

Supplementary material

Appendix 1

Table A1. Plumage features of breeding Black-tailed godwits accessed from ventral and dorsal photographs. Orange tones were given a standard Pantone code (PC).

Plumage Score	Range	Description
Bars extension	1-5	1= upper chest to low chest (>25%), 2= low chest to upper belly (25-50%), 3= upper belly to low belly (thy) (50-75%), 4= to legs (>75%), 5= black bars extended the legs and underneath the tail
Colour extension	1-5	1= neck (until the beginning of shoulders), 2= neck to upper chest, 3= upper chest to low chest, 4= low chest to upper belly, 5= upper belly to low belly
Bill orange extension	0-100	percentage of orange colour along the bill
Bill colour	1-5	1= pink, 2= pink-orange, 3= pale orange, 4= orange, 5= dark orange
Back wintering feathers	Count	absolute number of wintering feathers on the back

Table A2. Sex-specific PCA results of feather colouration according to the colour perception of *Scolopacidae* birds, which thus consider the following near visible cone peaks: NV - near visible; SWS – short; MWS - medium and LWS - long wavelength sensitives; DC – double-cone.

Variable	Male PCA	Female PCA
<i>Feather colour</i>		
VS	-0.9796	-0.9630
SWS	-0.9926	-0.9836
MWS	-0.9991	-0.9991
LWS	-0.9779	-0.9514
DC	-0.9965	-0.9937
Cumulative variance (%)	97.843	95.715

Table A3. GLM models used to determine the effects of innate immunity and body condition (independent variables) on SSC (dependent variables) of males (A) and females (B). The models were ranked by Akaike's Information Criteria (AIC) and chosen according to the lowest AIC values. The 30 first models are shown, and the best fitted is at the top. *BC*, Body condition; *Hp*, haptoglobin; *Agg*, agglutination; *Lys*, lysis and *Subsp*, subspecies.

A

GLM - SSC1	<i>BARS EXTENSION, % ORANGE BILL COLOUR, BILL COLOUR, NBR WINTERING FEATHERS</i>								df	AIC	P
	Var.	Var.	Var.	Var.	Var.	Var.	Var.	Var.			
1	BC								1	87.443	0.411
2	Cell PC2								1	87.470	0.420
3	Lys								1	87.524	0.440
4	Hp								1	87.558	0.454
5	Cell PC1								1	87.779	0.559
6	Agg								1	87.844	0.600
7	Subsp								1	87.961	0.690
8	BC	Hp							2	88.465	0.437
9	Lys	Cell PC2							2	88.576	0.462
10	BC	Lys							2	88.771	0.510
11	Hp	Cell PC2							2	88.776	0.511
12	BC	Cell PC2							2	88.975	0.564
13	Agg	Cell PC2							2	88.983	0.567
14	Hp	Lys							2	89.004	0.572
15	BC	Agg							2	89.098	0.600
16	Cell PC2	Subsp							2	89.133	0.611
17	Cell PC1	Cell PC2							2	89.191	0.629
18	BC	Cell PC1							2	89.254	0.649
19	Hp	Agg							2	89.284	0.658
20	Lys	Cell PC1							2	89.301	0.664
21	Hp	Subsp							2	89.356	0.683
22	Hp	Cell PC1							2	89.401	0.698
23	BC	Subsp							2	89.404	0.699
24	Lys	Agg							2	89.518	0.740
25	Lys	Subsp							2	89.519	0.741
26	Agg	Cell PC1							2	89.550	0.752
27	Cell PC1	Subsp							2	89.667	0.798
28	Agg	Subsp							2	89.827	0.864
29	BC	Hp	Lys						3	89.828	0.514
30	BC	Hp	Cell PC2						3	89.906	0.529
GLM - SSC2	<i>Colour extension</i>										
1	Hp	BC	Lys	Agg	Cell PC2	Subsp			6	55.773	0.000
2	Hp	BC	Lys	Agg	Subsp				5	56.567	0.000
3	Hp	BC	Lys	Cell PC2	Subsp				5	57.686	0.000
4	Hp	BC	Lys	Agg	Cell PC1	Cell PC2	Subsp		7	57.769	0.000
5	Hp	BC	Lys	Subsp					4	57.959	0.000
6	Hp	BC	Lys	Agg	Cell PC1	Subsp			6	58.558	0.000
7	Hp	BC	Lys	Cell PC1	Cell PC2	Subsp			6	59.681	0.000
8	Hp	Lys	Agg	Subsp					4	59.703	0.000
9	Hp	BC	Lys	Cell PC1	Subsp				5	59.955	0.000

