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ESTABLISHMENT, GROWTH, AND BEHAVIOR OF AN EXTRALIMITAL POPULATION OF HOUSE FINCHES AT HUNTINGTON, NEW YORK

By DOUGLAS E. GILL¹ and WESLEY E. LANYON²

The range of the House Finch, *Carpodacus mexicanus*, extends from southern British Columbia south to southern Mexico and from western Nebraska west to the Pacific Coast. An introduced population is established in the New York metropolitan region. Elliott and Arbib (1953) conclude that the origin of this population was the multiple release of caged birds in the early 1940's. Documenting its history they cite an observation of a male by Fischer and Hines at Jones Beach, Long Island, on April 11, 1941, and Arbib collected the first specimen (Amer. Mus. Nat. Hist. 348793) on January 17, 1948. Cant (1962) and Cant and Geis (1961) document the subsequent history of this population and extend the known breeding range throughout much of Long Island, into New Jersey, and north into Westchester and Rockland Counties, New York, and Fairfield County, Connecticut. He further states that banding records indicate a migration pattern from the metropolitan area, across central New Jersey, to the Philadelphia region.

During the period from 1958 through 1963 the authors studied the establishment, growth, and behavior of the population of House Finches at the Kalbfleisch Field Research Station of the American Museum of Natural History at Huntington, Long Island. The results of this study are presented here and related where possible to what is known of this species in the West.

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¹Marietta College, Marietta, Ohio

²The American Museum of Natural History, New York

STUDY AREA AND METHODS

The Kalbfleisch Field Research Station is located in the Dix Hills section of Huntington Township, Suffolk County, New York. Oak-hickory woodland, shrubland and woody fencerows, and open fields are the three predominant vegetation communities on this gently rolling 94 acre estate. Irregular plantings of ornamental conifers (including *Picea*, *Pinus*, *Thuja*, and *Tsuga*) border the Station's roadways and lawns. Profuse growths of English Ivy (*Hedera helix*) occur on two of the Station's buildings.

During the autumn, winter, and spring House Finches frequented two feeders located one-quarter of a mile apart on the Station, and a third feeder in the community of Woodedge, three-quarters of a mile away. As a result of this concentrated activity, birds were readily secured in multicelled Potter traps, ground funnel traps, and mist nets. In summer trapping was irregular and less effective, but breeding birds were netted near their nests, and nestlings were banded prior to fledging. A total of 355 House Finches were banded during the five year period. That the skulls of immature House Finches do not become double-layered until January provided us with an aging criterion for all fall and early winter birds. A series of specimens was prepared to document the extent of individual variation in the plumage of both males and females. Laparotomies were performed on many of the banded birds in the population to further document individual and sexual variation in plumage coloration. All captured birds were color-banded to facilitate observations of breeding behavior and of the seasonal composition of the population.

ESTABLISHMENT, GROWTH, AND COMPOSITION
OF THE POPULATION

The establishment and growth of the House Finch population at Kalbfleisch can conveniently be documented by two indices: (1) increase of breeding activity, and (2) increase in the number of banded birds in winter. During the first breeding bird census at Kalbfleisch, conducted in early June 1958, no House Finches were recorded; but there was an unverified record of a singing Purple Finch, *Carpodacus purpureus*. Since there have been no subsequent summer records of the Purple Finch at the Station, this record is questionable and may well represent the presence of a House Finch at Kalbfleisch during the summer of 1958. Observations during the summer of 1959 revealed no House Finches. During the summer of 1960, however, eleven adults were present and the successful nesting of one pair in June is the first breeding record for the Station. In June 1961 we recorded 30 adults, five of which are known to have bred. By the summer of 1962 the number of known breeding adults had increased to 13 and the season of nesting activity lasted from mid-April to early August, during which time we found eight active nests. At least 22 breeding birds were present in 1963.

Winter records (November through February) reflect a similar growth in the Kalbfleisch population. During the winter of 1958-59 only one bird was trapped. In the following winter 12 birds were

banded, and this number increased to 73 during the winter of 1960-61. During the winter of 1963-64, 62 new birds were banded or collected, an additional 28 banded birds repeated and we estimated that there were another 20 to 30 unbanded individuals visiting the Station's feeders. Although the population growth at Kalbfleisch corresponds with the population explosion reported for the species in the metropolitan area, we must consider the possibility that the activity of a Huntington population might have been concentrated at Kalbfleisch as a result of the intensive feeding program in winter. This concentration of winter activity could conceivably have led to a subsequent invasion of hitherto unexploited breeding habitat.

