

ANTING IN WILD BIRDS, ITS FREQUENCY AND PROBABLE PURPOSE

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A major problem facing anyone investigating anting behavior in wild birds is the scarcity of detailed published accounts. Brackbill (1948) lists 13 records from Maryland, all between mid-May and the end of August, and notes that "the behavior patterns of anting and sunning appear to be complementary." Groskin (1950) adds 13 records from Pennsylvania, all between mid-May and the end of the first week in October, and expresses the opinion, which I share, that anting in the wild is more common than the published records indicate because many bird-watchers are prone to mistake the motions for ordinary preening.

Two important studies present opposing views on the purpose of anting in avian behavior. After nearly 3 years of experiments with a captive Orchard Oriole (*Icterus spurius*), Whitaker (1957) concludes that the bird "appeared to derive sensual pleasure, possibly including sexual stimulation," from anting. Simmons (1966), after reviewing at length the work of Mrs. Whitaker and others, states: "True anting is strictly functional and probably belongs to the feather-maintenance group of behaviour patterns." He considers anting with substitutes, however, to be "non-functional, arising from developmental 'error' in the learning process during the ontogeny of anting responses." Calling the evidence for self-stimulation "tenuous," Simmons concludes that it is "highly improbable" and contrary to "accepted evolutionary thinking" that a "widespread and stereotyped behaviour pattern such as anting has no function, existing solely for the 'pleasure' it gives."

Southern (1963) saw three species of birds anting while feeding and bathing on a freshly sprinkled lawn. He collected one of these birds and found it free of parasites but showing early stages of feather growth, which led him to advance the theory that birds use excretions of ants to soothe skin irritated by new feather growth.

In March 1964 I began systematic studies at Zebulon (about 20 miles east of Raleigh), Wake County, North Carolina, in an attempt to establish a relationship between frequency of anting activity and time of day, season of year, or weather conditions. I believed that a demonstrated peak of anting activity, if clearly related to any of these factors, would be a significant indication of the purpose of anting in avian behavior.

METHODS

From the glass-paned back door of my home in Zebulon, I could scan effectively without aid of a binocular a section of lawn approximately 75 feet square. I tried

to note the behavior of all birds within this area at least once every 2 hours from 06:00 until dark almost daily from 3 March 1964 through 31 August 1966.

Within the plot were three sizable ant colonies, one of *Formica fusca*, one of *Tampinoma sessile*, and one apparently occupied by *Lasius interjectus* as well as the two previously named species. Seeing a bird of any species near these three colonies, I watched continuously until the bird flew or walked out of sight. When a Blue Jay or Starling visited the plot, I watched continuously until it left because I have found these species prone to ant.

When I saw a bird anting, I used a 7×50 binocular as needed and recorded data as follows: date and time of day (Eastern Standard Time); species, age, and sex; location of activity within plot; species of ant used, if determined; feathers treated; evidence of molting, if any; other activity, such as feeding or sunning; and weather conditions. I also made notes on dusting and sunning not associated with anting. I used monthly reports of Local Climatological Data from the Raleigh-Durham Airport Weather Station to supplement my own weather records.

DEFINITION OF TERMS

For the purposes of this paper, "anting" refers to a bird's using ants or their excretions in the act of preening. "Active anting" refers to that form of anting in which the bird picks up live ants with its bill and inserts them among the feathers. In "passive anting" the bird remains, often with body flattened against the ground, where ants can crawl among the feathers and subsequently removes the ants with typical anting motions. "Typical anting motions" are the peculiar twisting of wings and tail accompanying the insertion of ants among the feathers in active anting or their removal in passive anting (see photographs in Whitaker, 1957). A "treatment" in active anting refers to the capture of an ant (or ants) by a bird and the subsequent insertion of the bill among the feathers. In passive anting a treatment includes each period of waiting for the ants to crawl upon the bird and their subsequent removal from the plumage. An "episode" refers to one or more treatments by one or more birds without any significant interruption—thus two birds anting simultaneously or one immediately after the other are considered participants in a single episode.

RESULTS

I recorded 15 episodes of anting within the selected plot at Zebulon during the 29 months of regular watching. These involved 25 birds of 6 species, namely: Blue Jay 2, Catbird 1, Robin 3, Starling 17, House Sparrow 1, and Slate-colored Junco 1.

On 1 September 1966 I moved to a house 3.5 miles north of Zebulon in a 2.58 acre tract of second-growth mixed woodlands adjoining the Zebulon Country Club. During the next 2 years, without consciously attempting to continue detecting anting, I saw 10 episodes involving 20 birds of 6 species: Yellow-shafted Flicker 1, Blue Jay 3, Catbird 1, Robin 13, Cardinal 1, and Rufous-sided Towhee 1.

All 25 anting episodes are described below, arranged by calendar months to facilitate comparison with Table 1, which lists most of the known incidents of anting among wild birds in North America based on the

