RELATIONSHIP OF ANTING AND SUNBATHING TO MOLTING IN WILD BIRDS

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AVIAN anting has generated a large and somewhat controversial body of literature, much of it based upon the behavior of captive or experimental birds (e.g. Ivor 1943, Whitaker 1957, Weisbrod 1971), birds treating plumage with substances other than ants (recently with mothballs in Dubois 1969 and with lemon oil in Johnson 1971), or single occurrences from widely scattered geographical locations. McAtee (1954) advised that in searching for a reasonable theory as to why birds ant only records from wild birds using ants should be examined. The authors agree with McAtee and further believe that data should be considered comparable only when taken from a limited geographical region (e.g. temperate North America in Potter 1970).

The literature on anting has been reviewed several times (Groskin 1950, Whitaker 1957, Chisholm 1959, Simmons 1966, Potter 1970). Principal theories are (1) that anting birds "derive sensual pleasure from anting, possibly sexual stimulation" (Whitaker 1957); (2) that ant secretions prevent, remove, or otherwise control ectoparasite infestation (Groskin 1950, Dubinin *in* Kelso and Nice 1963, Simmons 1966); (3) that ant secretions may be helpful in feather maintenance by increasing flow of saliva for preening, removing stale preen oil and other lipids, or increasing feather wear resistance (Simmons 1966); and (4) that ant secretions soothe skin irritated by the emergence of new feathers (Southern 1963, Potter 1970). Only four authors have published a dozen or more anting records involving wild birds using ants and taking place in or near a single location in temperate North America. These are Brackbill (1948) from Maryland, Groskin (1950) from Pennsylvania, Potter (1970) from North Carolina, and Hauser (1973) also from North Carolina.

Potter (1970) recorded 25 episodes of anting by 45 wild birds of 9 species from Zebulon, Wake County, North Carolina. Hauser (1973) described 48 episodes of anting by 59 wild birds of 13 species from Fayetteville, Cumberland County, North Carolina. Considered together, these 73 episodes by 104 birds of 16 species demonstrate that major anting activity begins in mid-May and continues through the first week of October with a peak in August and September (Hauser 1973). The earliest date for anting in North Carolina is 3 March (Potter 1970), and the latest is 17 December (Hauser 1973). Not only do more birds ant in August than at other times of the year, but more individuals are

[1] Deceased 30 March 1972.

likely to do so with greater intensity in August than in any other month. Although high intensity anting may occur from March through December, all April and May episodes from Fayetteville and Zebulon were of low intensity (Hauser 1973).

Only Hauser (1957) has published any significant amount of data on sunbathing among wild birds in temperate North America. She noted that "heat, alone, is not the motivating factor" in determining when birds sunbathe. Individuals of certain migratory winter resident species sunned when air temperatures were "as low as 50° F and 60° F." Commenting on the similarity between Hauser's (1957) descriptions and sketches of the involuntary sunbathing posture and some anting attitudes "in situations where, apparently, the only heat involved was in the anting material itself," Whitaker (1957) suggested a need for further study of sunning "in the light of birds' anting responses to thermogenic materials." Hauser (1973) continued to record sunning activity while watching for anting at Fayetteville, and she concluded that permanent resident species are more likely to sunbathe than to ant "from April through July than in any other months of the year. The August-September peak of anting coincides with a period of declining frequency of sunbathing, though the latter activity certainly is not unusual in late summer."

Wild birds tend to ant and sunbathe most frequently during periods of high humidity, particularly right after heavy or prolonged rainfall in summer (Hauser 1957, 1973; Potter 1970). Hauser (1973) noted that a sharp increase in one of these behaviors "does not presage a similar increase in the other." She recorded anting and sunning on the same day only 11 times, 3 of these being represented by single birds that combined the two activities. The anting that accompanied sunning was of low intensity and took place mostly in May and July when sunbathing involved "many individuals of several species on a single day [or occurred] frequently on several successive days" (Hauser 1973).

This paper attempts to review all the known records of anting and sunbathing among wild birds in North Carolina relative to the available data on molting and ectoparasite infestation among birds of the same species from the same region.

METHODS

The key to detecting anting and sunbathing behavior in wild birds lies not in long hours of observation but in one's knowledge of the "hot spots" in one's own yard. Once the anthills and favored sunning spots (standing dead trees, fallen trees, dead limbs, telephone poles, fence posts, brick walls, bare gravel, large rocks, compost piles, embankments, or bird feeders) have been located, ten or more 1-minute checks throughout the day are more likely to produce results than a full hour once a day.

From January 1969 through September 1973 Potter watched for anting and

sunbathing behavior almost daily at her home near Zebulon. Although she followed no regular schedule, she paid particular attention to the birds' activities for 48 hours after heavy or prolonged rainfall, on foggy mornings, for 48 hours following the known occurrence of either anting or sunbathing, and whenever flocks of anting-prone birds were in the yard. Unusual activities were verified with a 7 × 50 binocular.

From March 1958 through October 1963 Hauser watched for anting and sunbathing activity from a windowed bay of her home at Fayetteville, almost daily and usually from 08:00 to 18:00. Random observations continued through June 1966. Unusual activities were verified by use of a 7 × 35 binocular. Unpublished notes covering the entire period and an unfinished manuscript based on these notes were made available to Potter in June 1972. These provided data for posthumous publication of "Comparison of anting records from two localities in North Carolina" (Hauser 1973).

Potter examined for evidence of molt or ectoparasite infestation all birds captured for banding at her home station from January 1969 to the present (about 500 individuals) and all birds found dead in her yard. She also obtained molt and ectoparasite data through personal communication with Elizabeth P. Teulings of Chapel Hill, North Carolina, and examined specimens at the North Carolina State Museum of Natural History for evidence of molting.

Definition of Terms

Terminology in this paper follows Potter (1970) and Hauser (1973). "Active anting" refers to a bird picking up live ants with its bill and inserting them among the feathers. In "passive anting" the bird remains, often with body flattened against the ground in a sunbathing posture, 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 insertions of ants among the feathers in active anting or their removal in passive anting. A "treatment" in active anting is the capture of an ant (or ants) 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 anting simultaneously or one immediately after the other with no significant interruption. "High intensity anting" includes those episodes in which birds appear to be in a state of ecstasy, tumble over, or continue the activity for more than 5 minutes without significant interruption. "Low intensity anting" is brief, casual, or half-hearted, possibly consisting of only one treatment. "Sunbathing" or "sunning" refers to birds' exposing one or more feather tracts to direct sunlight by some combination of erecting contour feathers; drooping, lifting, or fanning wings; and fanning the tail. While doing so, birds remain motionless, usually leaning to one side, and sometimes allow the nictitating membrane to cover the eye. For illustrations of sunning positions see Hauser (1957).

Results

An Appendix lists 34 species of wild birds (7 winter residents, 6 summer residents, and 21 year-round residents) that are known to have anted or sunbathed in North Carolina and compares dates of sunning and anting with known dates of molting and ectoparasite infestation for the state.

Of the 34 species, 32 were seen sunbathing and only 17 were seen anting. Two species (Yellow-bellied Sapsucker and Pine Warbler) are recorded as anting but not sunning, while 17 species are recorded as sunning but not anting. Of the 17 species with no North Carolina anting records, 3 (Wood Thrush, Red-winged Blackbird, and Summer Tanager) are known to have anted in other states (Potter 1970).

Sunning and anting records in the Appendix are those of the authors unless otherwise stated. Molt data are from Potter unless otherwise noted. Elizabeth P. Teulings of Chapel Hill, North Carolina, supplied almost all the ectoparasite data. She banded more than 10,000 birds as a cooperator in a study of ticks as vectors of disease agents (Clifford et al. 1969, Sonenshine and Stout 1970), and the latter publication contains a detailed account of her work.

All anting records in the Appendix have been published elsewhere (McAtee 1954, Chamberlain 1954, Grimshawe 1964, Potter 1970, Hill 1973, Hauser 1973) except for 11 episodes Potter saw in the yard of her home 3.5 miles north of Zebulon from 1969 through 1972. These previously unpublished sightings are given below in chronological order by Eastern Standard Time:

Episode 1. 2 July 1969, 07:40. An adult female Cardinal anted briefly. Recent heavy rains had caused numerous nesting failures, and within the next week many adult birds (including Cardinals) had conspicuous gaps in their flight feathers. This particular bird is not known to have been molting at the time of the anting.

