sigmoid analysis. In such cases, or whenever adequate post-asymptotic data cannot be obtained, it may be necessary to choose a simpler model (e.g. linear or exponential) to test hypotheses. Such procedures, while failing to provide all the information contained in a sigmoid analysis, are nevertheless preferable to analytical procedures that are unwarrantedly complex with respect to the nature of the data available.

We thank the many individuals who have contributed to our thinking on this subject over the years, as well as at the recent Avian Growth Workshop. Manuscript preparation and the participation of Brisbin and White in the Workshop were supported by a contract (DE-AC09-76SROO-819) between the Institute of Ecology at the University of Georgia and the United States Department of Energy.

LITERATURE CITED

VON BERTALANFFY, L. 1957. Quantitative laws in metabolism and growth. Quart. Rev. Biol. 32: 217–231.

BMDP. 1983. BMDP statistical software, 1983 printing. Los Angeles, Univ. California Press.

BRADLEY, D. W., R. E. LANDRY, & C. T. COLLINS. 1984. The use of jacknife confidence intervals with the Richards curve for describing avian growth patterns. Bull. Southern California Acad. Sci. 83: 133–147.

BRISBIN, I. L., JR., K. W. MCLEOD, & G. C. WHITE. 1986a. Sigmoid growth and the assessment of hormesis: a case for caution. Health Physics in press.

———, G. C. WHITE, & P. B. BUSH. 1986b. PCB intake and the growth of waterfowl: multivariate analyses based on a reparameterized Richards sigmoid model. Growth 50: 1–11.

———, ———, ———, & L. A. MAYACK. 1986c. Sigmoid growth analyses of Wood Ducks: the effects of sex, dietary protein and cadmium on parameters of the Richards model. Growth 50: 41–50.

FABENS, A. J. 1965. Properties and fitting of the von Bertalanffy growth curve. Growth 29: 265–289.

FENDLEY, T. T., & I. L. BRISBIN, JR. 1977. Growth curve analyses: investigations of a new tool for studying the effects of stress upon wildlife populations. Proc. XIII Intern. Congr. Game Biol.: 337–350.

HUXLEY, J. S. 1932. Problems of relative growth. London, Methuen.

PASTERNAK, H., & B. A. SHALEV. 1983. Genetic-economic evaluation of traits in a broiler enterprise: reduction of food intake due to increased growth rate. Brit. Poultry Sci. 24: 531–536.

RICHARDS, F. 1959. A flexible growth function for empirical use. J. Exper. Bot. 10: 290–300.

RICKLEFS, R. E. 1967. A graphical method of fitting equations to growth curves. Ecology 48: 978–983.

———. 1983. Avian postnatal development. Pp. 2–83 in Avian biology, vol. 7 (D. S. Farner, J. R. King, and K. C. Parkes, Eds.). New York, Academic Press.

SAS INSTITUTE, INC. 1982. SAS user's guide: statistics, 1982 ed. Cary, North Carolina, SAS Inst.

WHITE, G. C., & I. L. BRISBIN, JR. 1980. Estimation and comparison of parameters in stochastic growth models for Barn Owls. Growth 44: 97–111.

On Paradigms vs. Methods in the Study of Growth

MICHAEL GOCHFELD[1]

Paradigms provide models for restructuring our investigations. New paradigms allow us to answer questions that formerly eluded us. Because growth is both a universal biologic property and a complex, usually nonlinear phenomenon, new approaches to quantifying growth are highly desirable. The sigmoid curve, long heralded as the growth curve, reappears in many mathematical, economic, and scientific analyses. Accordingly, access to mathematical tools for analyzing and characterizing sigmoid curves affords the opportunity to use parameters of the curve as discrete independent variables. Brisbin et al. (1987) detail new methods for approaching the study of the sigmoid growth function. With powerful statistical packages available to crunch the numbers, the iterative procedures for solving nonlinear function problems are now readily available.

