The following supplement accompanies the article

Trophic ecology of range-expanding round sardinella and resident sympatric species in the NW Mediterranean

Marta Albo-Puigserver*, Diego Borme, Marta Coll, Valentina Tirelli, Isabel Palomera, Joan Navarro

*Corresponding author: : albo@icm.csic.es

Marine Ecology Progress Series 620: 139–154 (2019)

Supplement. Additional data

Table S1. Dry weight (DW; µg) of prey and morphometric relationships used to calculate DW. TL = Total length (µm).

Prey item	DW (µg)	Regression (length-DW)	Reference
Euterpina acutiforms		DW = $(1.389*10^{-8})TL^{2.857}$	Ara (2001)
Acartia spp.		LogDW = 2.71*LogPL-7.28	Cataletto & Fonda Umani (1994)
Temora longicornis		LogDW = 2.815*LogPL-7.181	Hay et al. (1991)
Temora spp.		LogDW = (2.71*LogPL-3.685)/1000	Razouls (1981)
Calanoida		LogDW = 2.738*LogPL-6.934	Hay et al. (1991)
Corycaidae		LnDW = 1.96*LnPL-11.64	Van der Lingen (2002)
Oncaea spp.	1.34	Mean	Borme et al. (2009)
Microsetella spp.		LnDW= 1.15*LnTL-7.79	Satapoomin (1999)
Oithona spp.	2.2	Mean	Pitois & Fox (2006)
Clytemnestra scutellata		LnDW = 1.96*LnPL-11.64	Van der Lingen (2002)
Harpacticoida		LnDW = 1.96*LnPL-11.64	Van der Lingen (2002)
Sapphirina spp.		DW = $6.333*TL^{1.142}$	Lopes et al. (2007)
Candacia spp.	106.20	Mean	Pitois & Fox (2006)
Copepoda		LogDW = 3.13*LogPL-8.18	Uye (1982)
Centropages spp.		LogDW = 2.451*LogPL-6.103	Hay et al. (1991)
Decapoda	27.798	Mean	La Mesa et al. (2008)
Copepod nauplii		LogDW = 2.848*LogL-7.265	Durbin & Durbin (1978)
Copepod copepodites		LogDW = 3.095*LogPL-8.195	Durbin & Durbin (1978)
Cirripedia cyprid		LogDW = -5.375+2.191*LogTL	Muxagata & Williams (2011)
Cirripeda nauplii		LogDW = -9.088+3.377*LogTL	Muxagata & Williams (2011)
Bivalvia	3.758	Mean	La Mesa et al. (2008)
Evadne spp.		DW = $3.946*L^{2.436}$	James (1987)
Penilia avirostris		LogDW= 4.99*Log L-13.77	Uye et al. (1982)
Podonidae (no *Evadne* spp.)	1.6	Mean	Fonda Umani et al. (1979)
Cladocera	1.4	Mean (Podon and Penilia)	Fonda Umani et al. (1979)
Gastropoda	0.6	Mean	Sautor & Castel (1995)
Ostracoda juveniles	6.035	Mean	Borme et al. (2009)
Tunicata Appendicularian		LogDW = 2.51*LogL-6.54	Gorsky et al. (1987)
Salpida		DW=$11.33*L^{1.77}$	Heron et al. (1998)
Polychaeta	5.67	Mean	La Mesa et al. (2008)
Chaetognatha	1430	Mean	Omori (1969)
Amphipoda		LogDW=-2.348+2.793*Log L*1000	Percy (1993)
Fish eggs	30	Mean	Hunter & Dorr (1982)

Table S2. Numerical percentage (%N) and weight percentage (%W) obtained in stomach contents of round sardinella.

