The following supplement accompanies the article

Subtle but significant segregation in the feeding ecology of sympatric penguins during the critical pre-moult period

T. Otto Whitehead*, Maëlle Connan, Yan Ropert-Coudert, Peter G Ryan

*Corresponding author: whitehead.otto@gmail.com

Marine Ecology Progress Series 565: 227–236 (2017)

Table S1. Carbon and nitrogen stable isotope ratios of potential prey species of macaroni and eastern rockhopper penguins (APF: Antarctic Polar Front; PEI: Prince Edward Islands)

Prey	$\delta^{13}C$	$\delta^{15}N$	Location	Reference
Crustaceans				
Euphausia vallentini	-20.0	5.2	Kerguelen	Cherel et al. (2008)
Euphausia vallentini	-20.9	2.95	PEI (downstream)	Kaehler et al. (2000)
Euphausia vallentini	-23.7	3.95	PEI (upstream)	Kaehler et al. (2000)
Euphausia frigida	-24.2	4.2	APF	Schmidt et al (2003)
Themisto gaudichaudii	-22.8	5.0	Kerguelen	Cherel et al. (2008)
Thysanoessa spp.	-22.2	4.8	APF	Schmidt et al (2003)
Average	**-22.3 ± 1.6**	**4.4 ± 0.8**		
Fish				
Krefftichthys anderssoni	-22.3	7.6	Kerguelen	Cherel et al. (2008)
Protomyctophum tenisoni	-22.1	8.1	Kerguelen	Cherel et al. (2010)
Electrona carlsbergi	-21.6	9.5	Kerguelen	Cherel et al. (2008)
Average	**-22.0 ± 0.4**	**8.4 ± 1.0**		

Table S2. Species-specific discrimination factors between penguin feathers and food taken from captivity studies (adapted from Connan et al. 2016)

Species	$\delta^{13}C$	$\delta^{15}N$	Reference
Gentoo penguin *Pygoscelis papua*	1.3 ± 0.5	3.5 ± 0.4	Polito et al. (2011)
Humboldt penguin *Spheniscus humboldti*	-	4.8	Mizutani et al. (1992)
King penguin *Aptenodytes patagonicus*	0.1	3.5	Cherel et al. (2005)
Rockhopper penguin *Eudyptes chrysocome*	0.1	4.4	Cherel et al. (2005)
Average	**0.5 ± 0.7**	**4.1 ± 0.7**	

Table S3. Core niche widths (‰²) of macaroni and eastern rockhopper penguins and overlap between species (following Jackson et al. 2011)

Year	Macaroni	Eastern rockhopper	Overlap (‰²)
2011	0.34	0.30	< 0.001
2012	0.23	0.19	< 0.001
2013	0.32	0.24	0.04
2014	0.39	0.36	< 0.001
2015	0.54	0.39	0.03
Overall	**0.39**	**0.39**	**0.01**

Table S4. Carbon and nitrogen stable isotope ratios in feathers of male and female macaroni and eastern rockhopper penguins. Significance of within-year sex comparisons are shown; not significant (ns), $P < 0.05$ (*) and $P < 0.01$ (**). Sex of macaroni penguins in 2013 was unknown.

