The Continuing Problem of Fat Classes and a "Rule-of-thumb" for Identifying Interval and Ratio Data.—A paper published a few years ago in this journal (Hailman, *Bird-Banding*, **37:** 14-20, 1965) has evoked a volume of correspondence and numerous citations in the literature. From such comments I readily perceive that one of the basic points I attempted did not make its mark, and the same kinds of errors I wished to prevent are still being committed, sometimes (ironically) citing my paper as support.

The problem as to the quantitative treatment of subcutaneous fat is the major case in point. Fat class estimations are measurements in the ordinal scale, meaning that the classes can be ordered along a continuum unambiguously, but that the interval between adjacent classes on the continuum is unknown. (We cannot tell whether the difference between "fat 1" and "fat 2" is the "same" as the difference between "fat 2" and "fat 3.") The common error is to treat such ordinal data as if it were, in fact, interval or ratio data. To cite some examples: a worker (whom I shall not name) included in his paper, published in a leading ornithological journal, a comment that I did not "understand" fat measurements, and that they are really measured in the ratio scale. As another example, this time in this journal (Fretwell, *Bird-Banding*, **40:** 8, 1969) an author believes me to have stated that the major reason that one cannot use parametric statistics on fat data is because the data are not normally distributed. He calculates a least squares regression line using fat data, a method that requires data to be in at least the interval level of measurement.

Evidently what is needed is a "rule-of-thumb" for identifying when measurements are in the interval and ratio levels. All measurements can be dichotomized into qualitative and quantitative kinds. Qualitative measurements are of two kinds: (a) *nominal* measurements, in which observations are assigned to mutually exclusive categories that cannot be ordered on a single continuum; and (b) *ordinal* measurements, in which the categories can be so ordered. Quantitative measurements are also of two sorts: (c) *interval* measurements, which, instead of having categories into which observations are placed, have a continuous scale. Measurements are not assigned to categories by the observer, but are made by comparing the quantity to be measured with some calibrated standard. Reading errors and other factors determine the precision of the measurement, so that in practice, the continuous scale has minute (usually equal) steps. But these steps differ from the categories of ordinal measurement because the steps are defined by a certain *interval* between them. The scale used does not have to be linear (*e.g.*, logarithmic scales are common), but it must be transformable, mathematically, to a linear scale in which the basic interval is used. Interval scales have no true zero point (e.g., the Fahrenheit and Celsius scales of temperature). (d) *Ratio* scales are like interval scales with true zero points (e.g., the Kelvin scale of temperature), and are so called because *ratios* between measurements can be validly calculated (e.g., $5\,^{\circ}K/10\,^{\circ}K = 300\,^{\circ}K/600\,^{\circ}K$).

Since both forms of true quantitative measurement are operationally performed by comparing some variable attribute of an object with a standard that preserves the basic interval, my "rule-of-thumb" is this: you only have an interval or ratio scale of measurement when the act of measuring is one of comparing your unknown attribute with a standard that preserves in some form an internationally standard interval. The new International Scientific standard quantities can be reduced to six standard intervals: mass (kg), length (m), time (sec), electric current (A), radiant intensity (cd) and temperature (°K); consult late editions of the *Handbook of Chemistry and Physics*. If one cannot provide such evidence about his measurements then he is either working with qualitative measurements, or else he does not sufficiently understand the quantitative measurements he is taking. Without hammering the point unduly, it is clear from the "rule-of-thumb" that measurements of fat classes are *not* interval or ratio measurements. The measurement of wing-length *is* a quantitative measurement, because it compares the wing with the distance on a rule, and the interval that defines how that rule is made is preserved as an international standard of length.

A last caution. Quantitative measurement is a necessary, but not sufficient, condition for using parametric statistics. That a frequency distribution of measurements need conform exactly to a normal curve is probably a nicety that need not be adhered to strictly in practice, since few variables have rigorously been proven

normal. However, to apply any parametric test that assumes normality, one's data should be reasonably symmetrically distributed about the mean. If the "rule-of-thumb" is conscientiously applied, many future errors in data-analysis can be avoided.—Jack P. Hailman, University of Maryland. (Present address: Department of Zoology, University of Wisconsin, Madison, Wisc. 53706.)