The seasonal activity of House Finches for which we have adequate data provides us with a fundamental premise: House Finches feed and wander throughout a large area during the non-breeding period of the annual cycle, in a manner resembling the general errant behavior of *Carduelines* (Tordoff, 1954), but limit their movements to a relatively small portion of this area during the breeding season. This premise is consistent with Thompson's analysis (1960) of records of banded House Finches in the West. Daily observations of breeding birds of both sexes showed a consistent concentration of activity within the breeding area. A marked post-breeding dispersal followed the breeding activity; in five years we captured only one individual in the period mid-August to mid-October. Occasional observations of birds flying over the Station at this time indicate wandering of considerable distances. For evidence of winter movements of birds that breed at Kalbfleisch, we can consider the 1962-63 winter records of 13 individuals known to have survived and bred at the Station in 1963. Seven of these 13 birds were also observed at a winter feeding station three-quarters of a mile from their breeding ground.

The composition of the Kalbfleisch population was analyzed on the basis of the above premise. We recognize two groups: (1) birds which occur regularly during the breeding season, mid-April to early August, and irregularly throughout the non-breeding period, and (2) birds which are recorded at the Station only in the non-breeding period. The former group consists of 37 birds recorded during the project period. To illustrate:

1. Female GW-XW bred in June 1962; was captured twice at a Station feeder in December 1962; was observed at the Woodedge feeder in January and February 1963; was recorded nearly daily in nesting activity during June and July 1963; was observed in December 1963 and January 1964 at the Station and at the Woodedge feeder as well.

2. Male YX-YG bred in June and July 1962; was netted at a Station feeder in December 1962; was observed at the Woodedge feeder on four occasions in January and February 1963; was paired in June and July 1963, and observed at the Station in December 1963.

Application of the basic premise to birds that breed elsewhere

would account for the second and larger segment of the population. These birds are recorded at Kalbfleisch only in the event that they are fortuitously intercepted in the course of their wanderings during the non-breeding season. We have sufficient data to place 160 of our birds in this group. Four of these birds were reported elsewhere during the breeding season. To illustrate:

1. Female RW-XW was trapped at a Station feeder on March 10, 1962 and not observed again until she appeared at the Woodedge feeder a year later, on January 29, 1963; not observed during the 1963 breeding season but recorded at the Station feeder on December 13, 1963.

2. Female RG-RX was netted near a Station feeder on January 22, 1961 and recorded again on April 22, 1961; missed during the next winter, but observed at the Woodedge feeder on February 2, 1963; observed in Woodedge again the following winter, January 2 and 14, 1964.

3. Male XW-YW, trapped at the Station on February 11, 1962, was not recorded again until the following winter, December 8, 1962; observed at the Station on December 8 and 15, 1963.

4. Male RY-YX was captured at the Station in December 1962 and January 1963; was observed at a feeder two miles north on May 27 and again at the same location on June 19 and 20 with an unbanded female; observed at the Station on July 31 with an adult female and three young (we interpret this as an example of post-breeding dispersal); observed at a Station feeder on November 24, 1963.

Many of the birds banded during the non-breeding season did not repeat and we have not classified them for lack of survival data. In the five year study period we have longevity records for three birds (males W-X and XR-W, and female RX-YB) with a minimum of four years, and for six birds with a minimum age of three years (males RX-RG, RX-RR, and females RG-RX, -XR, WX-, and WR-XW).

Banding recoveries give additional evidence of the distance covered in the wandering during the non-breeding period. On April 1, 1960, Walter Terry trapped at Blue Point, New York male GX-that was captured at the Station the previous February and March (a distance of 15 miles). Male BX-Y was trapped at the Station on December 24, 1960, but Mrs. Wagenhauser reported him from Islip, New York, on March 30, 1961 (a distance of nine miles). Female R-X was trapped at the Station on February 14, 1960, and was reported at a feeder in Babylon, New York (eight miles south), on April 6 and regularly thereafter throughout the spring. The complements of these are the two birds banded elsewhere and re-trapped at the Station. A bird banded at Oakdale, New York, by Leroy Wilcox on February 18, 1960, was trapped at the Station a month later (a distance of 12 miles). The breeding locality is unknown for each of the foregoing birds but is surmised for the bird

Figure 1. Female House Finch, WR-XW, perched near nest in growth of ivy on one of the Field Station's buildings. Fouled rim of the nest is visible just to the right and behind the female. Photo taken July 11, 1963.



banded at Great River, New York, by Leroy Wilcox on March 29, 1961, and retrapped at the Station on June 15 (a distance of 11 miles).