10	Hp	Lys	Agg	Cell PC2	Subsp		5	60.609	0.000
11	Hp	Lys	Agg	Cell PC1	Subsp		5	61.416	0.000
12	Hp	Lys	Subsp				3	61.647	0.000
13	Hp	Lys	Agg	Cell PC1	Cell PC2	Subsp	6	62.110	0.000
14	BC	Lys	Agg	Cell PC2	Subsp		5	62.387	0.000
15	Hp	Lys	Cell PC2	Subsp			4	62.917	0.000
16	BC	Lys	Agg	Subsp			4	62.931	0.000
17	Lys	Agg	Subsp				3	63.115	0.000
18	Hp	BC	Subsp				3	63.157	0.000
19	Hp	BC	Cell PC2	Subsp			4	63.267	0.000
20	Hp	Lys	Cell PC1	Subsp			4	63.287	0.000
21	BC	Lys	Agg	Cell PC1	Cell PC2	Subsp	6	63.408	0.000
22	Lys	Agg	Cell PC2	Subsp			4	63.740	0.000
23	Hp	Subsp					2	63.799	0.000
24	BC	Lys	Cell PC2	Subsp			4	63.829	0.000
25	Lys	Agg	Cell PC1	Subsp			4	63.921	0.000
26	BC	Lys	Subsp				3	63.944	0.000
27	Lys	Agg	Cell PC1	Cell PC2	Subsp		5	64.146	0.000
28	BC	Lys	Agg	Cell PC1	Subsp		5	64.235	0.000
29	Hp	Lys	Cell PC1	Cell PC2	Subsp		5	64.366	0.000
30	Lys	Subsp					2	64.587	0.000
GLM – FEATHER COLOUR	<i>Breast feather colouration</i>								
1	BC						1	78.594	0.050
2	BC	Hp					2	78.680	0.056
3	Hp						1	79.550	0.089
4	Hp	Agg	Subsp				3	79.641	0.079
5	Hp	Cell PC2	Subsp				3	79.687	0.080
6	Hp	Subsp					2	79.713	0.094
7	BC	Cell PC2					2	79.737	0.095
8	BC	Subsp					2	79.800	0.098
9	Cell PC2	Subsp					2	79.803	0.098
10	BC	Cell PC1					2	79.887	0.103
11	BC	Hp	Cell PC2				3	79.924	0.089
12	Hp	Agg	Cell PC2	Subsp			4	79.930	0.075
13	BC	Hp	Subsp				3	79.954	0.090
14	Subsp						1	80.206	0.135
15	BC	Cell PC2	Subsp				3	80.241	0.102
16	Agg	Cell PC2	Subsp				3	80.263	0.103
17	Agg	Subsp					2	80.352	0.129
18	Hp	Cell PC2					2	80.462	0.137
19	BC	Hp	Agg				3	80.511	0.115
20	BC	Agg					2	80.513	0.140
21	BC	Hp	Cell PC1				3	80.551	0.117
22	BC	Hp	Cell PC2	Subsp			4	80.563	0.096
23	BC	Lys					2	80.584	0.145
24	BC	Hp	Lys				3	80.647	0.122
25	BC	Hp	Agg	Subsp			4	80.677	0.101
26	BC	Agg	Subsp				3	80.798	0.130
27	Hp	Lys	Subsp				3	80.806	0.131

