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THE GROWTH RATE OF THE LONG ROUGH DAB *HIPPOGLOSSOIDES PLATESSOIDES* (FABR.)—A CORRECTION

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(Text-fig. 1)

In a recent paper (Bagenal, 1955) on the growth rate of the Long Rough Dab *Hippoglossoides platessoides* (Fabr.) in the Clyde Sea area, a serious mistake was made.

The ages of 1561 Long Rough Dabs, which were collected from October 1953 to September 1954, were determined from an examination of the otoliths, and from the age analysis each fish was allocated to a population *f* to *a*, depending on when it was supposed to have spawned. This procedure was designed to obviate the difficulty during the winter and spring when fish of the same year-class would be grouped differently according to the condition of the otolith edge. The mean lengths of the fish of populations *f*–*a* were taken as the mean lengths of Long Rough Dabs after 1–6 years. This, however, is wrong, and they should be taken as the mean lengths after 2–7 years. I wish to apologize for this inexcusable mistake, and to give the correct figures at the earliest opportunity. They will be found in Table I.

Turning next to the mathematical treatment of the data, and applying the correct figures to the same formulae as were used before, it is apparent that the regression equation

$$l_{n+1} = ml_n + C, \tag{i}$$

where l_n is the mean length at age n, will be exactly the same, as will the asymptotic value, l_∞, to which the growth approaches. This is because the regression is based on the l_{n+1} to l_n ratio, and the actual values of n are immaterial. The figures obtained for m and l_∞ $(= C/1 - m)$ may again be incorporated in the exponential equation modified from Bertalanffy (1938, 1949):

$$l_t = l_\infty\,(1 - e^{-kt}), \tag{ii}$$

where $e^{-k} = m$ of equation (i). However, with the correct figures there is a large discrepancy between the values of C and what would be reasonable figures for l_1; for equation (i) and (ii) to be comparable these should be the same:

for the females $C = 11{\cdot}262$ cm, the calculated $l_1 = 2{\cdot}130$ cm,

for the males $C = 7{\cdot}368$ cm, the calculated $l_1 = 5{\cdot}335$ cm.

It is clear, therefore that the growth is only described by the equations given in the previous paper over the upper range of the curve, and in order to describe the growth over the whole life span a sigmoid curve which above the point of inflexion approximates to the exponential type given in equation (ii) is required.

TABLE I. THE MEAN LENGTHS OF LONG ROUGH DABS, FROM POPULATIONS *f–a*

Population	Age	Mean lengths (cm.) Males	Females
—	1	—	—
f	2	10·5	12·6
e	3	13·5	18·3
d	4	15·3	22·1
c	5	16·3	23·4
b	6	—	25·3
a	7	—	25·3

Of the commoner growth equations the most appropriate would appear to be the Gompertz equation whose properties have been given by Winsor (1932). This equation has the form

$$l_t = l_\infty \ \exp[-be^{-kt}]. \tag{iii}$$

Its relation to equation (ii) is seen by considering the graph of l_{n+1} plotted against l_n. With the Gompertz equation one obtains a curve which cuts the 45° line at the origin and at l_∞, and a straight line regression can be got by plotting the logarithms of the lengths. In this case the regression is

$$\log l_{n+1} = m' \log l_n + C'. \tag{iv}$$

The value of l_∞ is obtained from the equation

$$\log l_\infty = \frac{C'}{(1-m')}. \tag{v}$$

The slope of the curve on the simple $l_{n+1} - l_n$ plane at any fraction $(1/x)$ of l_∞ is equal to $\frac{m'}{x^{m'-1}}$. The curve rises rapidly from the origin and at its intersect with the 45° line has the same slope as that for equation (iv). It is therefore apparent that the two curves are indeed similar, particularly at their upper ranges when they approach their asymptotic levels.

Applying equation (iv) to the Long Rough Dab data of Table I gives

for the females: $\log l_{n+1} = 0{\cdot}475 \log l_n + 0{\cdot}742$,

for the males: $\log l_{n+1} = 0{\cdot}501 \log l_n + 0{\cdot}619$, and equation (v) gives:

$$\text{for the females: } \log l_\infty = \frac{0{\cdot}742}{(1-0{\cdot}475)} = 1{\cdot}4133 \,.\, l_\infty = 25{\cdot}90,$$

$$\text{for the males: } \log l_\infty = \frac{0{\cdot}619}{(1-0{\cdot}501)} = 1{\cdot}2405 \,.\, l_\infty = 17{\cdot}40.$$