We have no evidence of migratory behavior in our population. Of 61 adults recorded at Kalbfleisch during the height of the breeding season (May through July), 51 (84 per cent) were also recorded at the Station during the period from November through March. Mortality and an irregular program of trapping and observation during the non-breeding season could easily account for the failure to record the remaining 16 per cent of this group.

BREEDING BEHAVIOR

Nidification. Details on nidification were accumulated from seven nests during June and July, 1963. Four of these nests were constructed in three days: the first half of this period for foundation, and the remaining half for lining and molding. The extremes for duration of nidification were two and five days. Most males carried material to the nest, though less frequently than the females. Male XW-BW usurped material from an abandoned House Finch foundation two feet from his nest. Whether Kalbfleisch males actually contributed to nest construction or just dropped material on the nest was not determined. Bergtold (1913) and Thompson (1960) reported that males drop the material, but Evenden (1957) concurs

Figure 2. View of nest, showing construction and placement with respect to the ivy and the brick wall in the background. Some ivy cover had to be temporarily displaced to take this photo on July 6, 1963.



with Grinnell and Linsdale (1936) that both sexes actively participate in nest construction. Examinations of eight nests revealed that coarse grass formed the bulk of five foundations and that three nests were 90 per cent hemlock twigs. The lining was always made of soft materials, including frayed twine, string, cotton lint, fine grass, etc.

Sixteen of 21 completed nests were built in dense English ivy (*Hedera helix*) growing on the walls of the Station's buildings (Figs. 1 and 2). No preference was exhibited for locations beneath eaves or projections from the walls, as has been reported in the West. The first nest, recorded in June 1960, was located three feet above ground in an arbor vitae shrub (*Thuja occidentalis*). In August 1962 one nest was twenty feet above ground in an Austrian pine, *Pinus nigra*. In 1963 two nests were built twenty feet above ground in a white spruce, *Picea glauca*. In June 1963 one pair reared a brood in a rose arbor (*Rosa*, hort. var.) twelve feet from the ground (Figs. 3 and 4). We have no record of House Finches reusing a nest of their own or of any other species, and all records of multiple broods at the Station involved new nests.

Agonistic Behavior. Nesting pairs exhibited remarkable tolerance of other House Finches. In June 1963 there were three active nests (all in different stages of the nesting cycle) on one ivy-covered wall; one nest was only eight feet from another. On several occasions

Figure 3. Female RX-BY near her nest in a rose arbor. Photo taken July 1, 1963.



individuals other than the nesting pair approached within a few inches of a nest. Though Thompson (1960) states that the male defends the territory around the female, we observed occasional groupings of paired birds only six inches apart and above the nest of one pair. Unpaired males often associated with mated females and *vice versa*. On the other hand frequent agonistic behavior occurred among closely associated individuals. Supplanting was common and often without apparent provocation. Low intensity head forward displays (Thompson, 1960) were not observed. All food-begging and copulation invitations by the female appeared to be high intensity head forward displays, in Thompson's terminology (1960).

Copulation. The male often mounted the female and copulated upon returning from gathering nesting material. After dismounting he preened and sang while the female went to the nest to construct and mold. Although Thompson indicates that copulations terminate when egg-laying is complete, copulation was frequent throughout nest building and incubation within the Kalbfleisch population. We observed one instance of reverse copulation:

At 10:05 both birds flew up into the willow. Female invited, the male mounted and copulated. Right after the male dismounted, the female mounted him. They both fell off the branch and flew to separate perches. Female still had bill full of nesting material, flew to nest in rose arbor at 10:08, then back to willow.

Figure 4. View of nest in rose arbor, containing young just prior to fledging. Nest is fouled in typical *Cardueline* fashion. Photo taken July 4, 1963.



