Fish Population Dynamics

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ESTIMATION OF GROWTH PARAMETERS

- The study of growth means basically the determination of the body size as a function of age. Therefore all stock assessment methods work essentially with age composition data. In temperate waters such data can usually be obtained through the counting of year rings on hard parts such as scales and otoliths. These rings are formed due to strong fluctuations in environmental conditions from summer to winter and vice versa. In tropical areas such drastic changes do not occur and it is therefore very difficult, if not impossible to use this kind of seasonal rings for age determination.

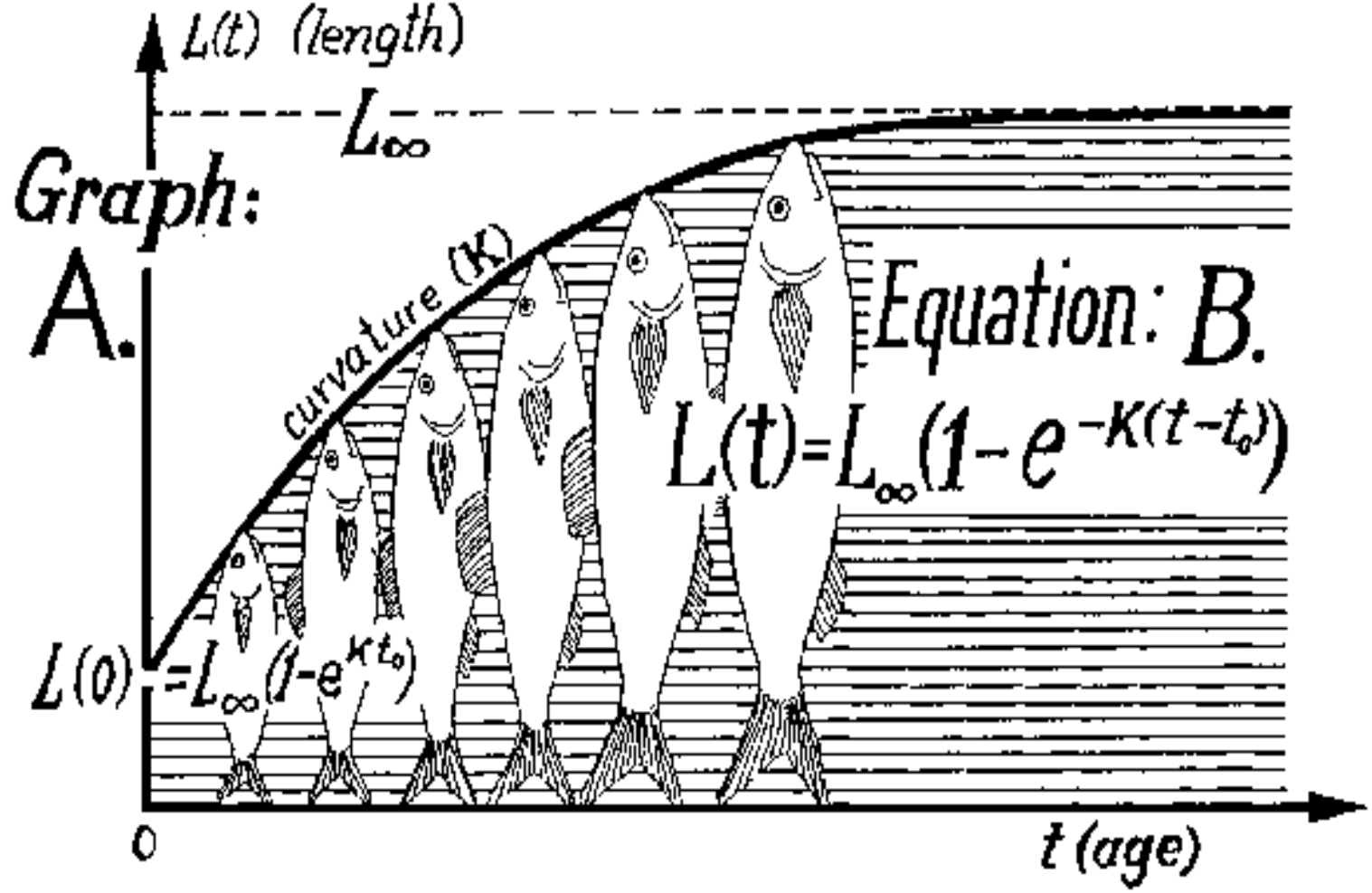
- Only recently methods have been developed to use much finer structures, so-called daily rings, to count the age of the fish in number of days. These methods, however, require special expensive equipment and a lot of manpower, and it is therefore not likely that they will be applied on a routine basis in many places.