Episode 2. 2 August 1969, 06:40. A juvenile American Robin made 12 anting treatments within about 5 minutes, concentrating upon wings that showed evidence of molting remiges. The bird was probably of the locally breeding race *T. m. achrusterus* that, unlike *T. m. migratorius*, apparently undergoes a complete postjuvenal molt beginning in early July for the young of first broods.

Episode 3. 2 October 1969, 10:30. Juvenile American Robin anted seven times under wings with treatments apparently directed toward base of primaries. The bird had nearly completed its postjuvenal molt, but some juvenal wing coverts remained. Its throat was still that of a young bird, but the breast appeared entirely red.

Episode 4. 8 October 1969, 07:40. Molting juvenile American Robin anted under wings three times.

Episode 5. 10 October 1969, 08:47. Juvenile American Robin with missing greater wing coverts anted under wing six times.

Episode 6. 3 August 1970, 06:10. Juvenile Rufous-sided Towhee made at least five treatments under wings that were molting primaries.

Episodes 7, 8, and 9. 28 July 1971, 07:40 to 08:30. An adult Gray Catbird and an adult female Cardinal anted from 07:40 to 07:45. Both birds were molting rectrices and concentrated treatments under the tail. At 08:00 a juvenile American Robin almost completely in first winter plumage but having some missing tail feathers repeatedly thrust its tail forward between its legs and anted the caudal area so vigorously that it tumbled over backwards. A juvenile robin that apparently had not yet begun to molt watched the anting bird but did not join

the activity. At 08:30 an adult male Cardinal also anted between its legs, but I could not determine the bird's plumage condition.

Episode 10. 23 April 1972, 09:45. A White-throated Sparrow that was obviously in prenuptial molt made six treatments of its posterior underparts. A pearl-gray patch of clean new feathers on the lower breast surrounded by dingy gray old plumage showed the bird was just beginning to replace its ventral contour feathers. Its throat as yet showed no sign of acquiring nuptial plumage.

Episode 11. 28 June 1972, 07:25. A juvenile Pine Warbler anted actively on the ground outside the kitchen window. The bird was obviously in postjuvenal molt. It had juvenal head plumage and rectrices, but its sides were heavily streaked, the breast had enough bright yellow to distinguish the bird as a male, and the crissum was predominantly white. Both wings had only one white bar, indicating the almost simultaneous molt of one set of wing coverts. After each treatment the bird looked about, spotted an ant, ran to capture it, and treated either the underwings or the crissum. Sometimes it tumbled over in an effort to reach the caudal area. Other times it inserted the bill into the tip of the tail, apparently having missed the target completely. The bird made about 30 treatments in a period of 5 minutes and then flew straight back to the tall pines overhead. During the next several days I watched for more anting by Pine Warblers, but saw only a few juveniles bathing in water. Seeing Pine Warblers on the ground at all from the beginning of the nesting season until August is somewhat unusual. Apparently a few individuals visited the ground level in late June specifically to ant and bathe during the postjuvenal molt. The species was not seen on the ground again until 19 July when a juvenile Pine Warbler bathed and, as on the previous occasions, flew to a high perch to preen without foraging on the ground.

Weather conditions—Of the 11 anting episodes listed above, 8 occurred within 72 hours after the last local rainfall. The three episodes of 28 July 1971 came less than 36 hours after the last in a series of thundershowers (19 through 27 July) that ended a long dry spell. Episode 10 came less than 12 hours after rainfall that had been preceded by 3 days of almost continual drizzle. All three episodes (4, 5, and 11) that took place more than 72 hours after rainfall occurred on damp foggy mornings.

Evidence of molt relative to placement of ants.—Ten of the 12 birds that anted at Zebulon from 1969 through 1972 were definitely molting. In this respect the record of 8 October 1969 (Episode 4) is of particular interest. The bird anting was one of four juvenile American Robins on the ground near a set mist net, and I flushed the birds into the net so I could examine their plumage in hand. The birds appeared to be of the race *T. m. migratorius*. On all four birds the juvenal rectrices and remiges, which are retained through the first breeding season, were fully grown. The breast, belly, crissum, back, and most of the head had molted into first winter plumage; the throat was still juvenal; and the tibias were mostly bare. On the upper wing the lesser and middle coverts were mostly juvenal, the greater primary coverts were emerging from sheaths, and the

greater secondary coverts were missing. The wing lining was in approximately the same stage of molt with juvenal coverts on the leading edges of the wings and greater coverts either missing or just emerging from sheaths, thus laying bare the bases of the quills of the flight feathers and exposing much of the skin on the under side of the wing. The skin was coated with a waxy substance. Examination of the heads (particularly eye and ear openings) and wings for ectoparasites showed none that could be seen with the unaided eye, nor did any skin injury indicate a recent infestation; but both parasites and sores could have been hidden by the waxy substance on the skin. The important fact is that the bird directed anting treatments to the underwing while the lower wing coverts were molting rapidly.

The birds in Episodes 3, 5, and 11 also treated the underwing while they were in the process of renewing wing coverts. In Episodes 2 and 6, birds with missing remiges also anted their wings. On the other hand, the birds in Episodes 7, 8, and 9 all directed treatments toward the caudal feather tract. Three of the four individuals had missing rectrices, and the plumage condition of the fourth was undetermined. The birds in Episodes 10 and 11 treated the posterior underparts while renewing the lower ventral contour feathers.

Thus 10 of the 12 birds mentioned in the episodes above not only were in molt when the anting took place but also directed treatments toward exactly those feather tracts that had missing feathers, sheaths still visible on feathers, or obviously mixed plumages (i.e. juvenal/first winter or winter/nuptial).

Evidence of molt relative to sunbathing.—In mid-July 1972 Zebulon received a good amount of rainfall in the form of heavy thundershowers. After each one I watched in vain for anting; but I did see an extraordinary amount of sunbathing by juvenile American Robins, juvenile Common Flickers, adult Gray Catbirds, and juvenile Wood Thrushes. None of these birds showed missing rectrices or remiges. The young robins were molting head, neck, upper breast, and dorsal contour feathers. Days of the year when 32 species of wild birds sunned in North Carolina are given in the Appendix along with local molt data. With a single exception (White-breasted Nuthatch), December through March sunning is confined to winter residents (Ruby-crowned Kinglet, Purple Finch, Dark-eyed Junco, and White-throated Sparrow). Two other winter residents (Yellow-rumped Warbler and Evening Grosbeak) sunned in April. Four of these six migrants are known to molt regularly on the wintering grounds, and a fifth (Purple Finch) is subject to erratic winter feather renewal. The one Purple Finch that sunbathed at Zebulon on 1 December 1972 had sheaths on so many feathers of the neck that it appeared to be

wearing a ruff. Other birds in the same flock did not appear to be molting and were not seen sunning.

No summer resident bird has been seen sunbathing in North Carolina earlier than 11 June or later than 23 September, which are the extreme dates for Summer Tanager sunning activity at Fayetteville. Instances of sunning by two summer residents merit full descriptions.

On 31 August 1960 at 12:15 Hauser saw a Common Nighthawk immobile on an exposed pine branch perch 60 feet high. When the sun came out the bird preened its wings and back, then settled on the limb with a layer of feathers raised across the midback. Soon the bird raised on its feet and began to rock from side to side in fairly good one-quarter roll, constant and with even tempo. While rocking the bird raised other layers of back and belly plumage and preened its wings (under and above, particularly primary and secondary coverts) and sometimes its lower back. After the sun fully emerged from shifting cloud cover, the bird assumed a full fluff with tail widely fanned and wings fanned and drooped for 30 seconds. As the fluff subsided, the bird resumed rocking with a wider roll. After changing position on the limb, it remained immobile while the sun was again behind a cloud. At 13:45 the bird was still on same perch, and sun exposure brought a minor fluff with rocking and preening: the wings were low at the sides, partly away and overhanging the tree limb, but not fanned. The bird remained in various positions on the same limb until dark.

On 13 September 1961 at 14:55 Hauser watched a Yellow-billed Cuckoo sunning (Level III, as in Hauser 1957) on a high slanting limb of a tree. The bird's wings were open and fanned, showing full russet. The right wing was held over the lower back. At the end of the brief sunbath the bird quickly preened its right shoulder and flew away. The cuckoo was in molt, shaggy at breast and cheeks with the tail not yet fully grown.

