

MAINTENANCE BEHAVIOR OF THE AMERICAN GOLDFINCH¹

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A one and one-half year study of the general behavior patterns of the American Goldfinch (*Spinus tristis*) in Michigan has included a description and analysis of postures utilized during maintenance activities. These include locomotion, feeding, drinking, bathing, preening, defecation, and sleeping. Laboratory and field observations were compared with photographs to allow accurate descriptions of postures and sequences of behavior. In addition to presenting a general description of maintenance behavior, a basis is provided for further study of derived movements significant in aggressive and sexual displays.

METHODS

Field work was conducted at or near the University of Michigan Biological Station (Pellston, Michigan) during the summer of 1961 and at the Edwin S. George Reserve (Pinckney, Michigan) in the summer of 1962. Wild birds were studied by observing them with 7×50 binoculars. Because most individuals quickly became accustomed to the presence of a human being nearby, this method was often quite effective. Approach to within 10 or 20 feet of the birds was possible without noticeable changes in normal behavior. Use of a blind in the nesting areas provided closer observation at 5 to 10 feet.

Although field observations were invaluable in providing basic concepts of the gross behavior of the birds, close observation facilitated by laboratory confinement was essential. For this purpose, five nestlings were captured in August 1961, at the age of approximately 10 days, and were hand-reared for two weeks thereafter. They were fed a "paste" composed of boiled egg yolk, pablum, and milk. The young birds accepted this mixture readily and appeared to be in good condition throughout the study. Gradual inclusion of a seed mixture allowed a shift to the diet described below.

The captive birds were confined in a small cage ($18 \times 22 \times 24$ inches) during August and September, but were moved to a flight cage ($3 \times 3 \times 4$ feet) on 1 October. A flock of five House Finches (*Carpodacus mexicanus*) and a pair of Indigo Buntings (*Passerina cyanea*) were also present in this cage. The birds apparently adjusted well to these conditions, and only a slight degree of interspecific conflict was noted. After initial courtship had been observed in March and April, the pairs were isolated. Live dogwood in addition to willow and alder branches on which artificial leaves were placed provided nesting sites and cover.

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A total of 350 hours of observation included field work during all portions of the day, and laboratory observations restricted to 15 to 50 minutes in the morning.

FEATHER POSTURES

A discussion of feather postures of the goldfinch is essential before complete descriptions of skeletal postures can be presented. Feather postures, as here discussed, pertain to the raising or lowering of the contour feathers in relation to the body surface. On the whole, these changes are quite subtle in the goldfinch. That is, little deviation from the relaxed position is seen, even in high-intensity displays. Feathers of the crown and forehead appear to be the most expressive, showing a greater degree of both fluffing and sleeking than the other contour feathers.

Relaxed.—In the normal, relaxed position, the tips of the feathers remain slightly above the body surface, resting upon each other and producing a smooth body outline.

Fluffed.—Fluffing is performed by raising all contour feathers, usually with the exception of those on the head. The feathers are raised to their full extent only during preening or when accompanied by shaking. Partial fluffing is noted during avoidance reactions, when the crown and forehead feathers are also prominently raised. No ruffled submissive posture was observed.

Sleeked.—The contour feathers are sometimes closely appressed to the body surface. In agonistic encounters, all feathers may be sleeked when high-intensity aggression is evident. Again, partial sleeking is the rule with no extreme change from the normal feather position. Feathers of the forehead and crown are more often sleeked than other contour feathers, as this occurs during fixation of seeds, perch, or opponent during feeding, bill-wiping, and aggression, respectively.

LOCOMOTION

Hopping.—Movement along the ground or from one perch to a closely adjacent one is performed by hopping. The bird flexes its legs, lowering its body almost to the ground and leaning forward slightly. Rapid extension of both legs propels the bird into the air. This is immediately followed by flexion of the legs, reorienting them so that the extended feet touch flat on the ground as the bird alights. Extension of the legs to the normal perching position completes the hop. This movement seems to be identical to that described by Marler (1956) for the Chaffinch (*Fringilla coelebs*).

Sidling.—When moving along a horizontal perch, the bird lifts one foot one or two millimeters and moves it a few millimeters to one side, replacing it on the perch. This is followed by a similar movement of the other foot in

the same direction, allowing the bird to progress along the perch while continually facing in the same direction. Sidling may also be performed on slanting or vertical perches. In this case, the same movement of the feet is usually accompanied by flicking or fluttering of the lowermost wing. The wing movement may appear as a distinct flick with each "step" or may be a continuous fluttering as the bird moves up or down the perch.