These may be compared with 26·437 and 17·754 for the females and males respectively given in the previous paper for equation (ii). The value for b for the curve to pass through the origin is given by

$$b = \frac{\log l_\infty}{\log e}, \tag{vi}$$

$$\text{for the females: } b = \frac{1{\cdot}4133}{0{\cdot}4343} = 3{\cdot}2542,$$

$$\text{for the males: } b = \frac{1{\cdot}2405}{0{\cdot}4343} = 2{\cdot}8563,$$

and e^{-k} equals m' of equation (iv). The Gompertz equations (iii), for the Long Rough Dabs, are therefore

$$\left.\begin{aligned} &\text{for the females: } l_t = 25{\cdot}90 \,.\, 2{\cdot}7183^{-3{\cdot}2542 \,.\, 0{\cdot}475^t} \\ &\text{for the males: } l_t = 17{\cdot}40 \,.\, 2{\cdot}7183^{-2{\cdot}8563 \,.\, 0{\cdot}501^t} \end{aligned}\right\} \tag{vii}$$

The calculated values from these equations are given in Table II, and in Fig. 1.

TABLE II. THE OBSERVED MEAN LENGTHS OF THE LONG ROUGH DABS, AND THE VALUES CALCULATED FROM THE GOMPERTZ EQUATION (vii)

	Females		Males	
t	Observed	Calculated	Observed	Calculated
1	—	5·52	—	4·16
2	12·6	12·43	10·5	8·50
3	18·3	18·27	13·5	12·14
4	22·1	21·95	15·3	14·87
5	23·4	23·94	16·3	15·90
6	25·3	24·96	—	—
7	25·3	25·44	—	—

In the previous paper it was argued that the calculated mean lengths are less liable to bias (as might, for example, be produced by net selection) than are the observed values. This is because the regression equation is based on the ratios of the lengths and not on their absolute values. The same argument applies to the present treatment with the $\log l_{n+1} - \log l_n$ plane and the Gompertz curve. It will be seen that the agreement between the observed and calculated values is remarkably good with the females, but there is an appreciable discrepancy with the males. The reason for this is not readily apparent, and it can only be suggested that different reactions of the fish to the trawl might be responsible, in leading to greater escape by the males. In this connexion one should remember that there is a marked difference between the numbers of males and females caught; even in comparable size-groups the females are much more numerous.

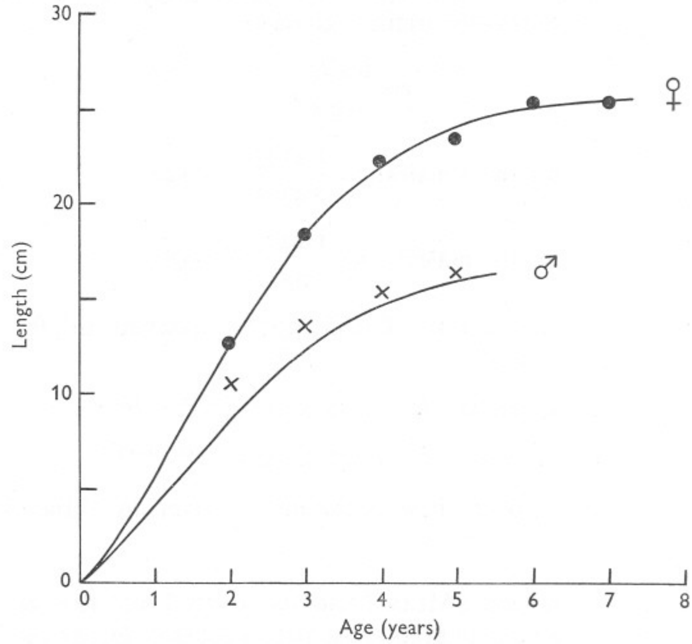

Fig. 1. The growth curves of male and female Long Rough Dabs given by the Gompertz equations (viii), together with the observed mean lengths for the males (×) and females (●). Data from Table II.

Summary

A serious mistake in a previous paper on the growth rate of the Long Rough Dab *Hippoglossoides platessoides* (Fabr.) is corrected. The growth equation originally used is shown to be inapplicable to the correct figures over the whole life span, though for suitable data the method of fitting the curve would still appear to be the most accurate. More suitable for the correct Long Rough Dab data is the Gompertz equation, and this approximates to the previous equation over the upper ranges.

The method previously developed of finding estimates of the coefficients to be used for the growth curve is shown to be equally applicable to the Gompertz

equation. The agreement between the calculated and observed values is very close with the females, but less so with the males. It is suggested that this may in part be connected with the scarcity of the males in the samples, since a greater ability to escape would produce both effects.

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