Supporting information

Abundance and trait-matching both shape interaction frequencies between plants and birds in seed-dispersal networks

APPENDIX 1- Morphological traits of fleshy-fruited plants and legitimate avian frugivores of the Cantabrian Range (northern Iberian Peninsula).

Table S1.1. Average values of morphological traits of fleshy-fruited plant species.

Species	Common name	Acronym	Fruit width (mm)	Height (m)
Crataegus monogyna	Hawthorn	Cramon	9.54	9.00
Ilex aquifolium	Holly	Ileaqu	8.96	12.00
Rubus fruticosus/ulmifolius	Bramble/blackberries	Rubfru	3.57	1.50
Sambucus nigra	Elder	Samnig	5.01	4.00
Sorbus aria	Whitebeam	Sorari	11.34	18.00
Sorbus aucuparia	Rowan	Sorauc	10.35	20.00
Taxus baccata	Yew	Taxbac	9.37	25.00

Table S1.2. Average values of morphological traits of frugivores and legitimate seed dispersers.

Species	Common name	Acronym	Bill width (mm)	Kipp's index
Erithacus rubecula	European robin	Erirub	7.28	0.22
Garrulus glandarius	Eurasian jay	Gargla	17.60	0.19
Sylvia atricapilla	Eurasian blackcap	Sylatr	7.48	0.27
Turdus iliacus	Redwing	Turili	10.78	0.32
Turdus merula	Common blackbird	Turmer	12.39	0.23
Turdus phillomelos	Song thrush	Turphi	12.20	0.32
Turdus pilaris	Fieldfare	Turpil	12.90	0.33
Turdus torquatus	Ring ouzel	Turtor	13.37	0.31
Turdus viscivorus	Mistle thrush	Turvis	13.05	0.35

APPENDIX 2- Relationship between plant and bird species abundances with their degree of specialization (d'). Plant-bird pairwise interactions of fleshy fruited plants and avian seed dispersers and their abundances.

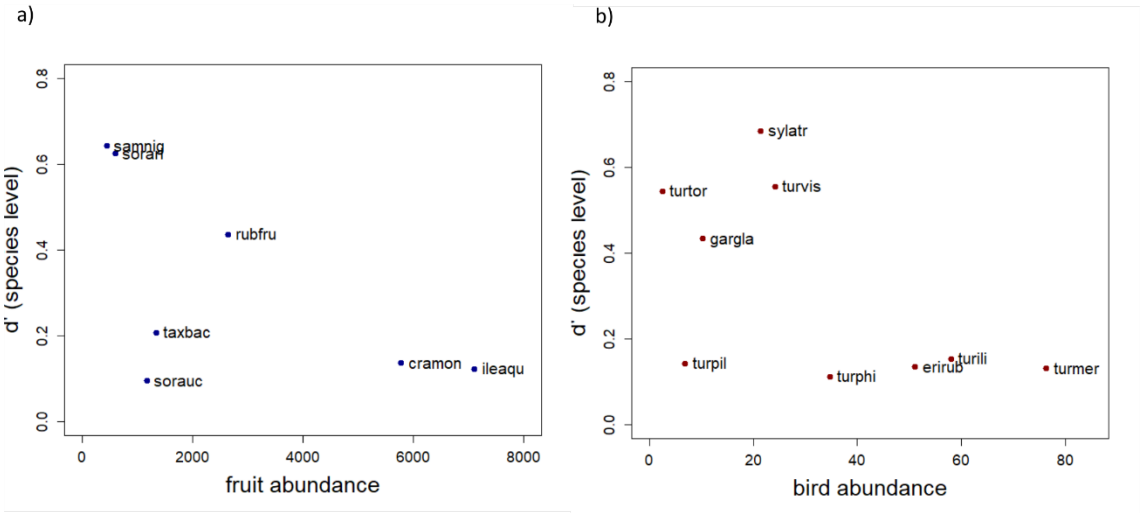

Figure S2. Relationship between the degree of specialization (d') of each fleshy-fruited plant and bird species —estimated from the plant-frugivore regional network (two pooled years) — and species abundances —as the cumulative number of individuals of each species observed in the two sampled years (squared root-transformed)— for a) plants and b) birds. Points represent each species, and species names are indicated by their acronyms (see tables S1.1 and S1.2)

Table S2.1 Cumulative and relative abundances and the relative interaction frequency of each fleshy-fruited plant species per sampled year.