28	BC	Cell PC1	Cell PC2		3	80.913	0.137
29	Hp	Lys	Cell PC2	Subsp	4	80.966	0.113
30	BC	Cell PC1	Subsp		3	81.016	0.143

B

GLM - SSC1

BARS, COLOUR EXTENSION

STEP	Var.	Var.	Var.	Var.	Var.	df	AIC	p
1	Hp	Lys	Agg			3	113.565	0.031
2	Lys	Agg				2	113.898	0.038
3	Hp	Lys	Agg	Cell PC2		4	114.447	0.041
4	Lys	Agg	Cell PC2			3	114.993	0.059
5	Hp	Lys	Agg	Cell PC1		4	115.038	0.052
6	Lys	Agg	Cell PC1			3	115.152	0.063
7	BC	Hp	Lys	Agg		4	115.512	0.063
8	Hp	Lys	Agg	Subsp		4	115.540	0.064
9	Hp	Lys	Agg	Cell PC1	Cell PC2	5	115.654	0.056
10	Lys	Agg	Subsp			3	115.759	0.083
11	BC	Lys	Agg			3	115.800	0.084
12	Lys	Agg	Cell PC1	Cell PC2		4	115.954	0.075
13	Cell PC2					1	116.002	0.119
14	Agg	Cell PC1	Cell PC2			3	116.127	0.097
15	Hp	Lys	Agg	Cell PC2	Subsp	5	116.240	0.070
16	BC	Hp	Lys	Agg	Cell PC2	5	116.371	0.073
17	Cell PC1	Cell PC2				2	116.468	0.137
18	Lys					1	116.558	0.170
19	Lys	Agg	Cell PC2	Subsp		4	116.562	0.096
20	Hp	Agg	Cell PC1	Cell PC2		4	116.583	0.097
21	Agg	Cell PC1	Cell PC2	Subsp		4	116.632	0.099
22	Agg	Cell PC1				2	116.810	0.163
23	BC	Lys	Agg	Cell PC1		4	116.826	0.107
24	BC	Hp	Lys	Agg	Cell PC1	5	116.835	0.087
25	BC	Lys	Agg	Cell PC2		4	116.865	0.109
26	Lys	Cell PC2				2	116.943	0.174
27	Lys	Agg	Cell PC1	Subsp		4	116.974	0.113
28	Hp	Lys	Agg	Cell PC1	Subsp	5	116.995	0.093
29	Cell PC1					1	117.010	0.232
30	Agg	Cell PC2				2	117.037	0.183
GLM - SSC2	% orange bill colour, nbr wintering feathers							
1	Subsp					1	118.583	0.176
2	Lys	Subsp				2	119.617	0.247
3	BC					1	119.874	0.464
4	Hp					1	120.140	0.602
5	Lys					1	120.318	0.759
6	Cell PC2					1	120.389	0.881
7	Agg					1	120.397	0.903
8	Cell PC1					1	120.397	0.904
9	Agg	Subsp				2	120.415	0.369
10	Cell PC2	Subsp				2	120.455	0.376
11	Hp	Subsp				2	120.515	0.387
12	BC	Subsp				2	120.544	0.393
13	Cell PC1	Subsp				2	120.568	0.398

14	Lys	Cell PC2	Subsp	3	121.030	0.336
15	Lys	Cell PC1	Subsp	3	121.473	0.401
16	Hp	Lys	Subsp	3	121.561	0.415
17	BC	Hp		2	121.605	0.668
18	Lys	Agg	Subsp	3	121.613	0.424
19	BC	Lys	Subsp	3	121.613	0.424
20	BC	Cell PC1		2	121.768	0.725
21	BC	Lys		2	121.798	0.736
22	BC	Agg		2	121.820	0.744
23	BC	Cell PC2		2	121.846	0.754
24	Hp	Lys		2	122.025	0.824
25	Hp	Cell PC2		2	122.102	0.857
26	Hp	Cell PC1		2	122.138	0.872
27	Hp	Agg		2	122.139	0.873
28	Lys	Agg		2	122.194	0.897
29	Lys	Cell PC1		2	122.222	0.909
30	Lys	Cell PC2		2	122.262	0.928
GLM - SSC3	<i>Bill colour</i>					
1	BC			1	118.288	0.377
2	Lys			1	118.354	0.398
3	Hp			1	118.640	0.513
4	Agg			1	118.873	0.659
5	Subsp			1	118.875	0.661
6	Cell PC2			1	118.992	0.784
7	Cell PC1			1	118.996	0.790
8	BC	Subsp		2	119.488	0.454
9	BC	Lys		2	119.623	0.486
10	Lys	Cell PC1		2	119.736	0.514
11	BC	Hp		2	119.843	0.542
12	Hp	Lys		2	119.981	0.581
13	BC	Cell PC1		2	120.015	0.591
14	BC	Agg		2	120.186	0.643
15	BC	Cell PC2		2	120.223	0.656
16	Lys	Subsp		2	120.345	0.697
17	Lys	Cell PC2		2	120.350	0.699
18	Lys	Agg		2	120.353	0.700
19	BC	Lys	Cell PC1	3	120.457	0.456
20	Hp	Cell PC1		2	120.506	0.755
21	Hp	Cell PC2		2	120.529	0.764
22	Hp	Subsp		2	120.541	0.768
23	Hp	Agg		2	120.572	0.781
24	Agg	Cell PC1		2	120.675	0.822
25	BC	Cell PC1	Subsp	3	120.726	0.505
26	Cell PC1	Subsp		2	120.752	0.854
27	Cell PC2	Subsp		2	120.758	0.856
28	Agg	Subsp		2	120.785	0.868
29	Agg	Cell PC2		2	120.797	0.873
30	Cell PC1	Cell PC2		2	120.922	0.930
GLM – FEATHER COLOUR	<i>Breast feather colouration</i>					
1	Cell PC1			1	124.597	0.161