Turning.—Perched birds often turn around so as to face in the opposite direction. This is accomplished by raising one foot, then pivoting on the opposite leg. When the body has turned through 180° , the first foot is lowered to the perch, the second raised slightly and rapidly turned about. Birds stopping in "mid-turn" can be seen perched with the feet pointing in opposite directions. This movement appears to be similar to the "pirouetting" described by Ficken (1962) for the American Redstart (*Setophaga ruticilla*). The goldfinch, however, does not utilize this pattern for moving along the perch. It is usually performed but once, and if it occurs twice in succession, the bird tends to return to the first position. Thus, after a series of turns, the bird still remains in approximately the same place on the perch.

Hanging.—The goldfinch sometimes hangs upside-down on the underside of perches or food plants. In most cases, both feet grip the perch, but occasionally the bird is suspended by only one foot. Since hanging usually occurs during feeding or pecking at the toes, the legs are flexed and the neck is bent in a "U" shape, allowing the bill to touch the toes or food. Movement in this position is usually accomplished by sidling, often accompanied by fluttering of the wings.

Takeoff.—Before actual flight occurs, the bird faces in the direction of flight, sleeks its feathers, and flexes its legs. The body is thus horizontal. The wings and tail are then raised and spread. This is followed by a rapid downward movement of the wings and tail in addition to extension of the legs, catapulting the bird from the perch. Actual flight may be preceded by wing flicks (rapid raising and lowering of closed wings) and tail flicks (the tail moved rapidly in a small arc or circle). Caged birds may turn the head upside-down as the bird looks toward the top of the cage just before takeoff.

Bounding flight.—The familiar undulating flight of the goldfinch is performed by alternation of flapping and gliding. Two to five wing beats are given in each trough, sending the bird upward. The wings are kept folded during a portion of this climb and the following glide downward. A second series of wing beats permits a second climb, and continuation produces the "bounding" flight. In most cases, each bound is punctuated by the sharp Per-chic'-o-ree display, the accent occurring during the wing beats. This flight vocalization varies considerably within and between individuals and may contain from

three to six syllables, with the accent moving from one syllable to another on successive bounds. Sometimes the bounding flight is silent.

Flapping flight.—A more direct flight, usually associated with "true song," is produced through continual flapping of the wings. It appears similar to "butterfly" flight described by Conder (1948) for the European Goldfinch (*Carduelis carduelis*) and Hinde (1955-56) for several other fringillids, but the wing beats do not appear to be appreciably slower than normal. This flight is accompanied by a vocal display composed of an intricate combination of warbles, sliding squeals, and *swee-eeet* notes. The whole constitutes a display which occurs frequently during the breeding season and seems to be a major factor in definition and defense of territory among the males.

Hovering.—Rapid fluttering of the wings produces hovering, or but slight forward progression. This, too, occurs during the breeding season in conjunction with aggressive and sexual behavior.

Alighting.—The movements involved here occur very quickly and I did not analyze them with high-speed photography. Laboratory observations show that alighting birds extend the legs slightly as they are brought forward. Rapid wing fluttering and an erect posture (the bird appearing to lean backward) are also apparent.

FEEDING

The American Goldfinch has been found to feed extensively on the seeds of plants belonging to the family Compositae, particularly the genera *Cirsium*, *Taraxacum*, *Lactuca*, *Aster*, *Hieracium*, and *Solidago*. Catkins of *Betula* or *Salix* as well as seeds of the Evening Primrose (*Oenothera biennis*) and Common Mullein (*Verbascum Thapsus*) are also taken. As evidenced by field observations and supported by Walkinshaw (1939) and Allen (1928), a few insects are eaten. Aphids and larvae of the Frog hopper (*Philaenus leucophthalmus*) were eaten by goldfinches at the Biological Station. In most areas, these insects seem to act merely as a dietary supplement, since they are eaten in such small quantities. Where the supply of suitable composites was limited, as in one area under consideration during 1961, *Philaenus* larvae were more prominent in the diet. Laboratory animals were provided with a seed mixture containing oats, canary, rape, millet, radish, and sunflower seeds. A commercial food supplement and occasional mealworms (larvae of *Tenebrio* sp.) in addition to lettuce, radish, or other green leaves were also supplied. The birds were observed to eat all of these foods except the larvae.

Wild birds usually alighted either directly on the head of the flower or on the stem just below it. The bird's head and neck were then bent forward and down, and seeds pecked from between or just alongside the feet. On a few occasions, the birds reached upward, but extensive stretching was not noted. Horizontal stretching of the head and neck allowed the birds to grasp

adjacent stems with the bill and feed from them directly or draw them closer. The wings were often fluttered and the tail was lowered and/or spread in order to maintain balance on swaying stems.