TABLE 1
KNOWN ANTING EPISODES AMONG WILD BIRDS IN NORTH AMERICA

Date	Species/individuals	Reference
3 March	Starling, <i>Sturnus vulgaris</i> (5)	Potter, 1964
4	Slate-colored Junco, <i>Junco hyemalis</i> (1)	Present paper
15	Yellow-shafted Flicker, <i>Colaptes auratus</i> (1)	Present paper
22 April	House Sparrow, <i>Passer domesticus</i> (1)	Present paper
14 May	Wood Thrush, <i>Hylocichla mustelina</i> (1)	Groskin, 1950
15	Catbird, <i>Dumetella carolinensis</i> (1)	Brackbill, 1948
15	Brown-headed Cowbird, <i>Molothrus ater</i> (1)	Hebard, 1949
20	Starling (1)	Present paper
22	Prothonotary Warbler, <i>Protonotaria citrea</i> (1)	Tedards, 1967
24	Catbird (1)	Brackbill, 1948
29	Cardinal, <i>Richmondia cardinalis</i> (1)	McAtee, 1954
30	Brown Thrasher, <i>Toxostoma rufum</i> (1)	Chamberlain, 1954
31	Robin, <i>Turdus migratorius</i> (1)	Present paper
1 June	Catbird (2)	Groskin, 1950
8	Red-winged Blackbird, <i>Agelaius phoeniceus</i> (1)	Nero, 1951
8	Catbird (1)	Brown, 1953
16	Robin (1)	Brackbill, 1948
16-19	Indigo Bunting, <i>Passerina cyanea</i> (3)	Shackleton and Shackleton, 1947
19	Starling (1)	Present paper
21	Starling (1)	Brackbill, 1948
27	Catbird (2)	Groskin, 1950
27	Common Grackle, <i>Quiscalus quiscula</i> (1)	Brackbill, 1948
27	Common Grackle (1)	Brackbill, 1948
28	Brown-headed Cowbird (2)	Nice, 1945
Early July	Cardinal (1)	Edwards, 1932
4	Common Grackle (2)	Brackbill, 1948
5	Blue Jay, <i>Cyanocitta cristata</i> (1)	Present paper
8	Common Grackle (2)	Brackbill, 1948
10	Robin (1)	
	Rufous-sided Towhee, <i>Pipilo erythrophthalmus</i> (1)	Van Tyne, 1943
12	Robin (1)	Staebler, 1942
Mid-July	Brown Thrasher (1)	Hauser, 1964
20	Song Sparrow, <i>Melospiza melodia</i> (2)	Groskin, 1950
22	Catbird (1)	Brackbill, 1948
24	Robin (1)	Present paper
26	Robin (3), Catbird (2)	Brackbill, 1948
27	Catbird (1)	Present paper
28	"many birds"	Hauser, 1964
"almost daily"	Song Sparrow	Mayr, 1948
1 August	Red-winged Blackbird (2)	Nero, 1951
3	Robin (1)	Grimshawe, 1964
3	Robin (3)	Nichols, 1943
4	Rufous-sided Towhee (1)	McAtee, 1944
6	Starling (1)	Present paper
7	Starling (1), Catbird (1), Blue Jay (2)	Present paper
7	Song Sparrow (2)	Groskin, 1950
8	Common Grackle (1)	Brackbill, 1948
8	Common Grackle (1)	Brackbill, 1948
10	Blue-winged Warbler, <i>Vermivora pinus</i> (1)	Dater, 1953
11	Robin (1)	Present paper
11	Starling (1)	Present paper
14	Song Sparrow (2)	Groskin, 1950
16	Blue Jay (1)	Davis, 1950
18	Song Sparrow (2)	Groskin, 1950
19	Song Sparrow (2)	Groskin, 1950

TABLE 1 (Continued)

Date	Species/individuals	Reference
25	Robin (4)	Present paper
26	Robin (1)	Present paper
26	Robin (2), Cardinal (1), Rufous-sided Towhee (1)	Present paper
27	Robin (1)	Present paper
29	Robin (4)	Present paper
30	Song Sparrow (1)	Groskin, 1950
30	Starling (1)	Brackbill, 1948
30	Blue Jay (3)	Laskey, 1949
?	Starling (2)	Pearson, 1938
?	Starling (2)	Pearson, 1938
2 Sept.	Robin (1), Starling (3), Yellow-shafted Flicker (1)	Southern, 1963
8	Starling (3)	Present paper
12	Blue Jay (2)	Present paper
14	Scarlet Tanager, <i>Piranga olivacea</i> (2)	Groskin, 1950
16	Cardinal (3)	Snyder, 1941
22	Robin (1)	Present paper
24	Starling (2)	Present paper
25	Starling (1)	Present paper
26	Summer Tanager, <i>Piranga rubra</i> (1)	Thomas, 1941
2 Oct.	Scarlet Tanager (2)	Groskin, 1943
3	Starling (1)	Present paper
5	Robin (1)	Groskin, 1950
11 Nov.	Starling (4)	Kalmbach in McAttee, 1938
30	Scaled Quail, <i>Callipepla squamata</i> (1)	Thomas, 1957

present study and a search of the literature. Considered unacceptable for this table were records omitting month of occurrence, those involving captive or semicaptive birds, and those in which the birds used substances other than ants, such as wasps, moth balls, cigarette butts, walnut hulls, or orange peels.

March.—About 13:00 on 3 March 1964 five Starlings anted while standing close together around mounds built by large black ants (later identified as *Formica fusca* Linné). The birds appeared to be in a state of ecstasy and took flight only when approached very closely (Potter, 1964).

From 13:40 to 13:45 on 4 March 1966 a Slate-colored Junco anted at the same *Formica* mounds. The bird made 53 treatments while anting first under the wings and later under the tail. At the first attempt to treat the under-tail area, the junco brought the tail forward between the legs and fell over backwards. Thereafter the bird twisted the tail to one side of the body and forward with typical anting motions. It paused several times to scratch the side of its head. At the end of the anting episode, the bird wiped its bill on a fallen tree branch. Inspection showed the ants busily rebuilding mounds eroded by recent rainfall.

At 11:30 on 15 March 1967 a male Yellow-shafted Flicker anted its breast briefly in the wooded yard of my new home.

The above three records appear to be the only observations of anting among wild birds in North America during March. All three are associated with unseasonably warm weather (Table 3). To the best of my knowledge, the junco record is the only one that unquestionably represents anting by a migrant bird on its wintering grounds in North America.

April.—At 11:40 on 22 April 1965 several House Sparrows were feeding on freshly turned ground in my yard. For about 1 minute a female anted the breast, under the wing, and under the tail. So far as I know, this is the only record of anting among wild birds in North America during April.

May.—At 08:25 on 20 May 1965 I saw five Starlings feeding at the foundation of a neighbor's house. One Starling anted once under the left wing. Investigation showed a moving column of small ants later identified as *Tamponoma sessile*.