2	Lys	Cell PC1			2	125.091	0.176
3	BC				1	125.702	0.354
4	Cell PC1	Subsp			2	125.818	0.254
5	Hp	Cell PC1			2	125.827	0.255
6	Cell PC2				1	126.023	0.463
7	Cell PC1	Cell PC2			2	126.034	0.283
8	Hp				1	126.122	0.508
9	BC	Cell PC1			2	126.202	0.308
10	Subsp				1	126.226	0.563
11	Agg				1	126.258	0.583
12	Hp	Lys	Cell PC1		3	126.307	0.235
13	Lys				1	126.414	0.702
14	Lys	Agg	Cell PC1		3	126.488	0.254
15	Agg	Cell PC1			2	126.589	0.373
16	BC	Lys	Cell PC1		3	126.794	0.288
17	Lys	Cell PC1	Subsp		3	126.872	0.297
18	Lys	Cell PC1	Cell PC2		3	126.925	0.304
19	Hp	Lys	Agg	Cell PC1	4	127.042	0.238
20	Cell PC1	Cell PC2	Subsp		3	127.096	0.325
21	BC	Cell PC2			2	127.126	0.488
22	Hp	Cell PC1	Cell PC2		3	127.187	0.338
23	BC	Hp			2	127.259	0.522
24	Hp	Cell PC1	Subsp		3	127.295	0.352
25	BC	Hp	Cell PC1		3	127.464	0.377
26	Hp	Agg			2	127.491	0.586
27	BC	Lys			2	127.516	0.593
28	BC	Agg			2	127.518	0.594
29	Hp	Cell PC2			2	127.530	0.597
30	Agg	Subsp			2	127.534	0.598

Table A4. GLM full model results testing the effects of male and female Black-tailed godwit breeding plumage features on baseline constitutive innate immunity. *BC*, Body condition; *Hp*, haptoglobin; *Agg*, agglutination and *Lys*, lysis. Cell PC1 corresponds to lymphocyte & heterophil proportions and H/L index and Cell PC2 to eosinophil & monocyte proportions and WBC. Significant results ($p < 0.05$) are in bold.