Seeds are held in the bill so that their long axes are parallel to the edges of the mandibles. Movements of the lower mandible, both backward and forward and from side to side, along with rapid manipulation of the seed with the tongue, cause the seed to rotate on its long axis. The seed is moved to the edge of the mandible and cracked by a scissors-like action of the two mandibles. After this it is rapidly hulled through continued rotation, and the husk is dropped from the side of the bill. In some cases, the seed was withdrawn into the oral cavity, then returned to the bill before it was cracked. The entire procedure was performed in two to three seconds in most cases. Sunflower seeds took as long as 30 seconds or more to crack.

On only a few occasions was feeding accompanied by vocalization. This consisted of a rapid "twitter," continued while cracking seeds. Although sounds were not usually made while actually feeding, loud warbles, squeals, and *sweet's* were common from perches within feeding areas. In addition, short calls of *per-chee* or *per-chee-chee* were given when flying from one food plant to another.

Of necessity, captive individuals were fed from a dish placed on the floor of the cage. This placement provided an immovable food source and resulted in postures on the edge of the dish similar to those of normal perching. The wings were folded completely, so that they crossed at the rump, or were lowered slightly, giving a separation of one-fourth to one-half inch at the rump. Contour feathers were neither markedly sleeked nor fluffed. The legs were usually slightly flexed, the tail pointing directly backward or held to one side (Fig. 1). When eating seeds in rapid succession, the body was tilted forward and the head extended toward the seeds (Fig. 2). Seeds were picked up singly from directly in front of the bird or slightly to one side. The head was then raised, usually only to the shoulders, while the seed was husked and swallowed (Fig. 3).

A second type of feeding was observed during which movements were more rapid. At this time, the birds flicked their heads rapidly from side to side with the bill down among the seeds, resulting in a wide scattering of seeds from the dish. This movement was seen both when individuals were alone at the dish and when all five were present. It may represent searching for a particular type or size of seed, a displacement activity similar to bill-wiping (as described below), or simply a phase of normal feeding behavior. Again the head was raised between seeds, either to the horizontal or erect position.

One of the most outstanding characteristics of feeding by goldfinches is

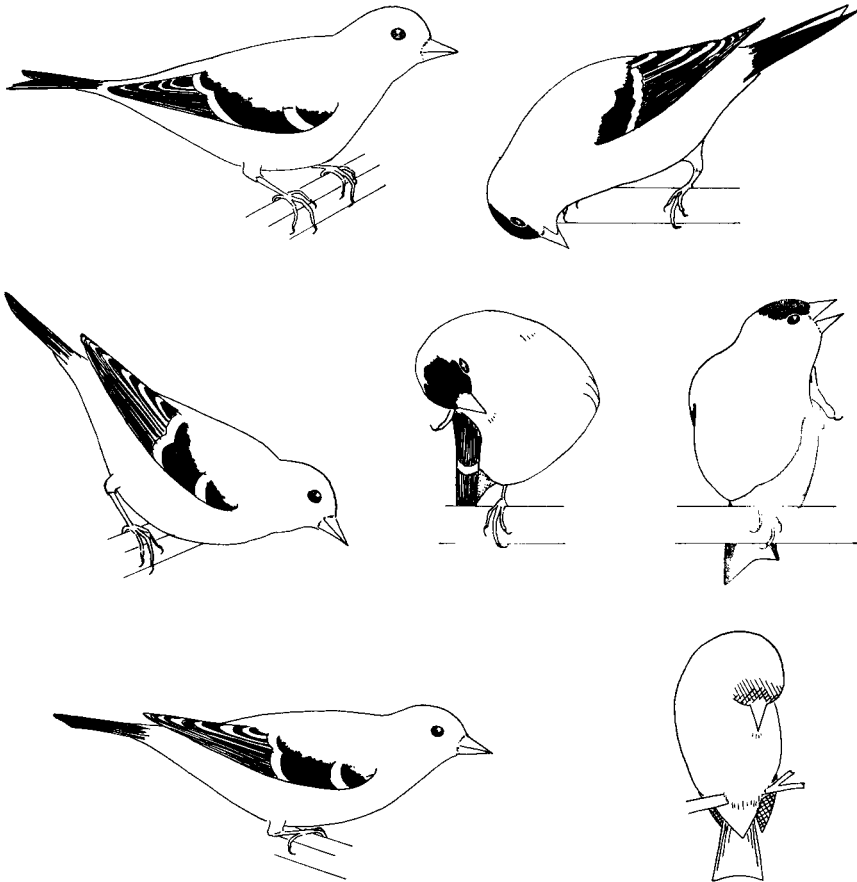


FIG. 1. (UPPER LEFT). Normal perching on food dish.
FIG. 2. (MIDDLE LEFT). Picking up seeds from food dish.
FIG. 3. (LOWER LEFT). Husking seeds.
FIG. 4. (UPPER RIGHT). Wiping head across perch.
FIG. 5. (MIDDLE CENTER). Scratching nape and crown.
FIG. 6. (MIDDLE RIGHT). Scratching throat and auriculars.
FIG. 7. (LOWER RIGHT). Preening breast.