Yellow-billed Cuckoos sunned at Zebulon in July 1973 while I had a nest under daily observation at about 40 feet with a 30× Balscope. At 11:11 on 25 July the adult female with young still in the nest perched on a high northward-leaning branch of an oak tree (*Quercus* sp.), raised her ventral contour feathers, and sunned for about a minute. She moved to another perch, sunned her back, and preened the base of the tail briefly. This bird was in the process of renewing rectrices, undertail coverts, and upper breast plumage. On 29 July the last chick remaining in the nest sunned several times, deliberately moving to sunny places on the rim other than the ones where it usually took food and defecated. This particular chick hatched on 22 July from an egg laid on 13 July. It began to burst

the quills about noon on 28 July, sunned off and on during the next day, and left the nest the morning of 30 July.

Although some year-round resident species sun as early as March and as late as November, their peak of sunbathing activity comes in late May, June, and July (Appendix), months that are generally marked by the early stages of postnuptial and postjuvenal molt in small land birds breeding in North Carolina. Of the 20 permanent resident species the authors have recorded as sunbathing at Fayetteville and Zebulon (Appendix), only 1 did so in March, 7 in April, 11 in May, 13 in June, 14 in July, 7 in August, 4 in September, 3 in October, and 2 in November. All but three of these 20 permanent resident species sunned in May, June, or July.

Dusting and sunning.—Together the authors have recorded dusting by only three species of birds in North Carolina: Carolina Wren, Brown Thrasher, and House Sparrow. House Sparrows seem to dust and sun more or less regularly throughout the warmer months of the year. Hauser saw dusting and sunning by two young Brown Thrashers with tails not yet full length on 3 June 1958. Potter (1970) saw dusting and sunning by two molting juvenile Brown Thrashers on 4 July 1966. Potter also watched a juvenile Carolina Wren dusting in the cooled ashes of a charcoal grill on 26 August 1965. Earlier Gray Catbirds had hovered over the grill while it was still too hot for them to perch upon it, and they returned later to perch above the still-warm coals. Because no smoke was visible, Potter assumed that the attraction was the rising hot air.

Anting and sunning in same episode.—Anting and sunning are not mutually exclusive forms of behavior. On three occasions Hauser (1973) saw birds sunning in conjunction with anting: a juvenile Rufous-sided Towhee on 28 August 1960, a juvenile Red-bellied Woodpecker on 5 September 1960, and an adult Red-bellied Woodpecker on 28 September 1960.

Sun position assumed by bird feeding on ants.—Potter witnessed one example of avian behavior that cannot be classified as either sunning or anting. On 15 July 1972 a Gray Catbird was feeding on a flagstone walkway that was in deep shade and crawling with large black ants. Standing with wings drooped and tail spread, the bird would snatch an ant, fluff body plumage, lean to the left with the partly open wing on the right side pointed straight up in a sun position (Hauser 1957), eat the ant, compress contour feathers, and droop wings while looking for another ant. The bird repeated this cycle several times before being driven away by another catbird.

Absence of recorded anting in January and February.—The Appendix lists at least one instance of sunning during every month of the year, but

to the best of our knowledge no anting has been reported among wild birds from North Carolina or elsewhere in temperate North America during January and February. King and Kepler (1970) have seen the Puerto Rican Tanager (*Nesospingus speculiferus*) anting in January and March, and Sick (1957) has reported anting by *Tangara cyanoventris* on 1 February and by *T. cyanicollis melanogaster* on 18 September; but if any species breeding in temperate North America has as yet been found anting while wintering in the tropics, we are not aware of it. The authors would be the last to suggest that birds never ant in North Carolina between 17 December and 3 March; but we do believe that if an appreciable amount of anting took place here during the winter, our records would indicate the trend. Indeed the arrival of unusual visitors at our feeders frequently keeps us at our windows for longer periods of time in winter than in summer. Perhaps the scarcity of published accounts of anting by wild birds reflects the fact that average bird watchers do relatively little birding from the time spring migrants pass until fall migrants appear at their feeders.

December 1971 and January 1972 were unseasonably warm in North Carolina except for two brief cold snaps on 14 and 24 January. During this period at least 12 ant colonies were active in the Potter yard. Ground-level temperature at 17:00 on 20 January was 65° F in the shade, and on 28 January one ant colony actually swarmed. Realizing that some ectoparasites are more abundant in winter than in other seasons, I made an effort to spend more time than usual watching for anting and sunning while temperatures were high and ants were active. All results were negative even though birds fed regularly in the vicinity of at least three of the ant colonies, one of these being near the post supporting a bird feeder and the site of several known anting episodes.

Water-bathing.—Neither author has made a consistent effort to record water-bathing in wild birds. Only since mid-May 1972 has Potter had a concrete fish pool that is shallow at one end and a drip-fed ground-level bird bath to provide unfailing sources of water for the birds within sight of the kitchen, dining area, and living room windows. During the first year following construction of the pools, I was struck by the fact that no bird (either individual or species) seemed to bathe regularly throughout the year. The pools were seldom used for bathing during the nesting season, in late autumn, and in winter. Spring use involved mostly winter residents, some of which bathed on rather cold days. Year-round and summer resident birds frequently ignored the water on the hottest, driest days of the year even though a sprinkler was operated to entice them to visit the pools.

Water-bathing records from North Carolina are summarized in Table

TABLE 1
MONTHS WHEN WILD BIRDS ARE KNOWN TO HAVE WATER-BATHED IN NORTH CAROLINA

Bird	Month
WINTER RESIDENTS	
Yellow-bellied Sapsucker, *Sphyrapicus varius*	October
Brown Creeper, *Certhia familiaris*	April
Yellow-rumped (Myrtle) Warbler, *Dendroica coronata*	October, November, and April
Evening Grosbeak, *Hesperiphona vespertina*	April
Purple Finch, *Carpodacus purpureus*	November
Red Crossbill, *Loxia curvirostra*	April
Dark-eyed (Slate-colored) Junco, *Junco hyemalis*	November
White-throated Sparrow, *Zonotrichia albicollis*	April
Song Sparrow, *Melospiza melodia*	November
SUMMER RESIDENTS	
Ruby-throated Hummingbird, *Archilochus colubris*	August (by flying through spray of lawn sprinkler)
Eastern Wood Pewee, *Contopus virens*	August (on wing in drip from leaves)
Gray Catbird, *Dumetella carolinensis*	July
Yellow-throated Warbler, *Dendroica dominica*	July, August, and September
Orchard Oriole, *Icterus spurius*	July
Summer Tanager, *Piranga rubra*	May and July (Potter 1973)
YEAR-ROUND RESIDENTS	
Bobwhite, *Colinus virginianus*	June (wallowing and preening in wet leaf mold)
Mourning Dove, *Zenaida macroura*	April (Hauser)
Common (Yellow-shafted) Flicker, *Colaptes auratus*	June (juvenile), September, and October
Red-bellied Woodpecker, *Centurus carolinus*	April (adult, Hauser), June (juvenile, Hauser), September, and October
Blue Jay, *Cyanocitta cristata*	July, September, and October
Carolina Chickadee, *Parus carolinensis*	August, September, October, and November
Tufted Titmouse, *Parus bicolor*	August, September, and October
Carolina Wren, *Thryothorus ludovicianus*	September, October, and November
Mockingbird, *Mimus polyglottos*	September and October
Brown Thrasher, *Toxostoma rufum*	July (molting, Hauser) and September
American Robin, *Turdus migratorius*	July through November (mostly juveniles in molt)
Eastern Bluebird, *Sialia sialis*	July through October (mostly juveniles in molt)
Pine Warbler, *Dendroica pinus*	Late June through November (mostly juveniles in molt)

TABLE 1 CONTINUED

Bird	Month
Common Grackle, *Quiscalus quiscula*	May and June (adults), July (juveniles)
Cardinal, *Cardinalis cardinalis*	July, September, and October
Rufous-sided Towhee, *Pipilo erythrophthalmus*	July (one bird in molt also sunbathed on 19 July)
Chipping Sparrow, *Spizella passerina*	April, August, September, October, and November (head molt obvious in most individuals)
FALL MIGRANTS	
Tennessee Warbler, *Vermivora peregrina*	September (immature)
Cape May Warbler, *Dendroica tigrina*	September (immature)
Chestnut-sided Warbler, *Dendroica pensylvanica*	September (immature)
Rose-breasted Grosbeak, *Pheucticus ludovicianus*	September (hatching year birds in heavy molt)

1. Sightings are from Zebulon unless attributed to Hauser. Although the data are admittedly scanty for many species listed and do not represent all bathing actually seen, they suggest a tendency for birds to bathe more often while molting than at other times of the year. Birds seem to bathe most frequently in September, which is usually a very dry month in North Carolina.