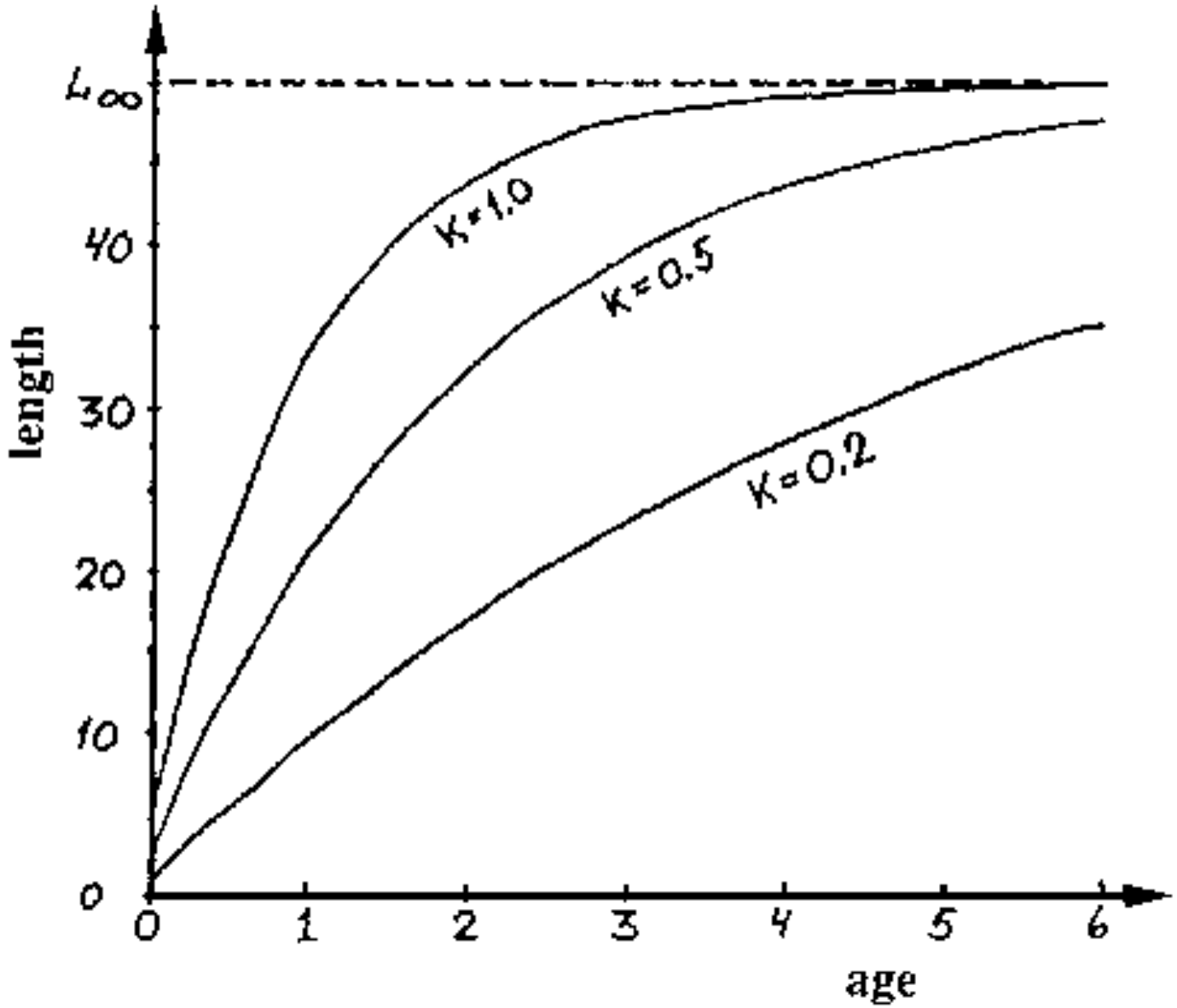
- Fortunately several numerical methods have been developed which allow the conversion of length-frequency data into age composition. Although these methods do not require the reading of rings on hard parts, the final interpretation of the results becomes much more reliable if at least some direct age readings are available. The best compromise for stock assessment of tropical species is therefore an analysis of a large number of length-frequency data combined with a small number of age readings on the basis of daily rings.

THE VON BERTALANFFY GROWTH EQUATION

- Pütter (1920) developed a growth model which can be considered the base of most other models on growth including the one developed as a mathematical model for individual growth by von Bertalanffy (1934), and which has been shown to conform to the observed growth of most fish species. The theory behind various growth models is reviewed by for example Beverton and Holt (1957), Ursin (1968), Ricker (1975), Gulland (1983), Pauly (1984) and Pauly and Morgan (1987), but we shall deal here only with the von Bertalanffy growth model of body length as a function of age. It has become one of the cornerstones in fishery biology because it is used as a sub-model in more complex models describing the dynamics of fish populations.

- The mathematical model, B, expresses the length, L, as a function of the age of the fish, t:
- $L(t) = L_{¥} *[1 - \exp(-K*(t-t_0))]$.....(3.1.0.1)
- The right hand side of the equation contains the age, t, and some parameters. They are: "$L_{¥}$" (read "*L-infinity*"), "K" and "t_0" (read "*t-zero*"). Different growth curves will be created for each different set of parameters, therefore it is possible to use the same basic model to describe the growth of different species simply by using a special set of parameters for each species.
- To illustrate the use of the model, assume that the three parameters have been estimated for some particular fish stock and that the values are:
- $L_{¥}$ = 50 cm, K = 0.5 per year and t_0 = -0.2 year


L(t) (length)
L∞
Graph:
A.
curvature (K)
Equation: B.
L(t)=L∞(1-e^-K(t-t0))
L(0)=L∞(1-e^Kt0)
0
t (age)


L_∞
40
30
20
10
0
length
K=1.0
K=0.5
K=0.2
0
1
2
3
4
5
6
age

- Growth parameters, of course, differ from species to species, but they may also vary from stock to stock within the same species, i.e. growth parameters of a particular species may take different values in different parts of its range. Also successive cohorts may grow differently depending on environmental conditions. Further growth parameters often take different values for the two sexes. If there are pronounced differences between the sexes in their growth parameters, the input data should be separated by sex and values of K, $L_{¥}$ and t_0 should be estimated for each sex separately.