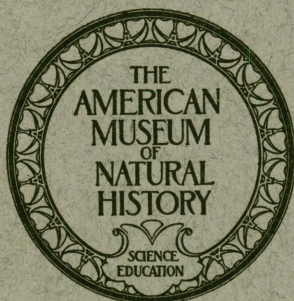


RESULTS OF THE ARCHBOLD  
EXPEDITIONS. NO. 34

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BY A. L. RAND

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BULLETIN  
OF  
THE AMERICAN MUSEUM OF NATURAL HISTORY

VOL. LXXVIII, ART. II, pp. 213-242

*New York*

*Issued August 7, 1941*





## Article II.—RESULTS OF THE ARCHBOLD EXPEDITIONS. NO. 34

### DEVELOPMENT AND ENEMY RECOGNITION OF THE CURVE-BILLED THRASHER *TOXOSTOMA CURVIROSTRE*

By A. L. RAND

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#### INTRODUCTION

This paper deals with the appearance of certain types of behavior in the curve-billed thrasher, and the characteristics of the objects which elicit these types of behavior. The widely divergent views held as to whether birds instinctively recognize objects and respond specifically to them, or whether they respond in the same manner to a wide variety of objects and only through trial and error learning come to respond to the appropriate objects in the appropriate manner are well illustrated by the divergent views on enemy recognition.

Lloyd Morgan (1896, *Habit and Instinct*, pp. 80-90) said that in his experience, which included raising many young birds, fear in birds is generalized but suggested that there may be specific fears. Thorndyke (1911, *Animal Intelligence*, pp. 162-166), from experience with chicks, decided that fear was generalized, of larger moving objects. On the other hand Lorenz (1935, *Jour. f. Ornith.*, pp. 137-213) and Strauss (1939, *Zeitschrift f. Tierpsych.*, II, pp. 191-197) claim that some birds instinctively recognize their enemies.

As to what aspects of a stimulus object cause the birds to respond there are widely divergent views. Lashley (1938, *Psych.*

*Review*, XLV, pp. 445-471), in a summary of the experimental evidence up to 1938, based chiefly on the study of maternal and sexual behavior, concluded that animals in general respond to a complexity or pattern of stimuli emanating from the stimulus object, of which any single character can be modified within limits without disrupting the pattern of the response. Lorenz, at the other extreme, discussing social behavior, claimed that single stimuli, or a very few stimuli, act as the motivating factor in eliciting a response.

The present study is concerned with the development of thrashers from hatching to about the 96th day of age in some individuals (about 77 days after normal nest leaving, about 50 days after becoming adult-like in appearance and behavior) and their response to natural enemies and other objects, presented to them in captivity. Since the state of development of the birds plays an important part in determining what response is given to an object, since some harmless objects are instinctively treated as enemies, and since the responses to enemies are not confined to responses which might be construed as fear alone, but partake of elements of pugnacity and curiosity, it seems advisable to give a general picture of the development of the

young thrasher before discussing enemy recognition.

Observations were made on the young in the nest until between the 14th–18th day of age, when seventeen were removed and raised in captivity. Upon removal from the nest the birds were hand-fed until they became self-feeding, which varied greatly with the age of capture and treatment of the individuals. They were given as little attention as was consistent with their well-being, so that their human associations would affect them as little as possible. At first each brood was kept in a separate small box, but as soon as they became active, they were transferred to their larger, permanent cages.

They were divided into three groups, which were experimented with separately:

(1) The "eight-thrasher group," in which the eight birds were finally housed in an outdoor, wire-mesh cage 15 by 35 by 7 feet high. These were kept to the age of 90 to 96 days.

(2) The "six-thrasher group," in which the six birds were finally housed in an outdoor, wire-mesh cage 6 by 6 by 7 feet high. These were kept to the age of 80 to 90 days.

(3) The "three-thrasher group," finally

housed in a cage 35 by 9 by 7 feet high. These were kept to the age of 28 to 30 days.

These birds were raised in partial isolation, in that, presumably, they did not see natural enemies and other stimulus objects until they were introduced in the experiments.

The work was done near Tucson, Arizona, as part of the program of the Archbold Expeditions in the spring of 1940. I take pleasure in acknowledging the help of my wife, Rheua Medden Rand, who not only aided in raising the young birds, but supplied some of the ideas which I have incorporated into the text, and of Mr. Archbold, who, besides making the whole project possible, took a keen interest in this phase of it and was ever ready with discussion and helpful suggestion. Dr. F. A. Beach has kindly read and criticized this manuscript.

For a general account of the habitat, habits and nesting of this species see Bailey, 1928, *Birds of New Mexico*, pp. 555–557 and Engels, 1940, *Univ. of Cal. Pub. in Zool.*, XLII, No. 7, pp. 341–350.

#### PHYSICAL GROWTH

The physical growth develops the equipment which makes possible behavior, so that an outline of the gross physical growth is given, as a background against which to view the behavior discussed beyond.

The following data on nestlings are based on daily observations on about nine birds, from the day of hatching to the day of leaving the nest. Data beyond nest leaving are from birds kept in captivity, some until about ninety-six days old (see above). Weights and primary and rectrix lengths are given in the table.

**FIRST DAY.**—The young at hatching are typically altricial birds; blind, nearly naked and nearly helpless. The huge abdomen is asymmetrical; when the bird is placed on a flat surface, both "heels" cannot reach the floor at once; a slender neck connects the body and a disproportionately large head. The mandibles may be equal or unequal, the upper or lower being slightly longer. The skin is translucent pink, darker above, allowing the

flesh and viscera to show through. There is no trace of feather tracts, but long gray down is present on the upperparts, about 11 mm. long on the back, and 12 mm. long on the crown, and paler gray down, about 12 mm. long, is present in a line on each side of the abdomen, where the feather tracts will appear. The legs are grayish flesh, bill gray, with a large white flange at the gape; inside of mouth yellowish, shading to white at the gape; egg tooth whitish.

**SECOND DAY.**—Little change; the skin becomes slightly darker, more grayish.

**THIRD DAY.**—Skin more dusky; feather tracts becoming visible under the skin.

**FOURTH DAY.**—Skin grayer; feather tracts more plainly visible.

**FIFTH DAY.**—Remiges and rectrices protruding in sheaths; eyes beginning to open.

**SIXTH DAY.**—Eyes can be widely opened; contour feathers just breaking skin; remiges and rectrices continue to grow, the



rectrices beginning to break out of their sheaths at the tip.

SEVENTH DAY.—The bird appears pinfeathery all over, rump and breast feathers about 3 mm. long; the crown feathers about 1 mm. long. The feathers of the abdomen have begun to break their sheaths at the tip; legs grayer; some specimens, hatched with subequal mandibles, now have them equal in length.

EIGHTH DAY.—Feather sheaths breaking everywhere except on head, especially advanced on underparts; all birds now have mandibles equal in length.

NINTH DAY.—Tips of feather sheaths have broken enough so that feather tracts are fairly well covered with feathers, concealing the bases of the quills; head and foreback backward; sheath of bases of remiges and rectrices not yet concealed by coverts; legs grayer, bill darker.

TENTH DAY.—Pin feathers show only at the base of the tail and at bases of remiges; though feathers cover the tracts they are not large enough to cover the apteria, especially on the underparts; most of the down is still on the upperparts; the abdomen is relatively much smaller, and its asymmetry has almost disappeared; feet gray, having lost the pink tinge; iris paler brownish gray.

ELEVENTH DAY.—Bill is becoming decurved; apteria covered by feathers.

TWELFTH DAY.—A few feather sheaths still show in the wing and tail.

FOURTEENTH DAY.—The bird is now well feathered, though the remains of a few feather sheaths may be visible in the wings and tail.

SIXTEENTH DAY.—Sometimes a trace of feather sheath may still show in wing or tail; down gone except for a trace on the head; bill black, gape and tip whitish; the flange of the gape is reduced in size; inside of mouth yellow; the tongue is black for a portion of the base; this blackness starts at the outer, posterior corners and spreads forward; feet grayish brown. The tail is less than half grown and the wings are only partly grown; this is the

state in which the nest is left. The egg tooth is knocked off with the use of the bill; the remaining down on the head disappears.

EIGHTEENTH DAY.—When young leave nest well feathered and tail short.

TWENTY-FOURTH DAY.—At about this time the tail is about half grown; eyes are turning whitish colored.

THIRTY-FIFTH DAY.—The tail is almost three-quarters grown.

FORTY-FOURTH DAY.—The tail is full length, the birds appear similar to the adult, except for the pale grayish-white eye.

One of the young in a thrasher's nest was usually twenty-four hours older than the other or others.

The physical development of these thrashers exhibits no peculiarities; it closely parallels that of the bluejay, birds that are only slightly larger (Rand, 1937, *Proc. Linn. Soc. New York*, No. 48, pp. 27-29). The weights were taken once a day, which probably accounts for the wide variations in weights of the young birds the first day.

The individual series of weights and measurements of the four young birds from nests A and B show that the two young in a nest may have a very similar size at the same age (as in nest B), or the size of the two nestlings may vary widely (as in nest A). Comparing the weights of the two young in nest A with the average maximum and minimum weights, it is seen that after the third day the weight of the smaller of the two young was that of the minimum, while the weight of its larger nest mate was that of the maximum after the sixth day, until it began to lose weight on the sixteenth day. The smaller bird was a weakling; its behavior developed considerably more slowly than normal, and it stayed in the nest until two days older than its nest mate at leaving. The delayed growth of this weakling is correlated with the more rapid growth of its nest mate. Perhaps the latter received more food than one of two equally active nestlings would have.

## WEIGHTS IN GRAMS

Age in days	(No.)	Min.-Max.	(Av.)	Nest A		Nest B	
Egg, the day before hatching	(11)	4.0 - 5.1	(4.6)				
1	(7)	3.5 - 6.25	(4.9)	4.5	...	...	...
2	(9)	6.25- 9.5	(7.2)	7.25	9.25	6.25	7.75
3	(9)	9.06-13.5	(11.6)	10.00	13.00	9.0	71.75
4	(9)	11.75-17.75	(15.8)	11.75	16.5	13.5	16.25
5	(9)	13.5 -23.5	(20.8)	13.5	23.5	17.75	20.75
6	(9)	14.5 -30.5	(26.2)	14.5	28.0	25.0	28.5
7	(9)	17.25-35.5	(30.5)	17.25	35.5	28.5	33.5
8	(9)	18.0 -40.25	(34.7)	18.0	40.25	35.5	38.75
9	(9)	20.75-45.5	(39.5)	20.75	45.5	39.25	42.5
10	(9)	24.5 -51.25	(43.5)	24.5	51.25	43.25	46.25
11	(9)	27.5 -59.5	(46.6)	27.5	59.5	45.25	50.25
12	(9)	31.5 -56.5	(46.8)	31.5	56.5	47.5	52.5
13	(8)	32.5 -60.0	(50.5)	32.5	60.0	50.75	54.0
14	(7)	35.5 -59.5	(51.4)	35.5	59.5	53.5	56.0
15	(6)	38.5 -59.75	(53.1)	38.5	59.75	55.5	56.0
16	(5)	41.5 -58.5	(53.2)	41.5	56.5	55.0	58.5
17	(3)	44.0 -54.75	(50.5)	44.0	...	52.75	54.75
18	(1)	45.5 -45.5	(45.5)	45.5	Has left	Removed from nest yesterday	
19				Has left			
Adult		1♂ 1♀					

## LONGEST PRIMARY IN MILLIMETERS

Age in days	(No.)	Min.-Max.	(Av.)	Nest A		Nest B	
5	(7)	5- 2	(1.2)	1	15		
6	(9)	2- 4	(2.6)	2	2	2	2
7	(9)	3- 9	(7.3)	3	7	5	8
8	(9)	5-14	(11.4)	5	11	10	13
9	(9)	9-19	(16.3)	9	15	15	18
10	(9)	12-24	(21.0)	12	21	22	24
11	(9)	15-30	(25.0)	15	27	28	29
12	(9)	19-35	(30.2)	19	32	33	34
13	(7)	22-38	(33.0)	22	36		
14	(6)	27-42	(36.6)	27	41		
15	(4)	30-46	(40.0)	30	45		
16	(6)	36-48	(42.0)	36	46	48	48
17	(3)	38-52	(47.0)	38		51	52
18	(1)	42		42			

## LONGEST TAIL FEATHER IN MILLIMETERS

Age in days	(No.)	Min.-Max.	(Av.)	Nest A		Nest B	
6	(9)	0- 1	(0.6)	0	0.5	1	2
7	(9)	1- 3.5	(2.3)	1	1.5	1	2
8	(9)	1- 6	(4.6)	1	4	3	5
9	(9)	1-12	(8.4)	1	8	9	11
10	(9)	3-15	(11.6)	3	13	12	15
11	(9)	5-20	(14.6)	5	18	16	20
12	(9)	7-25	(18.5)	7	22	21	24
13	(7)	8-28	(21.0)	8	27		
14	(5)	12-36	(28.2)	12	32		
15	(4)	15-37	(28.7)	15	36		
16	(5)	16-40	(29.2)	16	40	36	39
17	(3)	19-48	(37.3)	19		45	48
18	(1)	22		22			



## DEVELOPMENT OF BEHAVIOR

For ease in reference I have separated the data into two sections: (1) Behavior in the Nest, and (2) Leaving the Nest to Independence. The behavior of both sections is discussed together.

