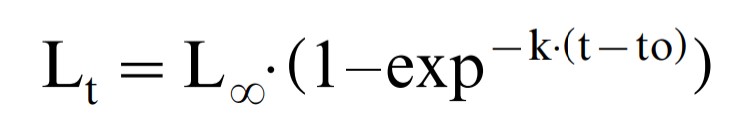
Sukhotin, A. A., Strelkov, P. P., Maximovich, N. V. and Hummel, H. , 'Growth and longevity of Mytilus edulis (L.) from northeast Europe ', Marine Biology Research, 3:3, 155 - 167

In all samples, growth for each mussel older than 4 years was reconstructed in accordance with individual growth history reflected in the shell external structure winter marks. Growth curves were approximated using the von Bertalanffy growth equation



where Lt is the length (mm) at age t (years), Loo (asymptotic or theoretically maximal length, mm), k (rate at which Loo is approached, year-1) and to (theoretical time at which Lt=0, year) are constants.

Although individual growth curves of mussels in most cases were S-shaped with a small flexure at early years, we did not use the Gompertz model for growth description in order to compare our results with numerous literature data on mussels’ growth usually approximated by a von Bertalanffy model. Because mussels younger than 4 years old in studied populations have not shown growth deceleration yet, their growth could not be described by the von Bertalanffy model. Thus, they were excluded from the analysis.

A comparison of mussel growth in the studied sites was performed using two estimates: (1) overall growth performance index (OGP), proportional to the maximal rate of size increase during the lifetime, was calculated as OGPlog(Lk) (Pauly 1979, cited in Brey 2001); (2) a pairwise comparison of growth curves and their clustering was performed according to an algorithm suggested by Maximovich (1989). Briefly, the significance of the differences between growth curves was determined using the ratio of the residual variances FSI 2 /SII 2 . SI 2 was calculated for each of the compared growth curves as SI 2(SS1SS2)/(n1 3n2 3), where SS1 and SS2 are the sums of squares of variants’ deviations from the separate compared regression lines 1 and 2; n1 and n2 are the numbers of variants in each of the compared lines. SII 2 was calculated as SII 2 SS/(n1 n2 3), where SS is the sum of squares of variants’ deviations from the common regression line based on the pooled data. The ratio of Fisher’s F-statistic to the critical F value at PB0.05, F/Fcr, was used as a measure of distance between the compared curves. The value of F/FcrB1 meant the absence of significant differences between the compared growth lines. Clustering was performed using a method of weighed pairgroup average. The integration of the growth curves was carried out starting with the pair characterized by the lowest value of F/Fcr ratio.

Brey T. 2001. Population Dynamics in Benthic Invertebrates. A Virtual Handbook. Version 01.2 (<http://www.awi-bremerhaven>. de/Benthic/Ecosystem/Food Web/Handbook/main.html) :

Growth Performance Measures

<http://www.thomas-brey.de/science/virtualhandbook/navlog/index.html>

Individual growth is a non-linear process which has to be described by multi-parameter non-linear models. Therefore it is difficult to compare growth between different organisms or taxa in a definite and statistically proper way. Several attempts have been made to solve this problem (e.g. the index http://www.thomas-brey.de/science/virtualhandbook/growth/pics/omega.gif of Gallucci & Quinn 1979), but Pauly (1979) was the first who developed a consistent concept of "Overall Growth Performance" (OGP) to make individual growth comparable. OGP measures how "well" an organism grows, in a similar way as the use of acceleration as a measure of the performance of a car.

Pauly (1979) and Munro & Pauly (1983) introduced several closely related indices of OGP which are derived from the specialised VBGF to characterise growth of fish. Their index P is proportional to the maximum rate of body mass increase during lifetime, i.e. the mass increase at the inflexion point of the VBGF describing growth in body mass M:

|  |  |
| --- | --- |
| von Bertalanffy function describing growth in mass and assuming M = a \* S3 | Mt = Moo \* (1 - e-K \* [(t - to) + T1 - T2])3 |
| Maximum growth rate in mass at inflexion point | *d*M/*d*tMax = 4/9 \* K \* Moo |
| Index of growth performance **P** | **P** = log(K \* Moo) |

Their index http://www.thomas-brey.de/science/virtualhandbook/growth/pics/phi.gif (phi) is derived empirically from the relation between the parameters K and Soo in many fish stocks:

|  |  |
| --- | --- |
| von Bertalanffy function describing growth in size | St = Soo \* (1 - e-K \* [(t - to) + T1 - T2]) |
| Index of growth performance http://www.thomas-brey.de/science/virtualhandbook/growth/pics/phi.gif | http://www.thomas-brey.de/science/virtualhandbook/growth/pics/phi.gif = log(K) + 2 \* log(Soo) |

Moreau et al. (1986) demonstrated that the index P and the closely related index http://www.thomas-brey.de/science/virtualhandbook/growth/pics/phi.gif (phi) developed by the same authors are suitable for statistical comparisons of OGP. The index of Gallucci & Quinn (1979) showed very poor statistical properties, making comparisons of OGP based on this index less reliable.

In contrast to single growth function parameters such as K and Soo, OGP seems to be a taxon specific feature. I.e., whereas growth function parameters may vary considerably among various populations of the same taxon, the correspondig OGP parameters show less variance. Growth performance data can be presented and compared graphically using an "Auximetric Grid" (Pauly 1979, Pauly et al. 1994), i.e. a plot of log(K) versus log(Moo).

The concept of OGP = (dM/dt)Max could easily be extended to other growth models, because all common models describing growth in body mass have one (and only one) inflexion point.

If, however, we do not know the growth function, but know maximum body mass Mmax and maximum age Amax of a population, we can estimate OGP by the index http://www.thomas-brey.de/science/virtualhandbook/growth/pics/psi.gif (psi) developed by Brey (1999a):

|  |  |
| --- | --- |
| Index of growth performance http://www.thomas-brey.de/science/virtualhandbook/growth/pics/psi.gif | http://www.thomas-brey.de/science/virtualhandbook/growth/pics/psi.gif = log(MMax / AMax)  MMax = maximum body mass AMax = maximum age |

The empirical comparison of http://www.thomas-brey.de/science/virtualhandbook/growth/pics/psi.gif with P based on invertebrate data sets indicates a linear and highly significant relationship.

Therefore http://www.thomas-brey.de/science/virtualhandbook/growth/pics/psi.gif is equivalent to those indices developed and tested for fish populations and can be used to measure and compare growth performance in benthic invertebrates in the same way as with the growth function based OGP indices ( auximetric grid, "statistical analysis).

Pauly, D., 1979. Gill size and temperature as governing factors in fish growth: a generalization of von Bertalanffy´s growth formula. Berichte aus dem Institut für Meereskunde Kiel 63: 1-156.

Brey, T., 1999a. Growth performance and mortality in aquatic benthic invertebrates. Advances in Marine Biology 35: 153-223.