Category	Taxon	Spring 2012				Winter 2013				Summer 2013			
		Juvenile		Adult		Juveniles		Adults		Juvenile		Adult	
		%N	%W	%N	%W	%N	%W	%N	%W	%N	%W	%N	%W
Copepoda	Copepod naupli	6.68	0.06	0.57	<0.01	3.85	1.13	1.89	0.32	0.88	0.02	1.56	0.17
	Copepodita					0.16	0.01	0.81	0.18				
	Copepoda eggs			0.07		3.47		7.57				1.18	
	Calanoida												
	Acartia spp.	0.49	0.05	0.21	<0.01	0.41	0.33	4.59	23.14	2.65	4.41	27.99	21.36
	Centropages spp.	8.57	5.87	0.07	<0.01	0.35	3.46	0.27	7.55	9.12	21.71	0.31	0.69
	Diaixis pygmaea											0.01	<0.01
	Temora spp.	1.02	0.09					0.27	5.89				
	Candacia spp.									0.29	7.60		
	Calanoida n.d.	4.59	1.85	0.82	0.01	2.81	11.63	2.43	16.78	4.12	6.76	22.53	31.33
	Cyclopoida												
	Oncaea spp.	1.35	0.09	0.05	<0.01	0.16	0.09	0.27	0.41	0.59	0.19	0.79	0.19
	Oithona spp.	0.20	0.02	0.11	<0.01	0.00	0.00	0.27	0.67	0.59	0.31	0.19	0.08
	Corycaeus spp.					0.30	0.31					0.13	0.02
	Sapphirina spp.			0.21	0.01								
	Harpacticoida												
	Euterpina acutiforms	3.36	0.05	0.05	<0.01	1.50	0.68	5.14	8.68	4.71	1.01	3.95	0.64
	Microsetella spp.	0.04	<0.01	0.05	<0.01	2.51	0.53	0.54	0.19	2.06	0.19	0.61	0.04
	Clytemnestra spp.	0.49	0.07	0.00		0.35	0.66						
	Harpacticoida n.d.									1.18	0.17	0.05	0.01
	Copepoda nd.	26.97	9.13	1.79	0.03	5.92	10.50	7.03	33.34	5.00	2.71	16.65	6.91
Cladocera	*Evadne nordmanni*											0.19	0.03
	Evadne spinifera											0.31	0.03
	Podonidae									1.76	0.69	2.68	0.78
	Penilia avirostris									55.59	33.50	11.69	4.90
	Cladocera n.d..			0.02	<0.01							0.03	0.01
	Cladocera eggs									0.29	0.02	0.05	<0.01
Ostracoda	Ostracoda			0.07	<0.01	0.23	0.57				0.00	0.12	0.13
Cirripedia	Cirripedia cypris	3.28	1.50	0.07	<0.01	0.43	0.58					0.02	0.01
	Cirripedia nauplii			0.02	<0.01	0.56	0.08						
Mollusca	Bivalves larvae	5.45	0.97			0.73	1.13	0.27	1.14	3.24	2.96	1.13	0.77
	Gastropod larvae	0.66	0.06			0.16	0.54			0.88	0.41	0.76	0.26
	Mollusca n.d.					0.68							
Decapoda	Zoea Carcinus					0.07	0.85			0.29	1.99		
	Anomura larvae	0.16	0.22										
	Caridea larvae									0.59	3.98		
	Decapoda larvae	0.08	0.11	0.02	<0.01					1.47	9.95	0.05	0.12
Chaetognatha	Chaetognatha n.d.	0.12	8.32	0.02	0.09	0.07	11.79				0.00	0.11	28.13
Polychaeta	Polychaeta n.d..	0.08		0.07	<0.01	1.18	2.76	0.27	1.73	0.29	0.41	0.13	0.13
Tunicata	Appendicularia	0.70	0.35	0.21	<0.01	10.46	37.13			0.29	0.76		
	Pirosoma	0.08	0.01	0.00						0.29	0.26		
	Salpida	25.16	70.96	85.11	99.20	0.69	1.27					0.18	0.01
	Tunicata n.d.	0.00		0.14	<0.01	18.65	11.96						
Amphipoda	Amphipoda hyperiidea	0.45	0.23	0.92	0.59	0.14	0.31						
	Phoronimia sedentaria			0.02	0.05								
	P. sedentaria eggs			0.92									
Invertebrates	Eggs					1.39		0.54				0.10	
Eggs Teleost	*E. encrasicolus*			0.07	0.01								
	Teleostea n.d.			0.07	0.01	0.14	1.71					0.60	3.27
Ctennophora	Ctenophora					0.21						0.02	
Cnidaria	Cnidaria ephyra					0.07		0.27					
Foraminifera	Foraminifera					0.00		0.27				0.01	
Tintinnina	Rhabdonellidae	0.49		0.00				10.54		1.18		1.44	
	Stenosemella ventricosa	5.61		2.86		5.84		9.19				0.99	
	Codonella spp.					0.40		4.05					
	Propectella spp.					0.88		0.27					
	Tintinnida n.d.					7.16				0.29		0.20	
Dinoflagellata	*Noctiluca* spp.	0.49										0.01	
	Protoperidium spp.	1.02		0.02		6.46		3.51		1.76		0.41	
	Ceratium spp.					3.18						0.09	
	Prorocentrum spp.					0.40						0.05	
	Dynophysis spp.					0.07							
	Dinoflagellata n.d.					0.33							
Diatoms	*Pleurosigma* spp.	0.49		2.63		6.10		5.41		0.29		0.48	
	Coscinodiscus spp.			0.02									
	Bacillariphyceae n.d.	0.04		0.02		1.06		30.00				0.06	
Radiolaria	Radiolaria					0.23		0.54					
Pollen grain	Pollen grain	1.68		2.68		8.79		3.51		0.29		1.16	
Vascular plant	Hair vascular plant	0.16		0.02		0.34		0.27				0.12	
Microalgae	Microalgae					0.56							

