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Parameterisation of a zooplankton population model for *Pseudocalanus elongatus* using stage durations from laboratory experiments

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ABSTRACT

A zero-dimensional population model based on a copepod model by Fennel (2001) was parameterised according to the population dynamics of *Pseudocalanus elongatus*. Biological functions were chosen particularly and formulated to get realistic characteristics of growth and development under conditions of temperature and food reported for the North Sea. Parameter values for weight, hatching and assimilation were taken from the literature, employing robust values from various published studies and parameters derived from similar species. The influence of temperature on feeding and basal respiration and the half-saturation of ingestion were obtained indirectly by successive fitting of developmental times to stage durations observed from laboratory culture studies. A data set from Klein Breteler et al. (1995) was used, which includes estimates at temperatures of 5, 10, 15 and 20 °C each at food concentrations of <70, ∼100 and >200 $\mu g\,C\,l^{-1}$. Simulations at each scenario showed the effectiveness of adjustments. The sensitivity of model parameter values was tested in terms of variances in generation times. The analysis exhibited the sensitivity of development to specific metabolic processes, while the importance of temperature is reflected in its recurrence within several processes. The model is able to represent consistent development patterns, while reflecting the physiological complexity of a population of *P. elongatus*.

1. Introduction

Fennel (2001) formulated a stage resolved zooplankton population model adapted to *Pseudocalanus* sp. in the Baltic Sea, which calculates biomass and abundance for five model stage groups. Necessary process parameterisation was derived from the literature and the Baltic Monitoring Programme to study the physical impact on zooplankton dynamics and the interaction with fish larvae in the frame of the German GLOBEC Programme (Fennel and Neumann, 2003).

Within this project we aimed to study the North Sea zooplankton development, where copepods also form the major part of the marine mesozooplankton throughout the year. For both regional seas the three copepod groups *Acartia* spp., *Temora longicornis* and *Pseudo-/Paracalanus* dominate the biomass, but for the North Sea a number of additional cope-

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Table 1 – Stage durations (in days) from *Pseudocalanus elongatus* laboratory culture experiments (Klein Breteler et al., 1995) and re-arrangement for comparison to population model results

