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Supplementary material

Trophic relationships among animals associated with drifting wrack

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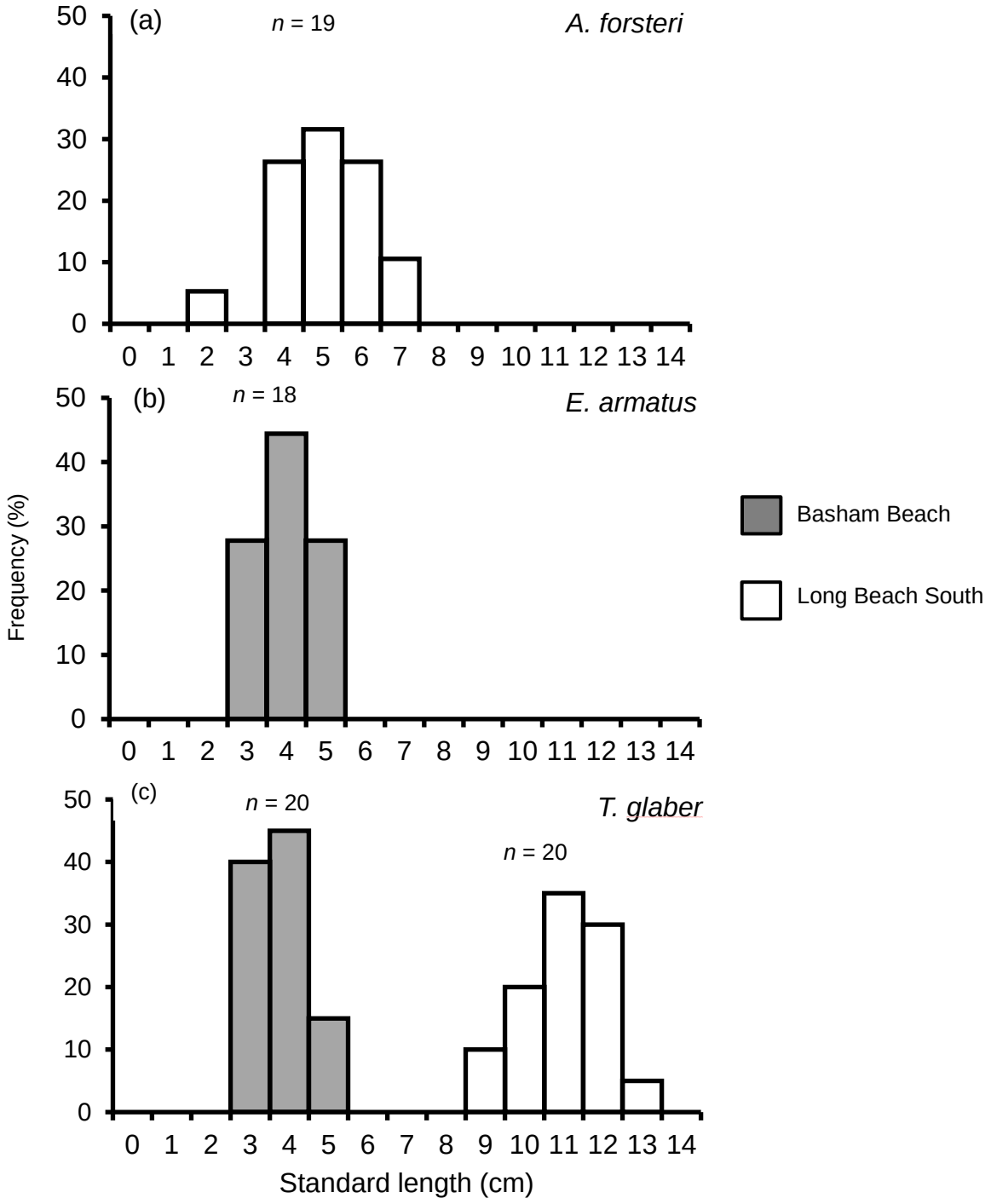

Fig. S1. Standard length–frequency distributions of the most common fish species associated with wrack accumulations in sandy beach surf zones of Basham Beach (BB) and Long Beach South (LBS), namely (*a*) *Aldrichetta forsteri*, (*b*) *Enoplosus armatus* and (*c*) *Tetractenos glaber*. *n*, number of guts examined.

