SUPPLEMENTS

Sexual dimorphism patterns of the White Sea threespine stickleback (*Gasterosteus aculeatus*)

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Supplement 1

Description of landmarks (see Fig. 1).

Landmark	Description of the landmarks
1	The tip of the premaxilla
2	The end of the jaws
3	The anterior-most point of the orbital circumference
4	The uppermost point of the orbital circumference
5	The posterior-most point of the orbital circumference
6	The lowermost point of the orbital circumference
7	Anterior edge of ectocoracoid on ventral midline
8	Anterior edge of the pelvic girdle at the ventral midline
9	The insertion point of the pelvic spine
10	The anterior-most point of the anal fin
11	The posterior-most point of the anal fin
12	The beginning of the caudal fin, where it contacts the ventral surface on the ventral side
13	The midpoint between origin of the dorsal and ventral lobes of the caudal fin (insertion of the caudal fin)
14	The beginning of the caudal fin, where it contacts the dorsal side
15	Insertion of the last ray of the dorsal fin
16	Insertion of the first ray of the dorsal fin
17	The posterior-most point of insertion of the third dorsal spine
18	The tip of the third dorsal spine
19	The posterior-most point of insertion of the second dorsal spine
20	The tip of the second dorsal spine
21	The posterior-most point of insertion of the first dorsal spine
22	The tip of the first dorsal spine
23	Posterior edge of supraoccipital on the dorsal midline
24	The uppermost point of the pectoral fin base
25	The uppermost point of the pectoral fin end
26	The lowermost point of the pectoral fin end
27	The lowermost point of the pectoral fin base

Supplement 2

List of morphometric traits (see also Fig. 1)

Landmarks, which the trait is based on (Fig. 1a and b, if not indicated specially)	Abbreviated name of a trait	Description of the trait
		Body shape
1–13	SL	The standard length of fish
1–21	Pred-1	Distance between the tip of snout to beginning of the first dorsal spine
1–19	Pred-2	Distance from tip of snout to beginning of the second dorsal spine
1–9	Prev	Distance from tip of snout to anterior edge of pelvic spine
1–24	Pred-PL	Distance from tip of snout to anterior edge of base pectoral fin
1–10	Pred-A	Distance from tip of snout to anterior insertion of the anal fin
9–24	PL-PS	Distance from base of the pectoral fin to base of pelvic spine
9–10	PS-A	Distance from base of the pectoral fin to base of anal fin
1–16	Pred-S	Distance from tip of snout to anterior insertion of the dorsal fin
1–15	Pred-E	Distance from tip of snout to posterior insertion of the dorsal fin
1–14	Pred-C	Distance from tip of snout to the beginning of the caudal fin on dorsal midline (DML)
21–8	BD1	First body depth (maximum) — from base of the first dorsal spine to venter
19–9	BD2	Second body depth — distance from the second dorsal spine to the anterior edge of pelvic spine
17–10	BD3	Third body depth — distance from the third dorsal spine to anal spine
12–14	TD	Tail Depth — Distance from the beginning of the caudal fin at ventral midline (VML) and dorsal midline (DML)
23–21	T1	Distance from supraoccipital notch to the first dorsal spine
21–19	T2	Distance from the first to the second dorsal spines
19–17	T3	Distance from the second to the third dorsal spines
17–16	T4	Distance from the third dorsal spine to the insertion of the dorsal fin
1–7	T5	Distance from tip of snout to anterior border of ectocoracoid
7–8	T6	Distance from the anterior border of ectocoracoid on the ventral midline (VML) to the posterior tip of ectocoracoid
8–9	T7	Distance from pelvic spine base to the posterior tip of ectocoracoid
9–10	T8	Distance from pelvic spine base to insertion of the anal fin
11–12	T9	Distance from the beginning of the caudal fin on VML to posterior insertion of anal fin
12–13	T10	Distance from the beginning of the caudal fin on VML to the insertion of the caudal fin
13–14	T11	Distance from the beginning of the caudal fin on DML to the insertion of the caudal fin
14–15	T12	Distance from the posterior insertion of the dorsal fin to the beginning of the caudal fin on DML
11–13	LPC	Length of caudal peduncle — distance from posterior insertion of anal fin to caudal fin insertion

