected them from harm, but that remains to be proven.

The remaining birds are more aggressive than ever (fig. 49). Like the Barn Owl, they throw themselves upon their backs and use their claws when hard pressed, and like these owls, they also run at the intruder of their own accord. As yet they are harmless, however. Oil gland about 13 mm. long.

April 17. During the two days since the last visit, no. 543278 (c) has also disappeared.

April 21. The young are no longer present, although one of the adults was heard to hoot as I climbed up to the nest.



Fig. 49. YOUNG OF THE LONG-EARED OWL WHEN ABOUT TWENTY-SIX DAYS OLD. ALTHOUGH UNABLE TO FLY, THEY HAVE TUMBLED OUT OF THE NEST, AS DESCRIBED IN THE ACCOMPANYING TEXT. SHOWS ALSO CHARACTERISTIC POSE, WITH WINGS INVERTED.

Table 6. LONG-EARED OWL, Summary of Development

Bird	Weight				
	March 3	March 24	March 30	April 10	April 15
a	26.2 (egg)	32.7	111.6	208.2	.....
b	26.5 (egg)	20.2	93.8	222.7	.....
	27.1 (egg)	.....	.....	.....	.....
c	25.1 (egg)	21.5 (egg)	50.5	207.3	232.7
d	25.5 (egg)	21.8 (egg)	32.5	173.5	194.3
e	25.6 (egg)	22.7 (egg)	21.2	139.3	190.2

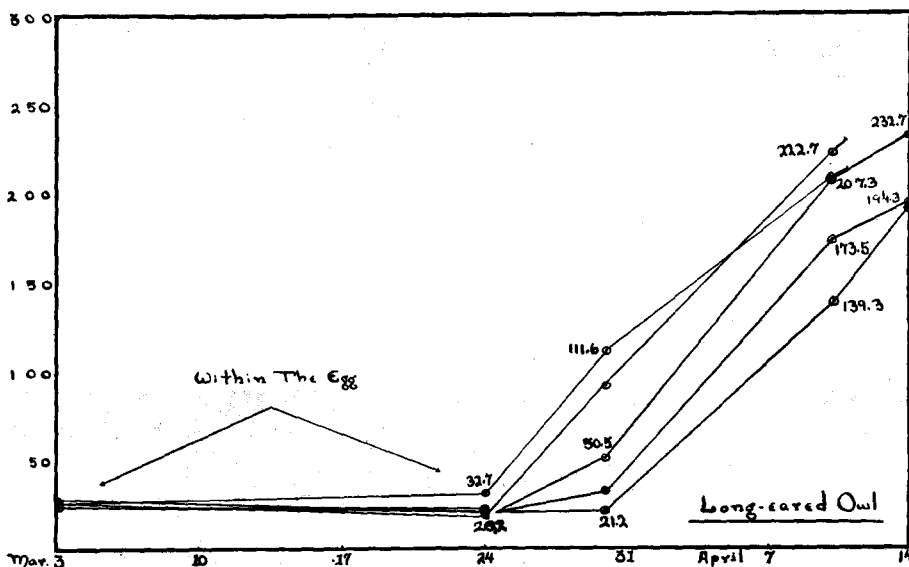


Fig. 50. GRAPH SHOWING INCREASE IN WEIGHT (GRAMS), WITH ADVANCING AGE, OF YOUNG LONG-EARED OWLS.

SCREECH OWL

As in the case of the Golden Eagle, my notes on this species are confined to a single pair, which has been studied for two successive years; and for the same reason the present account will be short.

In 1927, there were four young, which I visited every two days; while in 1928, there were only three, and these were visited but once each week. For this reason my later notes are not as complete as the early records, although as far as they go, they confirm the previous findings. This cavity has been used for many years, and the adult female, no. 290928, has worn a band for the past three seasons.

April 21, 1928. Female in the nest and as savage as ever. After her first attempts at resistance proved futile, however, she became silent and submissive, with relaxed feathers and half-closed eyes. In this state she would remain lying upon the ground, even after I had gone off to a distance of twenty feet. Two young are hatched. Egg tooth present. Eyes closed. Length about 64 mm. Bill and claws light gray, becoming whitish at the tips. Birds are feeble and whimper continually.

April 27. Age about 7 days. Female in nest; actions as before. Bands on young have slipped off, so that no connection can be made between this and the previous visit. The youngsters are torpid, remaining silent except for an occasional feeble whimper and lying prone upon the ground wherever placed, like so many stones. Egg tooth absent in *a* and *b*, present in *c*. Eyes of *b* are partially open. This bird stands up, although with difficulty; the other two cannot.