DISCUSSION

Data in the Appendix indicate that the peak of sunbathing for winter residents comes in March and April, for summer residents in June and July, and for permanent residents in late May through July. Anting is rarely recorded among winter visitors (three episodes), and it occurs most frequently among summer and year-round residents from late July through September. Tick infestation is heaviest from November through April. Records of wild birds with lice and mites are not adequate to show seasonal peaks, but most of the species of birds seen sunning and anting in North Carolina (with Starlings, House Sparrows, and Common Grackles as notable exceptions) do not appear to be heavily infested with lice or mites at any season. Four popular theories advanced to explain anting behavior are discussed below in relationship to the sunning-anting-molting data from North Carolina as summarized in the Appendix.

Anting for sensual pleasure, possibly sexual stimulation.—Anting for self-stimulation may occur often among captive birds as it apparently did in the case of the oriole studied by Whitaker (1957), but we find little to

support this theory in the behavior of wild birds. The peak of anting comes in August and September when gonads are normally in nonbreeding condition. Treatments are directed toward the lower breast, bases of the rectrices, and bases of the remiges far more often than toward the anus. Together the authors have watched anting performed by 116 wild birds. In only one case did the bird definitely treat the vent. A molting juvenile male Rufous-sided Towhee "would snatch an ant and thrust its bill through the partly black primaries or make a sharp dab at the vent while sitting on its tail" (Hauser 1973). Both authors have witnessed anting of the anal area, but in most cases the treatments appeared to be intended for portions of the caudal tract other than the vent. Is there any evidence that birds are sexually stimulated by touching the anus? Among small land birds anting at Zebulon and Fayetteville, precopulatory sexual stimuli appear to be predominantly aural or visual rather than tactile. Courtship feeding and mutual grooming involve touch, but these behaviors bear little resemblance to anting of the vent. Even when a wild bird does ant the vent, could the reason not be molting of the anal ring rather than sexual stimulation?

Potter (1972) has seen an adult male American Robin mounting pine cones while his mate was unreceptive during the brief interval between the failure of one nesting attempt and the beginning of the second. In July Potter (1972) has seen juvenile robins in pursuit flights, mobbing pine cones, mobbing sunbathing juveniles of the same species, and mounting pine cones. Apparently the pine cones and the sunning birds resembled soliciting females and permitted sublimation of ill-timed sex drives. No anting was associated with the mobbing and pine-cone-mounting behavior.

Whatever sensual pleasure birds derive from anting is probably related to the thermogenic property of ant excretions (Whitaker 1957), which may have much the same soothing effect upon birds as a hot towel or after-shave lotion does upon human skin. Groskin (1950) quotes a wide variety of references that generally agree on the pleasant effect one ant excretion has upon the skin, concluding that "use of formic acid as a counter-irritant has been well-known to the medical profession for several hundred years."

At Fayetteville Hauser (1973) found birds anting with three species of Myrmicinae that possess a functional sting: *Pheidole morrisi*, *Pogonomyrmex badius*, and *Crematogaster ashmeadi*. Although ants of this subfamily were considered unacceptable to the oriole studied by Whitaker (1957), "the Florida harvester ant (*P. badius*) was used by anting birds [at Fayetteville] more frequently than any other identified species. In addition to its sting, this species gives off a pungent odor that may cause birds to select it for anting in spite of the risk of being stung" (Hauser 1973). In view of the frequency with which we see birds

scratching their heads or rubbing their heads against perches, we should consider the possibility that anting of wing- and tail-feather tracts with stinging insects serves as an acceptable substitute for scratching these pterylae.

Prevention or reduction of ectoparasite infestation.—To the best of our knowledge only three people have examined birds for ectoparasites immediately after they anted in the wild. Southern (1963) collected one such bird and found it free of ectoparasites. Potter (present paper) mist-netted an anting American Robin and found it uninfested. Dubinin (*in* Kelso and Nice 1963) collected four Transbaical Steppe Pipits (*Anthus pratensis godlewskii*) that had been seizing ants and "smearing them on the wing feathers." The birds had anted for 20 to 40 minutes. Dubinin also collected four other birds of the same species that were not anting at the time. He found all eight birds infested with feather mites. Mites on the anting birds were disturbed, and of "642 live mites taken from the four anting pipits, 163 died within 12 hours, and 8 more within 24 hours." Of 758 mites removed from the control pipits, only 5 died within 12 hours and 2 more within 24 hours. We cannot help wondering if 20 to 40 minutes of vigorous preening would reduce the mite population significantly even without the use of ants. A similar experiment Dubinin conducted with Hoopoes (*Upupa epops*) that anted in the wild "showed no noticeably great decline" in the number of live mites during the 12-hour holding period.

According to Teulings' data (Appendix) ectoparasites are uncommon from May through October among most of the 14 summer and permanent resident species that are known to ant in North Carolina. This might be interpreted as evidence that anting has successfully repelled or removed the vermin during the 6 months of low infestation. If anting caused the decline in the number of ectoparasites found beginning in May, might one not expect the peak of anting to occur in late April or early May rather than in August and September? If abundance of mites caused anting, one would expect heavily infested young Common Grackles to ant frequently in June and July; but the data in the Appendix show far more anting during these months by rarely infested species such as the American Robin and the Cardinal than by grackles.

While we cannot deny that some anting episodes possibly represent attempts to control ectoparasites, we agree with Simmons (1966) that "this may not be its only—or even main—function." Indeed, we find no positive evidence that birds anting in the wild are either more or less likely to be infested with lice or feather mites than nonanting wild birds of the same species. We do find that anting birds are not likely to be carrying ticks, and we attribute this not to any beneficial effect of anting,

but rather to the life cycles of the tick species found on North Carolina birds (Sonenshine and Stout 1970). Larvae and nymphs of *Haemaphysalis leporispalustris* are bimodal in host-seeking activity with the dominant peak in early fall and a weak resurgence in March and April. Adults of this species are found on cottontail rabbits (*Sylvilagus floridanus*) but not on birds. Larval host-seeking in *Ixodes dentatus* is also bimodal, but the fall peak is later than in *H. leporispalustris*. *I. brunneus* activity is restricted to the colder months, November through April, with with peak activity of females in December.

Anting and feather maintenance.—Simmons (1966) placed anting in the feather maintenance group of behavior patterns. Other than removing or repelling ectoparasites, he suggested that ant excretions might increase the flow of saliva for use in preening, help in removing stale preen oil and other lipids, or increase feather wear resistance. Potter (1970) noted the coincidence of the peak of molting with the peak of anting and suggested that ant excretions might help remove waxy deposits from the skins of molting birds or facilitate emergence of feathers by softening sheaths. If the last three of the above reasons were the primary purpose of anting, one would expect a more or less regular rate of activity during the molting period. Instead anting most frequently follows heavy or prolonged precipitation (Potter 1970). Anting is relatively infrequent during the nesting season and after molting, the very times when Dubinin (*in* Kelso and Nice 1963) found the highest levels of lipid substances on the feathers of the birds he studied. Apparently the low level of lipids during molting can be attributed to the large number of newly emerged feathers that have been treated with preen oil only a few times if at all. Anting may have some bearing upon feather maintenance, but at the present time that role remains undefined and unproved.

Anting and the cycle of molt.—In North Carolina some adult small land birds begin dropping rectrices as early as mid-May, and a few individuals (usually juveniles) are still molting in late fall; but by far the heaviest period of quill molt comes from late July through early October with the peak in August and September. This compares very well with the known dates of anting episodes by those species that both breed and ant in the state (Appendix). Of the 11 episodes added in the present paper, 9 indicate that anting birds not only were in molt but also were directing treatments toward exactly those tracts with missing feathers, feathers with sheaths on them, or obviously mixed plumages. When observers specified the feather tracts in molt at the time of anting, (Appendix) they were: rectrices 6 times, remiges 4 times, wing coverts 4 times, lower breast or crissum 5 times, and breast 1 time. These records

indicate a strong correlation between anting and renewal of plumage on those feather tracts not easily exposed to sunlight.