Species	Year	Sex	N	$\delta^{13}C$ (‰)		$\delta^{15}N$ (‰)		C:N
Macaroni penguin	2011	Male	4	-21.4 ± 0.2	ns	10.1 ± 0.4	ns	3.11 ± 0.01
		Female	6	-21.7 ± 0.2		10.3 ± 0.4		3.12 ± 0.01
	2012	Male	4	-21.3 ± 0.2	ns	10.5 ± 0.2	ns	3.10 ± 0.02
		Female	6	-21.2 ± 0.1		10.2 ± 0.3		3.10 ± 0.01
	2013	Both	7	-21.3 ± 0.2	-	10.7 ± 0.4	-	3.10 ± 0.01
	2014	Male	6	-21.5 ± 0.2	ns	10.8 ± 0.5	ns	3.14 ± 0.03
		Female	2	-21.7 ± 0.4		10.7 ± 0.3		3.17 ± 0.04
	2015	Male	6	-21.7 ± 0.2	ns	10.6 ± 0.4	ns	3.13 ± 0.03
		Female	2	-21.6 ± 0.4		10.4 ± 1.3		3.13 ± 0.03
Eastern rockhopper penguin	2011	Male	5	-21.2 ± 0.2	ns	10.0 ± 0.4	ns	3.10 ± 0.02
		Female	5	-21.2 ± 0.2		9.5 ± 0.4		3.09 ± 0.01
	2012	Male	10	-21.3 ± 0.1	ns	9.7 ± 0.3	**	3.12 ± 0.02
		Female	10	-21.2 ± 0.2		9.2 ± 0.3		3.12 ± 0.02
	2013	Male	5	-21.3 ± 0.2	ns	10.4 ± 0.3	*	3.13 ± 0.03
		Female	5	-21.1 ± 0.2		9.9 ± 0.3		3.11 ± 0.03
	2014	Male	11	-21.1 ± 0.2	ns	10.1 ± 0.4	**	3.10 ± 0.02
		Female	9	-21.2 ± 0.3		9.4 ± 0.5		3.11 ± 0.02
	2015	Male	11	-21.5 ± 0.2	ns	9.8 ± 0.5	**	3.11 ± 0.01
		Female	9	-21.5 ± 0.2		9.2 ± 0.4		3.12 ± 0.02

Table S5. Summary of best linear models explaining variance in carbon and nitrogen stable isotopes of macaroni and eastern rockhopper penguins (CHL: chlorophyll-a; SST: sea surface temperature)

Species	**Isotope**	**CHL**			**SST anomalies**			***P*-value**	**F-statistic**	**R^2**
		JAN	**FEB**	**MAR**	**JAN**	**FEB**	**MAR**			
Macaroni	$\delta^{13}C$	+	+					0.005	203.2	0.99
	$\delta^{15}N$						+	0.06	8.9	0.66
Rockhopper	$\delta^{13}C$				+	+		0.15	5.9	0.71
	$\delta^{15}N$	+	+				+	0.25	8.5	0.85

References

Cherel Y, Hobson KA, Hassani S (2005) Isotopic discrimination between food and blood and feathers of captive penguins: implications for dietary studies in the wild. Physiol Biochem Zool, 78:106-115

Cherel Y, Ducatez S, Fontaine C, Richard P, Guinet C (2008) Stable isotopes reveal the trophic position and mesopelagic fish diet of female southern elephant seals breeding on the Kerguelen Islands. Mar Ecol Prog Ser, 370:239-247

Cherel Y, Fontaine C, Richard P, Labat JP (2010) Isotopic niches and trophic levels of myctophid fishes and their predators in the Southern Ocean. Limnol Oceanogr, 55:324–332

Jackson AL, Inger R, Parnell AC, Bearhop S (2011) Comparing isotopic niche widths among and within communities: SIBER—Stable Isotope Bayesian Ellipses in R. J Anim Ecol, 80:595–602

Kaehler S, Pakhomov EA, McQuaid CD (2000) Trophic structure of the marine food web at the Prince Edward Islands (Southern Ocean) determined by $\delta^{13}C$ and $\delta^{15}N$ analysis. Mar Ecol Prog Ser, 208:13-20

Mizutani H, Fukuda M, Kabaya Y (1992) $\delta^{13}C$ and $\delta^{15}N$ enrichment factors of feathers of 11 species of adult birds. Ecology, 73:1391-1395

Polito MJ, Abel S, Tobias CR, Emslie SD (2011) Dietary isotopic discrimination in gentoo penguin (*Pygoscelis papua*) feathers. Polar Biol, 34:1057-1063

Schmidt K, Atkinson A, Stübing D, McClelland JW, Montoya JP, Voss M (2003) Trophic relationships among Southern Ocean copepods and krill: Some uses and limitations of a stable isotope approach. Limnol Oceanogr, 48:277–289