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Comparison of the olfactory morphology and morphometry of three pelagic perciform species from Pakistan

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Table S1 — Percentages (mean ± SD) of some olfactory morphometric variables with respect to some body lengths in *S. commersonnianus*, *R. kanagurta* and *S. obtusata*

Olfactory traits	*S. commersonnianus*	*R. kanagurta*	*S. obtusata*
		Over TL	
ANS	2.11 ± 0.27	2.77 ± 0.45	9.80 ± 0.90
APN	1.03 ± 0.23	1.87 ± 0.21	1.45 ± 0.13
BAN	0.43 ± 0.11	0.55 ± 0.15	0.20 ± 0.05
BPN	0.44 ± 0.12	0.67 ± 0.15	0.32 ± 0.08
DL	0.04 ± 0.02	0.05 ± 0.01	0.02 ± 0.01
LAN	0.58 ± 0.13	0.55 ± 0.15	0.20 ± 0.05
LPN	0.90 ± 0.20	1.00 ± 0.18	0.70 ± 0.11
LN	3.77 ± 0.44	6.10 ± 0.40	5.81 ± 0.55
LR	1.25 ± 0.19	0.91 ± 0.09	0.45 ± 0.10
PNE	1.31 ± 0.24	2.93 ± 0.31	1.90 ± 0.20
RL	1.94 ± 0.21	1.62 ± 0.27	1.94 ± 0.14
RW	1.61 ± 0.15	0.84 ± 0.38	1.10 ± 0.08
		Over SL	
ANS	2.66 ± 0.34	3.32 ± 0.50	11.71 ± 1.02
APN	1.31 ± 0.30	2.25 ± 0.24	1.73 ± 0.15
BAN	0.55 ± 0.14	0.66 ± 0.18	0.24 ± 0.05
BPN	0.55 ± 0.15	0.81 ± 0.18	0.38 ± 0.09
DL	0.05 ± 0.02	0.06 ± 0.01	0.03 ± 0.01
LAN	0.73 ± 0.16	0.66 ± 0.18	0.24 ± 0.05
LPN	1.14 ± 0.25	1.20 ± 0.21	0.83 ± 0.13
LN	4.79 ± 0.49	7.47 ± 0.56	6.91 ± 0.63
LR	1.59 ± 0.25	1.11 ± 0.12	0.54 ± 0.12
PNE	1.65 ± 0.29	3.52 ± 0.33	2.26 ± 0.23
RL	2.45 ± 0.26	1.95 ± 0.30	2.32 ± 0.14
RW	2.04 ± 0.19	1.00 ± 0.50	1.32 ± 0.09
		Over HL	
ANS	11.57 ± 1.65	11.17 ± 1.86	34.51 ± 3.3
APN	5.65 ± 1.20	7.57 ± 1.02	5.10 ± 0.44
BAN	2.36 ± 0.57	2.22 ± 0.65	0.70 ± 0.16
BPN	2.39 ± 0.65	2.71 ± 0.66	1.11 ± 0.25
DL	0.24 ± 0.08	0.22 ± 0.03	0.09 ± 0.02
LAN	3.17 ± 0.68	2.22 ± 0.65	0.70 ± 0.16
LPN	4.92 ± 1.03	4.02 ± 0.75	2.44 ± 0.38
LN	21.33 ± 2.71	25.95 ± 2.36	20.36 ± 1.98
LR	7.05 ± 0.98	3.87 ± 0.34	1.59 ± 0.35
PNE	7.17 ± 1.40	11.83 ± 1.18	6.66 ± 0.69
RL	10.58 ± 0.98	6.54 ± 1.12	6.83 ± 0.49
RW	8.83 ± 0.83	3.39 ± 1.57	3.88 ± 0.31

Table S2 — Correlation between various olfactory morphometric traits and some body lengths in *S. commersonnianus*, *R. kanagurta* and *S. obtusata*

