Mass or Weight: Response to (Murray 2008) and (Chardine 2008)

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Mass or weight: Response to Murray (2008) and Chardine (2008).—The recent exchange of views on whether biologists generally measure mass or weight of their subject organisms, and what units they should use to express these variables, has been a useful discussion. However, these authors did not offer much in the way of practical advice and, moreover, leave the practicing biologist in a conceptual bind. I suspect that most ornithologists are not overly concerned with such esoterica; still, most of us will want to do what is best in the scientific tradition. The dilemma is that, although we most often measure weights, we almost invariably express these measures in the standard unit of mass, namely "kilograms" or some nonmetric equivalents. A complication is that, in recent decades, there has been a trend to use "mass" loosely for either "weight" or "mass," which I believe is caused by an unfortunate perception that "mass" is a less old-fashioned term for "weight."

I submit that the campaign to persuade us to express weight in newtons (Murray 2008) is not going to be successful anytime soon. Does this mean, however, that we are left only with unscientific acceptance of improper terminology (Murray 2008)? In my view, neither of these proposed strategies is acceptable or, in fact, necessary. Below, I outline a solution to this conundrum that is both scientifically defensible and practical.

First, we should clearly differentiate mass and weight. Mass is a quantity of matter of which an object is composed and, hence, represents an intrinsic property of that object. Weight, on the other hand, measures the force of gravity on that chunk of matter and, therefore, varies geographically (force, in newtons, equals mass times acceleration; in this case, gravity takes the place of acceleration). On the surface of the Earth, the intensity of gravity changes both with altitude and with latitude (depending on the distance from the center of the Earth, along with centrifugal forces; for further discussion of these issues, see Lidicker 1997). A bird weighing 30 g at sea level on the equator will weigh 30.16 g at the poles (because one cannot get to sea level at the south pole, one can only check this out at the north pole). To roughly calculate the force in newtons, multiply the mass in kg times 9.8 (equals 2.9 for our 30-g bird).

Second, we should make it clear in the methods section of our papers what we actually did in our research. If we used an old-fashioned two-pan balance in which we compared our object of interest with a "weight" of known mass, we can correctly claim to have measured mass. The forces of gravity will be the same for both pans and, hence, our result is a measurable proportion of a known mass. A one-pan balance can come close to this if it is carefully calibrated using objects with known masses. On the other hand, if we used an instrument with a spring or a force plate (mechanical or electrical), we measured weight and, therefore, should report that our study used weight as an estimator of mass. By this caveat, we simultaneously justify using "kg" as our unit of estimated mass (weight) instead of the more cumbersome "kg-wt." To be clear, we should also label the data in tables and graphs as "weight."

Using this protocol, we can maintain scientific rigor and honesty, choose whatever measuring device is appropriate for a particular study, and continue to use the standard metric system for mass (the kilogram and its derivatives).

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