## BEHAVIOR IN THE NEST

This is a composite picture, based on regular observations on about nine birds, and irregular observations on about twelve others. The nestling period normally lasts for 18 days, though the birds may leave the nest when some days younger.

FIRST DAY.—Young thrashers, shortly after hatching, assume an embryo position, resting on their belly, the tarsus on each side touching the nest only because of the curve of the bottom of the nest; the head is bent under the breast, resting on its crown.

When a bird is turned over in the nest, onto its back, the weight of the head curved over the breast, and the huge abdomen bring the bird onto its side, where the pushing of the "heel" against the bottom of the nest pushes the animal onto its belly, apparently aided by twisting the neck. The wings and the clutching of the toes are ineffectual in helping.

The tarsus is pushed as a whole, so that the "heel" is the most effective locomotive organ.

When placed on a flat surface, the bird may remain quiet on its side, onto which its structure has caused it to roll, or it may right itself, by using head and heel, into the embryo position, with head under breast or with head resting on its side. Sometimes, when resting quietly, jarring of the surface will cause the bird to turn and crawl away. In crawling the head is raised on the bill, and the body pushed ahead by both "heels" striking out at once. Not infrequently a bird will crawl right off the edge of a board and fall. There appears to be little slope orientation, unless the turning when board is tapped can be so construed. A bird frequently will stay on its side for long periods without making an effort to right itself (fatigue?).

Sometimes the young begged, i.e., held up their open mouth in the food taking at-

titude, to a wide variety of stimuli: touch, jarring and sounds; at other times they responded to one only, or to none of these, or at most gave vague squirmings, presumably dependent on hunger, fatigue and perhaps individuality. At times a bird begged while resting on its side or back after vainly trying to right itself. Sometimes after being removed from the nest and handled a bird begged, though it did not do so at first.

FOURTH DAY.—There is a slight change in the begging attitude, probably correlated with increasing strength. The young bird stands on its belly and feet, with its wings directed out and down, but not touching the nest wall.

FIFTH DAY.—Correlated with physical changes, certain changes in the behavior appear. The embryo attitude is abandoned, and a typical nest position adopted, with head drawn in and chin resting on the nest lining. The wings are now effective aids in righting the young bird, perhaps the result of increasing strength. Placed on a flat surface (board) the young remain quiet; if the board is tapped the young bird does not turn or crawl, as it did when younger, but usually stays in one place and strikes out sideways and clutches with its feet. Here is an important modification for an arboreal nest life. The urge to travel when disturbed is replaced by a tendency to stay still and to secure itself more firmly in place by grasping, though the grip of the toes is still rather ineffectual at this age.

The tendency toward indiscriminate begging has been disappearing, and on the fifth day I was able to secure begging only once, in one bird, in response to intense squeaking.

SIXTH DAY.—The clutching of the feet has become effective and important now. The birds right themselves with ease, in part by pushing with their wings and in part by striking out and clutching with their feet and pulling their breast against the nest lining. This last is not so evident nor so important with this species, with a deep cup-shaped nest, as it is in species with shallow saucer-shaped nests, such as the phainopepla.

The staying still or "freezing" when removed from the nest is very evident, but there is no shrinking from a touch.

**SEVENTH DAY.**—Now a slight shrinking to jarring appears. The grip of the toes is much stronger, and when removed from the nest, the young may bring out bits of nest lining in their feet.

Placed on a board, there is but slight orientation to a slope. With feet drawn up and head drawn in they stay immobile on breast or side as they have been placed.

The only response to jarring is a striking out with a foot.

There is an absence of random movements.

**EIGHTH DAY.**—The shrinking at a touch or jarring is more pronounced; when removed from the nest there is a pronounced slope orientation, the bird turning to face up-hill. The eyes are open most of the time the bird is out of the nest. It was first noticed that the birds void when roughly handled.

**TENTH DAY.**—There is no change in their behavior in the nest, but when removed they give a "churr" and when handled look about instead of remaining perfectly still. However, when put down they still remain quiet. The birds still rest on breast and abdomen with their legs out to the side.

**ELEVENTH DAY.**—The same, except that one bird hopped a few inches to the ground, where, however, it stayed still.

**TWELFTH DAY.**—At my approach to the nest the young crouch wide-eyed; handled, they "churred"; but today a new pattern of behavior appeared, that of escape, barely indicated by one bird yesterday. Four of the birds I handled escaped, hopped and ran to the nearest shrubbery, where they crouched and I was able to pick them up easily and return them to their nest. Returned to the nest they crouched in it. The other birds I handled would have escaped if opportunity had been given them. When examining two young birds, in this stage of passive cowering, and returning one to the nest, the other, already in the nest, begged at the young above it, though I was standing by the nest, with my hand in full view on the nest rim.

**THIRTEENTH DAY.**—There is the same alternation of crouching and fleeing; handling caused crouching birds to flee; quiet caused reversion to crouching. However, birds that escaped into the shrubbery and crouched, now fled again at my approach and were difficult to capture.

**FOURTEENTH DAY.**—The young now sat up looking about, but at the approach of a human shrank back into the nest and closed their eyes at a touch. They were sometimes quiet when handled, but soon became alert and fled when possible, seeking the nearest shrubbery.

When returned to the nest, they frequently did not shrink into it at once, but stood up, alert, flicking their tails, and apparently only a little stimulus would have caused them to flee.

On this day one bird, while being handled, voided copiously in a mucous sac; a few moments later it voided again, but the excrement was not in a mucous sac.

**FIFTEENTH DAY.**—Now all attempted to escape when handled.

**SIXTEENTH DAY.**—By now the young were sitting up on the rim of the nest, but shrank back into it at my approach, frequently one on top of the other. They closed their eyes when touched, and churred when handled. Their escape efforts were more violent. Escaping into the shrubbery, they persistently eluded efforts to capture them, and one bird climbed into the bushes. Some did not crouch into the nest when returned to it, but perched on the nest rim, alert, or in a crouching position.

**SEVENTEENTH DAY.**—The birds first crouched into the nest, but tended to leave the nest at the close approach of a human, or when an attempt was made to seize them. Hopping about the cholla, they sometimes became impaled on its spines and called shrilly; returned to the nest, they remained alert and even hopped about outside it.

**EIGHTEENTH DAY.**—An approach to the nest sent the young hopping out of it to the opposite side of the nest cholla. They sometimes became inextricably impaled on the spines. It was extremely difficult to force them away from the cholla; when



forced from it they flew down toward the nearest shrubbery, where they attempted to elude capture by keeping on the far side and by climbing.

#### LEAVING THE NEST TO INDEPENDENCE

This is a composite picture, based on observations of many young birds in the wild and in captivity. It begins with the nest leaving, which may occur from the 14th to the 18th day.

Between the 14th and 18th day, with the tendency toward immobility diminishing and that toward activity increasing, the young leave the nest. Two young of one nest, usually one a day older than the other, often leave the nest a day apart, the stimulus causing one young to leave not causing the other to do so. Their physical equipment is such that they can hop and run well, but their wings only help them to flutter down at a steep angle.

At many nests under observation the young left during my absence. At others the young left at my approach. They hopped from the nest to the opposite side of the nest cholla from me, and continued to move to the side opposite me as I circled the cholla. It was practically impossible to seize them while in the spiny cholla, and I could secure them only after pushing them from the cholla with a stick. Several times young birds hopping about thus in the nest cholla became firmly impaled on the spines, and it was doubtful that they could have freed themselves. Probably becoming impaled on the spines was due to my influence in hurrying them. That they become impaled if undisturbed is doubtful. (Miller, 1940, *Condor*, XXXIX, p. 218, recorded young thrashers becoming impaled under similar circumstances.) The squealing cry, which the young thrashers first gave on the 10th day when injured, was also given by birds impaled on cholla spines. This call of pain caused the adult to come about scolding in an excited manner. When finally freed from the cholla, the young fluttered to the ground, and sometimes tried to escape capture by keeping the trunk of the cholla, 3 inches in diameter, between itself and me. Driven from that by my reaching

an arm around the trunk, if there was no cover nearby, the young would simply flee straight away, hopping and running. One young, 16 days old, fled straight away through a uniform stand of light shrubbery by a sandy wash. But when it came to the edge of the bare sand, it turned back and dashed between my legs into the shrubbery again.

Usually there were clumps of shrubbery at hand and, after the 13th day, the young fled directly to the clumps of shrubbery. Here they persistently kept on the opposite side of the shrubbery from me. By the sixteenth day they began to climb up into the shrubbery, and by the 18th day this tendency was well developed.

The following shows how the adult bird aids the young one, which has prematurely left the nest, in moving from the presence of a predator. This young was 14 days old. It left the nest about 4 days early, well-feathered but unable to fly. I had removed it from the nest to measure and weigh it, and it escaped my hand. It was sitting on its belly on the ground, in an alert attitude. One adult was walking about a few yards away, quietly, with food in its bill for the young. The young saw it and ran and hopped to it. The young opened its mouth and the adult fed it in a moment. Then the adult and young went directly away from me, past thickets, on foot, the adult usually leading, the young occasionally. Silently they disappeared over a ridge 40 feet away. I later searched in vain for this young. This adult was not greatly disturbed by my presence.

In birds in captivity, between the 14th and 18th days, the same changes were seen that were inferred from observations in the wild. For the first day or so the birds sat quietly, usually in the artificial nest provided. Then they hopped out, usually resting on the whole length of the tarsus, and usually stopping in a crouching attitude. They showed a tendency to get behind objects in the cage. When falling from the height of a table, the wings did little more than help break the fall. By the 18th or 19th day they abandoned this crouching attitude, hopped about and

rested on their toes, and flew down from a height at a steep angle.

The typically avian preening, stretching and sleeping with bill turned over back and wiping the bill were present. They also chirped somewhat like the adult. Exploratory pecking barely started by the 18th day.

In the latter part of this time of nest leaving the captive young birds were occasionally seized with sudden fits of wildness in their small cages; apparently not the result of fear of persons.

An act which appears about the 16th or 18th day, with the abandoning of "freezing," is what I have called the "juvenile defense." It was used occasionally for two weeks longer, until the thrashers began to keep away from fearsome objects.

"Juvenile defense" consisted in drawing back the head, opening the bill wide, and spreading the wings slightly. During this period of two weeks or so after nest leaving it was occasionally directed toward some object that appeared close to it. I saw it given toward a ring-tailed cat, a cactus woodpecker, occasionally toward an extended hand, and toward small objects which were quickly moved toward it in experiments. There was no fleeing, this appearing to be an alternative to fleeing. When the birds were two weeks or so older, they fled from this kind of object.