Traits	*S. commersonnianus*				*R. kanagurta*				*S. obtusata*			
	a	b	r	*p*-value	a	b	r	*p*-value	a	b	r	*p*-value
						over SL						
ANS	0.60	0.02	0.83	***	0.22	0.03	0.50	***	-9.69	0.16	0.97	***
APN	0.65	0.01	0.64	***	-1.75	0.03	0.80	***	0.32	0.02	0.86	***
BAN	0.27	0.00	0.59	***	-2.99	0.02	0.92	***	-0.09	0.00	0.64	***
BPN	-0.42	0.01	0.75	***	-2.64	0.02	0.88	***	-0.15	0.00	0.61	***
DL	0.12	0.00	0.10	N.s	0.21	0.00	0.36	N.s	-0.02	0.00	0.57	***
LAN	0.17	0.01	0.69	***	-2.99	0.02	0.92	***	-0.09	0.00	0.64	***
LPN	0.83	0.01	0.57	***	-1.35	0.02	0.64	***	0.27	0.01	0.64	***
LN	-2.77	0.06	0.97	***	4.98	0.05	0.44	N.s	8.88	0.03	0.54	*
LR	0.99	0.01	0.83	***	1.72	0.00	0.10	N.s	-0.79	0.01	0.66	**
PNE	-0.18	0.02	0.83	***	-1.32	0.04	0.76	***	-0.12	0.02	0.83	***
RL	1.66	0.02	0.88	***	-3.38	0.04	0.86	***	0.00	0.02	0.93	***
RW	1.04	0.02	0.89	***	-8.49	0.06	0.99	***	0.98	0.01	0.88	***
TNL	-0.34	1.04	0.88	***	0.10	0.77	0.75	***	-0.73	1.10	0.97	***
NLR	0.99	0.11	0.18	N.s	-0.39	0.71	0.35	N.s	4.43	-1.25	0.53	*
VR	-3.92	2.25	0.90	***	-25.40	11.54	0.92	***	-5.61	2.73	0.95	***
						over TL						
ANS	0.68	0.02	0.83	***	1.79	0.02	0.41	***	-10.13	0.14	0.96	***
APN	0.63	0.01	0.66	***	-0.79	0.02	0.76	***	0.31	0.01	0.85	***
BAN	0.27	0.00	0.60	***	-2.04	0.02	0.82	***	-0.08	0.00	0.62	***
BPN	-0.43	0.01	0.77	***	-1.66	0.01	0.77	***	-0.12	0.00	0.58	***
DL	0.12	0.00	0.08	N.s	0.21	0.00	0.27	N.s	-0.02	0.00	0.59	**
LAN	0.18	0.01	0.70	***	-2.04	0.02	0.82	***	-0.08	0.00	0.62	***
LPN	0.81	0.01	0.59	***	-0.70	0.01	0.60	***	0.27	0.01	0.63	***
LN	-2.60	0.05	0.96	***	0.72	0.06	0.50	*	9.28	0.02	0.53	*
LR	0.95	0.01	0.84	***	0.89	0.01	0.26	N.s	-0.71	0.01	0.67	**
PNE	-0.01	0.01	0.81	***	0.43	0.03	0.66	***	-0.09	0.02	0.81	***
RL	1.70	0.01	0.88	***	-1.86	0.03	0.77	***	0.09	0.02	0.89	***
RW	1.10	0.01	0.89	***	-6.42	0.04	0.90	***	0.95	0.01	0.88	***
TNL	-0.39	1.02	0.88	***	0.44	0.59	0.67	***	-0.86	1.12	0.95	***
NLR	1.01	0.10	0.16	N.s	-0.48	0.72	0.27	N.s	4.52	-1.24	0.55	*
VR	-4.09	2.22	0.90	***	-20.30	8.94	0.81	***	-5.89	2.76	0.93	***
						over HL						
ANS	0.25	0.11	0.81	***	2.30	0.07	0.32	*	-9.53	0.48	0.95	***
APN	0.28	0.05	0.70	***	0.02	0.08	0.57	***	0.31	0.05	0.85	***
BAN	0.16	0.02	0.61	***	-2.10	0.06	0.75	***	-0.06	0.01	0.61	***
BPN	-0.64	0.04	0.79	***	-1.76	0.06	0.71	***	-0.23	0.01	0.66	***
DL	0.11	0.00	0.03	N.s	0.18	0.00	0.24	N.s	-0.02	0.00	0.59	**
LAN	-0.04	0.03	0.73	***	-2.10	0.06	0.75	***	-0.06	0.01	0.6	***
LPN	0.46	0.04	0.66	***	-0.97	0.06	0.59	***	0.24	0.02	0.65	***
LN	-2.65	0.27	0.94	***	12.45	0.03	0.08	N.s	9.19	0.08	0.53	*
LR	0.75	0.05	0.88	***	1.65	0.01	0.11	N.s	-0.86	0.03	0.71	***
PNE	-0.33	0.08	0.80	***	-0.58	0.13	0.70	***	-0.15	0.07	0.8	***
RL	1.26	0.08	0.90	***	-1.81	0.10	0.68	***	0.03	0.07	0.9	***
RW	0.71	0.07	0.90	***	-6.42	0.16	0.81	***	1.08	0.02	0.8	***
TNL	1.69	0.22	0.43	**	-0.20	0.25	1.00	***	-0.17	1.08	0.9	***
NLR	1.06	0.11	0.46	*	0.25	0.57	0.25	N.s	3.79	-1.2	0.6	*
VR	0.68	0.35	0.32	*	-0.20	0.25	1.00	***	-4.24	2.68	0.9	***