the great use they make of their feet and the perch for manipulation of food. Wild birds utilized the feet to hold swaying branches or thistle tufts. In the laboratory, manipulation was seldom observed during feeding on small seeds such as canary, millet, or rape (2-3 mm in diameter), but was much more pronounced when sunflower seeds 3-5 mm in diameter were taken. A single seed was carried in the bill to a perch, where it was passed back and forth

between the mandibles as attempts were made to crack it. Individuals often placed the seed next to one foot and grasped it with the toes of that foot, holding the seed under the toes on top of the perch. At other times, the seed was placed on the perch next to the bird. This was accomplished by resting the tip of the bill on the perch, then lowering the head slowly, keeping the bill in contact with the perch while opening it slightly allowing the seed to rest on the perch. The bird then raised its head, leaving the seed balanced on the perch, looked forward for a few seconds, then turned to retrieve the seed. Although this balancing was a common occurrence in the captive birds under consideration, the seeds often fell to the floor. It seems unlikely that wild birds utilize this pattern, since it was not often observed with small seeds similar to those normally eaten in the field, and wild birds do not usually carry seeds to perches. There is little doubt, however, that the goldfinch is extremely proficient in the use of bill, perch, and feet in manipulation of food particles.

Kear (1962) describes similar feeding activities in the European Goldfinch. This bird, like the American Goldfinch, feeds on thistle and other weed seeds in the wild. The feeding postures seem identical to those described above for the American Goldfinch. According to Kear, captive European Goldfinches as well as wild birds use the feet to a considerable degree in holding and manipulating seeds. In addition, a preference for small seeds is sustained and only minimal amounts of sunflower seeds were taken by captive birds. Kear suggests that the type and size of seed preferred is influenced by learning. This may also be the case with the American Goldfinch since the birds studied here became more proficient in dealing with large seeds as they matured. After one year in captivity, however, the large sunflower seeds did not form a significant portion of the diet, and canary or rape seeds were still preferred.

Green leaves placed in the cage were also almost invariably held with the feet. Pecking was always directed to the margin of leaves and small pieces were broken off and swallowed in rapid succession. Live trees or branches were systematically defoliated, the leaves being removed by severing the petiole. The same process was observed when branches with artificial leaves were placed in the cage. Similar behavior in captive American Goldfinches has also been noted by H. L. Batts, Jr. (personal communication) and Paul Mundinger (personal communication). Tordoff (1954) mentions the defoliating of Scotch Pine and cedar by captive Red Crossbills (*Loxia curvirostris*). He suggests that this may result from "a compulsion to twist, pry, and bite at objects," rather than a method of obtaining food. Of course, the crossbill normally makes great use of the bill in manipulating pine cones, and Tordoff indicates that denuding branches in the cage may satisfy this

urge to pry and peck. In view of the fact that the goldfinch also uses its bill and feet to a great extent while feeding in the wild, defoliation of branches may indicate the same type of substitute activity in captive birds. This may well be the case since the birds did not attempt to eat leaves that had fallen from the branches and only occasionally pecked at the edges of attached leaves, most of their efforts being directed toward removing the leaves or pecking and stripping bark from the bare branches.

The social nature of the goldfinch is especially evident in feeding behavior. Communal feeding is the rule, with both sexes present in close proximity at major feeding areas. Captive birds showed a high degree of social facilitation correlated with feeding. When one bird began feeding, it was often joined by other individuals. In many instances, all five caged birds were noted on or near the seed dish at the same time. Wild birds also tended to feed in flocks, with as many as five individuals at once on a single thistle plant.

Feeding was usually followed by flying to a perch, fluffing and shaking the feathers, and/or bill-wiping. During wiping of the bill, the legs were flexed and the body turned so that it was almost parallel to the perch. The head was then lowered and the bill passed rapidly across the perch, from base to tip, removing food particles clinging to it. The process was usually repeated several times, the bird turning its head back and forth so that first one side of the bill, then the other, was drawn across the perch. This movement was performed either to the right of the body or to the left, alternately in random fashion.

