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Length–weight relationships of two varunid crab species, *Helice tridens* and *Chasmagnathus convexus*, in Japan

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Abstract Estimates of biomass are essential for studies modeling the structure, animal growth, production, and energy flow in ecosystems. The relationships between dry weight and carapace width of two varunid crab species in two different populations were examined. Distribution of the length–weight plots did not show remarkable differences between species, sexes, and populations. Our results suggest that length–weight relationships, regardless of sex or population or including multiple species, are valid for estimation of dry weight.

Key words Carapace width · Dry weight · Sex · Tidal flat · Varunidae

Introduction

Estimates of biomass are essential for studies modeling the structure, animal growth, production, and energy flow in ecosystems. Because indirect estimation of mass from the body length of an organism is much easier than direct measurement of its dry mass, the relationship between body mass and length is a useful tool in ecological research (Petrakis and Stergiou 1995; Koutrakis and Tsikliras 2003; Torcu-Koç et al. 2006). In addition, invertebrate samples are often fixed with chemical preservatives, which can cause alterations of their dry mass (Johnston and Cunjak 1999). There are some studies reporting the relationships between carapace width and wet weight of crabs (Kangas 2000; Atar and Seçer 2003; Ali et al. 2004), but there have been no reports describing the relationship of carapace width to dry weight up to the present.

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Dry mass, an important parameter in studies of the structure and production of animal communities, can be estimated from the population density and individual body mass of component organisms (Kawabata and Urabe 1998). *Helice tridens* de Haan and *Chasmagnathus convexus* de Haan (Varunidae) crabs are widely distributed in tidal flats in Japan (Sakai 1976) and are often dominant organisms in the biomass of tidal flat ecosystems (Takeda and Kurihara 1987). In this article, the relationships between dry weight and carapace width of crabs in the Awai and Shigenobu Rivers were examined for these two species. Because our main goal was to establish a handy tool for estimation of dry weight of crabs that would be available to a wide range of ecosystem ecologists rather than specialists in crabs, detailed statistical analysis was not included in the present study.

Methods

Surveys were conducted in the estuaries of the Awai (33°56′ N, 132°46′ E) and Shigenobu (33°48′ N, 132°42′ E) Rivers of Ehime Prefecture, southwestern Japan. A detailed description of the study area is provided in Omori et al. (1997) and Goda et al. (2006). Crabs were collected with pitfall traps (30 cm in diameter) in the Awai River in 2001 and in the Shigenobu River in 1986 and 1987.

Each individual crab was measured for carapace width to the nearest 0.1 mm using a digital caliper (Digimatic Caliper, series 500; Mitsutoyo, Kawasaki, Japan). All crabs were then preserved in a freezer until later measurement of dry weight. Individual samples were dried at 60°C for 24 h, cooled in a desiccator, and weighted to the nearest 0.001 g using an electronic balance (AB135-S; Mettler Toledo, Greifensee, Switzerland). Length–weight relationships (a and b values) were calculated by linear regression using the formula $\ln W = \ln a + b \ln L$, where W is dry weight and L is carapace width. The constant b represents the rate of increase (i.e., slope) of dry weight against length in log-transformed relationship (i.e., $\ln W = \ln a + b \ln L$), whereas