*: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$, N.s = Non-Significant

Table S3 — Relationship between ratios of some olfactory morphometric traits and body lengths in *S. commersonnianus*, *R. kanagurta* and *S. obtusata*

Olfactory Morphometric ratios	*S. commersonnianus*				*R. kanagurta*				*S. obtusata*			
	a	b	r	*p*-value	a	b	r	*p*-value	a	b	r	*p*-value
over SL												
BAN / BPN	1.00	-0.43	0.33	*	-2.00	0.85	0.33	**	-0.42	0.10	0.05	N.s
LAN / BAN	-0.10	0.10	0.14	N.s	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LAN / LPN	-0.79	0.26	0.24	N.s	-5.93	2.52	0.67	***	-1.46	0.39	0.20	N.s
LPN / BPN	1.69	-0.59	0.49	***	3.93	-1.67	0.51	***	1.03	-0.29	0.17	N.s
RL / RW	0.38	-0.13	0.30	*	11.43	-4.94	0.96	***	-0.66	0.39	0.63	***
RL / LR	0.33	-0.1	0.17	N.s	-3.03	1.46	0.67	**	2.94	-0.97	0.45	*
over TL												
BAN / BPN	1.08	-0.45	0.34	*	-1.78	0.73	0.32	*	-0.47	0.11	0.05	N.s
LAN / BAN	-0.10	0.09	0.13	N.s	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LAN / LPN	-0.77	0.24	0.23	N.s	-4.64	1.88	0.57	***	-1.47	0.38	0.19	N.s
LPN / BPN	1.75	-0.59	0.50	***	-1.78	0.73	0.40	**	1.00	-0.27	0.15	N.s
RL / RW	0.38	-0.12	0.30	*	9.44	-3.92	0.87	***	-0.65	0.37	0.58	***
RL / LR	0.33	-0.07	0.19	N.s	-3.10	1.43	0.50	N.s	3.11	-1.01	0.48	*
over HL												
BAN / BPN	0.12	-0.07	0.12	N.s	-1.16	0.62	0.24	N.s	-0.15	-0.03	0.01	N.s
LAN / BAN	0.10	0.02	0.06	N.s	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LAN / LPN	-0.39	0.12	0.25	N.s	-3.39	1.81	0.48	***	-1.13	0.31	0.15	N.s
LPN / BPN	0.61	-0.17	0.32	*	2.23	-1.19	0.37	**	0.98	-0.34	0.19	N.s
RL / RW	0.13	-0.03	0.17	N.s	7.56	-4.20	0.82	***	-0.51	0.41	0.65	***
RL / LR	0.13	0.02	0.14	N.s	-1.79	1.19	0.49	N.s	2.46	-0.96	0.47	*

*: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$, N.s = Non-Significant, N/A = Not Available (because LAN = BAN)

Table S4 — Correlation of body weight with olfactory morphometric traits and ratios in *S. commersonnianus*, *R. kanagurta* and *S. obtusata*