May 4. Age about 14 days. Weight of adult bird, 174.2 grams. When I first put my hand into the hole there was a snapping of bills from the youngsters; but when taken out into the daylight they became as silent and lifeless as ever. Egg tooth absent. Eyes open; iris yellow. The hind quarters of two pocket gophers are present in the nest. Oil gland 6 to 8 mm. long.

May 13. Age about 23 days. Adult still present. Young aggressive; at my approach, they hiss sharply and sway from side to side with out-stretched, inverted wings. If a finger is advanced toward them they back up rapidly, with furiously snapping bills and, if hard pressed, throw themselves upon their backs and strike out with their claws, which, however, are as yet incapable of inflicting any injury. Young and old alike always defecate prodigiously when first removed from the nest, this reaction probably being a result of nervousness. For the most part they are silent, with the exception of *a* which at regular intervals utters a hoarse muffled hoot. When undisturbed the birds are content to remain wherever placed, and gradually relax their belligerent attitude. Oil gland 9 mm. long.

May 20. Age about 30 days. Adult absent. Actions of young somewhat more aggressive. They use beak and claws so effectively that it is necessary to wear gloves, but they make no attempt to run away from me. Oil gland as before. Birds given bands, numbers 290939, 295322, and 295323.

May 27. Nest deserted. In comparison with the data obtained on the previous years, these youngsters failed to show any marked fluctuation in weight, there being, indeed, but one actual loss noted throughout the period. In the light of other observations, however, I would explain this on the ground that weekly visits are too infrequent to permit of adequately recording such fluctuations, rather than conclude that the young did *not* vary. A similar result could be obtained by going over the notes for 1927, and ignoring all data taken in the middle of the week.

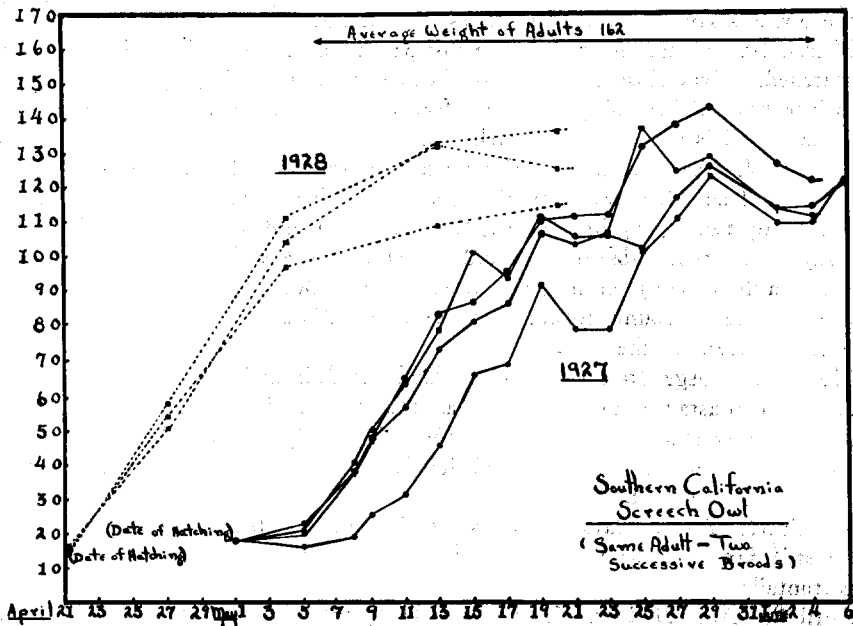


Fig. 51. GRAPH SHOWING FLUCTUATIONS IN WEIGHT (GRAMS), WITH ADVANCING AGE, OF TWO BROODS OF YOUNG SOUTHERN CALIFORNIA SCREECH OWLS.

Table 7. SCREECH OWL, Summary of Development
Weight

Bird	April 21	April 27 Age about 7 days	May 4 Age about 14 days	May 13 Age about 23 days	May 30 Age about 30 days
<i>a</i>	14.3	58.8	111.2	132.0	125.9
<i>b</i>	13.8	54.0	97.9	108.5	114.1
<i>c</i>	17.3 (egg)	51.2	103.9	133.7	136.8
		Total length			
<i>a</i>		96	121	146	171
<i>b</i>		92	121	140	156
<i>c</i>		92	121	146	165
		Fifth primary—ratio of total length to portion burst from sheath			
<i>a</i>			19	65 : 36	89 : 64
<i>b</i>			21	62 : 33	83 : 59
<i>c</i>			16	60 : 32	89 : 64
		Left deck feather—ratio of total length to portion burst from sheath			
<i>a</i>			3	25 : 16	48 : 29
<i>b</i>			3	22 : 16	46 : 27
<i>c</i>			1.6	22 : 6	41 : 22

PACIFIC HORNED OWL

February 25, 1928. Female flushed from three eggs whose incubation was estimated at about 15 days. Both parents flew about restlessly, snapping their bills and hooting. These owls have nested in the vicinity for six years at least; beyond that the writer's knowledge of them does not extend.