An illustration of how this may be of value is the following: I had two full-grown immature woodpeckers in the one cage with thrashers. The woodpeckers were very pugnacious, attacking each other or the thrashers when they came close to each other. Once, when a woodpecker attacked a 19-day old thrasher by perching close to it and pecking it, the thrasher adopted the juvenile display pose and squealed; the woodpecker retreated. Here was a case when a display and call caused the retreat of an attacking bird. Later I saw this woodpecker attack a 60-day old bird, which at once fled. Perhaps at about the time of nest leaving the young thrasher flees only from larger objects, giving the juvenile defense to the smaller objects from which it flees when older.

Between the 19th and about the 40th

day the young birds in the wild are out of the nest and apparently more or less associated with the adults and dependent on them. It was not until the wild young had their tails about three-quarters the length of the adult (almost 40 days old by comparison with captives) that they became conspicuous in the desert. They were then solitary.

On one occasion I saw two young thrashers, apparently 30 to 35 days old, following an adult on the ground, begging at it as it dug up something; the adult fed one, then flew away into the shrubbery, the young following it.

In captivity, by the 19th day, the crouching and creeping behind things had almost disappeared. The young were able to fly up a foot or so, hop about on their toes much like adults; stand with their feathers fluffed out like adults; and they began to spend some time in exploratory pecking. They begged eagerly for food and came to be fed. Though food was before them and they sometimes pecked at it, they picked up nothing. Frequently in pecking at plain boards there was a slight digging motion, foreshadowing a coming type of behavior. They began to seek heights for perching.

On the 21st day some individuals, half asleep, sang in an adult manner, but faintly; sprawling in the sun to sunbathe was begun; exploratory pecking occupied a great deal of time; occasionally one picked up a piece of food or some other small object and swallowed it. The young definitely sought heights for perching, though spending much time on the ground.

On the 22nd day I saw birds begging at each other. While waiting to be fed, they sometimes hopped back and forth in front of the person feeding them. By the 24th to 25th day they flew and lit fairly well, did much exploratory pecking, dug holes in the ground, pecked into crannies, picked up things, which acts are carried on into adult life. They ate some food themselves but begged for most of it. Except for feeding they were much like the adult in actions.

By the 35th day the begging, which had been decreasing, had almost dis-



appeared, and the birds were nearly self feeding; by the 40th day they became completely independent and somewhat shy of persons.

Birds taken from the nest on the 14th or 15th day and kept in small cages quickly learned to beg for food at the sight of a human. Two birds, removed from the nest at 18 days of age, never begged for food in captivity. After about a week of forced feeding they became entirely self feeding, at a much younger age than any of the others, which were hand-fed, but not force-fed. The duration of begging in captivity varied also with the amount of care (i.e., the number of feedings) the bird received; the greater the amount of care, the longer the period of begging.

Young thrashers, 20 to 24 days old, kept in small cages from 15 or 16 days of age, struggled and fluttered violently to get through the wire door to come to a person to be fed. One couple of thrashers, taken from a nest at 18 days, which never became tame and never begged, struggled and fluttered violently against the back of the cage at the approach of a person, trying to get out, away from the person. Here the same type of actions was used for two quite different aims: one to come toward an object; one to escape from it.

After becoming accustomed to being fed by humans (in most birds by the 20th day at least), most of the birds came to the humans from 20 to 30 feet away to be fed when hungry, or ignored them when not hungry, until about the 30th day, when a certain shyness was noted. By about the 35th day, the birds definitely avoided the close approach of humans, and this continued during their period of captivity; the birds flew up to perches or became alert when a person came to within 20 to 30 feet; if a person stayed quiet, they would come to within a few yards of him. A quick move would send them scattering.

When thrashers were first learning to beg at humans (15, 16 days old), they occasionally turned their back to the caretaker.

With these thrashers, between 20 and 30 days old, as appears common to many

passerine birds, motion to or from the caretaker was inhibited while they were actually begging. A shy bird in a large cage was easily caught by inducing it to beg. However, before begging the birds often came to the caretaker and they also sometimes interrupted their begging to come closer or to follow the caretaker. Also, as appears general with passerines, when hungry they would beg if a person was nearby, while, if not very hungry, they would feed themselves.

When young thrashers were beginning to feed themselves to a considerable extent (after about 30 days), they still begged occasionally. And two interesting points were brought out at this time. Sometimes the thrashers would beg, and when food was presented to them, and an attempt was made to put it in their mouths, they would make an effort to escape having the food put into their mouths, by drawing back the head and turning it to the side. When food finally was placed in the gullet, however, it was swallowed. I recorded the same thing with bluejays at the same stage of development (*loc. cit.*). Another related phenomenon was that the young thrashers, when nearly completely self feeding, sometimes turned their back to me when they begged, as they still did occasionally. This was not due to any tendency to flee, as, after they stopped begging, they did not flee. These two types of behavior suggest that the innate behavior of begging ceases gradually, and though some of the data recorded above show its cessation may depend in part on external conditions, this evidence indicates the cessation may also be controlled by internal conditions.

When nearly self feeding (about 35 days old) young thrashers sometimes begged at a lump of food lying on the floor of the cage. I have also records of this in two other species; a wild, nearly full-grown house sparrow feeding on crumbs in Central Park, New York, came to a larger crumb and, instead of pecking at it, begged at it; the other case is furnished by Mrs. Rand, who noted that at 12 days of age young song sparrows she was raising

begged at crumbs of food lying on the floor of their cage.

Exploratory pecking appeared by the 19th day and became pronounced a few days later. The thrashers approached, pecked at or seized twigs, pebbles, bits of paper, small cracks, small holes, edges of boards, tins, marks or color bands on other thrashers' legs. The only requisite of the stimulus causing exploratory pecking was some small visual difference in the uniformity of the environment. Anything that looked small and different was pecked at. Of course only objects could be seized. Moving objects, such as a wind-moved feather, or piece of paper, were much more quickly responded to. A smoking cigarette butt was at once approached.

The thrashers' digging action started at 19 days, even while they were still being kept on a board floor; they went through pecking and digging acts on smooth boards. When the birds were released on the ground, they at once began to dig, and up to 96 days old they did much digging, even when not hungry. This is a common action of adults. For details of the digging action of adult thrashers see Engels (*loc. cit.*).

Exploratory pecking appears before self-feeding, which appears about the 21st day, and the actions used in feeding are those used in exploratory pecking, except those for getting the objects into the gullet. Begging decreases gradually, quantitatively, not qualitatively. As begging becomes less, picking up and eating food increases. Very occasionally was there behavior that was intermediate, a partial begging and then a pecking action. The manner in which these birds sought for, picked up and ate food appeared to be rather rigidly determined innately. The young thrashers frequently picked up and swallowed non-food objects, pebbles, bits of wood, or paper, and it is probable that trial-and-error learning is responsible for determining just what a thrasher eats of what it finds. There may be an innate preference for things of certain texture as well as of certain taste. Certainly the captive thrashers learned to eat many foods they never encountered in the wild.

That they quickly discriminate against ill-tasting objects is shown by the following:

When the 6-thrasher group was 71 to 81 days old, and had not been fed yet that day I put in their cage a dish containing a dozen small cubes of hard-boiled white of egg, which were at once eaten. Then I put in a dozen cubes of egg white that had been soaked in formalin. The birds came down and ate them at once; one bird, at least, ate two pieces. None showed evident disgust or discomfort. Then I repeated the experiment with formalized egg white, and the birds did not even come near the dish for twenty minutes. They ignored it. After the twenty minutes the birds were moving about the dish, and some even looked at it, but none pecked at it at all. This was at 11:25 A.M. and the thrashers had not been fed and were hungry.

Each morning for the next six days a tin containing cubes of egg white which had been soaked in formalin was put in the cage and left for a half hour before the birds were fed, when they were very hungry and at a time when my visit usually meant feeding. Sometimes a bird came up and pecked at a piece of egg; occasionally one swallowed a piece, but the rest was not eaten. The birds had learned quickly to avoid bad-tasting food, and the learning was still rather strongly in effect at the end of the week.

During the ten weeks or so I had these birds they consorted amiably together during the day, feeding, resting, perching in close proximity, and at night slept together in the top of a piece of shrubbery in their cage. Rarely two birds quarreled. This they did by standing breast to breast, wings slightly opened and pecking at each other, sometimes hopping up a few inches. This is quite unlike conditions in the wild, where the thrashers are not gregarious. However, the captives were largely independent of group action, each bird acting for itself.

#### DISCUSSION

In common with most passerine birds the young thrasher hatches in a blind, nearly naked condition; has a tendency to keep



right side up and to open its mouth for food in response to a wide variety of stimuli; it is entirely dependent on the adult. In the course of 5 or 6 weeks its physical equipment and its behavior develop so that it can survive independently, finding its own food and escaping its enemies.

In the preceding pages I have recorded some of the progress of this development, and here I will discuss some aspects of it, particularly those in respect to feeding, self preservation and pugnacity.

#### Food Responses

Begging is an innate pattern of behavior appearing at birth and at first is elicited by a wide variety of stimuli. The bird will even beg upside down. Gradually, even before the young bird opens its eyes, the stimuli which will elicit this response begin to be limited in number.

This early indiscriminate begging appears to be a safety mechanism to insure that the young bird will open its mouth when the parent arrives with food. While Holzapfel (1939, *Jour. f. Ornith.*, LXXXVII, pp. 525-553), in a report on an intensive study of starlings, points this out, she also suggests that this early indiscriminate begging is necessary to stimulate the feeding urge of the adult. This latter hypothesis is less well founded and, being capable of proof, should be checked.

The gradual decrease in stimuli which will elicit begging looks like learning. The observations on the young 12 days old, in which one young begged at the other when returned to the nest edge, while I was in plain sight, with one hand on the nest rim, suggests that the young has become conditioned to respond to the sight of a bird above it, and that the lack of this stimulus, rather than fear of me, inhibited begging to various artificial stimuli. Unfruitful responses to inappropriate stimuli result in the elimination of these responses. This agrees with Holzapfel's findings. While the innate behavior is not modified greatly, the conditions under which it is appropriate and to which it comes to be restricted are learned.

That these conditions are actually

learned, and do not correspond to any "in-born perceptual patterns," is indicated by the young birds learning to beg at the approach of a human, while still twenty feet or more away, and to beg at a lump of food lying on the floor of their cage.

After a certain time begging gradually decreases and its place is taken by self feeding. The duration of begging after this time was greatly affected by external conditions, as also has been shown by Holzapfel. Begging did not change to self feeding; rarely was there behavior intermediate between the two; one replaced the other. Begging inhibits motion; one type of innate behavior excludes the other.

The cessation of begging by the young and its attempts to avoid being fed may have an effect on causing the adult bird to stop feeding it, and perhaps the young itself may initiate this change, as Howard (1940, *A Waterhen's World*, pp. 59, 60) has recorded for the waterhen.

Self-feeding acts are innate and appear as exploratory acts before they become important in self feeding, indicating that strength is not the dominant factor in their appearance and development. While the actions of searching for food and self feeding were innate, what the birds ate of what they found was dependent on experience.

This behavior is continued throughout adult life as exploratory pecking; certainly every peck of an adult thrasher does not yield food. Perhaps it has a very real biological use. A wide variety of stimulus objects elicits the pecking, seizing and digging throughout life, so that when the right stimulus is presented the bird responds. In this event further characteristics of the object, perhaps texture and taste, cause the animal to complete the feeding act. These exploratory movements, as incipient food-seeking movements, appear to be the raw material on which learning may work, to fit a bird's general inherited behavior to its particular environment.

Exploratory tendencies also appear in the responses to larger objects, including predators, but as the responses to them are

complicated by some other tendencies, I am discussing them together beyond.

#### Self Preservation Acts

At hatching there are no modifications of behavior for protecting the young birds from hostile elements in the environment. Perhaps the deep cup-shaped nest and the almost constant brooding of the adult make this unnecessary. The adaptations for this appear and change with age and some are present only for a time and are replaced by others.