Year	2012			2013		
Plant species	**Fruit abundance**	**Relative abundance**	**Interaction frequency**	**Fruit abundance**	**Relative abundance**	**Interaction frequency**
Cramon	16804146	0.5	0.745	16590478	0.272	0.346
Ileaqu	10627070	0.316	0.064	39833401	0.654	0.43
Rubfru	4810249	0.143	0.053	2170409	0.036	0.042
Samnig	104060	0.003	0.001	90006	0.001	0.053
Sorari	280	0	0.003	354104	0.006	0.065
Sorauc	165901	0.005	0.021	1199055	0.02	0.055
Taxbac	1130001	0.034	0.113	650543	0.011	0.008

Table S2.2 Cumulative and relative abundances and the relative interaction frequency of each avian frugivore species per sampled year.

Year	2012			2013		
Bird species	**Bird abundance**	**Relative abundance**	**Interaction frequency**	**Bird abundance**	**Relative abundance**	**Interaction frequency**
Erirub	889	0.136	0.021	1724	0.224	0.015
Gargla	53	0.008	0.004	52	0.007	0.002
Sylatr	187	0.029	0.037	273	0.035	0.08
Turili	1541	0.237	0.206	1825	0.237	0.144
Turmer	2535	0.389	0.544	3304	0.429	0.625
Turphi	864	0.133	0.114	342	0.044	0.072
Turpil	47	0.007	0.049	0	0	0
Turvis	398	0.061	0.025	184	0.024	0.057
Turtor	0	0	0	6	0.001	0.005

Table S2.3 Common pairwise interactions for each sampled year indicating the frequency of each pairwise interaction (IF).

			2012						2013					
	Bird species	Plant species	N. Interactions	Relative IF	Bird abundance	Bird relative abundance	Fruit abundance	Fruit relative abundance	N. Interactions	Relative IF	Bird abundance	Bird relative abundance	Fruit abundance	Fruit relative abundance
1	**Erirub**	**Cramon**	18	0.014	889	0.136	16804146	0.500	11	0.007	1724	0.224	16590478	0.272
2	**Erirub**	**Rubfru**	7	0.005	889	0.136	4810249	0.143	8	0.005	1724	0.224	2170409	0.036
3	**Gargla**	**Rubfru**	4	0.003	53	0.008	4810249	0.143	3	0.002	52	0.007	2170409	0.036
4	**Sylatr**	**Cramon**	1	0.001	187	0.029	16804146	0.500	3	0.002	273	0.035	16590478	0.272
5	**Sylatr**	**Rubfru**	38	0.029	187	0.029	4810249	0.143	37	0.023	273	0.035	2170409	0.036
6	**Sylatr**	**Samnig**	1	0.001	187	0.029	104060	0.003	76	0.047	273	0.035	90006	0.001
7	**Turili**	**Cramon**	195	0.150	1541	0.237	16804146	0.500	46	0.029	1825	0.237	16590478	0.272
8	**Turili**	**Ileaqu**	68	0.052	1541	0.237	10627070	0.316	186	0.116	1825	0.237	39833401	0.654
9	**Turmer**	**Cramon**	625	0.479	2535	0.389	16804146	0.500	424	0.264	3304	0.429	16590478	0.272
10	**Turmer**	**Ileaqu**	10	0.008	2535	0.389	10627070	0.316	457	0.284	3304	0.429	39833401	0.654
11	**Turmer**	**Rubfru**	8	0.006	2535	0.389	4810249	0.143	20	0.012	3304	0.429	2170409	0.036
12	**Turmer**	**Sorauc**	27	0.021	2535	0.389	165901	0.005	77	0.048	3304	0.429	1199055	0.020
13	Turmer	Taxbac	40	0.031	2535	0.389	1130001	0.034	7	0.004	3304	0.429	650543	0.011
14	**Turphi**	**Cramon**	63	0.048	864	0.133	16804146	0.500	68	0.042	342	0.044	16590478	0.272
15	**Turphi**	**Ileaqu**	6	0.005	864	0.133	10627070	0.316	34	0.021	342	0.044	39833401	0.654
16	Turphi	Taxbac	68	0.052	864	0.133	1130001	0.034	1	0.001	342	0.044	650543	0.011
17	**Turvis**	**Cramon**	10	0.008	398	0.061	16804146	0.500	5	0.003	184	0.024	16590478	0.272
18	**Turvis**	**Sorari**	3	0.002	398	0.061	280	0.000	75	0.047	184	0.024	354104	0.006
19	Turvis	Taxbac	20	0.015	398	0.061	1130001	0.034	5	0.003	184	0.024	650543	0.011
				0.929						0.960				

