Table S1. Metabolic measurements for diverse species

Taxa	Common name	$P_{crit\text{-}max}$ Calculated (MMR * Pcrit/BMR)	$P_{crit\text{-}max}$ Measured or Envn Estimate	P_{crit} (kPa)	BMR (µmol O_2 g^{-1} h^{-1})	MMR (µmol O_2 g^{-1} h^{-1})	MMR=BMR * $P_{crit\text{-}max}/P_{crit}$	α MMR /$P_{crit\text{-}max}$	α BMR/ P_{crit}	T °C	References
Mollusca											
Cephalopoda											
Illex illecebrosus	Short-fin Squid	19.45	21	4.87	13.97	55.80	60.24	2.66	2.87	13	(Birk et al., 2018; Demont and O'Dor, 1984)
Dosidicus gigas	Jumbo Squid	20.13	21	4.6	16	70.00	73.04	3.33	3.48	25	(Birk et al., 2018; Rosa and Seibel, 2010)
Doryteuthis pealei	Long-fin Squid	22.80	21	3.9	6.5	38.00	35.00	1.81	1.67	15	(Birk et al., 2018; O'Dor and Webber, 1991)
Doryteuthis opalescens	Market Squid	18.53	21	4.96	10.30	38.48	43.61	1.83	2.08	15	(O'Dor, 1982; Burford et al., 2019)
Lolliguncula brevis	Brief Squid	12.63	12.44	7.7	23.47	38.50	37.92	3.09	3.05	24	(Wells et al., 1988; Finke et al., 1996; Bartol et al., 2001)
Octopus vulgaris	Octopus	19.25	21	8	2.36	5.68	6.20	0.27	0.30	25	(Valverde and García, 2005; Wells et al., 1983a,b)
Nautilus pompilius	Nautilus	24.69	21	6.47	1.09	4.16	3.54	0.20	0.17	21	(O'Dor et al., 1990; Staples et al., 2000)
Gastropoda											
G. gibberulus gibbosus	Jumping Conch	16.17	21	3.5	4.06	18.76	24.36	0.89	1.16	33	(Lefevre et al., 2015)
Bivalvia											
Panopea zelandica	Geoduck Clam	20.01	21	8	6.25	15.63	16.41	0.74	0.78	15	(Le et al., 2016)
Arthropoda											
Crustacea											
Gnathophausia ingens	Lophigastrid	3.01	2.89	0.8	1.33	5.00	4.80	1.73	1.66	5.5	(Childress and Seibel, 1998; Cowles and Childress, 1988)
Calinectes sapidus	Blue crab	20.73	21	7.98	4.2	10.91	11.05	0.52	0.53	10	(Brill et al., 2015; Booth and McMahon, 1992)
Penaeus monodon	Tiger prawn	22.80	21	5.37	4.81	20.42	18.81	0.97	0.90	30	(Ern et al., 2015; Salvato et al., 2001)

Taxa	Common name	$P_{crit-max}$ Calculated (MMR * Pcrit/BMR)	$P_{crit-max}$ Measured or Envn Estimate	P_{crit} (kPa)	BMR (μmol O_2 g^{-1} h^{-1})	MMR (μmol O_2 g^{-1} h^{-1})	MMR=BMR * P_{crit}-max/P_{crit}	α MMR /P_{crit}-max	α BMR/ P_{crit}	T °C	References
Euphausia pacifica	Pacific Krill	17.38	21	2.38	3.57	26.07	31.50	1.24	1.5	10	(Childress, 1975)
Sergestes similis	Deep shrimp	20.74	21	3.05	10	68.00	68.85	3.24	3.28	13	(Childress, 1975; Cowles, 2001)
Homarus americanus	American Lobster	23.15	21	4.6	0.93	4.68	4.25	0.22	0.20	15	(Lyons et al., 2013; McMahon and Wilkens, 1975)
Janus edwardsii	Rock Lobster	23.11	21	7.66	0.72	2.16	1.97	0.10	0.09	13	(Crear and Forteath, 2000)
Insecta											
Schistocerca americana	Grasshopper	21.01	21	5	76.4	321.00	320.9	15.3	15.3	30	(Kirkton et al., 2005)
Chordata - Vertebrata											
Teleostei											
Morone saxatilis	Striped Bass	20.81	21	5.5	2.27	8.59	8.67	0.41	0.41	20	(Lapointe et al., 2014)
Centropristis striata	Black Sea Bass	21.01	21	4.73	2.72	12.08	12.08	0.58	0.58	22	(Slesinger et al., 2019)
Gadus morhua	Atlantic Cod	18.16	21	6.42	2.1	5.94	6.87	0.28	0.33	15	(Chabot and Claireaux, 2008)
Sciaenops ocellatus	Red Drum	14.02	15	4.2	5.78	19.30	20.64	1.29	1.38	24	(Ern et al., 2016)
Cyclopterus lumpus	Lumpfish	20.53	21	7.13	2.5	7.20	6.80	0.37	0.35	10	(Ern et al., 2016)
Lates calcarifer	Barramundi	21.11	21	4.42	5.81	27.75	27.60	1.32	1.31	29	(Norin et al., 2014; Collins et al., 2013)
Solea solea	Atlantic Sole	13.89	16.8	3.57	1.28	4.98	6.02	0.30	0.36	20	(Lefrançois and Claireaux, 2003; Van den Thillart et al., 1994)
Scophthalmus maximus	Turbot	20.00	21	4	1.32	6.60	6.93	0.31	0.33	17	(Mallekh and Lagardere, 2002; Maxime et al., 2000)
Fundulus heteroclitus	killifish	10.98	10.3	5.2	9	19.00	17.83	1.84	1.73	20	(Healy and Schulte, 2012; McBryan et al., 2016)
Chromis atripectoralis	Black-axil	22.12	21	4.31	5.15	26.43	25.09	1.26	1.19	31	(Ern et al., 2017)
Myoxocephalus scorpius	Sculpin	23.61	21	7.13	1.51	5.00	4.45	0.24	0.21	10	(Seth et al., 2013; Richards, 2011)