Dubinin (*in* Kelso and Nice 1963) collected three species of birds at different times of the year, counted the feather mites, and extracted "with ether the lipid substance from the primaries, secondaries, and greater wing coverts. He found this substance at its lowest point during the molt and in winter, at its highest after the molt and during the nesting season. The numbers of feather mites fluctuated in correspondence with the amount of lipid substance in the feathers." We interpret Dubinin's findings to support our opinion that the peak of anting in August and September is caused by the seasonal peak in new feather growth rather than by a seasonal increase in feather mite infestation or a seasonal need to remove excess preen oil.

Sunbathing and the molt cycle.—According to Hauser (1957), "Young birds are seen sun-bathing more frequently than adults except during the late summer molting season when many adult birds in all stages of molt may be seen preening and sunning." Data in the Appendix fully justify that early and apparently unintentional commentary on the relationship of molting to sunning in avian behavior.

Winter visitors, such as the Yellow-rumped Warbler, Evening Grosbeak, Dark-eyed Junco, and White-throated Sparrow, exhibit a close correlation between sunbathing and the prenuptial head or head and upper body molt. The time of year (mostly March and April) suggests the possibility of a relationship between this sunning activity and the effect Menaker (1972) noted of nonvisual light reception upon gonadal recrudescence. Among year-round resident species sunbathing occurs most frequently from late May through July, a period of gonadal regression and about the time of the onset of postnuptial molt.

When observers specified which feather tracts were in molt at the time of sunning episodes (Appendix), the head, neck, breast, and back were listed 19 times while rectrices, remiges, and crissum or undertail coverts were mentioned only 7 times. At least 6 of these 7 times appear to be irrelevant because in four cases the birds were also acquiring new feathers on head, neck, back, or breast; in another case the bird combined anting with sunning; and in the sixth case the bird was a young Brown Thrasher still being fed by its parent and almost beyond question growing contours as well as rectrices. The Summer Tanager that sunned on 11 June may have been molting contours as well as rectrices, but Hauser's notes mentioned only the condition of the tail plumage.

Another possibility is that sunning might promote vitamin synthesis (Weisbrod 1971), but the seasonal nature of the activity and the relatively small proportion of the total bird population apparently involved make

sunning seem unlikely to serve any biologically essential purpose. Although a biochemical process cannot be eliminated as a possibility, the correlation of sunbathing with head and upper body molt offers a more logical explanation, particularly in view of the apparently complementary relationship of anting to the molting of wing and tail feathers.

Effect of precipitation upon molting, sunning, and anting.—Both Potter (1970) and Hauser (1957, 1973) noted a sharp increase in sunning and anting activity during periods of high humidity, particularly for 2 or 3 days after heavy or prolonged rainfall from mid-May through August. Apparently such precipitation causes the almost simultaneous loss of feathers that would have dropped out gradually had the birds not been exposed to abnormal wetness while molting. Simultaneous feather loss leads to simultaneous replacement, and widespread feather growth in a given tract apparently causes skin discomfort not generally associated with replacement of only a few feathers at a time by successive molt. In the case of rapid molting of the head, neck, dorsal, and upper ventral tracts, birds attempt to soothe their skin by sunbathing, but certain tracts such as those of the lower breast, under tail, and under wing are not easily exposed to sunlight. Some birds sun the ventral surface by perching belly-to-the-sun at the tips of tree branches (e.g. Yellow-billed Cuckoo), but others apparently substitute anting for sunning while molting feather tracts that are difficult for them to sunbathe. Whitaker (1957) commented upon the similarities between passive anting postures and Hauser's (1957) descriptions and sketches of Level IV Sun Position (contours fluffed, wings spread, body close to the ground). Almost beyond question these postures are alike because passive anting exposes the ventral feather tracts to ants (and on some occasions to warm bare dirt at anthills) just as Sun Position IV exposes the dorsal tracts to sunlight. When sunning and dusting take place at anthills, the distinction between these activities and passive anting seems to depend more upon the behavior of the ants than upon that of the birds.

In extremely broad terms, a long wet spell in North Carolina in late May, June, or early July will usually be followed by a sharp increase in sunbathing. Similar weather in late July and throughout August will usually be followed by a sharp increase in anting. September and October anting episodes appear to be related to foggy mornings or heavy dew rather than to rainfall. Obviously dates when wild birds of a given species might both ant and sunbathe overlap considerably, as in the case of the towhee that did both in a single episode on 28 August 1960 (Hauser 1973).

Potter (1970) found no records of anting among wild birds from Florida, New England, or the Pacific Coast region of the United States.

Almost all the episodes from temperate North America took place within an area bounded on the north by the Great Lakes and New York City and lying east of the Great Plains and north of the 34th parallel. According to a map in the leaflet "Thunderstorms" (U.S. Government Printing Office 1973) all 29 known United States reporting points for anting by wild birds using ants lie in sections of the country averaging 20 or more thunderstorm days per year. Only four points (all in the vicinity of New York City) lie in the 20 to 30 per year range, and only five lie in the ranges of 50 to 100 or more per year. Thus anting is seen most frequently in portions of the eastern United States having an average of 30 to 50 thunderstorm days per year. Apparently where summers are extremely dry (e.g. California with only 0 to 20 thunderstorms per year) birds rarely get wet enough to induce rapid molting, and where summers are extremely wet (e.g. Florida with 70 to over 100 thunderstorms per year) drenching rains probably occur so often that rarely are anting episodes sufficiently concentrated to attract a potential observer's attention. In regions having 30 to 50 thunderstorms per year periods of dry and wet summer weather alternate to create conditions conducive to the simultaneous onset of rapid molt for many individuals of various species, and hence the sighting of communal sunning and anting. This matter needs further investigation. It might be useful to see if anting occurs most frequently on a worldwide basis in places subject to thunderstorms, hurricanes, and typhoons during and immediately following the breeding season. Our data are not adequate to draw any meaningful conclusions beyond stating that the correlation between the moderately high annual rate of thunderstorms in central North Carolina (40 to 50) and the frequency of anting observed here appears to be valid. Conversely there appears to be a valid correlation between the small number of thunderstorms (0 to 30 per year) in New England, California, Oregon, Washington, Alaska, and Hawaii and the lack of anting reports from these states. Anting probably occurs in all parts of the world where passerines and ants can both survive, but a moderate number of summer thunderstorms evidently enhances the opportunities for the activity's occurrence.

Probable relationship of dusting, smoke-bathing, and water-bathing to molting.—Potter's seeing Gray Catbirds apparently attracted to the heat of a charcoal grill brings to mind the many instances of smoke-bathing summarized by Whitaker (1957). Weisbrod (1971) does not mention dusting as a grooming behavior of the Blue Jay, a species prone to both sunning and anting as well as one known to have applied burning cigarets to its plumage (Miller 1952). Apparently the Blue Jay and several other species particularly prone to sunning and anting (e.g. American Robin, Starling, and Cardinal) do not indulge in dusting. The Brown

Thrasher, which sunbathes frequently (Appendix), seems to dust more often than it ants. Although our data are admittedly scanty, we suspect that dusting birds obtain from warm dry soil or ashes the same efficacy others derive from anting. Perhaps dusting and smoke-bathing should be viewed along with anting primarily as means of applying soothing heat or acids to rapidly molting feather tracts that are not easily exposed to sunlight.

Whitaker (1957) quotes Chisholm (1948: 163–175) as having suggested that smoke-bathing might "be complementary to water-bathing, sun-bathing and dust-bathing, and all four may well be allied to 'anting' with acids." Data in Table 1 strongly suggest that wild birds tend to bathe in water more frequently during their seasonal molts (Appendix) than at other times of the year. Potter (1973) has noted that adult male Summer Tanagers bathe at her pools immediately upon arrival in spring and after the nesting period, but apparently not during it, even though they often drink water while the female is on the nest. White-throated Sparrows and Evening Grosbeaks apparently bathe in conjunction with their prenuptial head molt; Chipping Sparrows bathe mostly during their two periods of molt in spring and in late summer or early autumn; and juvenile American Robins, Eastern Bluebirds, and Pine Warblers bathe frequently while molting. Water-bathing in wild birds appears to be as closely related to the cycle of molt as sunning, anting, and—presumably—dusting, smoke-bathing, and other forms of behavior adapted to applying heat or acids to the feather tracts. More different species of wild birds water-bathed at Zebulon during September, a month of heavy molt and scant precipitation, than at any other time of the year. This suggests that water-bathing may be a means of hastening the dropping of loose feathers during periods lacking heavy rainfall.