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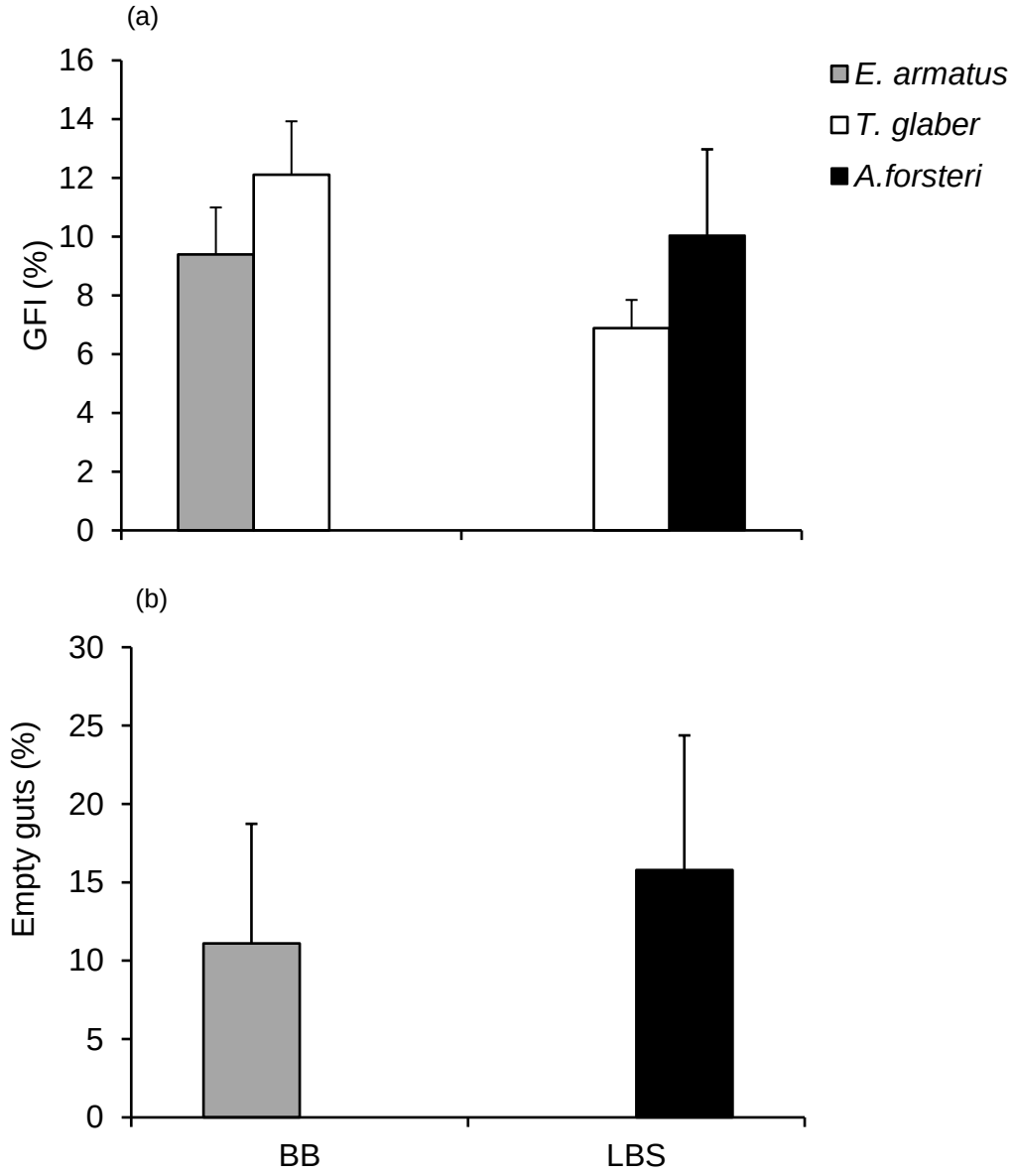

Fig. S2. (*a*) Gut fullness index (GFI) and (*b*) percentage of empty guts of common fish species *Enoplosus armatus*, *Tetractenos glaber* and *Aldrichetta forsteri* captured in sandy beach surf zones at Long Beach South (LBS) and Basham Beach (BB). *T. glaber* is not shown in (*b*) because no individuals had empty guts. Values of *n* are given in Fig. S1.