***n.d. :** not determined

Table S3. SIMPER analysis results between seasons. Only prey groups that contributed with more than 5% of the dissimilarity are reported.

Prey	Abundance 1	Abundance 2	Average Dissimilarity	Contribution dissimilarity (%)	Cumulative contribution (%)
(1) Spring 2012 – (2) Winter 2013					
Diatoms	0.47	3.65	7.89	10.25	10.25
Tintinnina	0.51	3.95	7.31	9.49	19.75
Dinoflagellata	0.11	3.35	6.72	8.73	28.48
Copepoda	1.45	4.01	5.70	7.41	35.88
Tunicata n.d.	0.09	3.03	5.33	6.93	42.81
Pollen grain	0.71	3.20	5.29	6.87	49.68
Copepod nauplius	0.43	2.78	5.18	6.72	56.40
Appendicularia	0.28	8.82	4.27	5.55	61.96
Salpida	2.78	0.63	4.22	5.48	67.43
Mollusca	0.11	2.03	4.02	5.23	72.66
(1) Spring 2012 – (2) Summer 2013					
Copepoda	1.45	5.62	12.30	15.74	15.74
Cladocera	0.03	3.59	8.20	10.49	26.23
Mollusca	0.11	2.82	7.76	9.92	36.15
Tintinnina	0.51	2.89	7.42	9.50	45.65
Copepod nauplius	0.43	2.27	5.65	7.23	52.88
Salpida	2.78	0.79	5.56	7.12	60.00
Dinoflagellata	0.11	2.09	5.36	6.86	66.86
Diatoms	0.47	1.93	4.20	5.37	72.23
Pollen grain	0.71	1.93	3.99	5.10	77.33
(1) Winter 2013 – (2) Summer 2013					
Cladocera	0	3.59	5.96	13.10	13.10
Diatoms	3.65	1.93	4.26	9.37	22.47
Tintinnina	3.95	2.89	3.43	7.55	30.02
Pollen grain	3.20	1.93	3.02	6.63	36.65
Tunicata n.d.	3.03	0.30	2.75	6.05	42.70
Dinoflagellata	3.35	2.09	2.48	5.45	48.15
Appendicularia	2.82	0.30	2.47	5.43	53.58

***n.d. :** not determined

References

Ara K (2001) Length-weight relationships and chemical content of the planktonic copepods in the Cananéia Lagoon estuarine system, São Paulo, Brazil. Plankton Biology and Ecology 48:121-127