March 10. Female flushed; actions of parents as above. Two of the youngsters have hatched. Eyes closed. Bill and claws slate gray. Egg tooth white, with a large white base. The older whimpers feebly, but cannot stand up yet; the second is still damp and is very weak and helpless.

March 17. Age one week. Female not on the nest; but at my approach both adults appeared and flew restlessly about, snapping their beaks and hooting as before. There are only two young in the nest, the oldest (*a*) and one other. Bill and claws slate gray. Egg tooth absent in *a* and scaled off in *b* when I picked at it. Eyes open (iris dull yellow) in *a*, still closed in *b*. Both birds torpid, not offering to move or utter a sound throughout the observations. Five fresh meadow mice (*Microtus*) present in the nest.

March 26. Age 16 days. Young birds as dull and lifeless as ever, offering absolutely no resistance and behaving as though sound asleep. In this they resemble the earlier stages of the Screech Owl previously mentioned. Bird *b* did not utter a sound even when I scratched its foot in changing bands. Hind portion of a meadow mouse in the nest.

March 31. Age 21 days. Youngsters hiss and snap their bills when I approach, but are still far from being wide awake. The nest contains the hindquarters of four cottontails.

April 8. Age 29 days. The young birds rear up and snap their bills when I approach, hissing as I draw nearer, and half opening their wings so as to give themselves a deceptively bulky appearance. They are still as harmless as before, however, and like the young Screech Owls and Long-eared Owls make no effort to escape. Oil gland prominent, being quite 19 mm. long. Hind portions of a cottontail in the nest.

April 16. Although both adults were present, flapping about from tree to

tree and hooting in protest, the nest was empty, and the young could not be found anywhere. The depression which marks the nest is situated about five feet up in a fern-covered bank, and it would be an easy matter for the young birds to slide down to the foot of the bank through the tangled mass of vines which covers its face. From there the hillside slopes downward through masses of poison oak (*Rhus diversiloba*), fallen logs, and all sorts of ideal cover; to judge from the actions of the parents it is there that the young have taken refuge.

Unfortunately this premature leave-taking deprives us of those last records of nest life which are the most interesting of all, and accordingly we shall have to turn to the other brood—of three owls—for the final records. This second brood was not discovered until the birds had attained considerable size, and it has not been chosen for discussion for that reason. Age about 36 days on April 9, 1928.

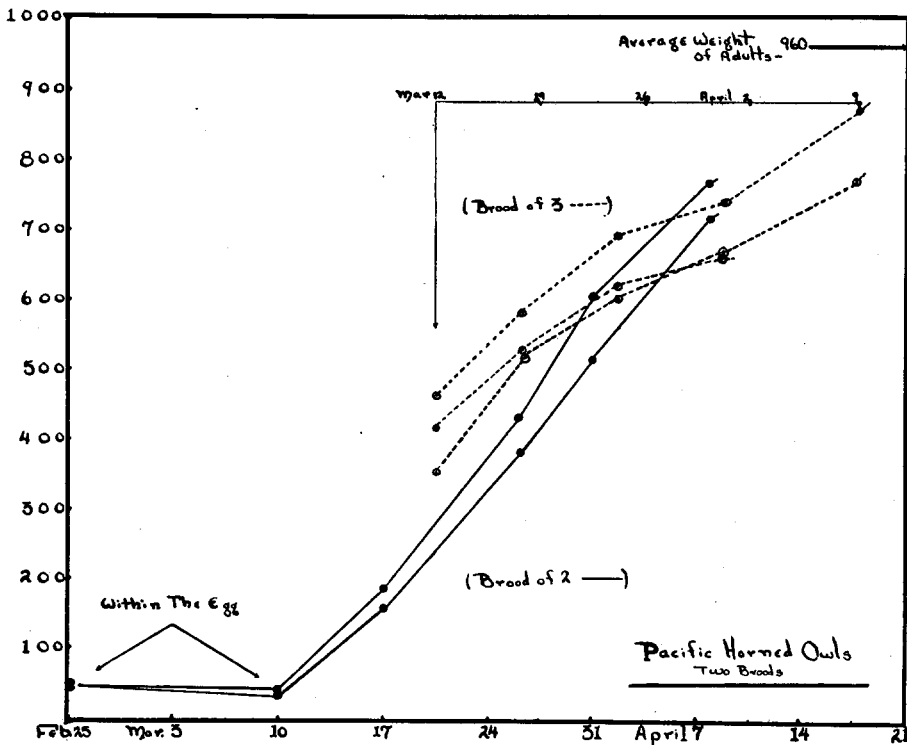


Fig. 52. GRAPH SHOWING INCREASE IN WEIGHT (GRAMS), WITH ADVANCING AGE, OF TWO BROODS OF YOUNG PACIFIC HORNED OWLS.