Table S1. Food items found in the most common fish species captured around wrack accumulations in sandy beach surf zones at Basham Beach and Long Beach South during March 2013

Percentage volume contribution (V), frequency of occurrence index (FOI) and the gut fullness index (GFI) were calculated and are shown for each item. GFI and V are given as the mean ± s.e.m. The most common food items for each set of samples are in bold. Values in blank cells were <0.1%

Food items	Basham Beach				Long Beach South			
	Enoplosus armatus (*n* = 18)		*Tetractenos glaber* (*n* = 20)		*Aldrichetta forsteri* (*n* = 19)		*Tetractenos glaber* (*n* = 20)	
	V (%)	FOI (%)	V (%)	FOI (%)	V (%)	FOI (%)	V (%)	FOI (%)
Polychaeta			6.8 ± 4.7	10.0	11.0 ± 5.9	21.1		
Ostracoda	2.7 ± 1.9	22.2	1.0 ± 0.9	10.0				
Harpacticoida Copepoda	0.2 ± 0.2	5.6						
Isopoda	**32.8 ± 6.7**	**88.9**	19.9 ± 6.8	40.0			**50.1 ± 7.3**	**95.0**
Amphipoda	4.2 ± 2.5	27.8	1.8 ± 1.4	10.0	4.7 ± 4.7	5.3	4.6 ± 2.0	45.0
Brachyura	16.8 ± 5.8	38.9	15.0 ± 6.7	25.0			28.9 ± 6.8	70.0
Caridea	5.0 ± 2.6	22.2						
Gastropoda	1.5 ± 1.2	11.1	2.6 ± 1.9	10.0			1.3 ± 0.7	25.0
Bivalvia	0.7 ± 0.5	11.1						
Unidentified invertebrate tissue	19.8 ± 6.2	44.4	**34.2 ± 9.2**	**50.0**	**68.5 ± 9.9**	**78.9**	8.9 ± 5.0	40.0
Algae			1.2 ± 1.2	5.0	5.3 ± 5.3	5.3	1.9 ± 1.0	35.0
Seagrasses	0.7 ± 0.7	5.6	2.0 ± 1.2	20.0			0.3 ± 0.2	10.0
Unidentified detrital matter	4.3 ± 3.2	27.8	12.6 ± 5.8	40.0			3.9 ± 3.3	20.0
Sand grains	0.2 ± 0.2	5.6	3.0 ± 1.9	15.0				
Number of food groups present	11		11		4		8	
GFI (%)	9.4 ± 1.6		12.1 ± 1.8		10.0 ± 2.9		6.9 ± 1.0	
Empty stomachs (%)	11		0		16		0	

Table S2. Comparison of fish diets from food items obtained from the guts of the two most common fish species captured at each of Basham Beach (BB) and Long Beach South (LBS)

Bray–Curtis similarity percentage values based on the percentage volume contribution of dietary food items (n = 18–20 guts of each fish species)

Fish species (site)	*Enoplosus armatus* (BB)	*Tetractenos glaber* (BB)	*Aldrichetta forsteri* (LBS)
Tetractenos glaber (BB)	67.6		
Aldrichetta forsteri (LBS)	27.1	43.9	
Tetractenos glaber (LBS)	74.9	52.2	15.5

Table S3. Results of univariate permutational multivariate analysis of variance (PERMANOVA) comparing $\delta^{13}C$ and $\delta^{15}N$ for species in common between the Basham Beach (BB) and Long Beach South (LBS) sites and the site with higher values for each isotope