At 12:15 on 31 May 1965 I watched an adult Robin on the ground near the *Formica* colony. The bird stooped, fluffed its feathers, and picked several ants from its plumage with typical anting motions.

June.—At 13:45 on 19 June 1965 I discovered an adult Starling anting at the *Formica* colony. The bird treated the breast, under wings, and tertials before beginning to move in a large circle. As it walked the bird occasionally paused to feed, ant, or scratch, giving particular attention to the bend of the wing. Returning to the *Formica* mounds, the Starling spread itself flat on the ground for several minutes, erected its back feathers, and appeared to be sunbathing. Upon arising, the bird picked some ants from its plumage. The episode lasted about 15 minutes.

July.—While the literature shows wild birds ant in July in North Carolina (Hauser, 1964), I saw no July anting until 1968, the fifth summer of study at Zebulon.

Driving through town about 09:10 on 5 July, I saw a Blue Jay anting on a front lawn. Circling the block, I found a parking place just as the bird stopped anting and flew away.

On 24 July a molting juvenile Robin anted in the yard of my new home for about 2 minutes beginning at 07:13. The bird concentrated treatments on the lower breast and belly, both of which still showed juvenal plumage while the molt of the upper breast appeared to be completed.

About 11:15 on 27 July a Catbird anted on a decaying log and in leaf litter at the edge of the spring flowing through our yard. Large black ants (*Camponotus* sp. ?) moved to and from the log. As my daughter and I walked to within 8 feet of the bird, it was apparently undisturbed by our

presence or by the noise of golf balls landing near us. The bird continued to ant until several golfers came to search for lost balls.

August.—At 08:00 on 6 August 1964 a Starling climbed about the trunk and limbs of a sapsucker-riddled pecan tree (*Carya illinoensis*) just outside the back door of the house in Zebulon. The bird appeared to be feeding, but once it anted under the wing.

At 07:00 on 7 August 1964 I saw an adult Starling climbing about the trunk of the pecan tree as on the previous day. The bird raised both wings slightly and fluttered them while anting under the wings. The wing on the side being treated was raised somewhat higher than the one on the other side. There was no apparent twisting of the tail. The Starling dropped to the ground at the base of the pecan tree and continued anting. Gradually the bird moved toward the *Formica* mounds, pausing occasionally to engage in anting. About 12 feet from the base of the tree, the bird began feeding normally and slowly wandered out of sight. The anting had lasted about 7 minutes. As the Starling moved away a juvenile Blue Jay, definitely molting, flew to the base of the pecan tree and began anting under the wings with very little twisting of the tail. Just as this bird seemed to lose interest in anting (after about 2 minutes), a Catbird alighted a short distance away and began anting under the wings with vigorous sideward movements of the tail. After only a few treatments the Catbird flew away. Immediately another Blue Jay, apparently an adult, began anting under the wings. This bird would ant several times on the ground, then fly to the pecan tree and ant a few times before returning to the ground to ant some more. The exact number of times the bird changed places was not recorded, but 8 to 10 times would be a fair estimate. Usually this bird twisted its tail while anting under the wings, but occasionally it did not. The jay stopped anting at 07:20 after an estimated 10 minutes of activity. Cardinals and House Sparrows in the vicinity did not participate in the anting, but they sat on the fence watching the performance. Large numbers of ants of several species were swarming over the trunk, some limbs, and the ground at the base of the pecan tree. The ants were arriving and departing along a trail leading toward the *Formica* mounds. Ants continued to swarm over the pecan tree for the rest of the day and all the next day, but I saw no further anting.

At 08:15 on 11 August 1966 a Robin obviously undergoing the post-juvinal molt anted on the ground near the *Formica* colony. The bird anted under the wings and tail and fed intermittently while moving about actively. In response to an alarm cry from a Blue Jay, the young Robin flew to a nearby tree, but it quickly returned to the same location and resumed anting and feeding. Twice it made anting motions before picking

up an ant. Once it flattened its body against the ground as if trying to ant passively. The episode lasted 15 minutes. At 08:58 a juvenile Starling anted under the wings while perched in the pecan tree. The ants used were *Lasius interjectus*. At 09:10 two juvenile Robins sunbathed on the lawn. They compressed their feathers simultaneously when a cloud covered the sun; one began feeding and the other preened vigorously, but neither anted.

At 17:56 on 25 August 1967 I noticed one molting juvenile Robin anting on a fairway at the Zebulon Country Club. The bird was soon joined by another molting juvenile Robin that also anted. The flock increased until there were 24 juvenile Robins as well as six birds of other species occupying a low section of fairway that had been flooded during recent heavy rains. Scanning the flock with a binocular, I repeatedly saw four Robins anting simultaneously. Between 18:10 and 18:15 two golf balls landed in the midst of the Robins, but they continued to feed and ant until the golfers approached in carts. As soon as the golfers left, four Robins returned to the same location, and two began anting while other golfers on foot were still nearby. These two birds remained in the same general area and continued to ant steadily until they went to roost at 18:50. All birds that anted actively seemed to concentrate their treatments in the under-wing area. Some anted with such vigor that they turned somersaults. Some anted passively. One bird changed from passive to active anting. The two birds that anted the longest appeared to be well-advanced in acquiring their first winter plumage.

At 06:15 on 26 August 1967 many Robins were foraging in or near the gravel driveway to my house. One anted six times within 5 minutes. Twice I watched this bird through a binocular at close range while it treated the under-tail area. Some of the tail feathers were newly emerged while others were badly worn, and I judged the bird to be in the latter stages of acquiring first winter plumage. Heavy fog obscured the fairway where anting had taken place the previous day. At 07:30 a different juvenile Robin anted in the driveway. This bird had only four visible tail feathers. After about 5 minutes it was joined by a molting juvenile male Cardinal, which anted several times despite the Robin's threat displays. As these two birds stopped anting, a molting juvenile female Rufous-sided Towhee began anting beside the driveway. Soon two molting juvenile Robins were anting in the same general area. The golf course was still shrouded in light fog when the Robins stopped anting at 07:50 and flew toward the fairway. A Robin apparently still in full juvenal plumage was in the yard continuously from 06:16 until 07:50 and did not ant even though feeding in company with anting birds. Late in the afternoon of 26 August a dozen

juvenile Robins occupied the section of fairway where anting had taken place the previous day, but I saw no anting on this occasion.