Speculations about winter anting.—At least five species from the genus *Icterus*, including the Northern (Baltimore) Oriole (*I. galbula*) and the Orchard Oriole, and at least 14 species of the Thraupidae, including the Scarlet Tanager (*Piranga olivacea*) and the Summer Tanager, have anted either in the wild or in captivity (Whitaker 1957, King and Kepler 1970). Migratory members of these two predominantly tropical groups of birds have in common a life history that finds them breeding in temperate North America and wintering mostly in Middle and South America. While on the wintering grounds young Orchard Orioles have a complete post-juvenal molt "in early fall" (Bent 1958: 200), and young Northern Orioles have "an extensive prenuptial molt involving most of the plumage except the primaries, their coverts, and the secondaries" after which the males have full orange and black body plumage and black and yellow rectrices (Bent 1958: 255). First-winter Scarlet Tanagers have a partial

prenuptial molt in March and April involving "the body plumage, wing coverts, tertiaries and the tail but not the primaries, their coverts, the secondaries and usually not the alulae" (Bent 1958: 484). Summer Tanagers vary more than Scarlet Tanagers in the extent of their first prenuptial molt, but they renew approximately the same feather tracts (at least in part) "in winter or early spring, beginning in February or earlier" (Bent 1958: 500). If the relationship between anting and the molting of rectrices, remiges, and their respective coverts is actually as has been proposed in this paper, wild birds of these four species should eventually be found anting in their winter quarters. A most promising candidate for winter anting observations in North Carolina is the Northern Oriole: first-winter birds have an extensive molt, the species is becoming increasingly plentiful as a winter resident, and these winter residents are feeder dependent (Erickson 1969). If first-winter Northern Orioles do not ant in North Carolina or elsewhere, it is probably because the molt takes place very gradually, thus apparently causing the birds little skin discomfort.

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SUMMARY AND CONCLUSIONS

Anting and sunbathing records from North Carolina are compared with molt and ectoparasite data from the same region (Appendix). These data demonstrate a strong correlation between the relative frequency of the two forms of behavior and the molting of specified feather tracts. Winter resident species in North Carolina sunbathe most often during the prenuptial molt, which in most cases involves only feathers of the head, neck, and upper breast. Summer residents sun most frequently in June and July while year-round residents sun most often from late May through July, months when they usually undergo the early stages of postnuptial and postjuvenal molt (head, back, and breast). The peak of anting occurs in August and September, coinciding with the latter stages of postnuptial and postjuvenal molt (rectrices, remiges, and their respective coverts).

Apparently birds prefer sunning to anting while molting feather tracts that are easily exposed to sunlight and impossible, or at least difficult, to reach with an ant held in the beak. Birds prefer anting to sunning while molting feather tracts that are not easily exposed to sunlight but can be

reached by the beak without undue difficulty. Thus anting and sunning appear to be complementary behaviors, i.e. two different means of meeting the same need under different conditions. The means chosen—anting, sunning, or a combination of the two—depends directly upon the location of the feather tract(s) currently in molt. Evidence supporting a common origin for the impulses to ant and to sunbathe may be seen in the unusual behavior of the Gray Catbird that picked up ants but instead of anting assumed a sunning position while standing in full shade.

Dusting and smoke-bathing appear to be two other means birds use to apply heat to the ventral feather tracts, and the few North Carolina records available conform to the season when sunning and anting behavior are seen in birds of the same species.

Anting and sunning occur most frequently among wild birds shortly after heavy precipitation which, if it occurs during normal molting, can cause sudden dropping of many feathers at once and consequently their rapid replacement. Support for this thesis may be seen in the close correlation between the geographic area of the United States in which anting has been reported most often and that in which thunderstorms occur from 30 to 50 times per year. The peak month for water-bathing at Zebulon appears to be September (Table 1), normally a month marked by heavy molt in wild birds and very little rainfall. Data are not sufficient for a critical analysis, but considerable evidence exists that birds bathe in water most frequently while molting, possibly as a means of hastening the dropping of loose feathers during periods of dry weather.

The authors find no positive evidence that birds use ants to control ticks, lice, or mites (Groskin 1950, Dubinin *in* Kelso and Nice 1963, Simmons 1966). The seasonal peak of anting activity coincides with a period of relatively low ectoparasite infestation for most species studied (Appendix). Nor can the authors find any data to support the ideas that wild birds might use anting for sexual self-stimulation (Whitaker 1957), to remove lipids (Simmons 1966, Potter 1970), to improve feather wear (Simmons 1966), or to soften sheaths (Potter 1970). Neither can we find satisfactory indications that sunbathing has a role in gonadal recrudescence (Menaker 1972) or vitamin synthesis (Weisbrod 1971). Anting and sunning appear to involve too few species of birds and to be too erratic in occurrence (mostly soon after summer thunderstorms) to assume any essential biochemical function.

On the basis of the facts now available, we conclude that sunning and anting are widespread and complementary comfort-motivated behaviors. Apparently wild birds use them as means of applying heat to the skin and practice them most frequently during periods of unusually rapid feather renewal, as when heavy rainfall comes during a seasonal molt, with the

choice between sunning or anting depending directly upon the location of the feather tracts currently in molt. The answer seems almost too simple to be true, but—as anyone with a rash or sunburn can attest—skin comfort can be very important to an animal's sense of well being even when it is not a matter of life or death.

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APPENDIX

SUMMARY OF NORTH CAROLINA DATA ON MOLTING AND ECTOPARASITE INFESTATION FOR 34 SPECIES OF WILD BIRDS KNOWN TO HAVE SUNBATHED OR ANTED IN THE STATE[1]

WINTER RESIDENTS

YELLOW-BELLIED SAPSUCKER, *Sphyrapicus varius*. Anting: 24 November. Molting: Some juveniles arrive in heavy molt (12 October); others arrive in full juvenal plumage and molt gradually through the winter. Ectoparasites: None found.

RUBY-CROWNED KINGLET, *Regulus calendula*. Sunning: 1 January. Molting: Not known to molt in state. Ectoparasites: March, ticks.

YELLOW-RUMPED (MYRTLE) WARBLER, *Dendroica coronata*. Sunning: 19 April, 21 April. Molting: Some head molt has begun by mid-March on scattered individuals. Head, throat, yellow breast patches, and secondary wing coverts undergo molt, mostly in April (Teulings). Ectoparasites: January, tick; February, tick (2).

EVENING GROSBEAK, *Hesperiphona vespertina*. Sunning: 19 April (2), 19–23 April, 26 April. Molting: February, 3 birds molting tertials. Some show of head and neck molt first half of March (Teulings) through late April. Sunning birds had sheaths on head, neck, or both 19–23 April. Ectoparasites: January, tick; April, tick (Potter).

PURPLE FINCH, *Carpodacus purpureus*. Sunning: 1 December, 20 March. Molting: 1 December, sunning bird had sheaths on many neck feathers. 22 December, hatching year bird with extensive body molt (Teulings). April, very occasionally new feathers are seen on head (Teulings). Ectoparasites: November, ticks; December, ticks (14); January, ticks (7); February, ticks (9); March, ticks (5).

DARK-EYED (SLATE-COLORED) JUNCO, *Junco hyemalis*. Sunning: 22 March (3), 1, 3 April. Anting: 4 March. Molting: Prenuptial head molt in February, March, and April; peak mid-March (Teulings). Ectoparasites: November, ticks (24); December, ticks (22); January, ticks (35); January, lice; February, ticks (13); March, ticks (16); April, ticks.

WHITE-THROATED SPARROW, *Zonotrichia albicollis*. Sunning: 18 November; many individuals from close of February to early May, with peak in March and early April. Anting: 5 November, 23 April. Molting: An occasional bird is still molting in late October, one as late as 27 November (Teulings). Prenuptial molt of head, throat, and upper breast begins by early March with heaviest molt about mid-

[1] Only one bird unless otherwise indicated.

April (Teulings). April sunning birds obviously molting head, breast, or both. Bird anting 23 April was molting lower breast. Ectoparasites: October, ticks (4); November, ticks (49); December, ticks (17); January, ticks; February, ticks; March, ticks (82); April, ticks (38); May, ticks (3).