Females	<i>SSC1 (Bars and colour extension)</i>					<i>SSC2 (% orange bill col & nbr wintering feathers)</i>					<i>SSC3 (bill colour)</i>					<i>Feather coloration</i>				
	SS	df	MS	F	<i>p</i>	SS	df	MS	F	<i>p</i>	SS	df	MS	F	<i>p</i>	SS	df	MS	F	<i>p</i>
BC	0.072	1	0.072	0.080	0.780	0.000	1	0.000	0.000	0.998	1.762	1	1.762	1.607	0.214	0.016	1	0.016	0.014	0.905
Hp (mg/ml)	1.503	1	1.503	1.666	0.206	0.030	1	0.030	0.026	0.873	0.551	1	0.551	0.503	0.483	1.102	1	1.102	1.016	0.320
Lys titre	1.469	1	1.469	1.628	0.211	1.299	1	1.299	1.143	0.293	0.848	1	0.848	0.774	0.385	1.301	1	1.301	1.200	0.281
Agg titre	4.376	1	4.376	4.849	0.035	0.005	1	0.005	0.004	0.950	0.244	1	0.244	0.222	0.640	1.018	1	1.018	0.939	0.339
Cell PC	0.734	1	0.734	0.813	0.374	0.200	1	0.200	0.176	0.677	1.352	1	1.352	1.233	0.275	2.654	1	2.654	2.448	0.127
Cell PC2	1.180	1	1.180	1.308	0.261	0.670	1	0.670	0.590	0.448	0.003	1	0.003	0.002	0.961	0.147	1	0.147	0.136	0.714
Subspecies	0.074	1	0.074	0.082	0.776	2.160	1	2.160	1.900	0.177	0.398	1	0.398	0.363	0.551	0.131	1	0.131	0.121	0.730
Males	<i>SSC1 (Bars ext, % orange bill col, bill col & nbr wintering feathers)</i>					<i>SSC2 (colour extent)</i>					<i>Feather coloration</i>									
	SS	df	MS	F	<i>p</i>	SS	df	MS	F	<i>p</i>	SS	df	MS	F	<i>p</i>					
BC	0.840	1	0.840	0.710	0.409	1.664	1	1.664	5.178	0.033	0.488	1	0.488	0.502	0.487					
Hp (mg/ml)	0.885	1	0.885	0.747	0.397	2.050	1	2.050	6.380	0.019	0.910	1	0.910	0.937	0.345					
Lysis titre	0.357	1	0.357	0.302	0.588	3.213	1	3.213	10.001	0.005	0.000	1	0.000	0.000	0.983					
Agg titre	0.016	1	0.016	0.014	0.908	0.984	1	0.984	3.064	0.094	0.435	1	0.435	0.448	0.511					
Cell PC1	0.012	1	0.012	0.010	0.920	0.001	1	0.001	0.003	0.959	0.099	1	0.099	0.102	0.753					
Cell PC2	0.660	1	0.660	0.557	0.463	0.689	1	0.689	2.143	0.157	0.990	1	0.990	1.019	0.325					
Subspecies	0.053	1	0.053	0.044	0.835	13.945	1	13.945	43.403	0.000	1.723	1	1.723	1.775	0.198					

Table A5. Mann-Whitney results testing for the effects of sex over Black-tailed godwit breeding plumage features. Significant results ($p < 0.05$) are in bold.

Breeding plumage features	U	Z	p
<i>Bars extension</i>	358.000	-3.511	0.000
<i>Colour extension</i>	502.500	-1.980	0.048
<i>Bill (% of orange)</i>	489.000	-1.745	0.081
<i>Bill colour</i>	638.000	-0.414	0.679
<i>Nbr of wintering feathers</i>	398.500	2.991	0.003
<i>Feather colouration</i>	609.000	0.233	0.816

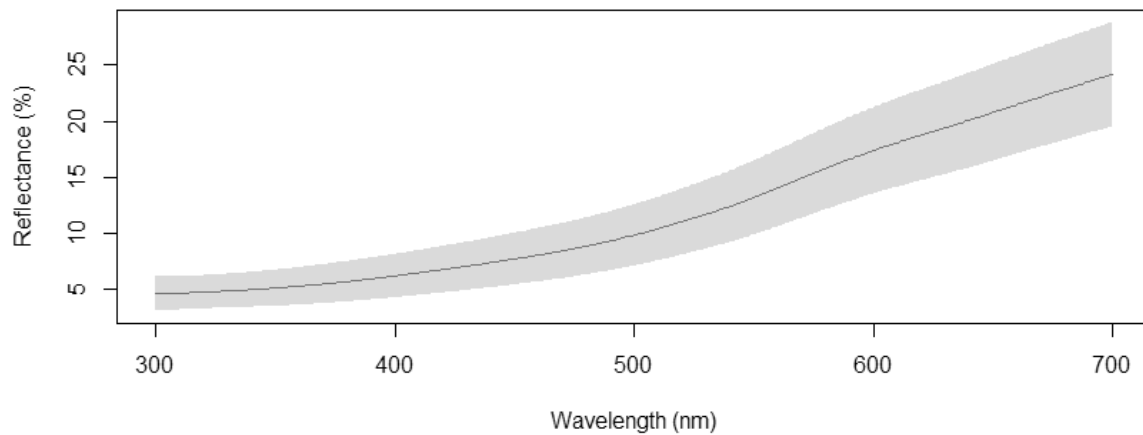


Figure A1. Reflectance spectra of melanin pigments. Black line and shaded area represents, respectively, the median value the standard deviation of all feather readings performed in this study. Measurements were taken with Ocean Optics USB4000 spectrophotometer.