The first change in behavior which could be inferred to have a survival value against predators is the change to discriminate begging. Though the factors bringing this about may have nothing to do with predation, the result in making the young birds less conspicuous to predators when the birds are not brooded is there.

The next change that appears to have value against predation is the staying still at the approach of an intruder. This appears just after the eyes open. A day or two later appears another change in behavior, a shrinking into the bottom of the nest and a clutching of the nest lining with the feet. This continues until about the time of nest leaving. The tendency to stay still is so strong that even when taken from the nest and placed on its side, the young may remain still. Somewhat later, when seized and injured, the young may cry out. The crouching and staying still is probably homologous with the "freezing" of young precocial birds.

One possible biological function is that the young birds, by crouching back into the nest and staying still, at the approach of a predator, may escape its attention. The clutching of the nest lining may serve the purpose of making the young bird more difficult to extract if a predator does see and seize it. In that case the cries attract the adult, and in the extra time gained by the young in clutching the nest lining, the adult might distract the attention of the predator. Perhaps, too, the cry of the young

may have an effect in startling the predator that seized it.

This crouching back into the nest keeps the young there when its locomotion would be ineffective outside the nest, where feeding and brooding by the adult would be more difficult.

While the thrashers were unable to crawl out of the nest, they moved about in it; when they became strong enough to climb out of it, an adaptation kept them there. That the young are able to leave the nest before they normally do so is easily demonstrated. During the 3 or 4 days preceding normal nest-leaving handling the young birds will cause them to flee. This change can be reversed and repeated. Rough handling causes fleeing; a period of quiet reinstates crouching.

Fleeing normally becomes evident and causes nest-leaving about the 18th day. However, it is not simply fleeing. There is a strong tendency to seek the shelter of shrubbery; to keep something between themselves and the pursuer, and slightly later to climb.

The young at nest-leaving respond in an ineffectual manner to ring-tailed cats, more effectively to a human; perhaps the important difference is one of size. At this stage the adult may aid the young in moving away from a potential predator.

The actions of the juvenile display toward predators during this period (and reappearing in adults when wounded and unable to fly?) may have a survival value in frightening away attacking animals as is indicated by the incident where the woodpecker attacked the young thrasher.

The adult, unlearned responses to predators are not simply self-preservation, and are so complicated by exploratory responses and pugnacity that I am discussing that under a separate heading.

#### Pugnacity

This is an innate type of behavior appearing somewhat late and seems to be brought about by each of two birds stimulating the other by its actions.

## RESPONSE TO STIMULUS OBJECTS, ENEMY AND OTHERWISE

All the data are given first, and then discussed at the end of this section.

## DATA

The procedure is to mention the relative size and the biological significance to the thrashers of the stimulus objects and the age of the thrashers when the objects were first introduced. The first introduction was the first time the birds of each group had seen such objects. Succeeding introductions of different objects can be quickly checked by referring to the ages of the groups, which are given in days.

The following stimulus objects were presented to the thrashers:

Chipmunk	Kites passed overhead
Woodrat	Live snakes
Rabbit	Dead snakes
Ring-tailed cat	Artificial snakes
Small cylinders	Miscellaneous stimulus
Electric train	objects
Red-tailed hawk	Gila monster
Fowls	Horned toad
Great-horned owl	Other lizards
Paper bundle	Artificial lizards
Roadrunner	Tortoise
Screech owl	Tadpoles

**CHIPMUNK.**—The chipmunk is a common, diurnal animal in the thrasher's habitat and probably biologically neutral to the thrasher.

A young chipmunk was introduced into the 8-thrasher cage when the birds were about 40 to 60 days old, and had presumably never seen a chipmunk before. The young chipmunk, about half the body size of the thrashers, moved feebly about.

The thrashers approached it directly and pecked at it without signs of excitement, until I removed it after a few moments.

**WOODRAT.**—The woodrat is common in the thrasher's habitat and probably frequently seen. Its actions probably do not affect thrashers. When birds of the 8-thrasher group were 31 to 37 days old, I introduced a woodrat about twice the size of the young chipmunk into their cage. It was the first time the birds had seen a woodrat.

The rat, running about, came within a foot or so of two birds, which fled a short distance. For some minutes several of the birds gathered about the now quiet rat, peering at it and sometimes spreading the

wings and calling a wooden "kut" repeated a number of times in a type of behavior I found to be commonly given to snakes, and which I discuss later, calling it the snake display. Several times the birds lost interest in the rat when it remained quite and then, with renewed activity of the rat, returned to inspect it. Once the rat fled rapidly from the group of birds, which followed it on foot, without calling or spreading the wings; one bird following very quickly caught up to it and pecked at its tail, but soon lost interest in it again when it became quiet. Later the rat, moving about the cage, caused birds to retreat from it when it came within a foot or so of them, and to ignore it when it stayed further away.

The rat finally found partial concealment under a piece of cardboard. While remaining quiet there, it was ignored; when it moved, thrashers up to five feet away sometimes gave the snake display for a few moments, though when it was in plain sight at this distance, it was ignored.

**RABBIT.**—The domestic rabbit used in the experiment was an exotic, but similar in shape to the three species of rabbits, two jack-rabbits and a cottontail that were common in the thrashers' habitat. They are harmless to thrashers. When the birds of the 8-thrasher group were 69 to 75 days old, I introduced a large black and white domestic rabbit into their cage. They had never seen a rabbit before.

All were at once alert; three came toward the rabbit, two on the ground, to within 4 feet of it. The rabbit sat up and washed its face. Five thrashers came onto the ground 5 to 7 feet from the rabbit, watching it. The rabbit hopped toward them leisurely and all the thrashers fled to a distance, when the rabbit was still 5 feet away. Seven of the eight thrashers then lined up on the table, peering down at the rabbit. When it hopped to a spot below them, they all fled to a distance. The rabbit then hopped leisurely about the cage, the thrashers watching from various perches, and sometimes one or two lighting on the ground behind the rabbit, and hopping along after it. Once one hopped

within 6 inches of it, as though to peck it, but then retreated. After twenty minutes all the birds had settled down to a state of watchful indifference, carrying on their activities in various parts of the cage, but keeping away from the rabbit. After fifteen minutes more one bird hopped along near the rabbit, and circled around it one foot from it.

This was checked with the 6-thrasher group, when they were 68 to 78 days old. Upon seeing a rabbit for the first time in their lives, the responses were similar to those of the 8-thrasher group.

**RING-TAILED CAT.**—This cat, about the body size of a house cat, is common in certain habitats in this part of the thrasher range, and thrashers occur in the same habitat. The cat is nocturnal, and probably would be seldom seen by the thrashers. It would undoubtedly eat thrashers, but their almost universal habit of sleeping in the tops of spiny cactus (cholla) would protect them well from night attacks. Over most of the thrasher habitat the cats are absent. In brief, wild thrashers probably seldom see this potential and probably unimportant enemy.

Two young thrashers, taken from the nest when 18 days old, were placed in a spacious cage and allowed to become at ease. An adult ring-tailed cat was then introduced. It ran past them several times, frequently only a few inches distant from them, and once it stopped to sniff at them. Though well able to flee, the young thrashers did not do so. Once one gave the juvenile defense act, but for the rest this dangerous enemy was ignored.

When the birds of the 8-thrasher group (which included the above two birds) were between 57 and 63 days old, I released a ring-tailed cat into their cage. Except for the above two birds, they had not seen a ring-tailed cat before. The cat at once ran past them to the far end of the cage. All the thrashers flew to distant parts of the cage, giving a few startled calls. The cat stayed still at the far end of the cage and one bird flew and lit about 3 feet from the cat, hopped closer, within 2 feet of the cat, peered at it, hopped about it, finally pecked at the end of its long tail,

then leisurely retired, after three minutes of attention. For thirty-five minutes the cat stayed quietly and, except for the above single bird, was largely ignored by the thrashers, except that they kept 4 or 5 feet away from it as they went about their affairs. I then made the cat move, and as it ran the length of the table in the cage, several thrashers followed it on foot at a distance of 3 to 6 feet. It then went to the ground; some thrashers followed it to the ground, some stayed on the table looking over the edge at it. The cat climbed back onto the table, sending all the thrashers fleeing wildly, to return almost at once to a place near the cat as it moved about. Shortly the cat began to go round and round a box on the floor of the cage, frequently stopping to peer around the corners as it came to them. The thrashers ranged themselves on perches 6 to 10 feet away and watched the cat, sometimes shifting their perches in order to be able to see the cat when it stayed for some time in one place. When the thrashers were on the ground, and the cat appeared suddenly close to them, they fled wildly, and far beyond the point to which they returned almost immediately. Shortly the cat went into a box lying on its side. None of the thrashers could now see the cat. Soon three thrashers flew to the ground a few feet in front of the box, peered at the cat for a few moments, then left. Now all the thrashers disregarded the stationary, quiet cat. About an hour after its introduction I removed the cat.

When the birds of the 6-thrasher group were between 68 and 78 days old, I introduced a ring-tailed cat into their cage. It was the first time they had seen one, and the responses were very similar to those of the 8-thrasher group recorded above. There was no scolding.

When the same 8-thrasher group was 69 to 75 days old, I again introduced a ring-tailed cat. The response of the thrashers on this second occasion was much milder than when they were 57 to 63 days old. There was little approaching and watching of the cat; and there was little hurried fleeing. The thrashers just ignored the

cat, except for keeping a few feet away. Once the cat slowly passed a thrasher at about 2 feet distance and the thrasher only watched intently.

**SMALL CYLINDERS.**—When the birds of the 8-thrasher group were 28 to 34 and 29 to 35 days old, small cylinders of wood or metal, varying in size from one-half inch diameter by two inches long, to one and one-half inches in diameter by ten inches long, were moved across the floor of the cage by means of an apparatus concealed in the ground. Sometimes the birds would follow, and peck at the smaller objects; if close to the larger objects, they would hop away. None of the objects received much attention.

**TRAIN EXPERIMENTS.**—To determine the importance of motion of larger strange objects I used an electric toy train. I introduced this to the birds of the 8-thrasher group when they were 27 to 33 days old. The train, consisting of an engine and four cars, standing still on the track, received little attention from the thrashers; a bird only occasionally pecking at some part of it. All of the thrashers were within a few feet of the train when I started it. At once all the birds flew to the opposite side of the cage, where they watched the train attentively. There was no indication of a snake display, only fleeing. This was later repeated a number of times on different days with similar results. With fewer cars on the train the fleeing was less violent.

**RED-TAILED HAWK.**—This hawk, about 20 to 22 inches long, is a heavy-bodied, slow-flying bird, common over the thrasher habitat and a potential though probably unimportant predator.

When the 8-thrasher group was between 89 and 95 days old, I introduced a full grown, immature hawk, the first they had seen, into the cage at about 5 o'clock in the afternoon. The hawk flew half the length of the cage, alighting on the ground. The thrashers hurriedly retreated into the far side of the shrubbery. The hawk then flew to a perch in the corner of the cage, where it stayed quietly. I left the hawk in the cage from late afternoon until mid-morning the next day. It spent the time

sitting quietly, only moving its head or shifting slightly on its perch.

The thrashers kept in the far side of the shrubbery or the width of the cage from the hawk. This they continued during the time the hawk was in the cage. They only kept a distance from it; they showed no tendency to approach it, nor did they display to it. The call of alarm occasionally uttered was the "wit-wit."

**FOWLS.**—Two chicks were raised in the 8-thrasher cage with the thrashers. By June, when the thrashers were 90 days old, these chicks were two-thirds grown. The relations had always been amicable. The two species often sprawled side by side. A fowl would occasionally run at a thrasher, which would flee, and the fowl chase, but in a moment the same thrasher might be back standing in the shadow of the same fowl.

**GREAT-HORNED OWL.**—This owl, about 20 to 24 inches long, is a heavy-bodied bird, common over the thrasher's habitat and is a potential predator.