At 06:45 on 27 August one molting juvenile Robin anted for 2 minutes on the ground beside the tree stump bird feeder. A Cardinal approached, picked up an ant in its beak, and lifted one wing in a typical anting motion; but it ate the insect instead of dressing the plumage. I watched for anting before, during, and after a late afternoon thunderstorm on 27 August. Robins fed around the flooded section of fairway during all but the most severe showers. Some bathing took place toward the end of the storm. Several Robins erected their contour feathers and shook; one perched in a tree and preened a little; and one fanned its tail and stretched one wing. However, I saw no anting that afternoon or the next day.

At 06:03 on 29 August two molting juvenile Robins anted beside the driveway. The first made only a few treatments, but the second anted steadily until 06:15. This bird on several occasions picked up a twig of white oak (*Quercus alba*) and swept the ground with it by turning the head 180 degrees, apparently in a successful attempt to locate more ants in the leaf litter. The twig measured 14.5 cm in length and had 13 small to medium-sized leaves still attached. At 06:19 another molting juvenile Robin anted for less than a minute. At 06:35 a Robin that had almost completed the postjuvinal molt began anting and feeding at the exact location in which the tool-using bird had anted; this particular bird anted only a few times while eating a large number of ants. I recorded all anting seen 29 August as one episode because the activities, viewed from widely separated windows, probably overlapped.

A flock of juvenile Robins was in the vicinity regularly from early August through October 1967, but I saw anting among these birds only during the 48-hour periods immediately following rainfall in the last week of August (Table 3).

September.—At 07:49 on 24 September 1964 a Starling anted on the lawn in Zebulon. The bird was soon joined in anting by a second member of the flock, which totaled eight birds. Anting continued for about 2 minutes until the entire flock took flight.

At 08:30 on 25 September 1964 a Starling anted occasionally while feeding on the lawn. A nonanting bird in the flock of three Starlings sideswiped the anting bird as if trying to displace it. After about 10 minutes the Starlings wandered out of sight.

At 07:44 on 8 September 1965 three Starlings anted near the *Formica* colony. The birds were undergoing the postjuvinal molt, and they concentrated treatments under their wings and tails. A half-eaten pear had

attracted at least three species of ants, among them *Lasius interjectus*, the only species actually seen in the birds' bills.

At 06:40 on 22 September 1965 two adult Robins and two juveniles fed on the lawn. One juvenile anted under the tail, drove away others in the group, anted, and drove away the returning birds. The young Robin defended the chosen spot until the other birds left. It continued anting and feeding in that one location for 7 minutes.

At 07:30 on 12 September 1966 two Blue Jays anted near the top of a mature pine tree (*Pinus* sp.) in the yard of my home near Zebulon. One bird was apparently molting, having tail feathers of irregular lengths. A column of unidentified large black ants was moving up and down the tree trunk.

October.—At 08:10 on 3 October 1964 one Starling in a flock of seven anted while feeding on the lawn. The bird anted once under each wing and three times under the tail.

November through February.—I have no records of anting for these four months. Kalmbach (*in* McAtee, 1938) saw Starlings anting in Washington, D. C., 11 November 1935. Thomas (1957) saw a Scaled Quail anting passively in Ward County, Texas, 30 November 1956. These are the only records I have found of anting among wild birds in North America after the first week in October and before the first week in March.

Examination of mounds built by *Formica fusca* at Zebulon indicated year-around activity. After winter rain, snow, or sleet I found fresh balls of dirt around some mounds. On very warm winter days a few sluggish individuals were sometimes above ground. While the opportunity for anting does not appear to be very good in North Carolina during November through February, I do not consider it an impossibility.

DISCUSSION

I kept records on anting at Zebulon for a total of 54 months, 29 of these devoted to watching regularly at one locality. The 25 episodes seen in Wake County are listed in Table 1 along with all comparable records I have found in the North American literature on anting in wild birds. These data reveal certain trends that help us understand the role of anting in avian behavior.

Diurnal peak.—Of the 49 anting records with a known time of day, 30 occurred between dawn and 10:00, 8 between 10:00 and 14:00, and 11 from 15:00 until dark (Table 2). Others gave the time of day as "early morning" (Dater, 1953), "mid-afternoon" (Thomas, 1957), "towards sundown" (McAtee, 1954), and "soon after sunset" (Van Tyne, 1943). Mayr (*pers. com.*) gives the time for his series of Song Sparrow anting episodes (Mayr, 1948) as "in the middle of the forenoon." Thus birds

TABLE 2
ANTING EPISODES RECORDED BY HOUR OF DAY (LOCAL STANDARD TIME)

Hour beginning at	Number episodes	Number birds
05:00	3	3
06:00	9	20
07:00	7	15
08:00	8	9
09:00	3	3
10:00	1	1
11:00	3	3
12:00	1	1
13:00	3	7
14:00	—	—
15:00	3	6
16:00	2	4
17:00	5	8
18:00	1	1

are seen to ant most frequently in the early morning hours that constitute the period of maximum normal daily activity. Lesser peaks of anting activity occur in late afternoon and at midday. Four of the eight midday records are from March and April, decidedly prior to the onset of the regular anting season (Table 1).