Taxa	Common name	$P_{crit\text{-}max}$ Calculated (MMR * Pcrit/BMR)	$P_{crit\text{-}max}$ Measured or Envn Estimate	P_{crit} (kPa)	BMR (µmol O_2 g^{-1} h^{-1})	MMR (µmol O_2 g^{-1} h^{-1})	MMR=BMR * P_{crit}-max/P_{crit}	α MMR /P_{crit}-max	α BMR/ P_{crit}	T °C	References
Bellapiscis medius	Intertidal triplefin	17.21	21	2.00	2.47	21.25	25.93	1.01	1.24	18	(McArley et al., 2019)
Forsterygion lapillum	Intertidal triplefin	17.69	21	3.00	3.13	18.43	21.91	0.88	1.04	18	(McArley et al., 2019)
Forsterygion varium	Subtidal triplefin	18.11	21	3.70	3.00	14.66	17.03	0.66	0.81	18	(McArley et al., 2019)
Forsterygion malcolmi	Subtidal triplefin	17.98	21	4.70	3.43	13.13	15.32	0.63	0.73	18	(McArley et al., 2019)
Argyrosomus japonicus	Mulloway	19.19	21	2.63	1.56	11.41	12.48	0.54	0.59	22	(Fitzgibbon et al., 2007)
Limanda limanda	Common Dab	24.09	21	5.46	1.6	7.06	6.15	0.34	0.29	15	(Duthie, 1982)
Dicentrarchus labrax	European Bass	18.58	21	4.46	1.68	7.00	7.91	0.33	0.38	11	(Claireaux and Lagardère, 1999) (Claireaux et al., 2006)
Onchorynchus mykiss	Trout	19.17	21	3.15	1.54	9.37	10.27	0.45	0.49	7.4	(Zhang et al., 2018)
Carassius auratus	Goldfish	4.69	3.96	2.49	3.79	7.14	7.15	1.87	1.52	20	(Fry and Hart, 1948)
Chitala ornata	Clown knifefish	21.02	21	8.7	2.91	7.03	7.02	0.33	0.33	33	(Tuong et al., 2018)
Ambloplites rupestri	Rock Bass	8.10	12.42	2.31	1.86	6.76	10.00	0.61	0.81	15	(Crans et al., 2015)
Lepomis gibbosus	Pumpkinseed sunfish	11.54	11.40	4.01	2.55	7.33	7.25	0.67	0.63	15	(Crans et al., 2015)
Lepomis macrochirus	Bluegill	10.20	9.61	3.63	2.48	6.97	6.57	0.63	0.68	15	(Crans et al., 2015)
Micropterus salmoides	Largemouth Bass	12.73	12.39	4.34	2.69	7.89	7.68	0.72	0.61	15	(Crans et al., 2015)
Salmo salar	Atlantic Salmon	21.08	21	11.55	13.68	24.97	24.87	1.18	1.18	16	(Oldham et al., 2019)
Micropogonias undulatus	Atlantic Croaker	13.83	13.0	5.6	3.93	9.70	9.12	0.70	0.70	25	(Marcek et al., 2019)
Leiostomus xanthurus	Spot	10.47	10.0	5.6	6.69	12.50	11.92	1.19	1.19	25	(Marcek et al., 2019)
Elasmobranchii											
Carcharhinus	Sandbar Shark	18.78	21	10	5.16	9.69	10.84	0.46	0.52	28	(Crear et al., 2019)