I placed an adult great-horned owl on a log in the corner of a large cage and released 2 thrashers 19 days old (of the 6-thrasher group) near it. The owl was continually turning its head and making other small movements. The thrashers paid it no more attention than they did the log; they hopped and pecked between its feet, lit on its head, whence they slid down its back when it moved its head. Finally the owl struck with one foot and seized a thrasher, which squealed as they do when roughly handled. The other bird hopped away a foot or so, then hopped back. The owl released the thrasher shortly, and it sat back, with bill open in the juvenile defense pose, occasionally squealing. The other bird was close to it. Even yet they did not flee from the owl.

When the birds of the 8-thrasher cage were between 29 and 35 days old, I introduced an adult great-horned owl. It was the first owl they had seen. It sat quietly in a corner. The thrashers watched it intently and one approached to within 4 feet of the owl and gave the snake display of spread wings and repeated "kuk" calls. The owl sat quietly, moving its



head. I gently drove three birds to within 3 feet of the owl. Two gave the snake display for a moment, then began to peck at the ground. One moved within 2 feet of the owl, gave the snake display, and then began to peck at the ground. Soon the thrashers began to disregard the owl. One hopped directly under it (it was only 6 inches above the ground), another perched beside it, only a few inches away. Occasionally one pecked at the owl's feet or breast feathers, one lit on the owl's back and, when the owl moved, that bird flew off and two other birds nearby flew away. Then, after a period of quiet, with the birds about the owl, it flapped its wings, sending all the thrashers fleeing. This was soon forgotten, and the thrashers lapsed into indifference.

When the 8-thrasher group was 57 to 63 days old, I again introduced a nearly full-grown immature owl. All the thrashers were at once alert and alarmed, staying 10 to 15 feet away from it, watching intently and giving the loud "wit-wit" alarm call of the species. Most of the birds went into the shrubbery, about 10 feet from the owl.

I then placed the owl in the shrubbery; three thrashers came to sit there in its outer edge, 4 feet from the owl; the others did not come as close, lining up on the edge of a table about 1 foot farther away. From there they peered at the owl, occasionally calling "wit-wit." This continued for ten minutes, until I removed the owl.

There was a tendency to go toward the owl, but 4 to 5 feet seemed to be the limit. There was little advancing and retreating; they stayed at one distance and watched, peering. There was no snake display.

When the 8-thrasher group was 84 to 92 days old, I introduced the immature owl again. The actions of the thrashers were similar to those when 57 to 63 days old. When the owl flew the length of the cage, all the thrashers flew into the shrubbery. I left the owl in the cage two days, by which time the thrashers had become somewhat used to it; occasionally one would come within a foot of it, but most of them kept 3 to 4 feet away. However,

one bird came and pecked at the owl's toes and later the same thrasher came and pecked at the owl's breast feathers. The owl was usually quiet, only turning its head, and I saw no attention paid by it to any of the thrashers.

The next day I put a well mounted great-horned owl on the perch which the live owl used to occupy in the 8-thrasher cage. The birds at first treated the stuffed owl as they had the live one, occasionally peering at it from 2 or 3 feet distance; but by the time the stuffed owl had been in the cage about 4 hours, the thrashers had come to ignore it completely, and perched close beside it. I left the stuffed owl in the cage over night. Early the next morning the thrashers pecked away part of the stuffed owl's head. The tearing of the head of the stuffed owl is more understandable when compared with the experiments with paper models given beyond.

The following experiments with the 6-thrasher group had similar results. When the 6-thrasher group was between 56 and 66 days old, I introduced a well-grown immature owl. The thrashers kept the full width of the cage away from the owl, watching it. Occasionally a sharp "wit-wit" was given. The owl kept looking about during this time. This continued for the five minutes I left the owl in the cage.

There was no approach toward the owl; perhaps due to the small cage they already felt they were too close. When the birds of the 6-thrasher group were between 70 and 80 days old, I again introduced the owl. All the birds watched it from the extremes of the cage. The owl shook itself vigorously, sending all the thrashers fleeing violently against the wire. The owl became quiet, and the thrashers resumed their perches, alert and watching. In five minutes time, the owl moving only its head, the thrashers began to lose interest, moving about the cage but keeping well away from the owl. In another ten minutes they paid less attention to it, but still avoided it. They were becoming accustomed to it. When the thrashers were 74 to 84 days old, I introduced a

mounted great-horned owl. At first the thrashers were as afraid of it as of the live owl, but five hours later they were perching about and on it, disregarding it as an owl completely.

**PAPER BUNDLE.**—When the 8-thrasher group was between 84 and 89 days old, directly after removing the red-tailed hawk that had been in their cage, I introduced a bundle of crumpled paper, about the size of the hawk. This I sent along the length of the cage, about 2 feet below the roof, on a string running over pulleys. It was brought to rest on the perch in the corner of the cage where the hawk had been and left there quietly. The thrashers fled from the vicinity of the paper bundle, but less violently than from the hawk, and in ten minutes the thrashers were going about their ordinary activities, keeping 10 to 15 feet from the paper bundle (they kept much farther from the hawk). After a half hour I made the paper move slightly, by pulling on the string. The thrashers fled to the shrubbery or to distant perches, much as they had done when the hawk was there.

I then placed the newspaper bundle in the shrubbery, on the perch where the great-horned owl had been. Most of the thrashers kept out of the shrubbery, though 2 or 3 occasionally came to perch in its fringes for a few moments. After a half hour I put the paper bundle on the ground and left it still. The thrashers soon came to ignore it, then in their wanderings about the cage they came to it, and pecked at it. A few hours later I found many holes had been pecked in the paper and strips torn from it.

When the 6-thrasher group was 75 to 85 days old, I introduced into their cage a brown paper bundle about the size of a great-horned owl. It was tied in the middle, giving an hour-glass shape. It was not ignored; at first the thrashers showed alarm by peering at it from a distance; some birds gradually approached it, peering, and pecked at it; one bird spent about twenty-five minutes exploring it, pecking at it, perching on it. The thrashers then came to ignore the paper bundle, only occasionally investigating it by pecking at it when they came in its vicinity. The bundle

was later tied into a variety of shapes, with the same results..

**ROADRUNNER.**—This slender, agile, largely terrestrial cuckoo, about 18 inches long, is common throughout the thrasher's habitat. It is carnivorous, and probably would eat young thrashers, but adults are undoubtedly too large and strong for it to prey on. Once I saw a thrasher driving a roadrunner from the vicinity of the thrasher's nest by flying down at and scolding it.

A young thrasher of the 3-thrasher group, from its 16th to its 18th day of age, was kept in a cage adjoining that of the two roadrunners. The thrasher frequently passed on foot close to the wire screen separating it from the roadrunners, and they continually tried to seize it through the mesh. The thrasher ignored them, never even retreating before their attacks. When the thrasher was 18 days old, one roadrunner got into its cage and seized it. It was at once released, but not before the plumage of one wing had been considerably damaged. Later in the day this same thrasher still ignored the attacks of roadrunners directed at it through the wire mesh. Apparently it did not learn by experience at this age. This was in striking contrast to what happened with a young quail. A roadrunner got into a cage containing young quail about two weeks old, ate three and seized one which escaped with a damaged wing. Afterward this injured quail was much more afraid of any approaching object than any of its companions; the result of personal experience.

Not until the above thrasher was 21 days old and had begun to seek heights did it retreat before the attacks of the roadrunners, directed at it through the wire.

When the birds of the 8-thrasher group were between 84 and 90 days old, I introduced two roadrunners, which I had raised in captivity, into their cage. The thrashers had never seen roadrunners before; and the roadrunners had no previous experience with thrashers.

At first the roadrunners were bewildered by the new surroundings, ignoring the thrashers, but they very soon became at

home. The thrashers at first kept 6 to 12 feet from the roadrunners, but soon they allowed the roadrunners to stalk within a foot or so of them.

The roadrunners soon went to the food dish and one began to worry a piece of meat. While it was doing this, one, then another thrasher came up to within 6 inches, to look at it. One gave the snake display. A few moments later a thrasher was worrying a piece of meat. The roadrunner ran toward it and the thrasher flew away. Then the roadrunners began to run at every thrasher on the ground and chase them up into the shrubbery or onto the table. At first the roadrunners often got to within 6 inches of a thrasher before it fled. When the roadrunner ran rapidly toward a thrasher it fled directly, sometimes calling "wit-wit," the generalized thrasher alarm call; when the roadrunner made a slower approach the thrasher sometimes spread its wings in the snake display; once a roadrunner stalked slowly after a thrasher which hopped ahead, giving the snake display, facing away from the pursuing roadrunner. Once a thrasher put the trunk of a shrub between itself and the roadrunner, and for some moments the birds circled around the trunk of this shrub, the thrasher with wings spread as in the snake display keeping opposite and facing the roadrunner.

Occasionally a roadrunner walked up slowly to a thrasher. Then the thrasher did not flee, and the roadrunner apparently did not know what to do and retired.

After an hour and a half the roadrunners were chasing every thrasher that came onto the ground, and sometimes followed them onto the table, but not into the shrubbery. Soon the thrashers no longer ignored the movements of the roadrunners, even when they were 6 to 8 feet away, but watched them nervously. Sometimes now they fled, when one passed them at 4 to 6 feet distance, while early in the day they allowed the roadrunners to pass within less than a foot of them. They had learned that the approach of a roadrunner meant that they would be chased. Sometimes this "wit-wit" of a fleeing thrasher started others nearby into flight. The

roadrunners continued throughout the day to chase thrashers spasmodically. For ten or twenty minutes every thrasher in sight on the ground or table would be chased. Then the roadrunners would rest for a period.

Though in the afternoon the roadrunner passing 6 feet from a group of thrashers would send them flying, when the roadrunner was at rest a thrasher often came and looked at it, and even pecked at its tail. The following is an example: at 4:10 P.M. a roadrunner was lying on its breast on the ground. A thrasher went to it and pecked at its tail feathers. The roadrunner slowly moved away, the thrasher followed and pecked at its tail; the roadrunner then moved four feet away, and the thrasher followed and pecked vigorously at the roadrunner's tail without the latter bird moving. The thrasher then retired.

The next day the roadrunners did much less chasing, and the thrashers paid less attention to them, except during periods of active chasing which still occurred. Two days later the two species associated closely with each other and got along fairly amicably together. Only occasionally a roadrunner would chase a thrasher, and sometimes a thrasher would run at a roadrunner, and the roadrunner would run away. They slept close together in the same shrub.

**SCREECH OWL.**—The screech owl, common over most of the thrasher habitat, is about 10 inches long, and somewhat larger in apparent size than the thrasher. Once I startled a screech owl into flight near a pair of nesting thrashers and at once they flew after and darted down at it, scolding in company with other passerine birds, in typical "mobbing" activity of passerine birds.

When the 8-thrasher group was between 86 and 92 days old, I introduced a full-grown, immature screech owl into their cage, perching it in a shrub. It was the first screech owl they had seen. The thrashers at once evinced interest in it, the owl sitting quietly, except for a few small movements. In a few minutes 6 of the thrashers were peering at the owl from a

distance of 1 to 3 feet. After 5 minutes the owl flew closer to two of the birds, which flew away a short distance, peered uneasily for a few moments, then flew farther away. The birds soon lost interest in the owl, which sat quietly. I then left, returning in an hour's time to find a thrasher sitting near the quiet owl. The thrasher was peering at the owl, occasionally reaching out and pecking at the owl's toes. Once a thrasher reached out quietly and pecked at the owl's face. The owl only shook its head. The thrasher lost interest and left in about 5 minutes.

I discontinued observations until mid-day (three hours and a half later) when I found the owl on the ground in the shade of a shrub. The thrashers were also gathered in the shade, some within 8 inches of the owl, but ignoring it except for occasionally peering at it. One thrasher, pecking at the ground, came to within 2 inches of the owl. The owl struck at it and the thrasher fled a foot. The seven other thrashers, all within 18 inches of the owl, ignored the incident, and nothing more happened.