Seasonal peak.—Only two observers have shown any particular interest in determining a seasonal peak of anting activity in North America. Working with semicaptive birds in aviaries near Toronto, Ontario, Ivor (1943) found the peak to be from mid-April to the end of July. Mrs. Whitaker (1957) found that her captive oriole anted every month of the year with varying intensity. She concluded that her work did not adequately test the seasonal differences, but states that "it is noteworthy that even live ants did not induce top intensity anting in September through February but did so from March through July." In experimental offerings of various species, she found a correlation between anting intensity exhibited by captive birds and the thermogenic (heating) property of the ants according to species. All species accepted for use in anting produced a "burning sensation to the human tongue." She found the thermogenic property noticeably reduced in winter. Mrs. Whitaker conducted her experiments in Michigan and Oklahoma.

The 25 records of anting involving 45 wild birds of 9 species from Wake County, North Carolina, show for March 3 episodes involving 7 birds; April, 1 episode, 1 bird; May, 2 episodes, 2 birds; June, 1 episode, 1 bird; July, 3 episodes, 3 birds; August, 9 episodes, 21 birds; September, 5 episodes, 9 birds; October, 1 episode, 1 bird; and November through

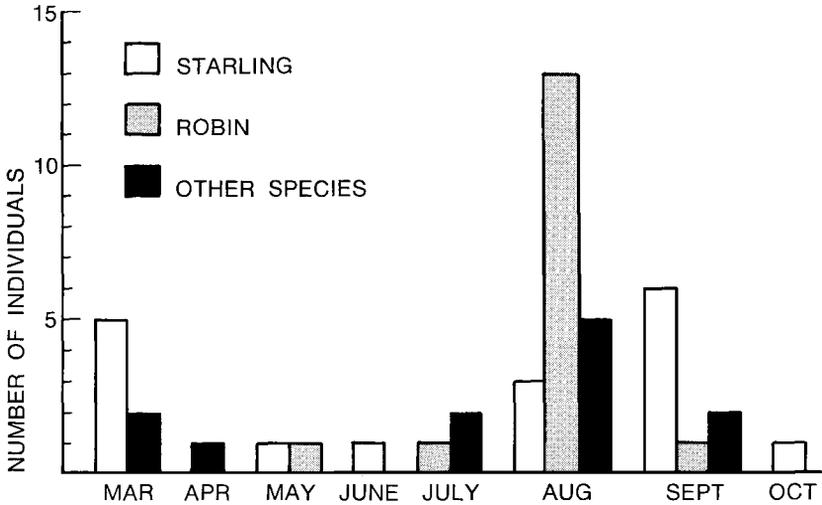


Figure 1. Anting by 45 wild birds at Zebulon, North Carolina, 1964-1968.

February, none. Thus 17 of these 25 episodes (68 per cent) occurred in the July through September period when most North American passerines normally molt. Of the 45 individuals anting at Zebulon, 33 (73 per cent) did so in July, August, or September (Figure 1).

Of the 13 anting episodes Brackbill (1948) lists, 7 occurred in July and August. Of Groskin's (1950) 13 episodes, 8 occurred in July, August, and September. Neither Brackbill nor Groskin recorded anting prior to mid-May or after the first week in October. When the records of Brackbill, Groskin, and Potter are added to those from wild birds in other parts of North America (Table 1), one can see an abrupt onset of major anting activity at mid-May, continuing through June and July to a peak in August, declining slowly in September, and virtually stopping the first week in October.

Disregarding the 25 anting episodes seen by Potter and those seen by Mayr (1948), which are biased by the behavior of a single bird, one finds that the remaining 56 random observations by more than 25 different authors (Table 1) still reflect the August peak of anting activity. They are distributed as follows: 18 in August, 13 in June, 10 in July, 7 in May, 4 in September, 2 in October, and 2 in November. July, August, and September records account for 57 per cent of the total.

Considered together, the data in Table 1 show anting by more individual birds of more different species in August than in any other month of the year.

If one accepts the hypothesis advanced by Southern (1963) that birds ant because their skins are irritated by new feather growth, the August peak of activity among wild birds in North America is logical, even predictable. Total avian population is greatly increased by recently hatched birds, and fall migration has not yet reduced their numbers. By August most adult passerines have completed one or more nesting cycles and are undergoing the postnuptial molt. At the same time most birds of the year have been on the wing long enough to be ready for the postjuvinal molt. While the coincidence of the peak of anting activity with the peak of seasonal molt is not in itself proof that the irritation of new feather growth causes birds to ant, the circumstantial evidence is very strong.

Anting and ectoparasites.—Groskin (1943, 1950) and others have suggested the possibility that birds use the formic acid sprayed by some species of ants to soothe skin irritated by ectoparasites. Mrs. Whitaker (1957) ruled out large ectoparasites as a cause of the oriole's pronounced anting of the under-tail region, but she conceded that minute parasites could have remained undetected and that endoparasites emerging from the vent or encysted under the skin could have caused irritation. She noted that the bird gave little attention to the vent region except when anting and accepted this as evidence against skin irritation there.

Simmons (1966), who has seen anting in 300 birds of 100 species (both captive and wild), believes "it is very likely that anting has been evolved to combat ectoparasites, particularly those under the wing, though this may not be its only—or even main—function." He suggests that ant excretions on feathers may act as a repellent to help prevent ectoparasite infestation. Simmons also states that the function of ants in feather maintenance may be to increase the flow of saliva for use in preening, to help in removing stale preen oil and other lipids, or to increase feather wear resistance in some yet undiscovered biochemical process.

Although Southern (1963) collected one bird that had been anting and found it free of ectoparasites, this in itself does not prove the bird's skin had not been irritated by a recent infestation. However if skin irritated by ectoparasites were a primary cause of anting, one would expect the peak of anting to occur when bird lice and ticks are most abundant on birds handled by banders.