DRINKING

Caged birds alighted on the edge of the water dish, wild birds just at the edge of streams, pools, or other sources of water. From the normal perching position the legs were flexed slightly and the head lowered and extended. The bill was then dipped into the water, almost to the nostrils. The bird then raised its head to or above the shoulders. These postures appear identical to those described above for feeding (Figs. 1-3). Often the bill remained closed during the first immersion, and drinking did not occur until the movement was repeated. Drinking was performed by opening the bill 2-3 mm at the tip, either as it touched the water or after it was immersed. The bill was then closed and the head raised, after which swallowing occurred. When drinking was complete, usually after two to four swallows, the bird shook its head, flicking water from its bill. Bill-wiping usually followed while the bird remained at the water source or after flight to a perch.

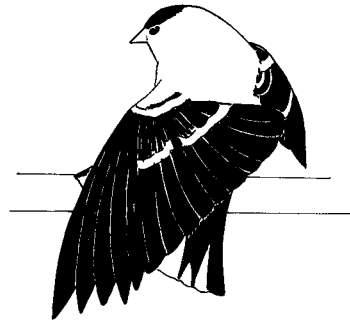
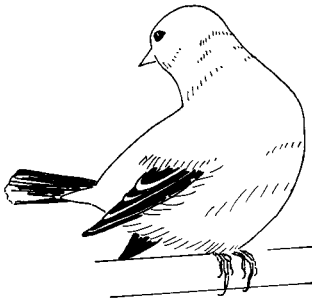
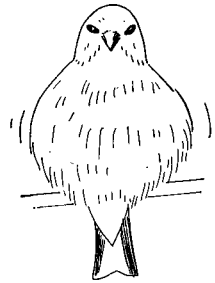
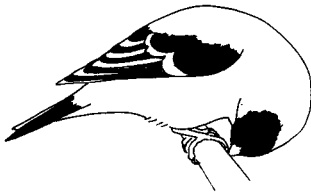
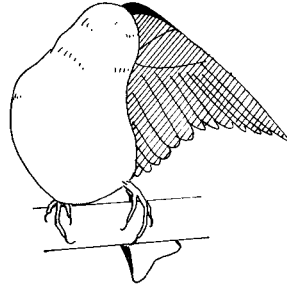
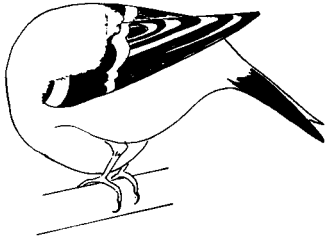
PREENING

One of the most common activities of the birds under observation was

preening, representing about 17 per cent of the time of observation of caged birds. In addition to its functions in cleaning or rearrangement of displaced feathers, it apparently becomes incorporated into displacement activities, as shown by its increase during the spring when courtship and agonistic behavior were prominent. Ficken (1962) suggests that an exceptionally large percentage of time is occupied by preening, bathing, stretching, etc., in caged American Redstarts, since less time is spent in other activities (i.e., foraging), than is the case in wild birds. This may be true of the goldfinch, although wild birds also preen frequently. No analysis was undertaken of the actual time occupied by preening in wild birds. The birds were 15 to 50 feet from the observer, and dense vegetation usually prevented precise observation of preening activities. In the present analysis, then, only caged birds are considered. An effort was made to record each movement involved in an entire sequence of preening, or bout, which usually continued for one to three minutes at a time. The postures were described carefully, correlated with photographs, and the data analyzed according to sequences and frequency of preening major tracts. The following description of postures is presented as a basis for further study of this activity.

Preening of the head and neck regions was accompanied by scratching with the foot or moving the head against the perch. Slow wiping of the head across the perch, similar to bill-wiping, sometimes occurred when feathers at the base of the bill required preening (Fig. 4). More often noted was scratching of the head with one foot to reach crown, nape, chin, auricular, or malar regions. The following sequence will serve to illustrate the procedure followed in this scratching movement. The bird leans to the right, the right leg supporting the entire body weight. The left wing is lowered and abducted slightly, the left leg flexed and raised beneath it, then extended toward the head over the bend of the wing. Scratching is accomplished by extending the toes, then rapidly and alternately flexing and extending the leg. The head may be turned to one side to allow scratching of nape and crown (Fig. 5) or tilted upward to reach the throat and auricular regions (Fig. 6).

