The Relationship Between Maximum and Asymptotic Length in Fishes

C.P. MATHEWS
Zoology Department
University of Reading
Whiteknights, Reading
England

and

M. SAMUEL
Kuwait Institute for Scientific Research
Mariculture and Fisheries Department
PO Box 24885, Safat
Safat 13109
Kuwait

Abstract

The case is made, based on growth curves and other data on Kuwait fishes, that the maximum length in a population does not provide a reliable approximation of asymptotic length.

It is frequently desirable to obtain a rapid estimate of asymptotic length (L_∞) of the von Bertalanffy growth function (VBGF) for a population for which no age data are available, and for which the substantial numbers of measurements needed to estimate L_∞, e.g., by means of the ELEFAN I program are not yet available.

For such cases, Pauly (1984), following on Taylor (1958) and Beverton (1963) suggested estimation of L_∞ from

$$L_\infty = L_{max}/0.95 \qquad ...1)$$

where L_{max} is the maximum length of the fish in the population in question (see below for details on this definition).

During recent discussions on the application of this technique, it was noted that some slow-growing fishes, e.g., from Kuwait, showed marked deviations from the relation defined in (1). Fig. 1 shows two growth curves in which the value of L_∞ is substantially less than that of L_{max}. Therefore it was thought useful to assess the accuracy of (1) for 15 populations of Kuwaiti fish, for some of which several years worth of length-frequency data are available. The estimates so obtained were compared with the values of L_∞ obtained by fitting von Bertalanffy growth curves to data on length-at-age. The original growth data are presented in Mathews

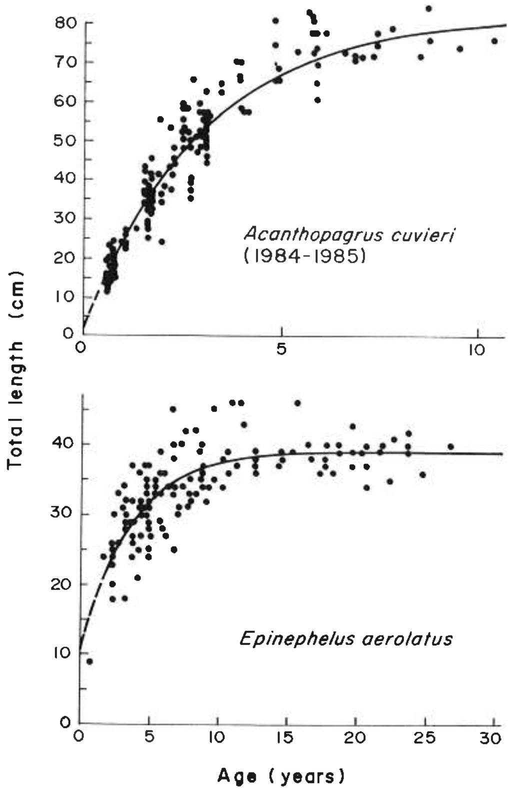

Fig. 1. Example of two fishes from Kuwait for which maximum length is substantially higher than estimated asymptotic length (see also Table 1).

and Samuel (1985, 1987), and in Samuel and Mathews (1987), while data for estimating growth parameters for *Pomadasys argenteus* were obtained from Brothers and Mathews (1987). Table 1 summarizes values of L_{max}, L_∞ and of maximum observed age (t_{max}) and sample size (n).

As might be seen, the ratios $(L_{max}/0.95)/L_\infty$ range from a low value of 0.82 for *Otolithes argenteus*, a fast growing, short-lived sciaenid, to a high value of 1.36 for *Lutjanus malabaricus*, a slow growing, long-lived snapper. The ratios varied considerably for some stocks in different years, so that they were treated as separate data points; a least squares regression of the ratios $(L_{max}/0.95)/L_\infty$ on t_{max} is presented as Fig. 2.

This shows a statistically significant tendency in long-lived fishes for $L_\infty \ll L_{max}/0.95$. For short-lived fishes, the situation is reversed: $L_\infty \gg L_{max}/0.95$.

Various definitions of "L_{max}" exist, e.g.,

(i) the largest fish ever recorded for the *species* in question ("$L_{max\ ever}$" in Pauly 1984);

(ii) the largest fish ever recorded for the *stock* (=population) in question;

(iii) the mean of the n-largest fishes recorded from the stock in question, with "n" ranging from 2 to any larger number (S. Garcia, pers. comm. to Pauly 1984); or

(iv) the largest fish in the contiguous part of a large length-frequency sample drawn from the population in question (Munro 1983, and see Fig. 3).

We have examined plots analogous to Fig. 2 for several of these definitions of L_{max} and our conclusion stands: L_{max} is not a reliable estimator of L_∞.

Table 1. Growth parameters and related statistics in 15 species of Kuwaiti fishes, ordered after their (mean) observed longevity (t_{max}).

