

***Calanipeda aquaedulcis* and *Arctodiaptomus salinus* are exceptionally euryhaline osmoconformers: evidence from mortality, oxygen consumption, and mass density patterns**

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Supplement. Empirical methods for determination of body volume and drag coefficient in copepod species

In order to calculate the mass density (ρ_b) of copepods using their sinking speed in the water, data on individual body volume (V_b) and drag coefficients (C_D) are required. Below, we attempt to establish significant regression models predicting V_b and C_D from linear body dimensions of the copepods.

Body volume

Several length–weight (volume) regression equations for copepod species were summarized by Mauchline (1998). For example, Svetlichny (1983a) measured body volume in 24 Calanoida and Cyclopoida species from the Black and Mediterranean Seas, and converted literature data available on body wet weight of 74 copepod species into body volume in the form of the equation: $V_b = k l_{pr} d_{pr}^2$, where l_{pr} and d_{pr} (mm) are the length and width of the prosome, and k is the volume-shape factor. Mean values of k were proposed to calculate V_b of the copepods with an accuracy of $\pm 15\%$. To improve the accuracy of this calculation, we included copepod total length (L , mm) into the analysis of the data of Svetlichny (1983a) and expressed V_b as $V_b = k_L L^3$, where $k_L \sim l_{pr}/L$ (d_{pr}/L). The regression equations were $k_L = 0.47 [l_{pr}/L (d_{pr}/L)^2]^{0.93}$ both for females and males (Fig. S1) of Calanoida and Cyclopoida with body shapes varying from spherical (*Pachos punctatum*) to elongated ellipsoid (*Rhincalanus nasutus*). The final equation for $V_b = 0.47 L_{tot}^{0.21} l_{pr}^{0.93} d_{pr}^{1.86}$ allowed us to calculate V_b of copepods with an accuracy of 9.8% for females and 13.5% for males.

Determination of body drag coefficients

The relationship between body drag coefficient C_D and the Reynolds number (Re) can be expressed for short range of Re following the power equation $C_D = c/Re^n$, where n is the regression slope and c is the hydrodynamic shape factor. To determine the hydrodynamic coefficients c and n , previous results concerning the hydrodynamic characteristics of passive sinking in 16 copepod species (Svetlichny 1983b) were supplemented with data on *Candacia pachydactyla* and recalculated (Table S1). Three types of body orientation in copepods during sinking were studied: sinking with the head down and antennules folded along the body (O_I), sinking with the abdomen down and antennules spread at an angle of 90° to the body axis (O_{II}), and sinking dorsally in a horizontal position with the antennules spread (O_{III}). When $Re < 1.0$, n is equal to 1.0 for any type of body orientation, and when $1.0 < Re < 10.0$, n is equal to 0.87 both for O_I and O_{II} and 0.82 for O_{III} .

The coefficient c was expressed as a function of $l_{an} l_{pr} : d_{pr}^2$ ratio (Fig. S2), where l_{an} is the length of 1 antenna. We found that for O_I , $c = 2.27 l_{an} l_{pr} / d_{pr}^2 + 52.8$; for O_{II} , $c = 5.1 l_{an} l_{pr} / d_{pr}^2 + 70.9$; and for O_{III} , $c = 6.17 l_{an} l_{pr} / d_{pr}^2 + 72.4$. The relationships revealed for types O_{II}

and O_{III} cannot be used for species with numerous long setae on the antennules (*Acartia clausi*, *Pontellina plumata*, and *Euchaeta marina*). For these species, the species-specific coefficients presented in Table S1 should be used.

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Table S1. Summary of the ratios of prosome length to width ($l_{pr}:d_{pr}$), antenna length to prosome width ($l_{an}:d_{pr}$), Reynolds number (Re), and the hydrodynamic coefficients c and n in the equation $C_D = c/Re^n$ for 3 types of body orientation during sinking: sinking with the head down and the antennules folded along the body (O_I), sinking with the abdomen down and antennules spread at an angle of 90° to the body axis (O_{II}), and sinking dorsally in a horizontal position with the antennules spread (O_{III}). Data on c and n from Svetlichny (1983b) were corrected and supplemented