During preening of jugulum and breast, the legs are flexed and tail lowered, with the body tilted backward so that the back is almost vertical. Extreme flexion of the neck allows the birds to reach breast feathers with the bill (Fig. 7). The abdomen is preened in like manner, but in this case the legs are extended, the anterior part of the body tilted forward, the tail lowered, and the neck extended down and back (Fig. 8). Cleaning of the feet and legs is also performed from this position but is usually accompanied by sleeking of the ventral feathers (Fig. 9). At times one foot was raised one-fourth to one-half inch from the perch and the toes extended or flexed as they were pecked.



- FIG. 8. (UPPER LEFT). Preening abdomen.
FIG. 9. (MIDDLE LEFT). Cleaning toes.
FIG. 10. (LOWER LEFT). Preening back, scapulars, or sides.
FIG. 11. (UPPER RIGHT). Preening under wing.
FIG. 12. (MIDDLE RIGHT). Fluffing and shaking.
FIG. 13. (LOWER RIGHT). "One-sided" stretch.

The sides and flanks were often preened by turning the head and neck to one side or the other while retaining the postures described above (Figs. 7, 8). In other instances, the bird lowered one or both wings and turned the head and neck to one side over the back to reach these areas (Fig. 10).

Extension of the neck over the back was also noted when back or scapular

feathers were preened. Most often, the neck was turned toward the side to be preened, but occasionally movements were directed to the opposite side (i.e., right back preened with the head extended over the left shoulder).

The bend of the wing was preened either from the top in conjunction with the scapulars, from the front as in preening the side of the neck, or from the underside, the carpals moved slightly away from the body through abduction of the radius and ulna. Abduction of the phalanges, resulting in raising of the folded primaries, often to an angle of 90 degrees with the body, was noted when the alula or outer primaries were preened.

Partial extension and lowering of the wings allowed preening of primaries and secondaries from the upper surface. The remiges were reached from the underside by raising the partially extended wing and bending the neck beneath it (Fig. 11). Each feather was grasped near the base and drawn through the bill from base to tip both by partial closure or raising of the wing and forward movement of the head. Tertiaries and coverts were preened in the same manner but with much less movement of the head and wing; most preening was accomplished solely by "chewing" motions of the mandibles.

The rump and crissum were preened from the top (Fig. 10), the rump from the same position as the back, and the crissum by tilting the side of the tail upward toward the head. In addition, the crissum and anal ring were sometimes reached from the position noted in preening the abdomen (Fig. 8), the legs being extended and the neck bent far down beneath the body while the tail was bent forward.

Preening of the rectrices was accomplished by extending the neck over the back to the right or left, spreading the tail toward the same side, and grasping the feathers at the base. They were then drawn through the bill in the same manner as the remiges. Outer rectrices received the most attention with rearrangement of barbs or cleaning of inner feathers dependent on rapid fanning and closing of the tail.

The contour feathers usually remained raised throughout the process of preening, the areas being preened at any given moment sometimes presenting a more fluffed appearance. All preening was interspersed with shaking and fluffing (Fig. 12). These two movements usually occurred together, the contour feathers (except those on the head) being fully raised and the body then shaken. This was sometimes accompanied by rapid opening and closing of the wings and tail.

Stretching of wings and legs was also common. The "one-sided" stretch was performed by lowering and extending one wing, spreading the tail, and turning the head in the same direction while fully extending the foot and leg on the same side (Fig. 13). This posture is apparently identical to the "wing

TABLE 1
PERCENTAGE OF PREENING IN EACH MAJOR AREA (1,457 MOVEMENTS)

Region	Percentage of preening
Head and neck	28
Breast and abdomen	17
Sides and flanks	4
Back and scapulars	13
Wings	28
Crissum and rump	4
Rectrices	3
Feet and legs	3

and leg sideways" stretch described by Ficken (1962) for the American Redstart. It was usually followed by stretching of the opposite wing and leg in the same manner. Both wings were sometimes raised high over the back and either kept folded or extended fully, then lowered.

A detailed analysis of preening was undertaken for the six-month period from August 1961 through January 1962. The hand-raised birds probably hatched on 22 through 27 July, and preening was not recorded until 12 August (about the 18th day). Preening after this date in August appeared identical with that of later months when the birds approached maturity and so was included here. The percentage of observation time during which preening occurred was calculated for each month. The range during five of these months was 16 to 21 per cent with an average of 17 per cent. An extremely low figure of 9 per cent was recorded for September. During this month, the birds were housed in a small cage (18 × 22 × 24 inches), and the effect of crowding may have disrupted normal behavior patterns. A high degree of agonistic behavior at this time prevented extended periods of quiet perching and did not seem conducive to undisturbed preening.