PERMANOVAs were based on Euclidean distances of the stable isotope values. Significant results are indicated by asterisks (*, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$). Blank cells are not significant. Where significant, the site with the higher enrichment according to $\delta^{13}C$ and $\delta^{15}N$ is specified

Taxonomic group	$\delta^{13}C$		$\delta^{15}N$	
	Significance	Site with higher value	Significance	Site with higher value
Tetractenos glaber			***	LBS
Sphaeromatidae	*	BB	*	LBS
Ecklonia radiata			**	LBS
Sargassum spp.	**	BB	**	LBS

Table S4. Stable isotope values for taxa sampled around and within drifting wrack in surf zones at Basham Beach and Long Beach South

Data are the mean ± s.e.m. (unless taxa had one replicate sample only). Blank cells indicate taxa not found in those samples and dashes (in SE columns) are for taxa with only

	Basham Beach		Long Beach South	
Taxa	C	N	C	N
Fish				
Aldrichetta forsteri			–19.25 ± 0.15	12.54 ± 0.05
Enoplosus armatus	–18.47 ± 0.16	10.38 ± 0.06		
Tetractenos glaber	–17.82 ± 0.38	10.21 ± 0.46	–18.69 ± 0.33	13.04 ± 0.20
Crustacea				
Amphipoda			–23.88 ± 0.31	6.62 ± 0.25
Euidotea spp.			–22.09 ± 0.86	8.22 ± 0.33
Ovalipes australiensis	–17.81 ± 0.26	9.90 ± 0.30	–17.79	11.51
Sphaeromatidae	–18.08 ± 0.27	3.63 ± 0.96	–22.19 ± 0.94	5.86 ± 0.13
Gastropoda				
Phasianella australis			–21.86	8.70
Prothalotia lehmanni			–22.06	8.72
Green algae				
Ulva spp.	–17.25 ± 0.23	6.16 ± 0.33		
Red algae				
Cryptonemia spp.			–33.79 ± 0.44	6.29 ± 0.16
Dicranema revolutum	–19.36 ± 0.68	5.62 ± 0.10		
Epiphytes	–20.78	4.97		
Gracilaria spp.			–19.14 ± 0.24	7.46 ± 0.19
Phacelocarpus spp.			–33.75	6.29
Plocamium spp.			–32.39 ± 0.39	7.31 ± 0.15
Brown algae				
Caulocystis spp.	–19.18 ± 1.69	5.14 ± 0.18		
Cystophora spp.	–17.79 ± 0.90	6.48 ± 0.58	–19.88	7.92
Dictyopteris muelleri	–19.58 ± 0.77	5.35 ± 0.05		
Ecklonia radiata	–20.76 ± 0.93	4.92 ± 0.14	–23.13 ± 0.71	7.37 ± 0.30
Perithalia caudata			–21.64 ± 0.37	7.62 ± 0.37
Sargassum spp.	–18.08 ± 1.33	5.36 ± 0.19	–24.43 ± 0.61	7.03 ± 0.25
Seagrass				
Amphibolis antarctica	–13.22 ± 0.49	5.25 ± 0.09		
Amphibolis griffithii	–13.30	5.41		

Table S5. Plausible consumers and potential food pathways established by the difference in fractionation of ΔC and ΔN between each consumer and potential food source pair

Consumers and food items were obtained from seine net sampling of the surf zone at Basham Beach and Long Beach South. Fractionation values shown are based on the difference in centroid values for carbon (ΔC) or nitrogen (ΔN) isotopes obtained from potential food item values subtracted from consumer values and then compared with a coarse range in discrimination of $\delta^{13}C$ at –1 to +1.3‰ and $\delta^{15}N$ at –1 to +5‰ for each trophic level step. Underlined values indicate plausible assimilation of only one of either $\delta^{13}C$ or $\delta^{15}N$ from potential foods to consumers. Bold values indicate plausible assimilation of both $\delta^{13}C$ and $\delta^{15}N$ from potential foods to consumers. Blank cells indicate consumers that were considered to be within the same trophic level and so unlikely to be feeding on each other. Species names are *Enoplosus armatus*, *Tetractenos glaber* and *Ovalipes australiensis*