Egg-laying and Incubation. At Kalbfleisch we observed no disappearance of adults between the times of nest construction and egg-laying as mentioned by Bergtold (1913) and Evenden (1957). Egg-laying seemed to start immediately after construction of the nest. One pair continued to add materials during egg-laying. Normally one egg was laid daily until the clutch was complete, but we observed two delayed layings: (1) one day was missed between the laying of eggs number one and two in one nest, and (2) at least two days were missed between the laying of eggs number four and five in another nest. Clutch size for eight Station nests averaged 4.75 with a range of 4 to 6.

The incubation period appeared to be 13-14 days, though we lack precise data. All of the young of RX-BY, for example, had hatched on the thirteenth day following the laying of the last egg in the clutch. But, as Thompson cautions, incubation may actually commence before the last egg is laid.

While the female incubated, the male sang from perches usually within 300 feet of the nest. A male frequently called his mate off the nest and fed her in response to her food-begging display: crouched position, wings quivering, head tilted back, accompanied by a high rapid "chee-chee-chee". In only a few instances did a male feed the female on the nest; e.g. male GW-XG fed his mate RX-BY twice on the nest during incubation.

Nestling Period. Nestlings remained in two nests for fourteen days and in a third nest for sixteen days. General observations indicated a two week nestling period. The male parent fed the young less often than the female. The young were never fed solid, fresh food, but rather the food was always regurgitated and appeared quite viscous. The adults cleaned the nest of fecal material for the first seven days, but thereafter the nest became heavily fouled in a manner characteristic of most *Carduelines* (Fig. 4). An entire brood of six nestlings, upon being banded and returned to their nest, immediately left the nest with sustained flights of up to 50 feet in length and gains in height of up to 10 feet.

Multiple Broods and Mate Preference. In the summer of 1962 we recorded the Station's first case of a second brood. In 1963 we recorded two second broods and one third clutch which was deserted. These observations of multiple broods are consistent with those made by Bergtold (1913). We have not recorded simultaneous broods as did Evenden (1957).

Color-banding has provided data on the identity of mated pairs in successive breeding seasons. Female GW-XW paired with male YW-XW in June 1962, but paired with male XW-BW for two broods in 1963. Female XW- paired with XY-YR in July 1962, but paired with YG-XY in June 1963. Since we have no records of either male subsequent to the summer of 1962, we have no proof that they survived the winter of 1962-1963.

Our most complete breeding record is that of female WR-XW (Fig. 1) who had four different mates for six nests during three consecutive breeding seasons. In June 1961 she paired with R-RX, a male for which we have no subsequent record. In June 1962 she paired with RW-RX, and we have no subsequent record of that male. For her second nesting in 1962 she shifted her activity to another locality on the Station, paired with RX-RR and successfully fledged a brood. During the following winter (February 1963) she was observed at a Station feeder in company with this same male, RX-RR, suggesting the possibility that they maintained some semblance of a pair bond during the non-breeding season. She retained RX-RR as her mate for two successful nestings in May and June 1963. In July of that year, however, she attempted a third nesting, this time with male XR-YG.

We have two additional records that suggest a retention of the pair bond throughout the non-breeding season. Male GW-XG and female RX-BY, known to have paired and fledged young successfully in July 1963, were recorded together at a Station feeder in November 1963. Male XW-BW and female GW-XW were paired and reared two broods in the summer of 1963, and were also observed associating with each other at a Station feeder in December 1963.

DISPERSAL AND SUBSEQUENT BREEDING OF IMMATURES

Of 63 birds banded at Kalbfleisch as nestlings or as local immatures, 13 have been recorded subsequent to the summer season in which they were banded. Eleven of the latter group repeated during one or more non-breeding periods, and five were present at the Station during a subsequent breeding season. Observations showed that young birds do not remain in the immediate vicinity of their nests but rather wander considerable distances. For example, WG-GX, banded as a nestling on May 4, 1963, was observed more than a quarter of a mile from the nest site in June. This bird was recorded about the Station throughout July, but did not repeat again until it was trapped at a Station feeder on December 14. On January 14, 1964 it was observed at the Woodedge feeder, three-quarters of a mile away. Demonstrating long distance wandering in first year birds, a nestling (GX-G) banded in June 1960 was trapped by Walter Terry at Blue Point, New York, on March 25, 1961 (a distance of 15 miles). We have no subsequent record for that bird.