Species, year(s)	L_∞ (cm)	K ($year^{-1}$)	L_{max} (cm)	t_{max} (year)	$\frac{L_{max}/0.95}{L_\infty}$	n
Otolithes argenteus	69.6	0.505	54	5	0.82	600
Pseudorhombus arsius	44.0	0.160	38	7	0.91	247
Acanthopagrus latus 1981	48.7	0.200	42	10	0.91	92
Acanthopagrus latus 1982	52.3	0.160	50	14	1.01	240
Acanthopagrus latus 1983	41.5	0.214	39	9	0.99	170
Acanthopagrus latus 1984	40.5	0.258	45	13	1.17	314
Acanthopagrus latus 1985	38.3	0.293	40	10	1.10	215
A. berda 1984	38.3	0.273	36	11	0.99	155
A. berda 1985	36.4	0.377	37	14	1.07	132
A. cuvieri 1984-1985	81.8	0.278	83	11	1.07	231
A. bifasciatus	34.9	0.189	38	19	1.15	21
Pomadasys argenteus	66.9	0.238	66	19	1.04	7
Lethrinus nebulosus	62.7	0.193	62	20	1.04	159
Epinephelus suilis[a] 1981	94.0	0.138	104	19	1.17	378
Epinephelus suilis 1982	90.0	0.161	111	21	1.30	466
Epinephelus suilis 1983	89.1	0.192	110	22	1.30	426
Epinephelus suilis 1984	99.2	0.171	120	21	1.29	614
E. areolatus	39.1	0.288	46	25	1.23	153
Cephalopholis miniatus	34.1	0.110	37	26	1.14	36
E. jayakari	72.7	0.273	77	28	1.12	49
E. latifasciatus	82.1	0.328	92	30	1.15	131
E. chlorostigma	64.8	0.195	75	41	1.20	98
Lutjanus malabaricus[b]	68.9	0.358	89	46	1.36	600

[a]Frequently referred to as *E. tauvina* in Kuwait.
[b]Frequently referred to as *L. coccineus* in Kuwait.

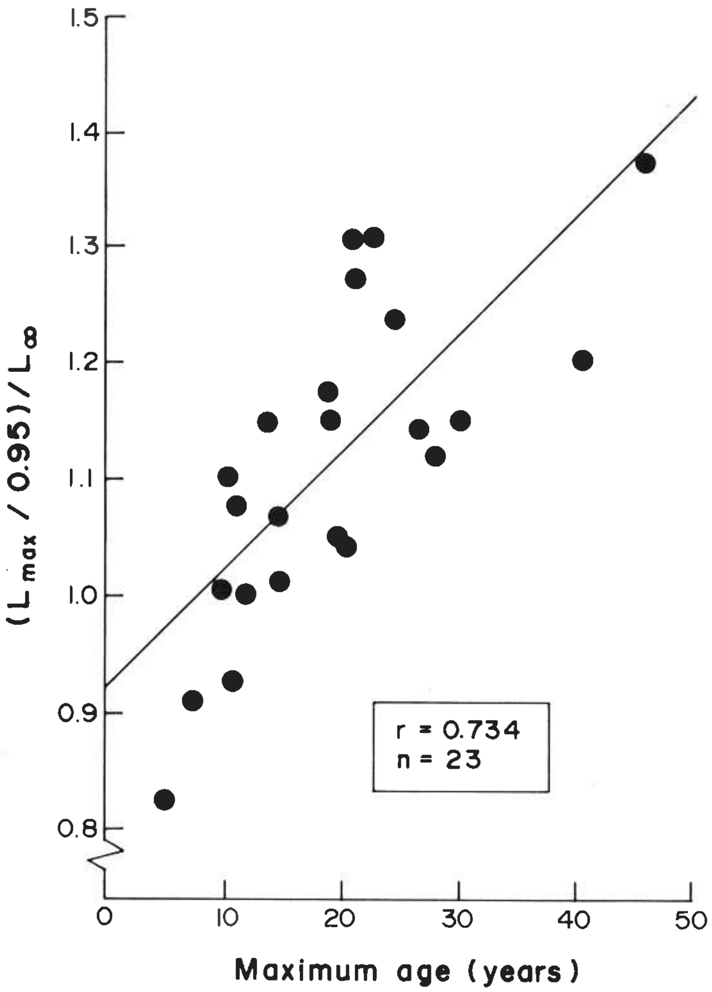

Fig. 2. Plot of $(L_{max}/0.95)/L_\infty$ *vs* t_{max}. Note strong positive relationship, suggesting that $L_{max} < L_\infty$ only in short-lived fishes.

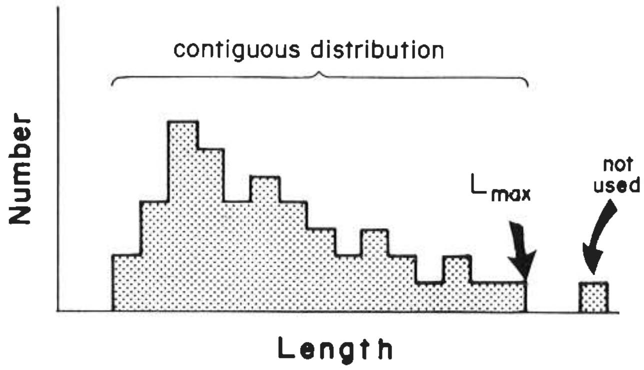

Fig. 3. Schematic representation of a length-frequency distribution illustrating one definition of "L_{max}" (see text).

We note, however, that the growth performance index $\phi'(= \log_{10}K + 2\log L_\infty)$ of Pauly and Munro (1984) will not be affected by over- or under-estimates of L_∞, because of the compensatory behavior of K.

Moreover, a method now exist (Wetherall 1986) which enables estimation of L_∞ from a single length-frequency sample representative of a steady-state (≈ average) population, thus rendering the approximation in (1) largely superfluous.

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