Apart from lauding the introduction of such procedures, I want to call attention to the fact that Brisbin et al. (1987) do indeed offer a paradigm and not merely a tool. I emphasize that the availability of these procedures, by themselves, allows us to restructure our investigations and to ask new questions. In fact,

[1] Environmental and Community Medicine, UMDNJ—Robert Wood Johnson Medical School, Piscataway, New Jersey 08854 USA.

if we ask old questions in old ways, we are likely to encounter frustration in our attempts to apply the reparameterized version of the Richards function to our data. Some of the reasons are given in the commentary by Brisbin et al. (1987).

The parameters one ought to be able to estimate are the rate of growth (Ricklefs 1967), the asymptote, and the shape of the curve. Most studies have focused on growth rate, largely because Ricklefs's (1967) analysis made it feasible to extract this information from a wide variety of growth data sets. In ornithology, at least, the asymptote has not been of much interest, because it is usually assumed to be close to the adult mass, which is usually readily obtained by weighing adults. It is not necessary that the asymptote remain underutilized.

The shape of the curve has rarely been addressed. In fact, deviations generally have been treated as noise rather than useful information. This has been particularly important to toxicologists and risk analysts, for whom extrapolation of sigmoid dose-response curves back toward the origin has been an active undertaking in the past 5 yr (Van Ryzin 1981). From the work of Brisbin et al. (1986) it is apparent that the shape parameter itself may provide important biological information, and researchers may choose to investigate this, even at the expense of the more traditional growth rate. Thus, some species may concentrate growth early, showing a short lag phase, whereas others may show negligible growth before a growth spurt. Stressors may act, for example, by prolonging the lag phase, a result readily identifiable if one studies the shape parameter.

It is here that the paradigm enters, for to investigate the shape parameter, it is essential to design studies that can yield sufficient information so that the iterative solutions can estimate the parameters of interest.

As Brisbin et al. (1987) mention, traditional studies of growth often end when the young birds fledge (or when the investigators find it impractical to recapture them). The problem emerges that the procedures fail to converge in an iterative solution when the data set is too sparse or terminates prematurely. A variety of artificial techniques have been discussed that might salvage particular situations, for example, creating artificial asymptotic data points. Most researchers, however, find this undesirable.

The value of the paradigm, therefore, is that it points the way to new study designs that will assure a data set worthy of the powerful new techniques. As a tool for analyzing pre-existing data sets, researchers are likely to be disappointed, and will turn to more traditional analyses. One should be careful, however, not to allow such frustrations to color one's understanding of the importance of new study designs and new analyses.

LITERATURE CITED

BRISBIN, I. L., JR., C. T. COLLINS, G. C. WHITE, & D. A. MCCALLUM. 1987. A new paradigm for the analysis and interpretation of growth data: the shape of things to come. Auk 104: 552–554.

———, G. C. WHITE, & P. B. BUSH. 1986. PCB intake and the growth of waterfowl: multivariate analyses based on a reparameterized Richards sigmoid model. Growth 50: 1–11.

RICKLEFS, R. E. 1967. A graphical method of fitting equations to growth curves. Ecology 48: 978–983.

VAN RYZIN, J. 1981. Review of statistics—the need for realistic statistical models for risk assessment. Fundamental Appl. Toxicol. 1: 124–126.

A Historical Explanation for Polyandry in Wilson's Phalarope

JOSEPH R. JEHL, JR.[1]

Early in the 20th century, A. O. Treganza recognized that great numbers of phalaropes were present at Great Salt Lake, Utah, in early summer. Because information about phalarope biology was then rudimentary, Treganza considered these flocks to represent nonbreeders, rather than postbreeders involved in a molt migration (Jehl 1981, Natl. Geogr. 160: 520; Jehl in press, Ornis Scandinavica 18). His

[1] Sea World Research Institute, Hubbs Marine Research Center, 1700 South Shores Road, San Diego, California 92109 USA.

interpretation, coupled with a lack of anatomical and physiological knowledge and an uncritical acceptance of scientific "authority," led W. L. Dawson (1923, The birds of California, San Diego, California, South Moulton Co., pp. 1090–1091) to concoct a marvelous hypothesis about a topic of much recent interest to biologists: the evolution of polyandry. Dawson's explanation reflects the passions and prejudices of the time, and should not be allowed to molder in the archives of avian science.

"According to a physician friend of Mr. Treganza's, who, pending the completion of his studies, desires his name withheld, the females of Wil-