We have evidence that House Finches in the Kalbfleisch population breed during their second summer. A female (WY-WX), banded as a local immature in June 1961, successfully fledged a brood of young at the Station in July 1962. Another female (YW-YX) banded as a local immature in July 1962 was recorded as having a brood patch in June 1963. Three males (GX-Y, RX-WY, and XR-GY) banded as nestlings were recorded at the Station during their first breeding season, though we lack proof that they actually bred. That some first year birds do not remain to breed in the locality where they were reared is demonstrated by our record of WB-XW, banded as a nestling at Kalbfleisch in July 1961 and observed two miles north of the Station in May and June 1963.

VARIATION IN PLUMAGE COLORATION

We can add nothing to the comprehensive description by the Micheners (1940) on the autumnal, and only, molt of this species. However, our notes on the extent of variation in plumage coloration, particularly of the first basic plumage (= postjuvinal) of immatures are noteworthy. For convenience we use the words "red" and "gold" to indicate the general colors without attempting to give a more exact nomenclature. Gradations in these colors have been extensively discussed by the Micheners (1931, 1932). We have a reference series of voucher specimens to document the variation described here.

Examination of the degree to which a double layer of bone had formed in the roof of the skull was our sole criterion for aging individuals other than those in juvenal plumage. Many birds were inspected repeatedly throughout their first nine months of age, which provided an opportunity to determine the progress of this growth process in the same individuals and to evaluate the effectiveness of this criterion in different months of the year. Skull "wind-dows" (areas of one layer of bone) apparently begin to disappear in

immatures of our population in late December, and by February most immatures have a completely ossified skull. As an aging criterion, then, the technique can be used accurately on an individual basis until mid December, but is subject to increasing error for the month thereafter and is totally ineffective by late January. Our earliest record of skull "closure" in an immature is that for XW-RG, recorded as having small windows on December 11 and a completely ossified skull when next handled on January 1. At the other extreme, XR-RB still had "large windows" on January 26, but unfortunately did not repeat thereafter. We have no record of an individual with an incompletely ossified skull after that date.

A series of 27 females, banded or taken as specimens from November 1963 through January 1964, were carefully checked for any red or gold coloration. All of these individuals were sexed by laparotomy or dissection. Ten (37 per cent) of these birds had the rump feathers or feathers of the rump and crown very slightly washed with red or gold. The extreme in extent of red coloration is exhibited by a specimen (AMNH 781678) that, in addition to the slight red coloration of rump and crown, has a few feathers of the throat and breast that show a red wash of lesser degree. It should be emphasized that this red coloration in females is only perceptible upon close inspection and would not normally be apparent in the field. Twelve of these 27 females had incompletely ossified skulls. Four (33 per cent) of these immatures had the feathers of the rump very slightly tipped with red, and one of these also had a slight wash of red on the crown as well (AMNH 781673). To our knowledge this constitutes the first published evidence that the first basic plumage of female House Finches may exhibit any red coloration.

In view of this demonstration that some females may acquire a slight red coloration on the rump and crown following their first prebasic molt (=postjuvinal molt), it is interesting that some females in our population have not acquired any perceptible red on the rump or crown for up to five years of age. Female RY-XR exhibited no red coloration in July 1963 when she was in at least her third basic plumage, and female RX-YB had not developed red on the crown or rump by December 1963 when she was known to be in at least her fifth basic plumage.

A series of 36 males, trapped from November 1963 through January 1964, were examined especially for variation in plumage coloration. Six of these, all immatures, were taken as specimens and assigned numbers to represent convenient stages along the gradient from the dullest-colored male (no. 1) to the male having the richest and most extensive red coloration (no. 6). Each of the 30 males that were banded thereafter was compared with this series and assigned the number of the voucher specimen that it most closely matched with respect to plumage coloration. Those individuals assigned to the dullest category (i.e. most "female-like") were laparotomized to be sure that they were, in fact, males. The results of this survey are presented in Table 1. Twenty one of these 36 birds had incompletely ossified skulls and provide evidence for the extent of variation in the coloration of the first basic plumage of

TABLE 1. DISTRIBUTION OF MALES ALONG GRADIENT OF
PLUMAGE COLORATION

	Red profuse, no gold; extensive red on back; streakings of underparts narrow and restricted			Red restricted, with suggestion of gold; no red on back; streakings of underparts broad and profuse.		
Gradient Category	6	5	4	3	2	1
Voucher Specimen (AMNH)	781679	781680	781682	781674	781677	781681
Total No. Birds	2	12	8	4	6	4
Immatures	1	4	4	3	6	3

males. It is well known that male Purple Finches (*Carpodacus purpureus*) and Cassin's Finches (*C. cassinii*) normally do not acquire their red coloration until their second basic plumage, and this has been used as a subgeneric character by Moore (1939) to set these northern finches apart from the house finch group. We have no evidence in our studies thus far that any males in the Kalbfleisch population are completely devoid of red or gold coloration, though this condition has been reported for a small percentage of the western populations (Van Rossem 1936, Moore 1939).