	Head	
1–2	ML	Mouth length
1–3	SnL	Preorbital distance — from tip of the snout to the anterior edge of the eye
1–23	HL	Head length
7–23	HD	Head depth
3–5	ED	Eye diameter
4–6	EDp	Eye depth
	Armor	
21–22	DS1	Length of the first dorsal spine
19–20	DS2	Length of the second dorsal spine
17–18	DS3	Length of the third dorsal spine
1–2 (Fig. 1c)	PGL	Ventral plate length on the ventral side
3–4 (Fig. 1c)	RPS	Right pelvic spine length on the ventral side
5–6 (Fig. 1c)	LPS	Left pelvic spine length on the ventral side
	Fins	
24–25 (Fig. 1a)	PL	Pectoral fin length
24–27 (Fig. 1a)	PLD	Pectoral fin depth
10–11 (Fig. 1a)	LA	Length of the anal fin base
15–16 (Fig. 1a)	LD	Length of the dorsal fin base

Supplement 3

Characteristics of morphometric traits of threespine stickleback from the Keret Archipelago in the White Sea. For each individual, all traits, except standard length (SL), are adjusted for SL. The differences between male and female means are expressed as a percentage of the female mean (sexual dimorphism index, SDI). Means ± SD and sexual dimorphism index (SDI=(Mm-Mf)/Mf *100) are shown. Negative value of SDI indicates that the trait is larger for females, and a positive value indicates that it is larger in males. Significant differences between the sexes (t-test) are marked by superscripts in column SDI: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$ and NS shows non-significant differences between sexes.

Trait	Adjusted mean values %		SD
	Male	Female	
SL (cm)	5.632 ± 0.2642	6.162 ± 0.3650	–8.603***
SL-standardized trait, %			
Body			
Pred-1	38.487 ± 1.279	35.892 ± 1.271	7.229***
Pred-2	49.056 ± 1.427	46.722 ± 1.388	4.995***
Prev	47.232 ± 1.942	44.679 ± 1.868	5.713***
Pred-PL	37.022 ± 1.633	33.598 ± 1.799	10.194***
PL-PS	15.016 ± 1.220	15.553 ± 1.355	–3.454***
PS-A	33.560 ± 1.893	39.263 ± 2.146	–4.526***
Pred-A	69.844 ± 1.771	72.597 ± 1.804	–3.793***
Pred-S	63.502 ± 1.695	62.910 ± 1.577	0.941***
Pred-E	87.519 ± 1.400	87.377 ± 1.650	0.163***
Pred-C	93.833 ± 0.880	94.279 ± 0.830	–0.473***
BD1	23.852 ± 1.125	23.754 ± 1.40	0.412 NS
BD2	23.537 ± 1.277	24.774 ± 1.693	–4.993***
BD3	41.247 ± 3.218	48.424 ± 3.427	–14.822***
TD	4.544 ± 0.379	4.281 ± 0.371	6.159***
T1	7.860 ± 0.964	8.388 ± 1.047	–6.298***
T2	10.926 ± 0.773	11.021 ± 0.792	–0.859*
T3	12.620 ± 1.209	14.219 ± 1.18	–11.243***
T4	2.312 ± 0.554	2.303 ± 0.467	0.389 NS
T5	30.775 ± 2.763	26.961 ± 2.679	14.146***
T6	10.726 ± 2.024	11.835 ± 2.233	–9.370***
T7	6.683 ± 1.199	6.702 ± 1.119	–0.285 NS
T8	23.992 ± 2.064	30.554 ± 2.269	–21.477***
T9	6.442 ± 1.361	6.544 ± 1.491	–1.557 NS
T10	7.065 ± 0.703	6.470 ± 0.725	9.192***
T11	6.740 ± 0.567	6.247 ± 0.556	7.901***