I left the owl in the cage overnight, and at 6:30 the next morning I found a group of the thrashers "mobbing" the owl. The owl was moving about the cage, perching for a few moments, then flying to another perch. Three to five thrashers were about the owl, calling sharp, excited calls, and occasionally flying in to strike at it where it was perched; following and striking at it as it flew. This was a typical "mobbing" scene such as is carried out by a great many passerine species in the presence of an owl.

Soon the owl settled quietly and the thrashers ignored it. During the morning the owl came to rest in the shade of a shrub, and the thrashers gathered in the same patch of shade, some within 6 inches of the owl, ignoring it for the most part.

When the 6-thrasher group was between 75 and 85 days old I introduced a screech owl for the first time. It flew and hopped about a few moments before perching quietly. The thrashers peered at it from their perches 1 to 5 feet away; one thrasher came up to within about 6 inches of the

owl, darted in at it and then away again, then approached the owl from behind, and pecked at it. The owl just ducked its head. Then 2 thrashers came to within 8 inches of the owl, in front of it, and the owl jumped at them, causing them to fly a foot away. Several times in the next few minutes the owl jumped at thrashers coming to peer at it. Once the owl flew at a thrasher 12 inches away, landing on the spot hastily vacated by the thrasher. The owl now began to move about, making short flights of 1 to 2 feet, the thrashers keeping 2 or 3 feet from the owl.

After that none of the thrashers were ignoring the owl. They were all peering at it, occasionally spreading the wings and giving a wooden "kuk" repeated a number of times. The thrashers then collected in a group 2 to 3 feet from the owl; several times a thrasher flew in to strike the owl and return to the group. The owl flew at them, to light on the place from which the group had just scattered. The thrashers began to keep away from the owl, which settled down quietly. This was the end of a typical "mobbing" scene. By the time it had been in the cage twenty minutes the owl was sitting quietly in a corner of the cage and the thrashers were going about their affairs, paying little attention to it, except to peer at it occasionally when near it.

For the next four and a half hours the owl spent most of its time sitting quietly. The thrashers ignored it, sometimes coming to perch within a few inches of the owl, and only peering at it. However, once a thrasher pecked at the owl's bill and body, only to have the owl strike at it and send it flying 18 inches. I saw no more mobbing.

**KITES PASSED OVERHEAD.**—When the 8-thrasher group was 36 to 42 days old, and 45 to 51 days old, experiments with kites of various shapes, including squares, circles, triangles, duck and hawk shapes, passing 30 feet over those birds at various speeds, produced a slight scattering for each trial. There appeared to be no discrimination of shape. The snake display was never given.

In this species fear of shapes moving

overhead seems to be generalized. These birds had occasionally seen birds flying overhead. I observed a slight scattering in the 8-thrasher group (84 to 90 days old), when a red-tailed hawk soared 100 feet overhead, and the same for a turkey buzzard. With the 6-thrasher group (65 to 75 days old) a mourning dove passing 20 feet from the cage caused the birds to scatter a few feet, some even flying up toward the dove. Sound perhaps played a part there.

**SNAKES.**—Snakes of several species are common in the thrasher's habitat, and the largest ones of some species will undoubtedly eat thrashers.

The following is the "snake display" I saw given by a wild adult bird. A 55-inch gopher snake was slowly crawling along on the ground against the wire mesh of a cage. An adult thrasher feeding on the ground through the shrubbery outside the cage came to within ten feet of the snake before seeing it. The thrasher then came closer, slowly, watching intently. The snake moved slowly along, and the adult followed it, coming within two feet of the snake's head, scolding a throaty, wooden "kuk" repeated a number of times, and spreading its wings in the horizontal plane while facing the snake at 18 inches to 2 feet distance. This continued for some minutes before the thrasher left. This thrasher had no nest within 100 yards, at least, of this spot.

I have called this a snake display, because I found it commonly given to snakes by captive birds; only rarely to a wide range of other objects. It is not only an expression of fear caused by snakes, because the behavior includes an approach toward and a scolding of an enemy, and afterward a leisurely leaving.

**LIVE SNAKES. A.**—Two young thrashers, 17 and 18 days old (later placed in the 8-thrasher group) and about ready to leave their nest, were removed from it and placed in a large cage. They were soon much at ease, spending most of their time resting, but sometimes moving about and peering at objects. They paid little attention to the slow approach of a human, but fled from a quick approach. To a

rapidly extended hand, and once to a ring-tailed cat, running quickly past them, they gave the juvenile defense display.

About eight hours after their removal from the nest a live 42-inch gopher snake was put alongside them. They paid no attention to the snake, even hopping onto the slowly moving coils, and once one even nestled down among the coils. Twice within a period of three minutes the snake struck and seized one of the thrashers, once wrapping its coils about the bird before I could release it. But even after this the thrashers showed no fear of the snake, and after this again perched on its slowly moving coils.

The young birds, which had presumably never seen a snake before, showed no fear of it, even after being struck by it. Their response to being struck by the snake was no different from their response to becoming impaled on and then escaping from the spines of the cholla in which their nest was placed.

That they were capable of other responses, if not the snake display, was shown by their "juvenile defense act" directed toward the ring-tailed cat and toward a rapidly extended hand, and by their fleeing from a rapidly approaching human.

This indicates that, though the birds are physically strong enough to respond to a snake, the pattern of behavior which adults show toward snakes was not used.

**B.**—I later put the 42-inch gopher snake in a cage with two twenty-day old, inexperienced thrashers (later placed in the 6-thrasher cage). The thrashers moved about the cage with considerable facility. When the snake came close to them they fled a few feet (3 to 5 feet) from the snake, regarded it intently, then simply kept away from it.

**C.**—The next experiment was conducted with the above two birds of Experiment A and six others (the 8-thrasher group). Their ages varied between 24 and 30 days. They had been removed from nests and raised by hand. Apparently they had never seen a snake, with the exception of the two birds used in Experiment A, in which the results had been negative.



The birds were in good condition, flew freely about their big cage, fed themselves in part, and as yet had no fear of humans if they did not move quickly. They still clustered about humans and begged for food. They were not yet at the age when they would have been independent in the wild.

The snake was a 55-inch gopher snake. I placed it about three feet from a group of four birds. The snake crawled slowly toward them; they fled several feet, then stopped, watched it alertly, then came toward it a short way and gave the "snake display" as I have described it for the wild adult. Shortly the snake crawled to another part of the cage and six thrashers gathered about it, from three feet to five feet from it and in more or less of a circle, facing the snake and giving the "snake display." After about five minutes the birds went about their affairs in other parts of the cage. When the snake in crawling about the cage came to within a few feet of thrashers on the ground, they retired before it, occasionally a bird giving the snake display for a few moments. Occasionally a bird, moving about the cage and chancing upon the snake, would give the snake display, approaching to within three feet or so of it, and continue this for a few moments, then move away.

Once the snake came around the corner of a box, appearing suddenly within a few feet of five birds resting on the ground. This caused all the birds to flee wildly.

This demonstrates that without previous experience these thrashers gave the "snake display" toward a snake just as does the adult.

The sight of the snake at 5 to 10 feet distance caused these birds to approach it and display. When the snake appeared suddenly near the birds it sometimes induced fleeing.

D.—The above observations suggested that one bird giving the snake display did not cause other birds to do the same. This was checked on the same birds three days later. The same 55-inch gopher snake was introduced into the cage in a box which was placed on its side and opened, facing away from the thrashers, so that they

could not see the snake. After some time one bird lit by chance in front of the box. It gave the snake display for a few moments, 2 feet from the snake, then flew away. Shortly another bird did the same for a few moments. Though there were five other birds within 10 feet of these scolding birds, none paid any attention to them.

The gopher snake, which differed from a king snake, which had been used just previously, in its larger size and bolder pattern, then crawled the length of the cage and all the thrashers gathered about 2 to 3 feet away from it, moving along with it and giving the typical "snake display" for much longer than they had to the king snake. This demonstrated clearly that the sight of the snake was necessary to cause the snake display. It also indicated that the larger (and more boldly marked) snake caused a much stronger response.

E.—In the next two weeks these thrashers were occasionally presented with the 55-inch gopher snake in the course of other work. The length of time the snake display was given, the distance from which the birds would come to display, and consequently the number of birds scolding at one time varied. The snake was never ignored when in the immediate proximity of a bird.

One day all eight thrashers at once gathered in a circle around the snake, which coiled itself and remained nearly motionless at the base of a shrub. Once they all continued this for about ten minutes. Another day the birds might be more indifferent, ignoring the snake from a distance of 7 to 10 feet, retreating as it came closer, and only an occasional bird hopping up from a distance to within 18 inches to 3 feet of the snake and displaying.

The effectiveness of the same snake, presented to the same birds, in evoking the snake display varies. Between the time the birds of the 8-thrasher group were 24 to 30 and 52 to 58 days old they were presented with snakes more than 15 times. The snake was usually left in beyond the time the group ceased to respond to it, usually 5 to 15 minutes; then individual birds only responded to it if

it crawled near them, or if they happened into its vicinity.

Despite these repeated presentations of the snakes, there seemed to have been little or no waning of the response to the snake each time it was introduced. Indeed one of the best displays of the whole group was when the birds were 46 to 52 days old.

F.—A number of experiments with various sized snakes (unfortunately usually of different species) indicate that the larger the snake the more intense was the snake display.

The following experiment carried on when the ages of eight birds were between 52 and 58 days is typical.

A 12-inch garter snake was placed, tethered, in the cage. Two thrashers at once came and inspected it, at a distance of about 2 feet, occasionally giving a momentary snake display, then flew away; other birds perched 10 feet away, peered at it for a few moments, then lost interest.

A few minutes later one bird came to the snake, hopped about, occasionally giving a momentary snake display; then the bird approached as though to peck it, and the snake, too small to be an enemy, struck at it. This caused the thrasher to jump back, and it continued its wary circling. Two other birds joined it, and for a few minutes they, too, hopped about it, only occasionally giving the snake display, and then only momentarily.

I removed this small snake and introduced the 55-inch gopher snake. The snake display given to it was much more intense than that given to the garter snake and the birds kept farther away.

DEAD SNAKES.—When the birds of the 8-thrasher group were 28 to 34 days old and had seen snakes three times before, I put a dead, coiled, 48-inch red racer in their cage, placing it about two feet from five birds sitting quietly. The birds became somewhat alert, two regarded it intently, peering down at it for a moment, then all ignored it. I removed it and placed a 30-inch, dead, coiled rattlesnake in the cage. One bird came to it, displayed, then hopped away. Other birds, only 2 to 3 feet away, ignored it. Ten minutes later

four birds came by chance to perch two or three feet from the snake. One displayed for a moment, then they all ignored it without coming closer. Similar results were obtained with the 6-thrasher group when they were older, though occasionally they came closer and pecked at the dead snake. The response to the dead snake was much less pronounced than to live snakes.

I then attached the dead, stiff, formalin hardened snakes to threads and by pulling the thread over pulleys moved the snakes along the cage. They moved slowly as coiled units, and the birds, 5 to 8 feet away, only watched them casually. When closer, they only hopped away. Apparently this type of motion did not bring forth the snake display, as a live, crawling snake would have done. When the 8 birds were 52 to 58 days old, I put a recently killed, wriggling 36-inch milk snake in their cage. Four birds at once came down and displayed. I then removed the snake, skinned it, and then put the quiet, skinned snake body in the cage. The birds' response was at first the same as for the whole, wriggling snake; four birds came from about 10 feet away and displayed; then there was a change in the birds' behavior. They came closer, abandoning their display behavior, and finally one bird pecked at the tail of the snake body. This they had not done to the whole snake. Very shortly (3 minutes after the introduction of the snake's body) they lost interest in the body and went away.

The skinned body of the snake elicited the snake display, but when the birds came close they changed their behavior to closer approach, pecking, and very soon lost interest. The wriggling snake just before had induced a prolonged snake display, without any close approach or pecking.