It is perhaps significant that of the six immature males prepared as voucher specimens for the above survey, all of which were taken in the month of November, the three specimens having the largest "windows" in the skull (signifying less time for ossification and hence a later hatching date) were the three positioned at the duller end of the gradient (numbers 1, 2, and 3). The Micheners (1940) have presented data that suggest a correlation between date of hatching and plumage coloration in first year males: ". . . it is generally true that the postjuvinal male plumages are red on the head, throat and rump in the earliest-hatched birds and in those hatched successively later, these areas are less and less red and then less and less yellow until the latest hatched show only a dull yellowish tinge" (p. 153).

We have evidence that some males undergo a substantial change in plumage coloration during an annual molt subsequent to the first prebasic molt. In July 1962, YB-YX was recorded as having gold feathers of the head and upper breast but in December of that year the plumage of this male had assumed the full red coloration. Another male (XW-BW), when banded in March 1962, was recorded as having a "slight tint of pink on crown and rump". When trapped

as a breeding bird in June 1963 (one molt later) it had acquired the full red coloration characteristic of most adult males. The Micheners (1940) have suggested that the duller-colored first year males normally acquire a more brilliant red coloration during their next annual molt (second prebasic).

SUMMARY

The establishment and growth of an extralimital population of the House Finch (*Carpodacus mexicanus*), at Huntington, New York, is documented by an increase in breeding activity and an increase in the number of winter birds from 1958 through 1963. Two groups contribute to this population: (1) birds which occur regularly during the breeding season and irregularly at other times, and (2) birds which breed elsewhere and are recorded only by virtue of their being intercepted during their Cardueline wanderings in the non-breeding season. No evidence of migratory behavior was found.

Breeding occurred from late April to early August, with some females rearing two broods. One female had four different mates for six nests during three consecutive breeding seasons. Most nests were built in ivy growing on the sides of buildings, though others were found in three species of conifers and in a rose arbor. Nesting pairs exhibited remarkable tolerance of other House Finches. Clutches varied in size from four to six eggs, and the incubation period appeared to be 13 to 14 days. Young were fed by regurgitation and the nests became heavily fouled during the two week nestling period. Young birds wander considerable distances, are capable of breeding during their second summer, and may or may not remain to breed in the locality where they were reared.

Degree of skull ossification is an accurate aging criterion until mid-December, but is totally ineffective by late January. Females, including some first year birds, may exhibit slight red coloration on the rump and crown, though some adult females have not acquired any perceptible red for up to five years of age. No males were without some red or gold, though there was considerable variation in the richness and extent of this coloration, especially in first year birds. The latest-hatched males may, on the average, be duller-colored than earlier-hatched birds, but may undergo substantial changes in plumage coloration during subsequent annual molts.

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NOTES ON QUANTITATIVE TREATMENTS OF SUBCUTANEOUS LIPID DATA

By JACK P. HAILMAN

The observation of subcutaneous lipid deposits on migratory passerines is becoming a standard part of banding procedure. That such data are useful to students of migratory physiology is evident (e.g., see Helms and Drury, 1960 and references therein). However, the quantitative treatment of such data has been variable, and, so far as I have been able to find, invariably inadequate or inappropriate. My present purpose is to draw attention to some statistical techniques that may prove useful for analyzing these fat data.

DETERMINING THE NATURE OF THE DATA

Before applying any statistical manipulation, the bander must answer certain questions about the nature of his data, for the answers to these questions govern his choice of both descriptive statistics (e.g., central tendency and variation expressions) and "comparative" statistics (e.g., tests of differences and of correlation). The two most important questions for banding data, including weights and measurements, as well as lipid observations, seem to concern the type of measurement and the sampling distribution. When a specific test of significance is chosen, one must also consider the kind of operation to be performed (including independence or relational properties in the data), and the size of the sample. The