SUMMER RESIDENTS

YELLOW-BILLED CUCKOO, *Coccyzus americanus*. Sunning: 25 July (adult female, twice), 29 July (newly fledged chick in nest, several times), 13 September. Molting: Adult female dropped and completely renewed rectrices 15 to 29 July, replaced undertail coverts 18 to 29 July, and was molting breast 18 to 29 July. Adult male dropped first rectrice 23 July and dropped undertail coverts 27 July. Bird sunning 13 September was shaggy at breast and cheeks; tail not full length (Hauser). Ectoparasites: No data.

COMMON NIGHTHAWK, *Chordeiles minor*. Sunning: 31 August. Molting: No data. Ectoparasites: No data.

GREAT CRESTED FLYCATCHER, *Myiarchus crinitus*. Sunning: 25 June (3), 24 July. Molting: No data. Ectoparasites: No data.

GRAY CATBIRD, *Dumetella carolinensis*. Sunning: 25 June, 13 July, 14 July, 8 August. Anting: 27 July, 28 July, 7 August, 19 August (Hill 1973). Molting: 5 May, adult with sheaths on outer primaries. 19 May through 2 June, breeding adult molting rectrices, neck contours, crissum. 21 May, breeding adult shedding on head; rectrices shabby but all in place. 6 June, same bird replacing rectrices. 18 June, shedding contours. 28 July, anting bird (banded adult) molting rectrices. Heavy molt mid-August to mid-September; almost over by the time most birds leave at end of September (Teulings). Ectoparasites: September, ticks (9).

WOOD THRUSH, *Hylocichla mustelina*. Sunning: 24 June (2 adults), 19 July (2 juveniles). Molting: 7 July, juvenile from first brood: central rectrices not fully grown, no middle coverts on upperwing, underwing bare from wrist to elbow except for bits of down. Molt underway by late August; heavy during early September; occasional birds still molting in early October (Teulings). Ectoparasites: May, ticks (2); September, ticks.

SUMMER TANAGER, *Piranga rubra*. Sunning: 11 June, 12 June, 16 June, 26 June (adult), 19 July (juvenile), 24 August, 23 September (2). Molting: 11 June, sunning bird had one missing central rectrix and one not yet fully grown (Hauser). Ectoparasites: None found.

YEAR-ROUND RESIDENTS

BOBWHITE, *Colinus virginianus*. Sunning: 11 June, 13 June (2), 15 June, 19 June. Molting: No data. Ectoparasites: No data.

MOURNING DOVE, *Zenaidura macroura*. Sunning: 8 April, 29 April, 14 May (many individuals), 27 May, 30 May, 27 June. Anting: 14 May (adult), 15 May (adult), 16 July. Molting: No data. Ectoparasites: April, ticks.

COMMON (YELLOW-SHAFTED) FLICKER, *Colaptes auratus*. Sunning: 8 April, 23 April, 5 May, 30 May, 4 July, 8 July, 9 July (juvenile), 10 July (juvenile), 20 July (juvenile), 28 August, 8 October. Anting: 15 March. Molting: Mid-September, one bird in heavy molt (Teulings). 12 November, rectrices in molt (specimen, NCSM). Ectoparasites: None found.

RED-BELLIED WOODPECKER, *Centurus carolinus*. Sunning: 2 May (adult male), 23 May (adult male), 15 June (juvenile), 28 June, 19 July (adult), 19 July (adult), 5 September (juvenile), 28 September (adult). Anting: 23 May (adult female),

5 June (adult), 13 June (juvenile), 21 June, 5 September (juvenile), 28 September (adult). Molting: 19 July, sunning bird, adult female, in heavy neck molt (Hauser). Molting in August and September (Teulings). 5 October, one bird in postjuvenal molt. 18 January through 27 February, juveniles in head molt (specimens, NCSM). Ectoparasites: None found.

RED-HEADED WOODPECKER, *Melanerpes erythrocephalus*. Sunning: 20 May (adult), 21 May (adult), 24 May, 13 June, 15 June (2), 20 June (3), 28 June, 4 July (2), 8 July (2 adults), 23 July (adult). Anting: 24 June. Molting: 13 January through 27 February, juveniles in head molt (specimens, NCSM). Ectoparasites: None found.

BLUE JAY, *Cyanocitta cristata*. Sunning: 29 April (2), 8 May, 14 May (many), 16 May (adult), 18 May (2), 19 May (2), 21 May (frequently), 22 May (frequently), 23 May (2), 24 May (several), 25 May (2 adults), 27 May (2), 10 June (adults), 11 June (2), 14 June (2), 24 June, 25 June (3), 4 July (2), 24 July (2), 14 September (juvenile). Anting: 31 May (adult), 5 July, 19 July (juvenile), 1 August, 1 August (juvenile), 7 August (juvenile), 22 August (juvenile), 10 September (2), 12 September (2), 13 September (2 juveniles), 1 October, 26 October, 13 November (2), 17 December (2). Molting: 22 May, adult minus central rectrices. 13 June, some adults beginning molt; adults appear to molt earlier than juveniles (Teulings). Mid-July, most adults beginning to molt (Teulings). Heavy molt in August (Teulings). 12 September, one anting bird molting rectrices. 8 October, two juveniles just beginning to molt. Ectoparasites: December, tick.

CAROLINA CHICKADEE, *Parus carolinensis*. Sunning: 10 August. Molting: 23 May, adult with only five old rectrices in place. Molt mainly in July and August (Teulings). Early September, juveniles with sheaths on rectrices. Ectoparasites: None found.

TUFTED TITMOUSE, *P. bicolor*. Sunning: 5 May, 25 June (2), 1 July. Molting: May begin very early (once 24 June), but late July is usual time; heaviest in August and September; mostly complete by October (Teulings). Ectoparasites: None found.

WHITE-BREASTED NUTHATCH, *Sitta carolinensis*. Sunning: 24 March. Molting: As early as 21 June; heaviest about mid-August; complete by mid-September (Teulings). Ectoparasites: None found.

CAROLINA WREN, *Thryothorus ludovicianus*. Sunning: 26 July (juvenile), 29 July (juvenile), 15 August. Molting: 26 July, sunning bird had dropped entire crissum (skin bare); head, breast, and back were shaggy with molt. Molt in July, August, and September (Teulings). 14 October, juvenile still in molt. Ectoparasites: January, ticks; March, ticks (2); April, ticks (3); June, ticks (2); August, ticks (3); September, ticks (2); October, ticks (4); November, ticks (12); December, ticks.

MOCKINGBIRD, *Mimus polyglottos*. Sunning: 19 May. Molting: Mid-August through late September (Teulings). Ectoparasites: March, ticks; September, ticks; November, ticks.

BROWN THRASHER, *Toxostoma rufum*. Sunning: 8 April, 8 May, 18 May (2), 26 May, 30 May (2), 3 June (2 juveniles), 3 June (juvenile), 3 June (juvenile), 4 June (2 juveniles), 10 June (adult), 11 June (juvenile), 14 June (2), 20 June (adults and young through day), 28 June (adult), 28 June, 1 July (adult), 1 July, 4 July (adult), 4 July (2 juveniles), 8 July (adult), 19 July, 19 July (2 adults), 19 July, 27 July (juvenile), 28 July (juvenile). Anting: 30 May, adult

(Chamberlain 1954), 5 September. Molting: 4 July, sunning birds were an adult in heavy molt (Hauser) and two juveniles in molt (Potter). 28 July, sunning bird was still being fed by parent and had incomplete tail growth (Hauser). Have found some birds with molt complete by late August and others only beginning in early September (Teulings). Ectoparasites: March, ticks (4); April, ticks (9); May, ticks (2); June, ticks (2); September, ticks (2).