Table 1. Results of length–weight regressions

Category	Taxon					
	a	*b*	r^2	*n*	Width range (cm)	Weight range (g)
Awai River						
Helice tridens						
Female	0.237	2.369	0.64	1142	2.02–3.42	0.84–7.61
Male	0.190	2.803	0.67	1312	2.00–3.69	0.86–7.22
Both sexes	0.182	2.744	0.61	2454	2.00–3.69	0.84–7.61
Chasmagnathus convexus						
Female	0.169	2.797	0.88	222	2.38–5.04	1.69–16.06
Male	0.125	3.101	0.92	324	2.30–5.49	1.25–23.65
Both sexes	0.127	3.063	0.91	546	2.30–5.49	1.25–23.65
Varunidae (two species)						
Female	0.152	2.815	0.85	1364	2.02–5.04	0.84–16.06
Male	0.179	2.855	0.88	1636	2.00–5.49	0.86–23.65
Both sexes	0.151	2.924	0.85	3000	2.00–5.49	0.84–23.65
Shigenobu River						
Helice tridens						
Female	0.161	2.983	0.91	257	1.20–3.17	0.23–7.71
Male	0.131	3.485	0.95	204	1.29–3.15	0.29–7.71
Both sexes	0.142	3.247	0.89	461	1.20–3.17	0.23–7.71
Awai and Shigenobu						
Helice tridens						
Female	0.251	2.337	0.72	1339	1.20–3.42	0.23–7.61
Male	0.216	2.707	0.73	1516	1.29–3.69	0.29–7.71
Both sexes	0.210	2.629	0.69	2915	1.20–3.69	0.23–7.71
Varunidae (two species)						
Female	0.187	2.649	0.85	1621	1.20–5.04	0.23–16.06
Male	0.203	2.764	0.88	1840	1.29–5.49	0.29–23.65
Both sexes	0.179	2.795	0.85	3461	1.20–5.49	0.29–23.65

a, b = constants in $W = a\ L^b$
$P < 0.001$ for all statistics

the constant a only represents the dry weight of an organism at a unit length (Genkai-Kato and Miyasaka, in preparation).

Results and discussion

We obtained the carapace width–dry weight relationships for two varunid crab species (Table 1). The relationships were described in relation to sex (female and male) and population (Awai and Shigenobu Rivers). In general, males had steeper slopes (i.e., larger b values) than females in each species in each population (Table 1), which was attributed to the allometric enlargement of male chelae with sexual maturation. However, the differences in b between sexes were not remarkable when the data for the two species were combined (Varunidae).

Plots of our Varunidae species fit well on the regression line obtained for all individuals regardless of species, sex, and population (Fig. 1). Notice that there were some plots that deviated below the regression line. These points correspond to post-molt individuals with a soft body.

Strictly speaking, there were some differences in the regression constants between species, sexes, and populations (see Table 1). However, distribution of length–weight plots in Fig. 1 did not show any remarkable differences between species, sexes, and populations. Although application of a length–weight relationship of the same species, sex, and population is no doubt the best way to estimate dry weights of varunid crabs, our results suggest length–weight relationships regardless of sex or population or including multiple species are also valid for estimation of dry weight.

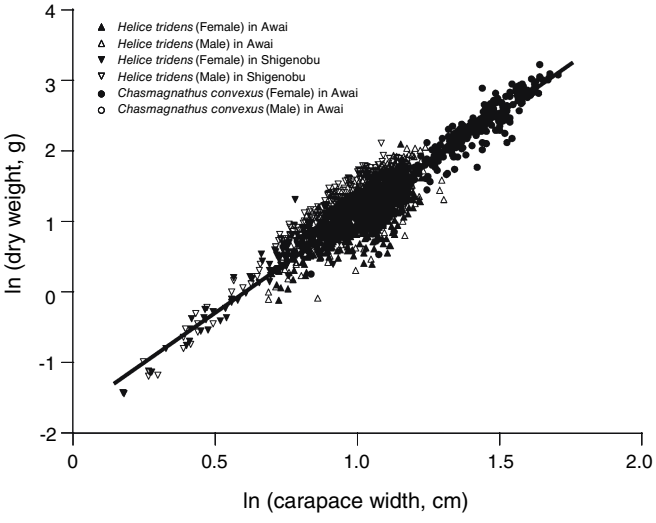

Fig. 1. Results of carapace width–dry weight relationships of two Varunidae species. Plots represent all individuals including the two species collected in both Awai and Shigenobu Rivers. The regression line (*thick line*) was obtained from all data including the two species in Awai and Shigenobu Rivers

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