T (°C)		Food supply																				
		1/16							1/4							1						
		Expt 1	Expt 2	Expt 3	Mea	%Expt	Sum	%Sum	Expt 1	Expt 2	Expt 3	Mea	%Expt	Sum	%Sum	Exp 1	Expt 2	Expt 3	Mea	%Expt	Sum	%Sum
5	E				[7.2]	–						[7.2]	–						[7.2]	–		
	1				[1.8]	–						[1.8]	–						[1.8]	–		
	2				[2.7]	–	11.7	–				[2.7]	–	11.7	–				[2.7]	–	11.7	–
	3	9.4	13.2	10.7	11.1	17			6.8	6.6	6.5	6.6	2			8.4	6.4	6.8	7.2	17		
	4	6.4	4.3	5.2	5.3	20			6.8	5.4	5.0	5.8	17			4.4	6.7	4.2	5.1	31		
	5	7.5	5.8	2.7	5.3	46			5.7	5.7	3.9	5.1	20			3.2*	3.4	6.1	4.2	44		
	6	3.1	3.0	4.2	3.4	19	25.1	8	1.8	1.8	2.9	2.2	30	19.7	7	3.2*	2.9	1.3	2.5	47	19.0	3
	7	6.2	7.1	6.8	6.7	7			7.8	6.0	5.4	6.4	20			5.3	5.7	6.6	5.9	13		
	8	3.9	4.7	4.5	4.4	10			3.9	4.9	7.6	5.5	35			6.3	4.1	4.4	5.0	28		
	9	5.2	5.7	5.1	5.3	6	16.4	7	4.6	4.2	5.8	4.9	17	16.8	11	5.0	4.0*	3.9	4.3	16	15.2	9
	10	13.1	6.3	4.2	7.8	59			7.8	8.1	3.4	6.4	41			4.7	4.0*	4.0	4.2	11		
	11	11.1	8.4	10.5	10.0	14	17.8	31	5.3	7.2	5.5	6.0	17	12.4	26	6.7	12.9	8.3	9.3	39	13.5	22
	Generation	77.4	70.0	65.4	71.0	9			61.9	61.6	57.5	60.4	4			58.9	61.7	57.2	59.3	4		
10	E				[3.7]	–						[3.7]	–						[3.7]	–		
	1				[1.0]	–						[1.0]	–						[1.0]	–		
	2				[1.4]	–	6.1	–				[1.4]	–	6.1	–				[1.4]	–	6.1	–
	3	4.8		5.4	5.1	6			4.7	4.5	4.0	4.4	8			3.8	4.1	3.6	3.8	7		
	4	4.3	3.8	3.7	3.9	8			2.0	2.1	1.9	2.0	5			2.7	1.6	2.2*	2.2	25		
	5	2.8	2.8	1.4	2.3	35			2.5	1.6	2.1	2.1	22			2.4	2.0	2.2*	2.2	9		
	6	1.3	1.6	1.1	1.3	19	12.6	8	2.3	1.9	1.2	1.8	31	10.3	11	2.8	2.6	0.9	2.1	50	10.3	14
	7	1.8*	4.0	5.4	3.7	49			1.8	3.6	3.4	2.9	34			1.5	2.2	3.5	2.4	42		
	8	1.8*	3.4*	2.4	2.5	32			4.5	2.4	2.6	3.2	37			1.6	2.0	2.5	2.0	22		
	9	4.1	3.4*	2.3	3.3	28	9.5	17	3.2	2.5	2.7	2.8	13	8.9	6	3.2	2.6	2.1	2.6	21	7.0	13
	10	7.5	3.4*	2.7	5.1	57			4.2	2.9	2.6	3.2	26			3.1	2.9		3.0	3		
	11	10.3	7.5	4.9	7.6	36	12.7	43	4.0	6.1	4.7	4.9	22	8.1	10	4.8	4.3		4.5	6	7.5	5
	Generation	44.6	41.1	35.3	40.3	12			35.0	33.7	31.2	33.3	6			31.8	30.2	30.4	30.8	3		
15	E				[2.1]	–						[2.1]	–						[2.1]	–		
	1				[0.5]	–						[0.5]	–						[0.5]	–		
	2				[0.8]	–	3.4	–				[0.8]	–	3.4	–				[0.8]	–	3.4	–
	3				[4.0]	–				1.9		1.9	0				1.6	1.9*	1.7	9		
	4		2.3*		2.3	0			2.1	2.3		2.2	5				1.9	1.9*	1.9	0		
	5		2.3*		2.3	0			1.7	1.7	2.2	1.9	16			1.4*	1.2	1.3	1.3	8		
	6	1.6	1.6		1.6	0	9.9	3	1.2	1.4	1.5*	1.3	11	7.3	6	1.4*	1.7	1.1	1.4	21	6.3	2
	7	3.9	3.4		3.7	7			2.7	1.8	1.5*	2.0	31			1.4*	1.9	2.0	1.8	18		
	8	3.2	1.4		2.3	39			2.2	1.7	2.1	2.0	13			1.4*	1.3	1.5	1.4	7		
	9	3.5	4.5		4.0	13	10.5	19	1.3	1.3	1.6	1.4	12	5.4	13	2.4	1.5	1.4	1.8	31	5.0	5
	10	1.9	6.6		4.2	55			3.5	2.4	1.6	2.5	38			2.2	1.5	1.8	1.8	20		
	11	6.5	2.4		4.4	46	8.6	4	2.1	2.6	5.1	3.3	49	5.8	15	2.7	2.6	3.0	2.7	8	4.5	9
	Generation	32.6	31.6		32.1	2			22.0	20.5	22.9	21.8	6			20.0	18.5	19.1	19.2	4		