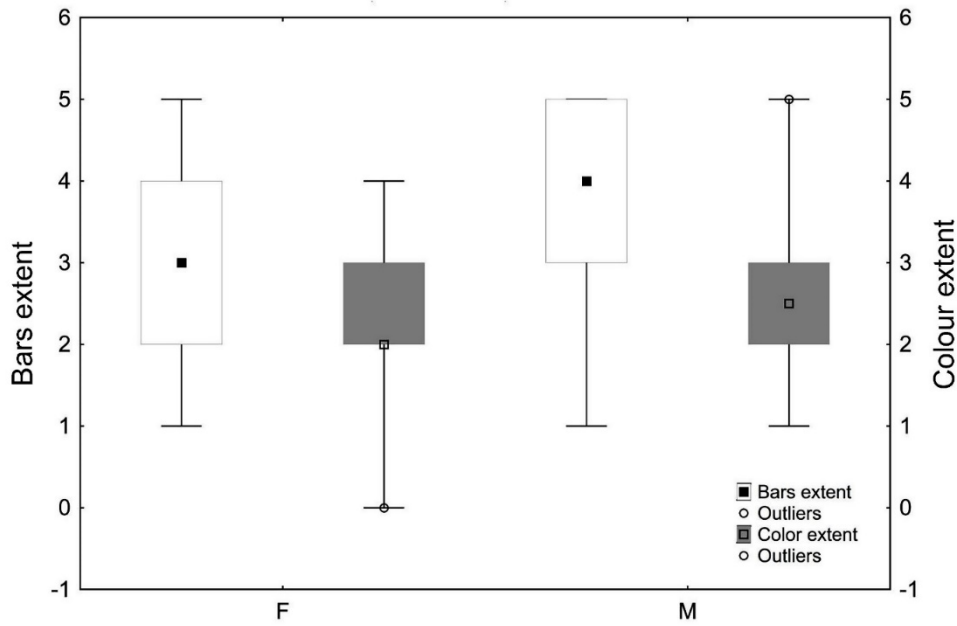


Figure A2. Box and Whiskers plots for the bar and colour extension plumage scores attributed to males and females. Middle point is the median value; box represent the 25-75% percentiles and the whiskers the minimum and maximum values. Outliers are represented by open circles. For details of the given scores of breeding plumage features see Table A1.

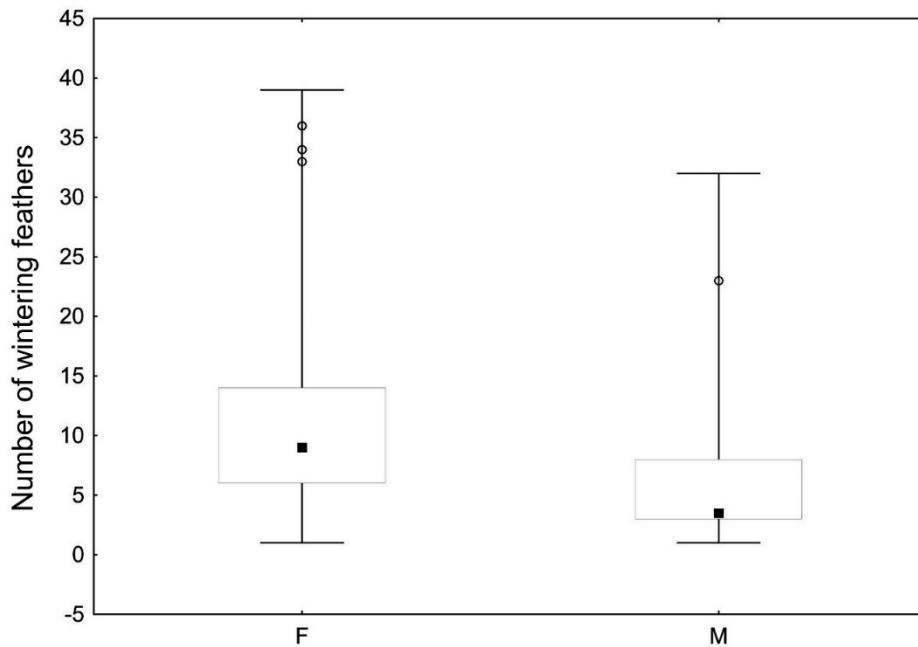


Figure A3. Box and Whiskers plots for the number of wintering feathers present on the breeding plumage of males and females. Middle point is the median value; box represents the 25-75% percentiles and the whiskers the minimum and maximum values. Outliers are shown by open circles. For details of the given scores of breeding plumage features see Table A1.