Taxon	$l_{pr}:d_{pr}$	$l_{an}:d_{pr}$	Re	Body orientation and antennule position during sinking								
				O_I			O_{II}			O_{III}		
				c	n		c	n		c	n	
					Re ≤ 1	Re ≥ 1		Re ≤ 1	Re ≥ 1		Re ≤ 1	Re ≥ 1
<i>Calanus euxinus</i>	3.39	5.16	0.3 – 16	82 ± 7		0.81	144 ± 15	1.1	0.72	184 ± 15		0.78
<i>C. gracilis</i>	3.25	7.6	2.6 – 25.8	108 ± 12		0.76	216 ± 13		0.74			
<i>Rhincalanus nasutus</i>	4.75	6.63	1.7 – 29.4	125 ± 10		0.92	219 ± 12		0.83			
<i>Mecynocera clausi</i>	3.66	9.9	0.04 – 0.16	137 ± 11	1.0		250 ± 18	0.78		292 ± 21		0.99
<i>Pseudocalanus elongatus</i>	3.33	3.36	0.25 – 2.3	89 ± 7	1.09	0.73	132 ± 7	0.93	0.93			
<i>Euchaeta marina</i>	2.54	3.06	3.8 – 14.8				144 ± 17 ^a		0.76	179 ± 14 ^a		0.7
<i>Scolecithrix danae</i>	2.19	1.75	2.7 – 4.6				89 ± 9		0.9	129 ± 22		0.8
<i>Centropages ponticus</i>	2.57	3.96	0.3 – 5	75 ± 7	0.99	0.97	114 ± 7	0.86	0.86	121 ± 20	0.85	0.85
<i>Lucicutia flavicornis</i>	2.42	3.38	0.57 – 1.0	70 ± 11	0.99							
<i>Haloptilus longicornis</i>	2.92	7.92	0.4 – 2.4				208 ± 32	1.08	1.0			
<i>Condacia pachydactyla</i>	2.09	2.6	2 – 4.6				101 ± 13		0.95			
<i>Pontellina plumata</i>	1.78	2.2	1.2 – 8.6	115 ± 9		0.89	161 ± 20 ^a		0.96	233 ± 22 ^a		0.9
<i>Acartia clausi</i>	3.06	3.28	0.1 – 1.9	102 ± 16	1.0	1.0	183 ± 18 ^a	0.95	0.93	208 ± 27 ^a	1.06	0.8
<i>Oithona setigera</i>	2.56	4.08	0.09 – 0.13				190 ± 16	1.3				
<i>Oncaea conifera</i>	2.19	0.64	0.11 – 0.86	60 ± 11	1.0							
<i>Pachos punctatum</i>	1.47	0.26	3.4 – 18.6	42 ± 4		0.8				52 ± 2.8		0.70
<i>Corycaeus limbatus</i>	2.5	0.76	0.86 – 1.68	66 ± 4		0.99						