Taxa	Common name	$P_{crit-max}$ Calculated (MMR * Pcrit/BMR)	$P_{crit-max}$ Measured or Envn Estimate	P_{crit} (kPa)	BMR (μmol O_2 g^{-1} h^{-1})	MMR (μmol O_2 g^{-1} h^{-1})	MMR=BMR * $P_{crit-max}/P_{crit}$	α MMR /$P_{crit-max}$	α BMR/ P_{crit}	T °C	References
plumbeus											
Reptilia											
Alligator mississippiensis	Alligator	22.00	21	5	6.7	29.48	28.14	1.40	1.34	15	(Gangloff and Telemeco, 2018; Lewis and Gatten, 1985)
Mammalia											
Spalax ehrenbergi	Mole Rat	12.69	11	4.56	42.4	118	111.6	10.73	9.30	30	(Arieli et al., 1977)
Rattus norvegicus	Lab rat	21.88	21	6.08	42.4	152.6	146.5	7.27	6.97	37	(Arieli et al., 1977)
Homo sapiens	Human	22.40	21	5.6	33.2	133	145.6	6.33	5.93	37	(Berger and Grocott, 2017; Day et al., 2003)
Thomomys bottae	Pocket gopher	21.00	21	12.5	89	149.50	149.5	7.12	7.12	37	(Lechner, 1977)
T. umbrinus melanotis	Altitude gopher	14.95	15.4	8.9	89	149.50	154.0	9.71	10.0	37	(Lechner, 1977)

*Calculations requiring $P_{crit-max}$ (MMR and α) use the measured value or estimated environmental P_{O2}. For hypoxic species, those values are listed in Table 2.

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Table S2. $P_{crit\text{-}max}$ and environmental P_{O2} (P_{O2env}) in diverse hypoxic species

Species	Predicted $P_{rit\text{-}max}(kPa) = \frac{MMR * P_{crit}}{BMR}$	P_{O2env} or measured $P_{crit\text{-}max}$	Description of P_{O2env}	Ref
Lolliguncula brevis	12.63	12.44	Summer P_{O_2} in Chesapeake Bay when squids are present (4 mg l^{-1} at 26°C).	(Bartol et al., 2002)
Gnathophausia ingens	3.01	2.89	$P_{crit\text{-}max}$ is 2.89 kPa (0.95 ml l^{-1} at 5.5°C), ~P_{O_2} maximum in California Current between 400-800 m depth.	(Childress and Seibel, 1998)
Sciaenops ocellatus	14-15.48	15	P_{O_2} high of 15 kPa (5 mg at 20°C) in estuarine habitat.	(Stunz et al., 2002)
Solea solea	13.89	16.8	$P_{crit\text{-}max}$ is 16.8 kPa. Bottom waters of the Adriatic Sea are hypoxic but a precise figure could not be determined.	(Van den Thillart et al., 1994)
Fundulus heteroclitus	10.98	10.3	P_{O_2} range day to night is ~6.7 to 10.3 kPa	(Cochran and Burnett, 1996)
Carassius auratus	4.69	3.96	$P_{crit\text{-}max}$ (20°C) is 3.96 kPa (Incipient lethal oxygen level). Goldfish ponds are hypoxic but highly variable.	(Fry and Hart, 1948)
Ambloplites rupestri	8.40	12.42	$P_{crit\text{-}max}$ estimated based on MMR measurements at 6, 9 and 20 kPa.	(Crans et al., 2015)
Lepomis gibbosus	11.54	11.40	$P_{crit\text{-}max}$ estimated based on MMR measurements at 6, 9 and 20 kPa.	(Crans et al., 2015)
Lepomis macrochirus	10.20	9.61	$P_{crit\text{-}max}$ estimates based on MMR measurements at 6, 9 and 20 kPa.	(Crans et al., 2015)
Micropterussalmoides	12.73	12.39	$P_{crit\text{-}max}$ estimates based on MMR measurements at 6, 9 and 20 kPa.	(Crans et al., 2015)
Spalax ehrenbergi	12.69	11	11 kPa is ~P_{crit} for MMR. Mole rats inhabit hypoxic subterranean burrows.	(Arieli et al., 1977)
T. umbrinus melanotis	14.95	15.4	Collected at 3200 m=15.4 kPa. Measured $P_{crit\text{-}max}$ is 14.95.	(Lechner, 1977)
Micropogonias undulatus	13.83	13	Estuarine habitat ~60% Saturation	(Craig and Crowder, 2005)
Leiostomus xanthurus	10.47	10	Estuarine habitat	(Ross et al., 2001)