Data obtained from all five birds during the entire period of observation each month were combined in an attempt to give a more general picture of the movements. Twenty-seven areas were considered, including notation of right or left side in bilateral tracts. These areas will be grouped here according to major tracts to facilitate presentation of the results. In order to tabulate the movements, a basic unit of measurement was required. One preening movement was designated as a period of preening (including scratching and mandibulating the feathers) of one area, without change in posture. Preening of a different area or facing forward to perch quietly thus indicated cessation of one movement.

In Table 1 the data are organized according to the percentage of movements during which each major area was preened. As indicated here, most

TABLE 2
SEQUENCES OF PREENING GIVEN PAIRS OF REGIONS

	Head and neck	Breast and abdomen	Sides and flanks	Back and scapulars	Wings	Rump and crissum	Rectrices	Feet and legs	Total number
Head and neck	35	21	2	8	25	2	5	2	208
Breast and abdomen	27	19	8	22	16	5	0	3	190
Sides and flanks	17	32	9	14	17	7	2	2	48
Back and scapulars	12	15	10	26	26	6	2	3	168
Wings	18	15	2	15	47	1	2	0	292
Rump and crissum	17	27	0	10	4	21	19	2	42
Rectrices	18	15	6	6	25	21	10	0	33
Feet and legs	15	28	0	9	15	0	0	33	21

Numbers represent the percentage of movements from regions in the left-hand column to each of those heading the vertical columns. The actual number of movements for each region is given in the column to the right.

preening is directed to the head and wings. Since preening usually begins at the anterior part of the body, short sequences are often confined exclusively to the head and neck regions. Displacement activities such as bill-wiping and head-scratching, occurring during aggressive encounters, are also included here. Under the heading "wings" is included remiges, coverts, tertiaries, and alula. In view of the importance of the wings in flight, it is not surprising that these areas should receive a great deal of attention. Areas which were seldom preened included sides, flanks, rectrices, crissum, rump, feet, and legs. Fluffing, shaking, and stretching occurred frequently throughout preening bouts, accounting for 25 per cent of the total preening time. These activities are apparently effective in rearranging the feathers.

In Table 2 the same groupings are used to indicate areas preened consecutively. Here again, data from five birds for six months are combined. This table is read from left to right in horizontal rows. The figures represent the percentage of times regions to the left were followed by preening of those heading the vertical columns. For example, preening of the head and neck was followed by return to that area in 35 per cent of the cases observed. Total areas preened in each category are also given. It can be seen that the birds preened rather randomly but that some sequences were noted more often than others. For instance, preening of the back and scapulars was followed 52 per cent of the time by preening of the wings, back, or scapulars. Thus we find a tendency to return to the same or closely adjacent areas. This tendency is exemplified throughout preening sequences, as can be seen in Table 2 for head and neck; breast and abdomen; sides and flanks; back and scapulars; and wings, all of which showed return to the same or immediately adjacent tracts at least 50 per cent of the time.

Some possible sequences were never observed. For example, breast or abdomen to rectrices; wings to feet or legs; and rump or crissum to sides or flanks. These data again indicate that widely separated areas are not preened consecutively. It will be noted that five sequences involving feet and legs were not recorded. This may be due to the fact that, on the whole, these areas received little attention (as evidenced by Table 1). In addition, the feet were sometimes pecked when no further preening occurred. Thus, these were not included when considering sequences.

BATHING

Bathing was analyzed only in captive birds. It is initiated by the sight of water as the bird drinks, or by splashing of water on the bird while another bathes. The bird perches on the edge of the water dish, usually with ventral feathers fluffed. Just before bathing, birds were often seen to perch on the dish with wings lowered, vibrating and/or fluttering, tail raised slightly, head lowered, and breast feathers fluffed. These movements also occur when the bird is in the water and undoubtedly represent intention movements for bathing. If the bird flies to a perch after performing these movements on the edge of the dish, it almost invariably returns to bathe.