Olfactory traits and ratios	*S. commersonnianus*				*R. kanagurta*				*S. obtusata*			
	a	b	r	*p*-value	a	b	r	*p*-value	a	b	r	*p*-value
ANS	0.07	0.32	0.79	***	0.24	0.26	0.46	***	0.50	0.45	0.94	***
APN	-0.11	0.25	0.57	***	-0.20	0.39	0.72	***	-0.03	0.30	0.86	***
BAN	-0.59	0.30	0.64	***	-2.11	1.05	0.88	***	-1.05	0.37	0.58	***
BAN / BPN	0.24	-0.11	0.25	N.s	-0.58	0.24	0.33	**	-0.28	0.04	0.06	N.s
BPN	-0.82	0.41	0.67	***	-1.53	0.81	0.79	***	-0.85	0.38	0.57	***
DL	-0.91	-0.02	0.09	N.s	-0.53	-0.18	0.29	N.s	-1.87	0.33	0.36	N.s
LAN	-0.50	0.32	0.67	***	-2.11	1.05	0.88	***	-1.05	0.37	0.58	***
LAN / BAN	0.09	0.02	0.08	N.s	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LAN / LPN	-0.34	0.07	0.20	N.s	-1.58	0.64	0.61	***	-0.76	0.10	0.16	N.s
LPN	-0.16	0.24	0.53	***	-0.53	0.41	0.57	***	-0.29	0.27	0.62	***
LPN / BPN	0.67	-0.17	0.40	**	1.00	-0.40	0.44	***	0.48	-0.06	0.12	N.s
LN	0.18	0.40	0.94	***	0.79	0.16	0.40	N.s	1.02	0.08	0.25	N.s
LR	-0.03	0.27	0.83	***	0.11	0.10	0.19	N.s	-1.28	0.65	0.60	***
NLR	1.21	0.02	0.09	N.s	0.83	0.18	0.29	N.s	2.17	-0.33	0.36	N.s
PNE	-0.33	0.40	0.80	***	0.09	0.34	0.78	***	-0.04	0.36	0.89	***
RL	0.19	0.24	0.88	***	-0.69	0.59	0.70	***	0.03	0.33	0.91	***
RW	0.02	0.29	0.91	***	-3.72	1.90	0.91	***	0.02	0.21	0.89	***
RL / RW	0.17	-0.04	0.31	*	3.03	-1.31	0.92	***	0.01	0.12	0.6	***
RL / LR	0.22	-0.02	0.17	N.s	-0.52	0.37	0.56	*	1.13	-0.2	0.3	N.s
TNL	1.34	0.35	0.87	***	1.39	0.21	0.74	***	1.15	0.35	0.95	***
VR	-0.37	0.78	0.92	***	-5.55	2.94	0.84	***	-0.97	0.86	0.93	***

*: $p < 0.05$, **: $p < 0.01$***: $p < 0.001$, N.s = Non-Significant, N/A = Not Available

Fig. S1 — Shape and position of nostrils in (a) *S. commersonnianus*, (b) *R. kanagurta*, and (c) *S. obtusata* and enlarged view of nostrils of *S. commersonnianus* (d), *R. kanagurta* (e), and *S. obtusata* (f). (Scale bar = 10 mm for a, b, c and 1 mm for d, e, f). AN: Anterior Nostril, E: Eye, PN: Posterior Nostril, NF: Nasal Flap. Note the dotted arrow indicating a transparent structure around the anterior nostril and the thick arrow is pointing towards Nasal Flap

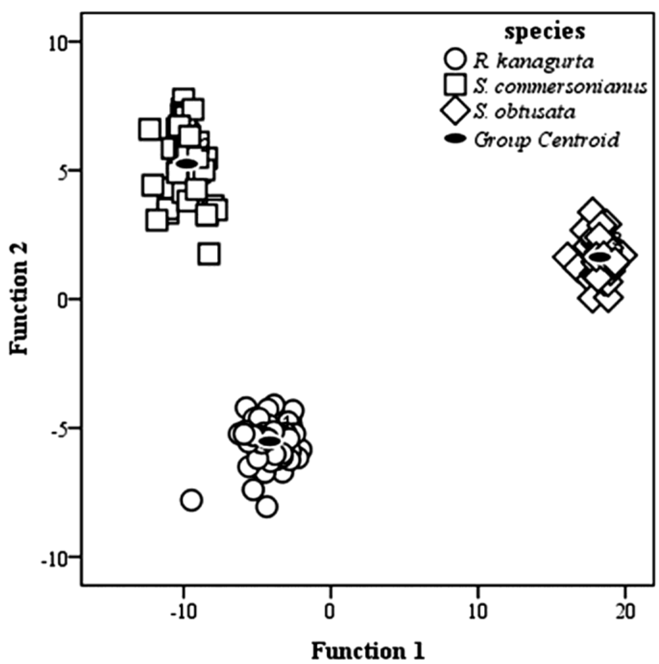

Fig. S2 — Scatter diagram of canonical discriminant function and sample centroids of the selected fish