Table S2.4 Pairwise interactions that occurred exclusively in only sampled year and their relative interaction frequencies (IF).

			2012						2013					
	Bird species	**Plant species**	N. Interactions	Relative IF	Bird abundance	Bird relative abundance	Fruit abundance	Fruit relative abundance	N. Interactions	Relative IF	Bird abundance	Bird relative abundance	Fruit abundance	Fruit relative abundance
1	Turpil	Cramon	59	0.045	47	0.007	16804146	0.500	0	0	0	0	0	0
2	Turpil	Taxbac	5	0.004	47	0.007	1130001	0.034	0	0	0	0	650543	0.011
3	Turphi	Rubfru	12	0.009	864	0.133	4810249	0.143	0	0	342	0.044	2170409	0.036
4	Sylatr	Sorari	1	0.001	187	0.029	280	0.000	0	0	273	0.035	354104	0.006
5	Erirub	Taxbac	2	0.001	889	0.136	1130001	0.034	0	0	1724	0.224	650543	0.011
6	Gargla	Taxbac	1	0.001	53	0.008	1130001	0.034	0	0	52	0.007	650543	0.011
7	Sylatr	Taxbac	7	0.005	187	0.029	1130001	0.034	0	0	273	0.035	650543	0.011
8	Turili	Taxbac	5	0.004	1541	0.237	1130001	0.034	0	0	1825	0.237	650543	0.011
9	Turtor	Sorari	0	0	0	0	280	0.000	8	0.005	6	0.001	354104	0.006
10	erirub	ileaqu	0	0	889	0.136	10627070	0.316	1	0.001	1724	0.224	39833401	0.654
11	Sylatr	ileaqu	0	0	187	0.029	10627070	0.316	7	0.004	273	0.035	39833401	0.654
12	Turvis	ileaqu	0	0	398	0.061	10627070	0.316	6	0.004	184	0.024	39833401	0.654
13	Erirub	samnig	0	0	889	0.136	104060	0.003	3	0.002	1724	0.224	90006	0.001
14	Turmer	samnig	0	0	2535	0.389	104060	0.003	7	0.004	3304	0.429	90006	0.001
15	Turphi	sorari	0	0	864	0.133	280	0.000	8	0.005	342	0.044	354104	0.006
16	erirub	sorauc	0	0	889	0.136	165901	0.005	1	0.001	1724	0.224	1199055	0.020
17	Sylatr	sorauc	0	0	187	0.029	165901	0.005	5	0.003	273	0.035	1199055	0.020
18	Turphi	sorauc	0	0	864	0.133	165901	0.005	5	0.003	342	0.044	1199055	0.020
19	Turvis	soraur	0	0	398	0.061	165901	0.005	1	0.001	184	0.024	1199055	0.020

APPENDIX 3- Trait matching and optimal ratio approach.