When sufficiently motivated, and with or without lowering and extension of the neck, the bird hops to the center of the dish. The legs are usually kept extended at first, keeping the feathers clear of the water. Actual bathing is sometimes preceded by complete turning in the dish, either to the right or to the left. The feet are kept close together, first one being raised and turned slightly, then the other. The bird thus remains in approximately the same place in the dish but faces in different directions. The bird may drink one or two swallows of water before bathing, while standing in the water. It then dips forward, wetting the ventral feathers. Next, the bird lowers and flutters its wings, both wetting them and throwing water over the back. Simultaneously, the tail is rapidly fanned and closed. Occasionally only one wing is fluttered, the tail being fanned toward the same side. This is then repeated with the opposite wing. Nice (1943) reports alternation of wing fluttering during bathing in the Song Sparrow (*Melospiza melodia*) but this is accompanied by an erect posture not seen in the goldfinch, the body remaining more nearly horizontal at all times. In some cases, the birds "walked" forward along the bottom of the water dish. The legs were flexed considerably, head and breast raised slightly, and tail pressed down to the bottom of the dish. Since the tarsometatarsus was almost parallel to the dish, most of the propulsion seemed to come from the fluttering wings. The entire sequence is repeated several times, after which the bird shakes, then flies to a perch and preens. The same movements described above for preening were utilized

after bathing. In this case, however, movements were more rapid and much fluffing and shaking of contour feathers occurred. In addition, the wings were vibrated or "shuffled" almost constantly, while they were held a few millimeters from the body. These vibrations were interspersed with frequent flicking movements, during which the wing was rapidly raised about one-half inch, then lowered again, usually being extended and refolded rapidly. These movements obviously aid in ridding the feathers of excess water and rearranging and drying them.

DEFECATION

Defecation often occurred in connection with preening. It is also noted in fear-producing situations such as after aggressive encounters or when the bird is held in the hand. It is sometimes performed just after takeoff, but is most often observed when the bird is perched. The ventral feathers are fluffed, the legs flexed, and the fecal mass ejected. This is followed by shaking of the body and/or rapid erection and lowering of anal ring, along with opening and closing of the cloacal aperture. Relaxation allows the contour feathers to resume their normal position. In some cases the cloaca or anal ring is pecked, but the fluffing and shaking movements usually seem sufficient to rid the bird of waste material which may cling to the feathers. Tail-flicking after defecation, as described by Marler (1956) for the Chaffinch, was not observed in the goldfinch.

SLEEPING

The American Goldfinch sleeps in a posture similar to that for most passerines. The legs are flexed fully, one usually being raised into the ventral feathers. All contour feathers except those covering the head are fluffed so that the proximal half of each wing is completely hidden. The head is turned back over one shoulder and pushed beneath the feathers of the scapular tract, so that the bill apparently rests on the body and the entire crown is covered. The tail is lowered somewhat and both the wings and tail remain completely closed.

SUMMARY

A study of maintenance behavior of the American Goldfinch was conducted from March 1961 through July 1962. Observations and analyses of postures and movements of caged birds were supplemented by field work during the summer months.

A description of basic feather postures is followed by a discussion of various types of locomotion. These include hopping, sidling, turning, hanging, takeoff, flight, and alighting. Movements occurring in each of these categories are described in detail.

Types of food and feeding behavior are described. The manipulation of food particles with the bill and feet is especially evident in this species. Social facilitation, as manifested during feeding, is discussed. Drinking involves movements similar to those occurring during feeding.

A description of postures and movements involved in preening is given. Preening for a six-month period is analyzed according to sequences and frequency of preening major areas. Head and wings received most attention with feet, legs, and rectrices being preened infrequently. Movements appear to be random, but there is a tendency to continue preening in the same area in which it is begun.

Bathing, defecation, and sleeping are also described and discussed.

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LITERATURE CITED

- ALLEN, A. A.
1928 Mother goldfinch tells her story. *Bird-Lore*, 30:287-293.
- CONDER, P. J.
1948 The breeding biology and behaviour of the Continental Goldfinch (*Carduelis carduelis carduelis*). *Ibis*, 90:493-525.
- FICKEN, M. S.
1962 Maintenance activities of the American Redstart. *Wilson Bull.*, 74:153-165.
- HINDE, R. A.
1955-56 A comparative study of the courtship of certain finches (Fringillidae). *Ibis*, 97:706-745; 98:1-23.
- KEAR, J.
1962 Food selection in finches with special reference to interspecific differences. *Proc. Zool. Soc. London*, 138:163-204.
- MARLER, P.
1956 Behaviour of the Chaffinch (*Fringilla coelebs*). *Behaviour*, Supplement No. 5:viii + 1-184.
- NICE, M. M.
1943 Studies in the life history of the Song Sparrow. II. The behavior of the Song Sparrow and other passerines. *Trans. Linn. Soc. N. Y.*, 6:viii + 1-328.
- TORDOFF, H. B.
1954 Social organization and behavior in a flock of captive, nonbreeding Red Crossbills. *Condor*, 56:346-358.
- WALKINSHAW, L. H.
1939 Life history studies of the Eastern Goldfinch, Part II. *Jack-Pine Warbler*, 17:3-12.

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