Groskin (1950) comments on the abundance of bird lice (Mallophaga) on Catbirds when they "first arrive in Ardmore [Pennsylvania] during the spring migration." Yet of his 13 anting records, only one occurred before 1 June, and that was by a Wood Thrush. Mallophaga attach themselves to the base of the feather rather than to the skin, so it does not seem likely that these lice would cause a great deal of skin irritation.

Sonenshine et al. (1966) examined for the presence of ticks birds mist-netted at three banding stations in Maryland. Birds found to be most commonly infested were Swainson's Thrush (*Hylocichla ustulata*), Gray-cheeked Thrush (*H. minima*), Veery (*H. fuscescens*), Brown Thrasher, Northern Waterthrush (*Seiurus noveboracensis*), Slate-colored Junco, and various sparrows (especially the White-throated Sparrow, *Zonotrichia albicollis*). The two most common tick species were *Haemaphysalis leporispalustris* and *Ixodes dentatus*, which were most abundant among fall migrant birds in early September and early November, respectively. It is significant that three species of birds frequently seen anting (Robin, Starling, and Catbird) are not on Sonenshine et alii's list of common hosts, and the periods of peak abundance for the most common ticks do not coincide with the August peak of anting activity (Table 1 and Figure 1).

In 1967 Elizabeth Teulings of Chapel Hill, North Carolina, banded over 5,000 birds and examined most of them for the presence of ticks as a cooperator in Dr. Sonenshine's research. Mrs. Teulings (pers. comm.) reports that at Chapel Hill the peak of ectoparasite infestation occurs during November when approximately half the birds handled have one or more ticks. She also finds a general increase in tick infestation in March, but with a much smaller percentage of the birds involved. During August, the month of peak anting activity, ectoparasite incidence is relatively low, which is also true of the other summer months.

Ectoparasites almost invariably attach themselves to the head and neck of the host bird, particularly around the eyes and ear openings (Elizabeth Teulings, pers. comm.). It is physically impossible for a bird to reach the head with an ant held in its bill. Conceivably the excretions could be transferred to the head by scratching with the toes, but I have seen head scratching performed in conjunction with anting in only one episode.

While the effects of ectoparasites cannot be completely eliminated as a possible cause of anting behavior, I can find no positive evidence that birds infested with lice and ticks are more likely to ant than uninfested birds.

Anting and the cycle of molt.—Varying slightly from one species to another, and within species from one season or locality to another, North American passerines generally molt in summer (July, August, and September). As the data in Table 1 clearly indicate, the peak of anting activity among North American wild birds comes during these same months.

Another point to consider is that birds frequently concentrate anting treatments on the wings and tail, areas where the largest feathers emerge. Is it not possible that the thermogenic effects of ants discussed by Mrs. Whitaker (1957) could be beneficially stimulating or soothing to the

feather tracts during molts? Can ant excretions help remove the waxy deposits found on skins of molting birds, or perhaps facilitate feather emergence by softening sheaths?

Of the 45 wild birds I saw anting at Zebulon, 22 were definitely molting. (In some cases, especially those involving Catbirds and adult Starlings, I was unable to determine condition of plumage.) Granted, all birds that ant are not necessarily molting, and all birds that molt do not necessarily ant; nevertheless it is apparent that a given bird is more likely to ant when molting than at any other time of the year.

Bent (1946: 39) states that young Blue Jays have a partial postjuvinal molt between 50 and 90 days after leaving the nest, and adults undergo a complete postnuptial molt between June and September. The five known episodes of anting among wild Blue Jays (Table 1) occurred in July, August, and September.

While Bent (1948: 329) indicates that both juvenile and adult Catbirds molt in August, I banded at Zebulon a Catbird undergoing a symmetrical molt of the tail feathers on 19 May 1965. The bird still had eggs in the nest, and its mate was not molting although its tail feathers were badly worn. A Catbird banded on 18 June 1965 was molting contour feathers. All 10 known episodes of anting in wild Catbirds (Table 1) occurred between mid-May and the end of August.

Adult Robins undergo a complete postnuptial molt in August and September. Birds of the year undergo a postjuvinal molt from August to October, "depending largely on date of hatching" (Dwight, *in* Bent, 1949: 24). It does not appear to be mere coincidence that of 17 known anting episodes involving Robins (Table 1), 8 occurred in August, 4 in July, 2 in September, and 1 each in May, June, and October. Staebler (1942) commented that the Robin he saw anting 12 July 1942 had "worn plumage" indicating the "molt was about to begin."

Bent (1950: 193-194) gives the period of postjuvinal molt in the Starling as "between July and September, depending upon the date of hatching; for birds of the first brood in New England, this occurs in August. . . . Adults and year-old birds have a complete postnuptial molt, beginning sometimes in June but usually from July through September." Table 1 lists 16 episodes of anting involving Starlings: 6 from August, 4 from September, 2 from June, and 1 each from March, May, October, and November. Thus 10 of 14 known episodes of anting by wild Starlings occurred within the July through September period when birds of the species usually molt.

All the published records of anting in wild Common Grackles are by one observer (Brackbill, 1948) on 27 June, 8 July, and 8 August. In

only one instance (8 August) does he specifically mention that the bird was molting. Dwight (*in* Bent, 1958: 378) gives the postjuvinal molt of the Common Grackle as taking place "early in August." Stone (*in* Bent, 1958: 378) reports gaps in the flight feathers of adults as early as 18 July with the molt continuing as late as mid-September. The apparent lack of a correlation between anting and molting in the Common Grackle may only reflect inadequate molt data.

For the Cardinal Bent (1968: 7) gives the time of the postjuvinal molt as "in August, or earlier in early broods" and of the postnuptial molt as "in late summer." At Zebulon I have banded adult Cardinals that were molting as early as 11, 12, and 15 May. Local birds of the year apparently molt in August for the most part, but I banded a juvenile male Cardinal with sheaths on the outer primaries 22 October 1968. The four known instances of anting in wild Cardinals occurred between 29 May and 16 September.