T12	6.617 ± 1.263	7.191 ± 1.460	–7.981***
LPC	13.440 ± 1.428	12.917 ± 1.599	4.042***
Head			
ML	8.028 ± 0.801	6.880 ± 0.796	16.687***
SnL	9.412 ± 0.949	7.774 ± 0.982	21.082***
HL	30.956 ± 1.406	27.740 ± 1.362	11.592***
HD	23.010 ± 0.925	21.482 ± 0.915	7.110***
ED	8.449 ± 0.574	7.819 ± 0.595	8.049***
EDp	8.305 ± 0.485	7.810 ± 0.480	6.339***
Armor			
DS1	11.870 ± 1.031	11.219 ± 0.986	5.809***
DS2	12.192 ± 1.070	11.733 ± 1.002	3.905***
DS3	4.351 ± 0.729	4.477 ± 0.693	–2.816***
PGL	18.121 ± 1.313	19.889 ± 1.358	–8.885***
RPS	17.360 ± 1.116	16.760 ± 1.185	3.578***
LPS	17.369 ± 1.144	16.835 ± 1.174	3.172***
Fins			
PL	20.402 ± 1.022	20.703 ± 1.085	–1.454***
PLD	6.890 ± 0.532	6.574 ± 0.513	4.804***
LA	18.999 ± 1.583	17.213 ± 1.729	10.375***
LD	25.900 ± 1.758	25.830 ± 2.025	0.003 NS

Supplement 4

Results of the Principal Component Analysis (using varimax rotation) of 43 traits of threespine stickleback. The traits are sorted according to loadings on PC1, PC2 etc. Only loadings exceeding 0.4 in absolute value are indicated. Loadings are shown for the first 11 PCs. Asterisks mark significant differences between males and females by t-test. NS means absence of significant differences. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$ and NS shows non-significant differences.

Trait	Factors										
	PC1**	PC2**	PC3**	PC4**	PC5**	PC6^{NS}	PC7^{NS}	PC8^{NS}	PC9^{NS}	PC10^{NS}	PC11^{NS}
Pred-PL	0.932										
HL	0.899										
SnL	0.871										
Pred-1	0.855										
Prev	0.802										
Pred-2	0.783										
Trait 5	0.770										
PS-A	–0.760										
T. 8	–0.739										
BD3	–0.682										
ED	0.672										
ML	0.525										
T. 3	–0.508										
PGL	–0.485										
Pred-C		0.882									
T. 11		–0.839									
T. 10		–0.826									
BD1			0.845								
BD2			0.710								
EDp			0.580								
HD			0.563								
TD			0.536								
DS2				0.801							
DS1				0.781							
LPS				0.738							
Pred-A					0.838						
T. 9						–0.904					
Lpc						–0.867					
LA						0.569					
PL-PS							0.767				

T. 7							0.765				
T. 6							0.420				
LD								0.826			
Pred-E								0779			
T. 12								–0.725			
T. 2									0.720		
Pred-S									0.513		
T. 4										0.790	
DS3										0.463	
T. 1											0.844
PL	–	–	–	–	–	–	–	–	–	–	–
PLD	–	–	–	–	–	–	–	–	–	–	–
Eigen value	11.403	5.790	2.867	2.600	2.014	1.820	1.549	1.245	1.240	1.185	1.122
% Var Explained	21.794	8.321	7.582	7.187	5.979	5.214	5.039	4.904	3.885	3.292	3.165
Cumulative %	21.794	30.115	37.697	44.884	50.863	56.077	61.116	66.020	69.905	73.197	76.361
Mean for Male	0.755	–0.239	0.089	0.158	–0.459	0.032	0.009	0.029	–0.034	–0.003	0.010
Mean for Female	–.699	0.221	–0.083	–0.146	0.425	–0.030	–0.008	–0.027	0.031	0.003	–0.009