An Observation of Midwinter Nocturnal Movement and Tower Mortality of Tree Sparrows.—That hibernal population movements by various species of "northern finches" may be frequent and widespread has been inferred from observations of sudden midwinter changes in the numbers of birds occuring at census plots, banding stations and the like (e.g., Middleton, 1943; Fast, 1962; Shaub, 1963). To our knowledge, however, only Stoddard and Norris (1967) have actually shown, by continuous collecting at a TV "tower kill" site, that some nocturnal movement occurs throughout the winter months, most notably by various fringillids.

In the late evening (2100-2300 hours, CST) of 29 January 1969 three of us (Jackson, Niles, and Rohwer) independently noted Tree Sparrows (*Spizella arborea*) calling overhead at Lawrence, Douglas County, Kansas. On the following night, at 2130 hours, Niles again heard Tree Sparrows calling and, under a low overcast, saw a number of birds fluttering about in the cones of light illuminating two flag standards atop a classroom building on the campus of the University of Kansas at Lawrence. As many as eight individual birds were visible at one time during the 10 minutes in which he watched this activity. This observation prompted a visit on that night and the following day to four radio and microwave towers in the vicinity of Lawrence, where the remains of 21 Tree Sparrows were found, 19 (9 ♂♂, 6 ♀♀, 4 not sexed) around the 600-feet KANU radio tower on the west edge of Lawrence and 2 (both ♂♂) at an approximately 300-feet mirco-wave tower about two miles north and six miles west of Lawrence.

All of these birds were embedded in a layer of thick ice resting atop approximately six inches of snow. The snow had fallen during the night of 26-27 January and was followed on the 27th and 28th by intermittent freezing rains which culminated in a major ice storm early in the morning of the 29th. It thus appears that the flights heard and seen on the evenings of the 29th and 30th had not contributed to the "tower kill", but that the mortality had resulted from an earlier movement, following the snowfall and during the period of freezing rains. Of the two possible nights, the evening of 27-28 January seems to have best offered weather conditions conducive to tower mortality. On this night there was heavy, local fog and persistent low cloud cover in eastern Kansas.

Baumgartner (1937, 1938), and Sargent (1959) have noted that midwinter wandering and population shifts by Tree Sparrows may often occur following heavy snows. The present movement seems similarly to have been nearly co-incidental with a period of heavy snowfall (and greatly lowered temperatures) which covered much of the northern Great Plains by early in the fourth week of January, and had left the northern plains (including Kansas), and Great Lakes area generally, under several inches of snow by 27 January. Given this general pattern of extreme cold and snow-covered ground to the north of Lawrence, it seems probable that any directed movement of birds occuring at this time through the Lawrence area would have been proceeding southward. Examination of the resting site of the individual KANU-tower casualties, with relation to the tower and its lateral guy-wires, implies a southerly or south-easterly direction for the flight. Each of the four wires guying the KANU tower extends outward approximately 15° to the right of the cardinal compass directions, approximately dividing the area about the tower into a northeastern quarter, a southeastern quarter, etc. Of the 19 casualties discovered at this locality, eleven were scattered about the southeastern quarter, four were in the southwestern quarter, one in the northwestern (almost under the east-west guy-wire), and three were in the northeastern quarter. We have no information on wind conditions prevailing at Lawrence during the above period; approximately 100 miles to the west, however, an intermittently strong wind blew from the north through much of the late evening of 27 January, and the possible influence of winds on the "fall pattern" cannot be discounted. The two birds at the microwave tower were found a short distance south of a guy-wire running approximately 15° south of east from the tower.

Tree Sparrows remaining in the area of heavy snow (and ice) cover probably suffered depleted energy reserves. This is indicated by a comparison of the fat