Brood of three. As I reached the edge of the nest (in the top of an oak tree), no. 320777 jumped out and flew across the cañon, alighting upon the other side at a distance of about 100 yards, and although I searched for it later it could not be found. The remaining young are quite aggressive, snapping bills, puffing out feathers, and half spreading their wings in the inverted manner so characteristic of juvenile owls. They sway from side to side with fiercely glaring eyes, and when closely approached throw themselves upon their backs and strike out viciously with their talons, which are capable of inflicting painful scratches. As soon as I withdraw a few yards, however, they stand upright, hesitating for just a moment as

they look about with craning necks, and then commence to flap and hop rapidly toward the nearest cover. Oil gland large; length 19 mm. Weights at this visit are included in table with those of the other brood. The following week the nest was empty and the parents not in evidence.

In closing my remarks on this species it may be of interest to mention that it was the only one of the eight hawks and owls which manifested a strong tendency to desert if molested while the eggs were still fresh. The parents of the first brood of Horned Owls mentioned have deserted at least three times within as many years, even when I did not handle the eggs, and I have had the same experience with other individuals of the species.

Table 8. PACIFIC HORNED OWL, Summary of Development
Weight

Bird	Feb. 25	Mar. 10	Mar. 17 Age 7 days	Mar. 26 Age 16 days	Mar. 31 Age 21 days	Apr. 8 Age 29 days	Apr. 9 Other brood Age about 36 days
<i>a</i>	48.8 (egg)	46.1	186.8	432.0	607.5	769.6	866.9
<i>b</i>	52.7 (egg)	37.4	158.7	382.4	515.2	720.9	773.7
	53.6 (egg)	51.1 (egg)					

SUMMARY

As I remarked at the beginning of this paper, one of the chief objects of these studies has been to find out if the loss of weight suffered by the species observed in 1927 would hold true for other Raptores as well. An examination of the foregoing series of graphs indicates the answer. Of the species concerned, the Eagle, Sparrow Hawk, Barn Owl and Screech Owl exhibit a marked loss toward the end of the nest life. After the first abrupt rise there is a gradual flattening of the curve and then a period of fluctuation and decline, usually without any marked increase thereafter.

The reason for this loss is not altogether apparent, but perhaps it may be accounted for as follows: A short time before the bird is ready to fly the feathers have very nearly reached their full development. At this point the blood and plasma in the quills begin to recede, the shafts become filled with air, and there is a general toughening and lightening of cellular structure in preparation for flight. So too, the bones, which until now have been soft and permeated with liquid, are entering upon a similar period of strengthening and lightening. This process, then, may be going on at a rate which is momentarily too rapid to be completely compensated for by the assimilation of food, although later on an equilibrium is reached again. Dr. J. R. Slonaker has suggested that perhaps there is less food brought in toward the end of nest life—this with the result of starving the young to a point where they will be willing to leave the nest in answer to the promptings of the parents who are trying to make them fly at this time.

It would appear at first sight as if the graphs of the Cooper Hawk, Red-tail, Long-eared Owl, and Horned Owl completely failed to confirm such an hypothesis, but a further consideration of these figures seems to strengthen rather than to weaken it. In the case of every one of these species it will be recalled that the young birds either left the nest at an unusually early stage, and before they had acquired the power of flight, or, as in the case of the Cooper Hawk, they left between visits and so could not be weighed for the last time. The abrupt cessation

of the lines, cut off right in the midst of development and without any gradual flattening of the curve, indicates this plainly. Indeed, the Cooper Hawks, which merely developed too rapidly to remain in the nest another week, show the nearest approach to a normal graph, and a visit in the middle of the week would probably have shown the customary loss.

In concluding, it may be of interest to point out the considerable discrepancy between the weights of the young barn owls, as indicated on the graph, and the average weight of an adult, the latter figure being derived from the weights of two male and two female birds taken at various localities during the months of August and September.

Pomona College, Claremont, California, January 12, 1929.