^aSpecies with antennules covered with numerous long setae

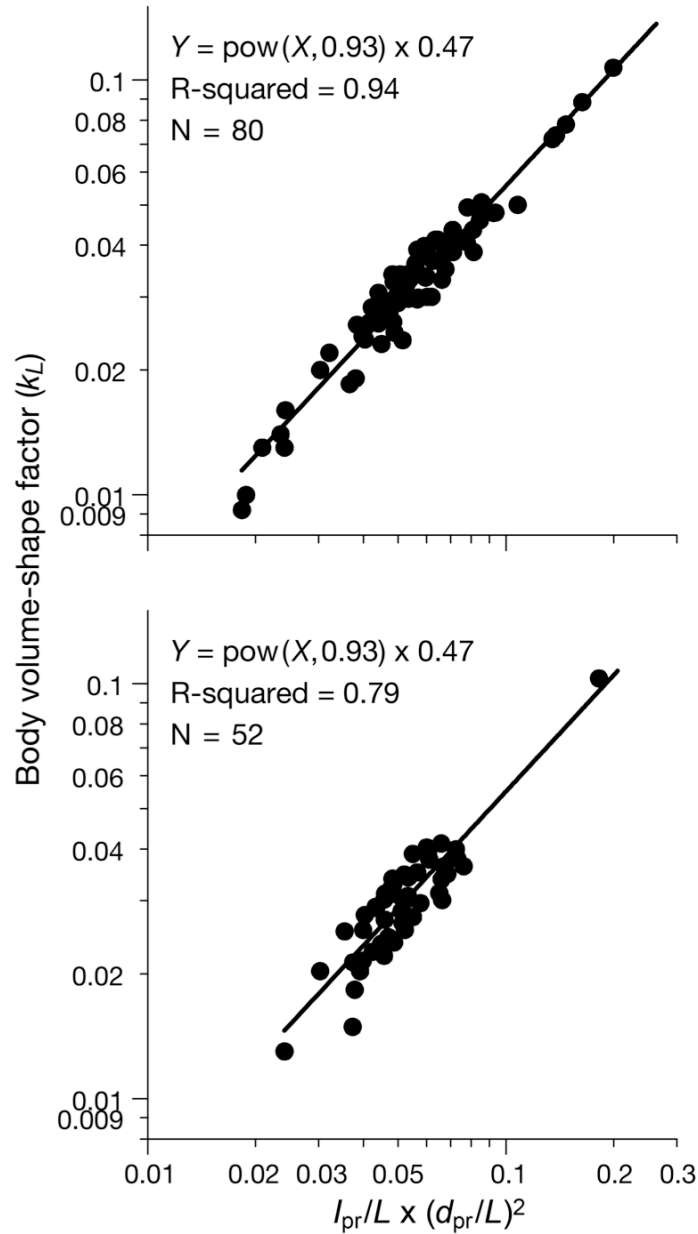


Fig. S1. Relationship between the volume-shape factor (k_L) and body proportions of (A) female and (B) male copepods calculated based on empirical data on wet weight and body dimensions (Bogorov & Preobrazhenskaya 1934, Kamshilov 1951, Petipa 1957, Kanaeva 1962, Shmeleva 1963, 1964, Pertsova 1967, Gruzov & Alekseyeva 1970, 1971, Chernyshova 1973, Gapishko 1976, Pavlova & Melnik 1981, Svetlichny 1983a)

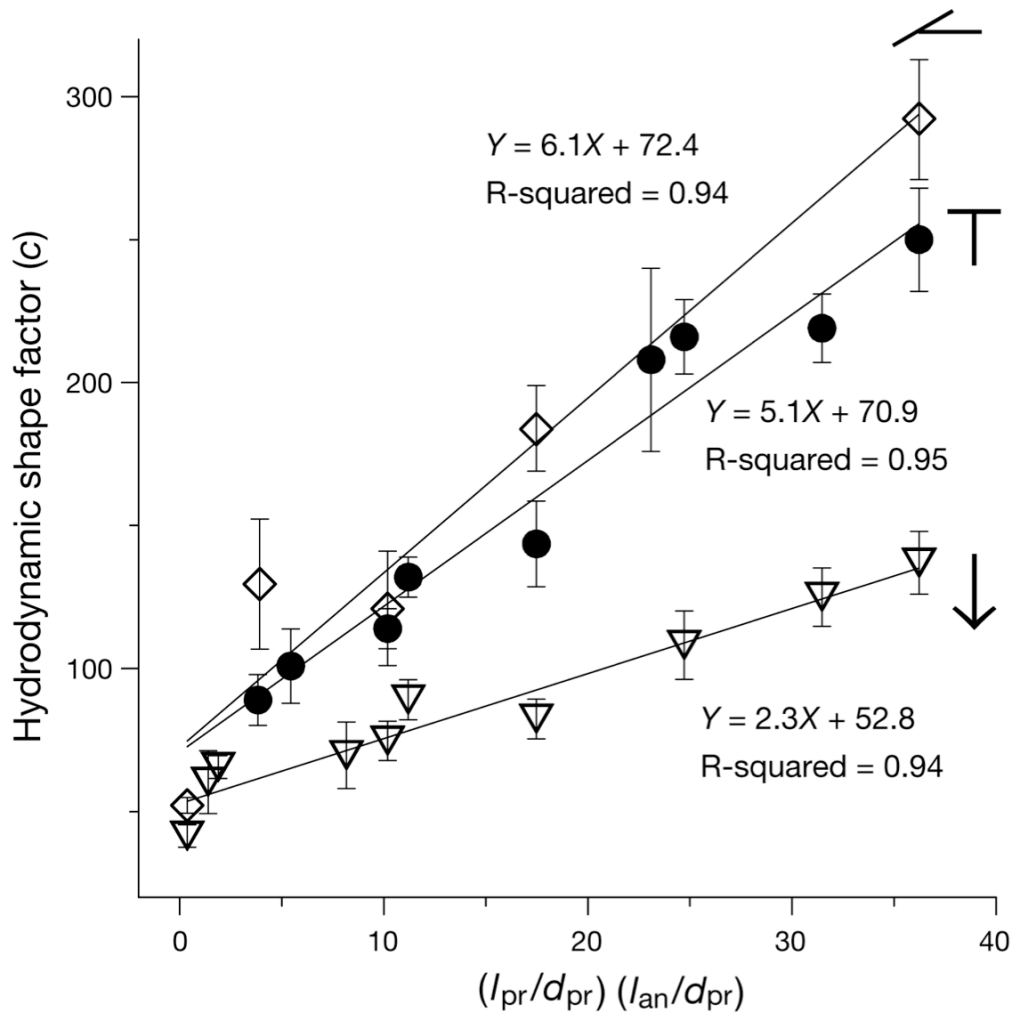


Fig. S2. Relationship between the hydrodynamic shape factor (c) and body proportions during copepod sinking in the water with the head down and antennules folded along the body (orientation type O_I, ▽), sinking with the abdomen down and antennules spread (O_{II}, ●), and sinking dorsally in a horizontal position with the antennules spread (O_{III}, ◇)