For the Rufous-sided Towhee Sutton (*in* Bent, 1968: 569) gives the onset of the postjuvinal molt as in mid-July. Davis (*in* Bent, 1968: 570) found evidence of the postnuptial molt in early July. Although I have no local data on the postnuptial molt, I have noted juvenile towhees molting in August, September, and October. The three known instances of anting in wild towhees occurred from 10 July to 26 August.

The only wild Slate-colored Junco known to ant did so on 4 March 1966, which coincides with the period of prenuptial molt in the first half of March (Helms et al., 1967). As the spring molt of this species usually involves only the feathers of the head (Elizabeth Teulings, pers. comm.), it is significant that the bird scratched the side of its head several times while anting. I did not see this behavior in the other birds anting at Zebulon, although a Starling did scratch its wing during one episode.

All known instances of anting in wild Song Sparrows occurred within the July through September period of molt given by Mrs. Nice (1937: 135). Two different observers indicate that individual Song Sparrows performed anting repeatedly. Mayr (1948) saw a Song Sparrow anting "almost daily" in July 1947 outside his office window on Long Island, New York. He commented that the behavior "seemed almost like part of the bird's daily routine." Groskin (1950) states that "it is almost certain that it was the same two banded Song Sparrows that performed in each of the five observations" as no birds of this species without bands anted. These episodes occurred from 20 July through 19 August 1948, "often several times on the same day." Unfortunately neither author mentions the condition of the birds' plumage.

Anting and temperature.—The three March anting episodes occurred

during unseasonably warm weather. Several August episodes followed cooling rains. With these two exceptions I find no correlation between anting and temperature trends or abnormalities (Table 3).

Anting and precipitation.—During the nearly 5 years I have kept records on anting behavior, it has become apparent that birds are most likely to exhibit intense interest in all forms of feather and skin care after prolonged periods of wet weather. It is only logical that birds must give special attention to plumage after exposure to rain, snow, and mud. Of my 25 anting episodes, 19 occurred within 72 hours after rainfall (Table 3). The multiple episodes of 6 and 7 August 1964, 11 August 1966, and 25 through 29 August 1967 all occurred less than 48 hours after heavy precipitation. One July and five September episodes are not correlated with local rainfall.

Duration of episodes.—While there are numerous records (especially in captive birds) of marathon anting sessions lasting half an hour or more (Whitaker, 1957; Snyder, 1941), I found episodes of 15 minutes or less to prevail. All Zebulon episodes lasting 20 minutes or longer occurred within 48 hours after heavy rainfall in August and involved several individuals of one or more species.

Anting and drought.—The summer of 1968 was so hot and dry in North Carolina that the state was declared a farm crop disaster area. By late September major rivers in eastern North Carolina had reached the lowest levels in 20 to 60 years. Local birds were late getting first broods out of the nest, and relatively few pairs attempted second broods. Numerous feathers dropped in the yard indicated postnuptial molt to be well underway by mid-July. In her studies of the Song Sparrow, Mrs. Nice (1937: 135) attributed to drought the onset of postnuptial molt in July and the subsequent early end of the nesting season in 1930. Drought-induced early molting may explain my seeing anting in July for the first time in the summer of 1968, as well as my failing to detect anting in August and September of that year.

Anting and sunbathing.—Brackbill (1948) comments on the similarity between anting and sunning behavior patterns. When a Robin anted passively on 31 May 1965 and a Starling did so on 19 June 1965, it was very difficult to discriminate between anting and sunbathing. I have seen sunning not associated with anting on six occasions, four of these at the *Formica* mounds in Zebulon. Two juvenile Brown Thrashers that sunbathed at these mounds on 4 July 1966 also dusted there. They moved about the yard dusting and sunning at four other sites marked by bare ground and ant hills, but they did not ant.

Anting and age of birds.—Mrs. Nice (1943: 80–81) first noted anting

TABLE 3
WEATHER CONDITIONS RELEVANT TO ANTING EPISODES AT ZEBULON, NORTH CAROLINA, 1964-1968

Date/time	Average daily temperature	Precipitation prior to occurrence	Weather conditions during occurrence	Hours since local rainfall
3 March 1964 ca. 13:00	18°F above normal	Snowfall 25 and 28 February, rainfall 2 and 3 March	Clear and warm	5
4 March 1966 13:40	15°F above normal	Rainfall 3 and 4 March	Clear and mild, ground very wet	3
15 March 1967 11:30	17°F above normal	Early morning fog, scattered thunderstorms	Clear and hot (high for day 87°F)	Less than 72
22 April 1965 11:40	5°F above normal	Rainfall 19 and 20 April, morning fog 19-21 April	Clear and warm	Less than 48
20 May 1965 08:25	7°F above normal	Rainfall 17 and 18 May	Heavy fog lifting	Less than 72
31 May 1965 12:15	5°F below normal	Early morning fog and afternoon thunderstorms on several consecutive days	Clear and mild	Less than 24
19 June 1965 13:45	3-17°F below normal 14 through 19 June	Rainfall 9 of 11 days, fog every morning but one	Sunny and warm	Less than 24
5 July 1968 ca. 09:10	About normal	Heavy rainfall for about 36 hours	Clearing	0
24 July 1968 07:13	About normal	None—unusually dry	Clear, hot, dry	More than 72
27 July 1968 11:15	About normal	Almost daily thunderstorms	Clear and mild	Less than 24
6 August 1964 08:00	10°F below normal on 4 August, remaining cool through 7 August	Rainfall daily 2-4 August (cold front arrived 3 August)	Clear and cool	Less than 48
7 August 1964 07:00			Clear and cool	Less than 72
11 August 1966 08:15 and 08:58	About normal	Early morning fog and afternoon thunderstorms 3-11 August	Cloudy and mild	Less than 24

TABLE 3 (Continued)