Borme D, Tirelli V, Brandt SB, Fonda Umani S, Arneri E (2009) Diet of *Engraulis encrasicolus* in the northern Adriatic Sea (Mediterranean): ontogenetic changes and feeding selectivity. Mar Ecol Prog Ser 392:193-209

Cataletto B, Fonda Umani S (1994) Seasonal variations in carbon and nitrogen content of *Acartia clausi* (Copepoda, Calanoida) in the Gulf of Trieste (Northern Adriatic Sea). Hydrobiologia 292–293:283–288

Durbin EG, Durbin AG (1978) Length and weight relationships of *Acartia clausi* from Narragansett Bay, RI. Limnol Oceanogr 23:958–969

Fonda Umani S, Specchi M, Buda-Dancevich M, Zanolla F (1979) Lo zooplancton raccolto presso le due bocche principali della Laguna di Grado (Alto Adriatico - Golfo di Trieste). Dati quantitativi. Boll Soc Adriat Sci 63:83–95

Gorsky G, Palazzoli I, Fenaux R (1987) Inluence of temperatura changes on oxygen uptake and ammonia and phosphate excretion, in relation to body size and weight, in *Oikopleura dioica* (Appendicularia). Mar Biol.94: 191-201

Hay SJ, Kiørboe T, Matthews A (1991) Zooplankton biomass and production in the North Sea during the Autumn Circulation Experiment, October 1987-March 1988. Cont Shelf Res 11:1453-1476

Heron AC, McWilliams PS, Dal Pont G (1988) Length-weight relation in the salp Thalia democratica and potential of salps as a source of food. Mar Ecol Prog Ser 42:125-132

Hunter JR, Dorr H (1982) Thresholds for filter feeding in northern anchovy, *Engraulis mordax*. Calif Coop Oceanic Fish Invest Data Rep 23:198–204

James AG (1987) Feeding ecology, diet and field-based studies on feeding selectivity of the Cape anchovy *Engraulis capensis* Gilchrist. S Afr J Mar Sci 5:673–692

La Mesa M, Tirelli V, Borme D, Di Poi E, Legovini S, Fonda Umani S (2008) Feeding ecology of the transparent goby *Aphia minuta* (Pisces, Gobiidae) in the northwestern Adriatic Sea. Sci Mar 72:99–108

Lopes RM, Dam HG, Aquino NA, Monteiro-Ribas W, Rull L (2007) Massive egg production by a salp symbiont, the poecilostomatoid copepod *Sapphirina angusta* Dana, 1849. J Exp Mar Biol Ecol 348: 145-153.

Muxagata E, Williams J (2011) Larval body size–mass relationships of barnacles common to the English Channel coast of the UK. J Mar Biol Assoc UK 91:181-189

Omori M (1969) Weight and chemical composition of some important oceanic zooplankton in the North Pacific Ocean. Mar Biol 3:4–10

Percy, JA (1993) Energy consumption and metabolism during starvation in the Arctic hyperiid amphipod *Themisto libellula* Mandt. Polar Biol 13: 549-555

Pitois SG, Fox CJ (2006) Long-term changes in zooplankton biomass concentration and mean size over the Northwestern European shelf inferred from Continuous Plankton Recorder data. ICES J Mar Sci 63:785-798

Razouls S (1981) Etude écophysiologique de deux copépodes pélagiques. Essai d'application au mesozooplancton des principes rélatifs aux systhèmes. PhD thesis, Université Pierre et Marie Curie, Paris VI

Satapoomin S (1999) Carbon content of some common tropical Andaman Sea copepods. J Plankton Res 21:2117-2123

Sautour B, Castel J (1995) Spring zooplankton distribution and production of the copepod *Euterpina acutifrons* in Marennes-Oléron Bay (France). Hydrobiologia 310:163–175

Van der Lingen CD (2002) Diet of sardine *Sardinops sagax* in the southern Benguela upwelling ecosystem. S Afr J Mar Sci 24:301–316

Uye S (1982) Length-weight relationships in important zooplankton from the Inland Sea of Japan. Journal of the Oceanographical Society of Japan 38:149-158