AMERICAN ROBIN, *Turdus migratorius*. Sunning: 7, 8, 29 April, 24 June (adult), 8 July (juvenile), 13 July (juveniles), 14 July (juveniles), 15 July (many juveniles), 16–19 July (sunning continues, somewhat abated), 18 July (juvenile), 24 July, 25 July (many), 8 August, 11 August (2 juveniles), 18 August, 22 August, 19 September (juvenile), 4 October (juvenile). Anting: 31 May (adult), 18 June (adult), 9 July, 24 July (juvenile), 27 July (juvenile), 28 July (juvenile), 2 August (juvenile), 3 August (Grimshawe 1964), 11 August (juvenile), 14 August (juvenile), 25 August (4 juveniles), 26 August (juvenile), 26 August (juvenile), 27 August (juvenile), 29 August (2 juveniles), 22 September, 2 October (juvenile), 8 October (juvenile), 10 October (juvenile). Molting: 20 and 25 May, breeding adults with missing central rectrices. 18 June, anting bird was adult in molt (Hauser). 9 July, anting bird was juvenile, molting breast (Hauser). By mid-July the complete postjuvenal molt is well underway for almost all young from early broods of the locally breeding race, *T. m. achrusterus*. Birds sunning at Zebulon 13–19 July 1972 were molting head, neck, upper breast, and dorsal contour feathers. 24 July, anting bird was molting (Hauser). 27 July, anting bird was molting lower breast (Hauser). 28 July, anting bird was molting rectrices. 2 August, anting bird was molting remiges. 11 August, anting bird was molting. 14 August, anting bird had rusty but heavily spotted breast (Hauser). 25 August, anting birds were molting. 26 August, anting birds were molting rectrices. 27 August, anting bird molting. 29 August, anting birds molting. Molt seems heaviest in August and early September (Teulings). By mid-September young of early broods are in almost full first-winter plumage, but young of late broods may be in full juvenal. In early October Potter has banded juvenile robins with retained rectrices and remiges. These birds had heavily spotted undertail coverts, red breasts, juvenal throat plumage, and were molting wing coverts on both upper and lower surfaces. These birds are probably fall migrants of the race *T. m. migratorius*. All three birds anting in October were molting wing coverts. The juvenile sunning in October was molting neck, throat, and cheeks. Ectoparasites: 10 November, 6 ticks on robins (race unknown).

STARLING, *Sturnus vulgaris*. Sunning: 20 April, 18 May (2), 19 May (juvenile), 22 May (2), 24 May (2), 25 May (2 adults), 30 May (2), 13 June, 28 June (2–5), 4 July (young and adult), 24 July (2), 5 October (1 bird, several times). Anting: 3 March (5), 20 May, 19 June (adult), 28 June (2), 17 July (adult), 27 July (adult), 6 August, 7 August, 8 September (3 juveniles), 9 September (juvenile), 24 September (2), 25 September, 27 September, 3 October, 6 October. Molting: 27 July, anting bird in almost complete winter plumage (Hauser). 8 September, anting birds were molting. Ectoparasites: About 50% infested with mites; caught only in winter (Teulings).

PINE WARBLER, *Dendroica pinus*. Anting: 28 June (juvenile). Molting: 28 June, anting bird was molting ventral contour plumage and wing coverts. 11 September to 6 October, juveniles molting crown and other head plumage. Ectoparasites: February, tick; October, tick.

HOUSE SPARROW, *Passer domesticus*. Sunning: 11 June (2), 13 June, 25 June,

4 July (2), 19 July (adult male and others), 24 July (2), 18 November (several). Anting: 22 March, 22 April, 4 July. Molting: No data. Ectoparasites: No data, but by reputation a frequent host for mites.

RED-WINGED BLACKBIRD, *Agelaius phoeniceus*. Sunning: 16 June (adult male), 4 July. Molting: 4 July, sunning bird was in heavy molt (Hauser). Ectoparasites: March, tick.

COMMON GRACKLE, *Quiscalus quiscula*. Sunning: 8 May (2), 16 May (adult), 16 May (juvenile), 18 May (same bird twice), 19 May (2), 19 May (adult), 21–22 May (2 or more, frequently), 23 May, 25 May (adult male), 26 May (2), 30 May (2), 10 June (adults), 11 June (2), 14 June (2), 4 July (adult), 4 July (adult), 4 July (juvenile), 8 July (juvenile). Anting: 31 May, 5 June (adult), 19 July. Molting: 11 May, adult male molting rectrices (specimen, NCSM). 19 May, some adults minus central rectrices. 21 June, nearly all adults seen at close range had gaps in flight feathers. 26 June, adult male molting central rectrices. 1 July, gaps in flight feathers. 4 July, sunning juvenile in molt (Hauser). 15 July, juvenile in molt. 12 October, adult male molting. Ectoparasites: May, tick (2). About 30% infested with mites in June and July, especially immatures (Teulings).

CARDINAL, *Cardinalis cardinalis*. Sunning: 4 April, 8 May (2), 14 May, 15 May, 16 May, 18 May (2), 19 May (2), 21 May, 21 May (2), 22 May (2, frequently), 24 May (2), 25 May, 25 May, 30 May (2), 8 June (juvenile), 10 June (some juveniles), 11 June (2), 25 June, 4 July (2), 8 July (2 adults), 19 July, 20 July (adult), 24 July (2), 9 August (adult male), 28 August (juvenile). Anting: 29 May (McAtee 1954), 18 June (2), 18 June (2), 2 July (adult), 28 July, 28 July (adult male), 26 August, 2 September (adult), 3 October (2), 3 October (2), 4 October, 9 October. Molting: Late March, some molt in throat and auricular area (Teulings). 11 May, adult female with bald crown. 12 May, adult female shedding upper body contours. 15 May, adult male with bald crown. 8 July, adults with gaps in flight feathers. 19 July, sunning bird was in heavy molt, especially about head (Hauser). 28 July, anting bird was adult female molting rectrices. Some Cardinals are in heavy molt by late July, but late August and early September seem prime time (Teulings). 9 August, sunning bird was molting upper body contours. 13 August, adult female with bare crown. 26 August, anting bird was molting juvenile. 1 September through 11 October almost all juveniles and adults banded by Potter had sheaths on rectrices, remiges, or both. Occasional birds are still molting in November and early December (Teulings). Ectoparasites: January, ticks (8); February, ticks (4); March, ticks (17); April, ticks (16); May, ticks (4); July, tick; October, ticks (2); November, ticks (19); November, tick (Potter); December, ticks (2).

RUFOUS-SIDED TOWHEE, *Pipilo erythrophthalmus*. Sunning: 8 July (juvenile), 19 July (adult), 28 August, 14 September (juvenile). Anting: 3 August (juvenile), 26 August (juvenile), 28 August, 30 August, 15 September, 18 September. Molting: 28 March, second-year male with juvenal secondaries and young eye color. 10 July, juvenile molting primaries. 19 July, sunning bird had dropped most of tail coverts; also water-bathed. Molt spread over August and September for most part (Teulings). 3 August, anting bird was molting primaries. 26 August, anting bird was molting. 28 August, juvenile male anting and sunning was molting primaries (Hauser). 30 August, anting bird was same individual that anted and sunned on 28 August (Hauser). 15 September, anting bird was juvenile male, molting rectrices (Hauser). 18 September, anting bird was juvenile male, belly still streaked, black crescent at breast below juvenal plumage at head and throat (Hauser). 3 October, young

female in almost solid winter plumage (Hauser). 9 October, juvenile with sheaths on crissum. 15 October, adult molting contours. Ectoparasites: January, ticks; January, mites; March, ticks (4); October, ticks; November, ticks (2); December, ticks.

CHIPPING SPARROW, *Spizella passerina*. Sunning: 6 August, 8 November. Molting: Mid-March to mid-April all undergo head molt, sometimes only chin and auricular area (Teulings). 6 August, sunning bird was in molt about head. Molt beginning by mid-August; peak late August and early September; one bird still molting in mid-October (Teulings). Ectoparasites: March, tick.

ADDENDUM

Between 18 November 1973 and 2 May 1974 Potter recorded water-bathing for the following species during months not listed in Table 1. While these sightings indicate that winter bathing is not uncommon for some species, they do not alter the previously expressed opinion that September is the peak month for this activity in North Carolina. The Dark-eyed Junco, White-throated Sparrow, Carolina Chickadee, Tufted Titmouse, and Pine Warbler are the only species that were seen bathing on five or more dates from 1 December 1973 through 3 March 1974, and bathing was noted on only 3 days during the entire month of February.

WINTER RESIDENTS:

Brown Creeper: January
Ruby-crowned Kinglet: December, January
Yellow-rumped Warbler: January, March
Purple Finch: January
Dark-eyed Junco: December, January, February, March, April
White-throated Sparrow: December, January

YEAR-ROUND RESIDENTS:

Mourning Dove: January
Blue Jay: November, December, January, May
Carolina Chickadee: December, January, April
Tufted Titmouse: November, December, January, March, April
Brown-headed Nuthatch: January
Carolina Wren: December, January, March, April
Brown Thrasher: April
American Robin: February, March, April
Pine Warbler: December, January, March, April
Common Grackle: February
Cardinal: April
Chipping Sparrow: May