Date/time	Average daily temperature	Precipitation prior to occurrence	Weather conditions during occurrence	Hours since local rainfall
25 August 1967 17:56	About normal	Heavy thunderstorms 20-25 August	Clearing and mild	1
26 August 1967 06:15 and 07:30	About normal	As above	Heavy fog	14 15
27 August 1967 06:45	About normal	As above	Light fog	39
29 August 1967 06:03	About normal	Afternoon thunderstorm 27 August, rainfall night of 28-29 August	Clearing and cool	Less than 6
24 September 1964 07:40	About normal	Last rainfall 20 September	Clear and mild	More than 72
25 September 1964 08:30	7°F below normal	As above	Clear and cool	More than 72
8 September 1965 07:44	6°F below normal	Last rainfall 1 September	Clear and cool	More than 72
22 September 1965 06:40	9°F above normal	Last rainfall 17 September	Fog, heavy dew	More than 72
12 September 1966 07:30	About normal	No rainfall for 3 weeks	Cloudy and mild	More than 72
3 October 1964 08:10	About normal	Rainfall on 5 consecutive days	Light rain falling	0

among hand-reared Song Sparrows at 36 and 37 days of age, although the birds had been exposed to ants earlier. This is approximately the same age at which the birds began sunning (Nice, 1943: 28–29). Of 45 birds seen anting at Zebulon, I could determine ages for 32 individuals, 19 juveniles and 13 adults. Juvenile birds appear to be enthusiastic anters in the wild, particularly if they become wet when molting into first winter plumage. Adult birds have anted prior to the nesting season (Potter, 1964), while on the nesting territory (Brackbill, 1948), and in family parties with young of the year (Snyder, 1941). The scarcity of records before mid-May (Table 1) suggests that adult birds do not generally engage in anting during the nesting season until the first brood is ready, or nearly ready, to leave the nest.

Habitat preference for anting.—Most published records give the habitat as lawns, sidewalks, or driveways, all being ground-level urban or suburban areas where birds are relatively conspicuous; however much anting takes place in wooded locations and above ground level. Tedards (1967) mentions an anting Prothonotary Warbler that picked ants from a vine, and Mayr (1948) mentions a Song Sparrow that anted while clinging to a stem of dock (*Rumex*). Davis (1950) saw a Blue Jay anting on a terminal branch of a white oak, and I have seen birds anting in pecan and pine trees. When birds ant in trees they may perch on the trunk or on branches all the way to the canopy.

Species of ants used.—Being an entomologist, Groskin (1950) naturally attached great importance to the species of ants used in anting and to the chemical composition of their excretions. Ants used by birds at Zebulon were species frequently mentioned in the literature on anting. Resident birds regularly visited mounds and trails of all ant species except when cold weather inhibited activity in ant colonies. Records show a preference for the *Formica fusca* colony, which was larger, more conspicuous, and usually more active than the others. However on many occasions I saw birds fly directly to all three colonies and immediately begin anting or feeding on ants. Obviously resident birds knew the locations of ant mounds and visited these sites deliberately. I failed to see anting on many occasions when ants of suitable species were abundant and birds were feeding, sunning, or dusting at the mounds. Some factor other than mere contact with the right kinds of ants must induce birds to ant. Simmons (1966) proposes that birds “have to learn that ants are biologically correct media for anting.” The chemical effect of formic acid in the olfactory organs “first releases anting instinctively in the inexperienced bird.” Subsequently the bird will “respond to ants visually,

anting 'deliberately' when in anting mood" and learn to discriminate between acceptable and unacceptable types of ants.

Anting and tool use.—The only instance known to me of tool use in conjunction with anting occurred near Zebulon on 29 August 1967. A juvenile Robin held a twig in its beak and swept the ground by rotating its head 180 degrees. The bird repeated this apparently successful attempt to locate more ants in leaf litter several times with the same twig, thus eliminating the possibility of chance behavior.

CONCLUSIONS

Anting is a common form of behavior in wild birds, and it most often takes place during the same early morning hours that constitute the normal period of greatest general activity. Anting among wild birds in North America has been recorded for more individuals and more different species in August than in any other month of the year. Intense anting activity is most likely to occur when heavy or prolonged rainfall coincides with the seasonal molt. Southern's hypothesis that birds ant to soothe skin irritated by new feather growth is greatly strengthened by the August peak of anting activity, as this is the time of year when nearly all North American passerines molt. A correlation between anting and molting is consistent with Mrs. Whitaker's theories on the thermogenic properties of ants and their possible effectiveness in soothing skin irritation. Such a correlation also agrees with Simmons' views on the feather-maintenance aspects of anting and on the functional origin of this widespread and stereotyped behavior pattern. Future published accounts of anting should include information on the condition of plumage and meteorological data for the preceding several days as well as for the actual date of observation. I am confident that additional records, if supported by adequate details on plumage condition, will prove beyond any reasonable doubt that anting among wild birds is in most cases directly related to the emergence of new feathers.

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SUMMARY

Between 1 March 1964 and 30 September 1968 I saw 25 episodes of anting among wild birds in or near Zebulon, Wake County, North Carolina,

involving 45 individual birds of 9 species. Anting took place from 3 March to 3 October with the largest number of episodes (9) occurring in August. A search of the literature revealed 56 comparable records from wild birds in North America. Considered together, these 81 records indicate 1) that birds are most likely to ant between dawn and 10:00; 2) that the month of peak anting activity is August; and 3) that for most species studied anting usually occurred during the normal periods of prenuptial, postnuptial, or postjuvenile molts. Of the 25 anting episodes detailed in the present paper, 19 occurred within 72 hours after rainfall. Intense anting activity occurred at Zebulon only in August and within 48 hours after rainfall. I noted similarities between anting and sunbathing as well as one instance of tool-using in conjunction with anting. While finding a considerable amount of evidence to support Southern's hypothesis that birds ant because of skin irritation from new feather growth, I found no positive evidence to support the theory that birds ant to soothe skin irritated by ectoparasites.

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