Then I removed the snake body and spread the fresh snake skin flat in the cage. The result was an immediate response. Five birds came and displayed from 8 to 18 inches from the snake. One came closer and pecked at the skin of the head. This bird was vigorously peck-

ing at and shaking the anterior 8 to 10 inches of the snake, so that it rolled into a rope shape, sometimes frightening the other four birds, which were sporadically displaying at 8 to 10 inches, into short flight by the movements of the snake skin, and sometimes the movements appeared to frighten the bird that was causing the movements and it fled a short distance to return at once. One other bird hopped onto the skin and pecked at the scales of the back; the other three remained alert, less than a foot away, and occasionally displayed. This continued until I removed the snake skin, five minutes after its introduction.

The previous experience of these birds with snakes may have influenced the behavior of these birds; that is, they had had an opportunity to learn.

**ARTIFICIAL SNAKES.**—The constant response of the thrashers to live snakes was next tested with artificial snakes moved across the cage. I hoped to devise an artificial snake which would duplicate the response to a live snake, and then to modify this to limits where the response differed. Snakes of various lengths up to 30 inches and various thicknesses were cut from sheets of sponge rubber. Some were shaped like snakes, some were colored to correspond with local snakes. Some had cuts made in their sides at intervals to increase their undulation when moved. They were moved by being attached to loops of thread which ran over pulleys at each end of the cage. These gave a fairly good imitation of a snake crawling.

The artificial snakes at rest received little attention; occasionally a bird approached and investigated them by pecking at them.

When the 8 birds were 31 to 37 days old, I tried them with various sized rubber "snakes."

A plain-colored rubber oblong, 30 by 1 inch in size, on its first presentation, moving across the floor of the cage, secured a complete snake display from all the birds for the five minutes of its presentation. When this was presented several times later in the day, it sometimes called forth a snake display, at other times it did not.

When I repeated the experiment with this rubber snake on subsequent days, the reaction was at most rather slight, and it was usually ignored.

When the birds were 31 to 37 days old I also sent a plain rubber oblong "snake" sixteen by one-half inch in size past them. This received but mild attention, and on later presentation on later days was largely ignored. At most the birds fled a few inches if it passed within a foot or so of them.

Also, when the birds were 31 to 37 days old, I passed a five by one-quarter inch plain rubber "snake" past them. One bird followed it intently, seizing and shaking it. Later experiments with this usually had negative results.

I later modified the shape, and then the color of these rubber "snakes" so that they conformed more nearly to real snakes, but the responses of the birds were very poor. Usually these artificial objects were ignored, and the occasional responses were so erratic in occurrence that I was unable to record data that I could interpret satisfactorily.

**MISCELLANEOUS STIMULUS OBJECTS. RESPONSE TO PATTERN ONLY.**—I conducted a considerable number of experiments with patterns of various sorts marked and painted on pieces of paper of various kinds, to see if it were the pattern which caused the snake display. Patterns in color more or less resembling those of local snakes were painted, and simple geometrical patterns in black and white were marked on rectangles of paper of various sizes. To such sheets of paper lying still I never got a response. When the wind moved the papers, the birds usually simply fled. However, the result of the following experiment was positive.

When the 8-thrasher group was 35 to 41 days old three letter-size sheets of paper (eight and one-half by eleven inches), one plain, one crossed by heavy, wavy black lines, one marked in heavy, black, one-inch squares, were laid in the cage. For a time the three sheets were avoided only, the birds keeping 12 or 20 inches away. The wind then rustled the squared paper, and for two minutes one

thrasher gave the typical snake display. The wind then blew all the papers against the side of the cage, and all the thrashers gave a mild fleeing response.

The 6-thrasher group, when 57 to 67 days old, were presented with a large dry, flat 45-inch gopher snake skin. They had never seen a live snake. The birds were at first alert, watching the skin, but soon came to ignore it; on a later occasion, when the experiment was repeated, there was a slight display to the snake skin, which the wind was moving a little, but it was soon ignored.

**MOVING BOX.**—The young thrashers, when small, had been kept in wooden, wire-mesh fronted boxes 12 by 12 by 24 inches in size, and when released into the large cage, these small boxes had been left in their cage. When the 8-thrasher group ranged between 36 and 44 days of age, I used one of these boxes as a carrying cage to move them temporarily to another wooden-walled enclosure. Upon their release they were somewhat excited, but soon became at ease. They remained excitable, and a sudden movement on my part sent them to the far end of the cage. I pushed the carrying box slowly along the ground toward them, at a distance of one to two feet. It made a grating sound on the sand. All the birds were at once alert, and four gave the snake display intermittently for a few minutes. The box was then left at rest. One bird that had been giving the snake display then approached the box, hopped about it and onto it, peering about, giving the snake display continually for almost five minutes. The other birds were now ignoring the box.

Keeping my hand out of sight behind me, I rubbed gravel on the board walls, reproducing the sound made by the moving box sliding over the gravel. This interested several of the birds near me, which peered about, evidently trying to locate the source of the sound, but no snake display was given, and the noise was soon ignored. When all was quiet again, I pushed the box a further six inches, and the original response was secured again.

Here a familiar object in strange surroundings was ignored when at rest, but

when doing something unfamiliar (moving) it elicited the snake display.

**OTHER THRASHERS.**—When the 8 thrashers were 24 to 30 days old, and had just been exposed to a snake to which they had reacted positively, one bird, flying to light near another, gave a momentary snake display to this other bird. Here a familiar object, perhaps suddenly seen at close range by an excited bird, caused the display.

**FALLING LOG.**—When the 8 thrashers were 31 to 37 days old, six of them were sitting on a gnarled log, delicately balanced, which rolled over under their weight. As it did, the 6 birds all flew a few feet, and one, on landing, gave the snake display for a few moments. This was an unfamiliar movement of a familiar object.

**GLOVES.**—When the 8 thrashers were 86 to 92 days old, I left a glove lying on the table in their cage, as I had occasionally done before. A thrasher passing it at 6 inches distance gave the snake display for a few moments.

**HAND.**—When the 8 thrashers were 29 to 35 days old, a hand, extended rapidly toward them occasionally called forth a momentary snake display. A stick one inch square, poked toward them, more frequently called it forth for a few moments, and a 36-inch snake invariably called it forth, and for a longer period.

**FOOD DISH.**—When the 6-thrasher group was 71 to 81 days old, I put in a new shallow tin food dish, 6 inches across, with a new food—pieces of egg white. As each bird came to the food dish, it paused 6 to 10 inches distant, and gave the spread wings of the snake display for a few moments. On subsequent occasions they did not do this.

**SHADOW.**—When the 6-thrasher group was about 68 to 78 days old, I noticed that on a number of occasions, when a bird lit by a certain dark crack under the edge of a board that had long been in the cage, it gave a momentary snake display to the crack.

**MEXICAN.**—When the 6-thrasher group was 78 to 88 days old, the Mexican who helped me care for the birds slowly passed 6 feet from the cage, carrying a dead rab-

bit. This caused a snake display from one bird for a few moments. The Mexican was quite familiar to them, and dead rabbits had been responded to negatively; however, the combination, moving, had caused the display.

**GILA MONSTER.**—The Gila monster is not common in the thrasher habitat; its actions probably do not affect thrashers. When the 8 birds were 31 to 37 days old, I put a dead 18-inch Gila monster (the first the birds had seen) in a corner of the cage. Six of the birds went to it, gave a typical snake display at one to two feet distance from it for several minutes, then all moved away to other parts of the cage. I left the lizard there for some time, and occasionally a bird, happening in its vicinity, gave a snake display for a few moments, then moved away.

When the 6-thrasher group was between 68 and 78 days old, I introduced a 12-inch live Gila monster into their cage, the first they had seen. At once all the thrashers were alert and all came down to the ground to give the snake display, keeping 18 inches to 3 feet from the lizard. After seven minutes they began to lose interest in it and after ten minutes I removed it.

The Gila monster, dead or alive, produced a good snake display, but of less duration than did a large snake.

**HORNED TOADS.**—Horned toads are common in the thrasher habitat, and harmless to thrashers. They were often ignored, but once, when the 6-thrasher group was 76 to 87 days old, I got a mild positive response. A 7-inch live horned toad was placed in the cage. Some of the thrashers occasionally came to it, displayed for a few moments, or pecked at it, and went away. As a thrasher accidentally passed within a few inches of the horned toad, it usually gave the snake display for a few moments.

**OTHER LIZARDS.**—Lizards are common in the thrasher habitat and harmless to thrashers. When the 8 thrashers were 31 to 40 days old, I tried various living and dead lizards, 6 inches to 12 inches long. Usually when still they were ignored, or mildly investigated by pecking at them and shaking them, as the birds did a stick.

When moved across the floor on a thread, a large, 13-inch lizard obtained a slight fleeing action from birds that happened to be close to it.

The smaller dead lizards which I moved across the cage (and also some live lizards which were used) evolved a following response in some birds occasionally, but the response was erratic. Very rarely a momentary snake display was given. The results with imitation lizards of rubber were similar.

Once, however, I secured a very good display to a 3-inch lizard from the 8-thrasher group, when 30 to 36 days old, and they had seen lizards only a few times. I tossed a live, 3-inch lizard near a group of four birds. It moved a little. At once they gave the snake display, advancing and retreating between 3 inches and 12 inches. Finally one bird pecked at it. The lizard ran a few inches, one bird following and displaying. The lizard then made a rapid 14-inch dash and the bird at once pursued without display, caught it and brought it back. At once began a peculiar form of activity. Four thrashers, closely grouped about the lizard, displayed continually; each bird, as opportunity offered, seizing and shaking the lizard for a few moments before dropping it, when another seized it. This continued very actively for a minute. The lizard was seized anywhere, head, body or appendages. The tail then broke off and one bird ate it. This bird then became less active. Shortly there were only two birds engaged in this display. They broke off more pieces of the tail, but did not eat them. The lizard, now dead, was ignored for about five minutes, when two birds returned, displayed and shook the lizard for a few moments, then one swallowed it. During the latter part of this performance two other birds treated a fourteen by one-half inch stick in much the same way for a few moments.

**ARTIFICIAL LIZARDS.**—Experiments with dead and artificial lizards of rubber, at rest and pulled across the cage, were inconclusive (as were those with live lizards). Sometimes the birds pursued and pecked at them, sometimes they hopped away



from them. Rarely did they give the snake display.

**TORTOISE.**—When the 8 thrashers were 46 to 52 days old, I introduced a desert terrapin with shell 11 inches long, the first they had seen, into the cage. The tortoise moved slowly about. The thrashers immediately became alert, watched it, and some approached to within 3 or 4 feet, occasionally giving a snake display momentarily. They soon ceased giving any snake display, before they lost interest in the turtle.

Immediately after removing the turtle I introduced the 55-inch gopher snake, and though its actions were slight, the birds all gathered about it and gave an intense, prolonged snake display.

A similar result was obtained when this turtle was introduced to the 6-thrasher group when they were 68 to 78 days old. At first there were occasional, momentary snake displays by a few birds, then a closer approach and investigation by pecking by an occasional bird.

**RESPONSE TO TADPOLE.**—When the 6-thrasher group was 69 to 79 days old, I put in their cage a tin of water containing black tadpoles, 1 inch long, in connection with some feeding experiment. The thrashers occasionally pecked at tadpoles that came near the surface, but once, one bird gave a short snake display to a tadpole, at a few inches distance.

#### DISCUSSION

This discussion is concerned with the innate behavior of thrashers elicited by a variety of objects, what aspects of the object elicit this behavior, and in a few cases the modification of the behavior by experience, and the biological significance of some of these objects.

In the preceding section I have shown that certain types of behavior appear only some time after hatching, or even after nest leaving, such as independent feeding, fleeing, seeking shelter and heights.