	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN
Basham Beach																
Consumers	*E. armatus*		*T. glaber*		*O. australiensis*		Sphaeromatidae		*Euidotea*		Sphaeromatidae		*P. australis*		*P. lehmanni*	
Potential foods																
Macroinvertebrates																
O. australiensis	**–0.7**	**0.5**	**0**	**0.3**												
Sphaeromatidae	–0.4	6.8	0.3	6.6	0.3	6.3										
Green algae																
Ulva spp.	–1.2	4.2	**–0.6**	**4**	**–0.6**	**3.7**	–0.8	–2.5								
Red algae																
Dicranema spp.	**0.9**	**4.8**	1.5	4.6	1.5	4.3	1.3	–2								
Epiphytes	2.3	5.4	3	5.2	3	4.9	2.7	–1.3								
Brown algae																
Caulocystis spp.	0.7	5.2	1.4	5.1	1.4	4.8	1.1	–1.5								
Cystophora spp.	**–0.7**	**3.9**	**0**	**3.7**	**0**	**3.4**	**–0.3**	–2.8								
Dictyopteris muelleri	**1.1**	**5**	1.8	4.9	1.8	4.5	1.5	–1.7								
Ecklonia radiata	2.3	5.5	2.9	5.3	2.9	5	2.7	–1.3								
Sargassum spp.	**–0.4**	**5**	**0.3**	**4.8**	**0.3**	**4.5**	0	–1.7								
Seagrasses																
Amphibolis antarctica	–5.2	5.1	–4.6	5	–4.6	4.7	–4.9	–1.6								
Amphibolis griffithii	–5.2	5	–4.5	4.8	–4.5	4.5	–4.9	–1.6								

	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN	ΔC	ΔN
Long Beach South																
Consumers	*A. forsteri*		*T. glaber*		*O. australiensis*		Amphipoda		*Euidotea*		Sphaeromatidae		*P. australis*		*P. lehmanni*	
Potential foods																
Macroinvertebrates																
O. australiensis	–1.5	1	**–0.9**	**1.5**												
Phasianella australis	2.6	3.8	3.2	4.3	4.1	2.8										
Prothalotia lehmanni	2.8	3.8	3.4	4.3	4.3	2.8										
Amphipoda	4.6	5.9	5.2	6.4	6.1	4.9										
Euidotea	2.8	4.3	3.4	4.8	4.3	3.3										
Sphaeromatidae	2.9	6.7	3.5	7.2	4.4	5.6										
Red algae																
Cryptonemia spp.	14.5	6.2	15.1	6.7	16	5.2	9.9	0.3	11.7	1.9	11.6	–0.4	11.9	2.4	11.7	2.4
Gracilaria spp.	–0.1	5.1	0.5	5.6	1.4	4.1	–4.7	–0.8	–2.9	0.8	–3	–1.6	–2.7	1.2	–2.9	1.3
Phacelocarpus spp.	14.5	6.2	15.1	6.7	16	5.2	9.9	0.3	11.7	1.9	11.6	–0.4	11.9	2.4	11.7	2.4
Plocamium spp.	13.1	5.2	13.7	5.7	14.6	4.2	8.5	–0.7	10.3	0.9	10.2	–1.5	10.5	1.4	10.3	1.4
Brown algae																
Cystophora spp.	**0.6**	**4.6**	1.2	5.1	2.1	3.6	–4	–1.3	–2.2	0.3	–2.3	–2.1	–2	0.8	–2.2	0.8
Ecklonia radiata	3.9	5.2	4.4	5.7	5.3	4.1	**–0.8**	**–0.7**	**1**	**0.9**	0.9	–1.5	**1.3**	**1.3**	**1.1**	**1.3**
Perithalia caudata	2.4	4.9	2.9	5.4	3.9	3.9	2.2	1	**–0.5**	**0.6**	–0.6	–1.8	**–0.2**	**1.1**	**–0.4**	**1.1**
Sargassum spp.	5.2	5.5	5.7	6	6.6	4.5	**–0.5**	**0.4**	2.3	1.2	2.2	–1.2	2.6	1.7	2.4	1.7