Table S3. Temperature effects on metabolic rate and critical oxygen pressures

Species	T°C	$P_{crit\text{-}max}$	BMR	P_{crit}	MMR	*E* (eV) BMR=MMR+P_{crit}–$P_{c\text{-}max}$	References
Morone saxatilis	20	19.9	2.27	5.5	8.59	0.80=0.38+0.39–0.0=0.**77**	(Lapointe et al., 2014)
	26	20.1	4.28	7.43	11.72		
Centropristis striata	12	23.0	1.31	3.36	8.95	0.54=0.27+0.25–0.0=0.**52**	(Slesinger et al., 2019)
	17	23.6	1.89	3.99	11.19		
	22	21.0	2.72	4.73	12.08		
	24	23.2	3.15	5.07	14.44		
	27	22.3	3.93	5.62	15.56		
	30	14.2	4.89	6.23	11.12		
Gadus morhua	18	18.8	3.84	6.42	11.24	0.71=0.39+0.34–0.0=**0.73**	(Schurmann and Steffenson, 1997; Chabot and Claireaux, 2008)
	5	18.2	0.9	3.49	4.69		
	10	17.5	1.66	4.91	5.9		
	15	18.2	2.1	6.42	5.94		
	2	15.5	0.75	3.2	3.63		
Sciaenops ocellatus	24	14.0	5.78	4.2	19.30	0.43=0.32+0.24–0.05=**0.51**	(Ern et al., 2016)
	30	15.4	8.09	5.05	24.80		
Cyclopterus lumpus	10	20.5	2.5	7.13	7.20	0.42=0.25+0.26–0.03=**0.48**	(Ern et al., 2016)
	16	22.2	3.57	8.83	9.00		
Chromis atripectoralis	35	17.6	7.56	4.88	27.21	1.10=0.20+0.75+0.06=**1.01**	(Ern et al., 2017)
	33	22.6	5.72	4.8	26.94		
	31	22.1	5.15	4.31	26.43		
	29	24.9	3.21	3.29	24.34		
Carassius auratus	5	2.25	0.36	0.52	1.56	1.00=0.71+0.54–0.16=**1.09**	(Fry and Hart, 1948)
	10	2.62	1.07	1.05	2.67		
	15	3.03	2.23	1.32	5.13		
	20	4.69	3.79	2.49	7.14		
	25	4.16	6.25	2.24	11.60		
	35	4.3	10	3.3	13.10		

Species	T°C	$P_{crit-max}$	BMR	P_{crit}	MMR	*E* (eV) BMR	MMR	P_{crit}	P_{c-max}	References
Salmo salar	18	2 21.9	6.37	7.56	18.44	0.33=0.021+0.19+0.07=**0.28**				(Barnes et al., 2011; Hvas et al., 2017)
	22	19.6	9.17	9.45	19.06					
Alligator mississipiensis	15	22	6.70	5.0	29.48	0.40=0.19+0.14+0.01=**0.34**				(Gangloff and Telemeco, 2018) (Lewis and Gatten, 1985)
	25	21	26.70	7.0	80.10					
Leiostomus xanthurus	10	8.23	2.19	5.77	3.13	0.46=0.59+0.037–0.171=**0.46**				(Marcek et al., 2019)
	15	8.47	3.59	4.87	6.25					
	20	8.45	4.81	4.82	8.44					
	25	10.5	6.69	5.6	12.50					
	30	13.3	7.59	6.13	16.44					
Micropogonias undulatus	10	11.5	1.57	5.77	3.13	0.37=0.49+0.028–0.144=**0.37**				(Marcek et al., 2019)
	15	10.4	2.34	5.13	4.73					
	20	8.47	2.76	3.68	6.34					
	25	13.8	3.93	5.6	9.70					
	30	16.4	4.28	6.13	11.47					

Basal (BMR) and maximum (MMR) metabolic rates in µmol O_2 g^{-1} h^{-1} and the critical P_{O_2} (P_{crit}) in kPa. Temperature coefficients (*E*) for metrics (Y=BMR, P_{crit} or MMR). The temperature coefficient is the slope of the relationship between lnY and $1/k_BT$; $Y=\exp(-E/1k_BT)$, T in °Kelvin and k_B is the Boltzmann constant), calculated within the tolerated temperature range for each species (excluded temperatures in red). Calculated $EP_{crit-max}$ is near zero for all species in this table except freshwater fishes that experience seasonally correlated changes in oxygen and temperature. Estimated $P_{crit-max}$ values for *C. auratus* are very similar to those directly measured (Fry and Hart, 1948). As described above, $E_{BMR}=E_{MMR}+E_{Pcrit}-E_{Pcrit-max}$.