In this section the experiments with the great-horned owl and the 19-day old thrasher, the ring-tailed cat and the 18-day old thrasher, the snake and the 17- to 18-day old thrashers, and the roadrunner

and the 16- to 18-day old thrasher indicate that at 16 to 19 days the young thrashers do not respond to these objects as they do when older. Apparently this is not a matter of physical strength. At this time painful experience, i.e., being seized by these animals, is ineffective in teaching the young thrashers to avoid such objects, as is indicated by the snake, great-horned owl and roadrunner experiments. Even the squeals of distress given by the young when seized do not affect other thrashers of the same age.

The fledgling responses to predators are woefully inadequate, and it is probable that the adult serves a very important function in leading the young from the presence of predators, as one incident in the previous section indicates.

That the appearance of the adult type of behavior toward predators may be gradual is indicated in the great-horned owl experiments, where the 19-day old birds paid the owl little attention, the 29- to 35-day old birds responded more definitely but less so than the older thrashers.

It is obviously incorrect to group all the responses of the thrashers to various objects as expressions of fear, for the responses include approaching and pecking at such things as ring-tailed cats. It is equally fallacious to call them enemy recognition, for the first time the thrashers saw a rabbit they responded in much the same manner as to a cat. Self-preservation acts would imply that all these acts were beneficial to the thrashers, but it is difficult to see how running after a rat and pecking at it, or pecking at the feet of a great-horned owl, or fluttering about a big snake, is a "self-preservation act." Experiments with the snakes and thrashers indicate that the snake display of one bird does not stimulate others to do likewise, so that the snake display at least does not serve to call other birds about and so teach the young (though this might apply to the mobbing of the screech owl). A commonly accepted explanation of the biological function of scolding or "mobbing" a predator is that it makes it impossible for the predator to hunt in that area, an "altruistic action," an idea which is not

very attractive, where the obvious self-preservation act would be to keep farther away from the enemy, if not to flee the area entirely.

The following is a classification of the various activities elicited by the various objects used in the experiments:

- 1.—Fleeing
- 2.—Keeping at a distance
- 3.—Approaching
- 4.—Peering
- 5.—Displaying
- 6.—Pecking
- 7.—Fighting
- 8.—Ignoring

Most of the objects presented to the thrashers elicited more than one response. Thus, the ring-tailed cat caused fleeing when it approached the thrashers rapidly; following when it moved away from them; approach and peering when it was still or moving slowly about; and even pecking at its tail when it was still. The rabbit, about the same size as the cat, caused very similar responses, indicating that without experience these birds do not differentiate between rabbits and cats; a harmless animal and a predatory one.

The rat, a much smaller animal, of almost the body size of the thrasher, caused similar responses, but the fleeing was much less and the tendency to approach and peck at the animal was much stronger.

The young chipmunk, of feeble actions, caused only an approach and a pecking at it, as though to explore its possibilities as food.

With the mammals there appears to be a direct correlation between the size of the animal and the response. The smallest mammal caused the approach with little sign of excitement and no fleeing; the largest mammal the most fleeing and keeping at a distance, the least approach.

Movement also played an important part in the response elicited, especially in the larger mammals. When the cat and the rabbit were slowly moving about, the thrashers watched them; when they retreated, the thrashers followed; when they approached, the thrashers fled. Here the approach caused the most violent response; with the rat the approach caused only a slight fleeing, while the re-

treating rat elicited a much more violent following response.

This indicates that thrashers tend to approach and peck at the smaller mammals, and to flee from the larger ones; but traces of each type of behavior occurred in actions toward all the mammals.

The tendency to move from a larger and toward a smaller moving object was indicated in the experiments with the cylinders, the cylinders resembling no natural object.

The experiment with the electric train showed investigation of the stationary train, fleeing from the moving train, and the longer the train (i.e., the larger the stimulus object) the more intense the fleeing.

The responses elicited by the various birds differed greatly among themselves and presented no such series as the mammal results did. It must be kept in mind that in addition to the diversity of physical appearance of the birds their actions in relation to the thrashers varied much more greatly than did those of the mammals.

The following general points may be pointed out from the above experiments:

The fowls were familiar objects, ordinarily disregarded, but the rapid, direct approach of one of these familiar, larger objects caused fleeing.

The only responses the hawk evoked were fleeing, and keeping at a distance. The noisy flight of the hawk may have increased the initial effect. The experiments with paper models are important in this experiment.

The paper bundle, about the size of the hawk, put up where the hawk had been and left motionless was avoided by the thrashers, but they did not keep as far away as they did from the hawk. However, when a slight motion was imparted to the paper bundle, the thrashers responded to it as to the hawk.

The great-horned owl was first avoided, but after a period when it stayed rather still in the cage, the avoidance was less; when the owl's movements were greater, the thrashers near it retreated; when movement was eliminated (stuffed owl), they came to disregard it as an object of

importance, and even pecked it to pieces, as they did the paper bundle.

There are some interesting points about the roadrunner's activities. Full-grown thrashers are probably too big to be even occasional prey of roadrunners. The roadrunners in the 8-thrasher cage had never had anything to chase. By accident they found the thrashers would flee from them. They began a period of violent chasing. But a thrasher that did not at once flee was left alone; and some sudden acts of thrashers sent the roadrunners fleeing. This apparently biologically useless chasing of thrashers was soon largely abandoned.

This seems to illustrate the general principle of chasing an object that would flee; that the thrashers would flee was learned by experience; continued for some time without beneficial results to the roadrunners, it was largely abandoned.

Considering the thrashers, when the roadrunners were originally introduced into the 8-thrasher cage, the thrashers at first kept some distance from them. They then became more familiar. After a time the roadrunners began to run at them, and they fled. At first they did not flee until the roadrunner was close, and they ignored passing roadrunners. After considerable experience of being chased by roadrunners, however, a roadrunner passing near caused them to flee. Even then a thrasher sometimes went to investigate a resting roadrunner, and sometimes a sudden movement or appearance of a thrasher sent a roadrunner fleeing. After the roadrunners ceased the period of violent chasing, the thrashers became familiar again with them, though a close, rapid, direct approach of a roadrunner would send one fleeing.

This illustrates instinctive shyness of unfamiliar slowly moving objects; becoming more or less accustomed to them by experience; fleeing from them when approached rapidly; investigation of them when not approaching rapidly; learning from experience to flee at a greater distance; then unlearning by experience, and not fleeing; occasionally investigation by approaching and pecking. When one bird fled, calling, this sometimes caused other birds to flee. The occasional spreading of

the wings when pursued recalls in part the behavior in the presence of large snakes, a type of behavior without obvious explanation.

The experiments with the screech owl provide no evidence for a recognition of the owl as such. It seems to be best interpreted by considering the actions the result of a number of general tendencies. The first is to come and explore by peering and then pecking. The small movements of the owl deter the thrashers from coming close, though they may do so, peck at it, and finally largely ignore it. But the owl may strike at the thrashers, making them flee a short distance, and by continuing to move about, striking at the thrashers peering at it, may arouse pugnacity in them, as when a thrasher is attacked by one of its own kind. The screech owl, while markedly differing from the thrasher, also has many points of resemblance and is about the same size. Instinctive recognition seems to be nonexistent, and the size, strange shape, plus certain activities of the owl, bring about the responses.

That the "snake display" is an inborn pattern of behavior appearing early is evident. Its stereotyped nature and relative lack of modifiability are striking. Only rarely is it given to other objects.

Part of the "snake display" is an approach of the bird toward a dangerous object, which is also seen in its response to many other objects and might be interpreted as generalized curiosity. This alone might be considered to have a generalized biological function in tending to increase the experience of the bird. But the rest of the display has no evident function. That it has no social function is evident as the display of one bird does not induce other birds to display. As far as the single bird is concerned, it would be much safer to flee. It does not necessarily have any relation to a nest defense. It appears to be a stereotyped performance. From generalized tendencies one might expect a graded series of responses, a going toward and seizing of small objects, a fleeing from large objects, and a display given to intermediate objects. But this is not the case. Larger and thus more

dangerous snakes evoke the most intense display.

In some ways it appears to be a maladaptation. Probably snakes sometimes take advantage of it to seize a bird.

It is easy to understand how earlier writers claimed that snakes charmed birds. (For a collection of some of these accounts see R. V. Medden, 1930, *Bull. Antiven. Inst. Amer.*, III, pp. 110-112.) However, most accounts of this sort are not critical enough to be of value in this discussion.

The data on what calls forth the display are more enlightening.

Many early writers claimed the eyes of the snake supplied the fascination, or the tongue was a lure. Lloyd Morgan took this last view seriously. I did not excise the tongue of any of the snakes I used, nor did I cover their eyes.

Since the stereotyped display to large snakes was little affected by experience, it seemed that here might be an instinctive recognition of an enemy. But the experience with artificial stimulus objects shows that this is not the case.

The various stimulus objects which evoked the "snake display" in greater or less intensity are so diversified that certainly one cannot say that one or a few aspects only of the snake elicit the display.

By varying simply the characteristic of motion the effectiveness of a large snake is greatly diminished. And it is not simply motion as a whole, but the gentle undulating movement of the live snake which is a necessary property of the large snake if it is to call forth the maximum response. When this undulating motion is well simulated by movements of an imitation rubber snake, the response is at first as intense as to a live snake, but through experience the rubber snake soon becomes useless as a stimulus object, while the real snake does not.

Pattern alone is a poor stimulus, though with motion it is sometimes effective.

The simple stimulus of motion of objects was usually ineffective, but occasionally was effective, as when the birds were pursued by the roadrunner.

The sudden moving of familiar objects, the suddenly noticed proximity of quite familiar or strange objects; the presence of strange objects which are approached, the approach of an unusual combination of familiar objects, all occasionally elicited the snake display.

The features that a non-moving strange dish of food, a moving familiar box, a Mexican carrying a dead rabbit, and a quiet shadow have in common are that they have some strange, new characteristic; either motion, shape or proximity.

We may conclude that the response is dependent on a complex or pattern of stimuli. Any one of a wide variety of stimuli may produce the response in less than optimum intensity or duration. But the pattern of stimuli furnished by a large snake alone elicits the response in maximum intensity and duration. This is in accord with Lashley's conclusion (1938).

Some instinctive activities when they are first used are given completely to various inadequate stimuli. This was not the case with the snake display. With the 8-thrasher group the first positive experiment was with a snake, and the response was full and complete. But with the 6-thrasher group a wide variety of inadequate stimulus objects was presented before live snakes were introduced. The responses were always mild; very similar to the responses of the 8-thrasher group when shown the same stimulus objects after they had seen live snakes. But when this behavior apparently has no use—how could experience perfect it?

## SUMMARY

Thrashers were studied in the wild and in captivity from hatching until about 90 to 96 days old. The physical development, and that of behavior, which appears typically passerine, are recorded. Experiments on enemy recognition were carried out.

Such fundamental acts as self feeding and some responses to predators were not exhibited even on leaving the nest; after appearing, both these types of behavior were modified by experience.

Enemies were not recognized as such; the thrashers responded to some non-enemies as to some enemies. These responses usually combined exploratory acts and fleeing acts, sometimes a display and once pugnacious activities. Which type was dominant, with the exception of the snake display, appeared to depend not only on the size of the object, its familiarity or otherwise, but also greatly on its activity in relation to the thrashers. Thrashers probably had to learn what not to fear.

The snake display appeared to be a more stereotyped pattern of behavior than other responses to enemies. While large

snakes elicited this response in maximum intensity, many other objects called it forth in less than maximum intensity. The snake display appeared to be elicited by a pattern of stimuli, and a wide variation in this weakened, without completely destroying, it.

The feeding response and exploratory pecking were also rather stereotyped in execution; but the stimulus objects which elicited them were very diversified. There was a tendency to actually swallow things within certain limits of size, taste and perhaps texture, but the tendency to peck and seize a wide variety of objects insured that when food objects were available, even though strange, they would be tried.

The thrashers' responses to objects appeared to be the result of general tendencies to respond to a wide variety of stimuli. While many of the thrashers' activities had an innate basis, the stimulus conditions in which they were given were generalized. This provided the raw material with which experience worked to fit the thrashers' generalized behavior to its particular environment.