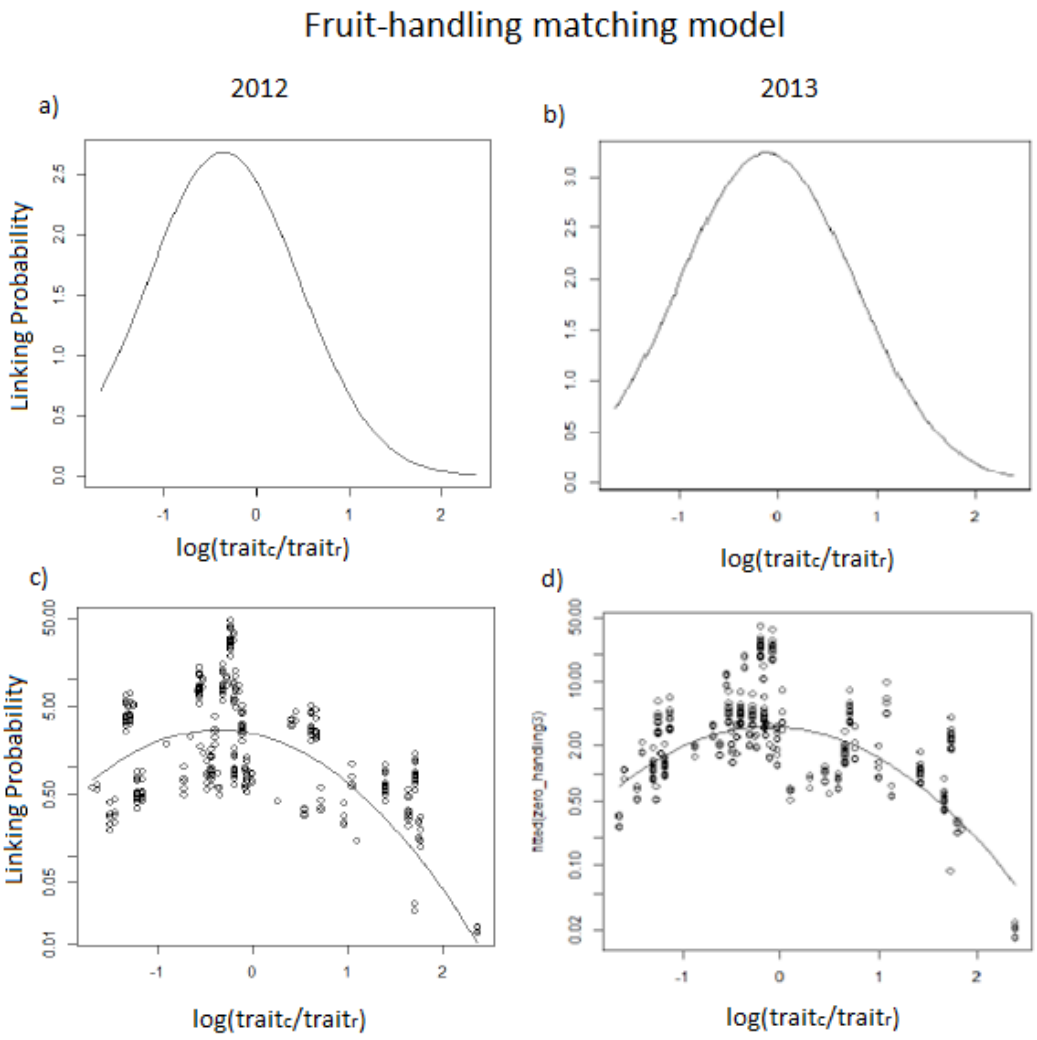

Figure S3.1 The black curves illustrated the part of the fitted linking probabilities contributed by the ratio terms of the corresponding fruit-handling model of matching for each sampling year, a) 2012 and b) 2013); c-d) White circles correspond to the observed pairwise interactions between plants and birds ($log(trait_c/trait_r)$ data was scaled to zero mean and unit variance; max-min ($trait_c/trait_r$) = 4.93 - 0.64 ; mean+SD = 1.71 ± 0.50, median=1.36).

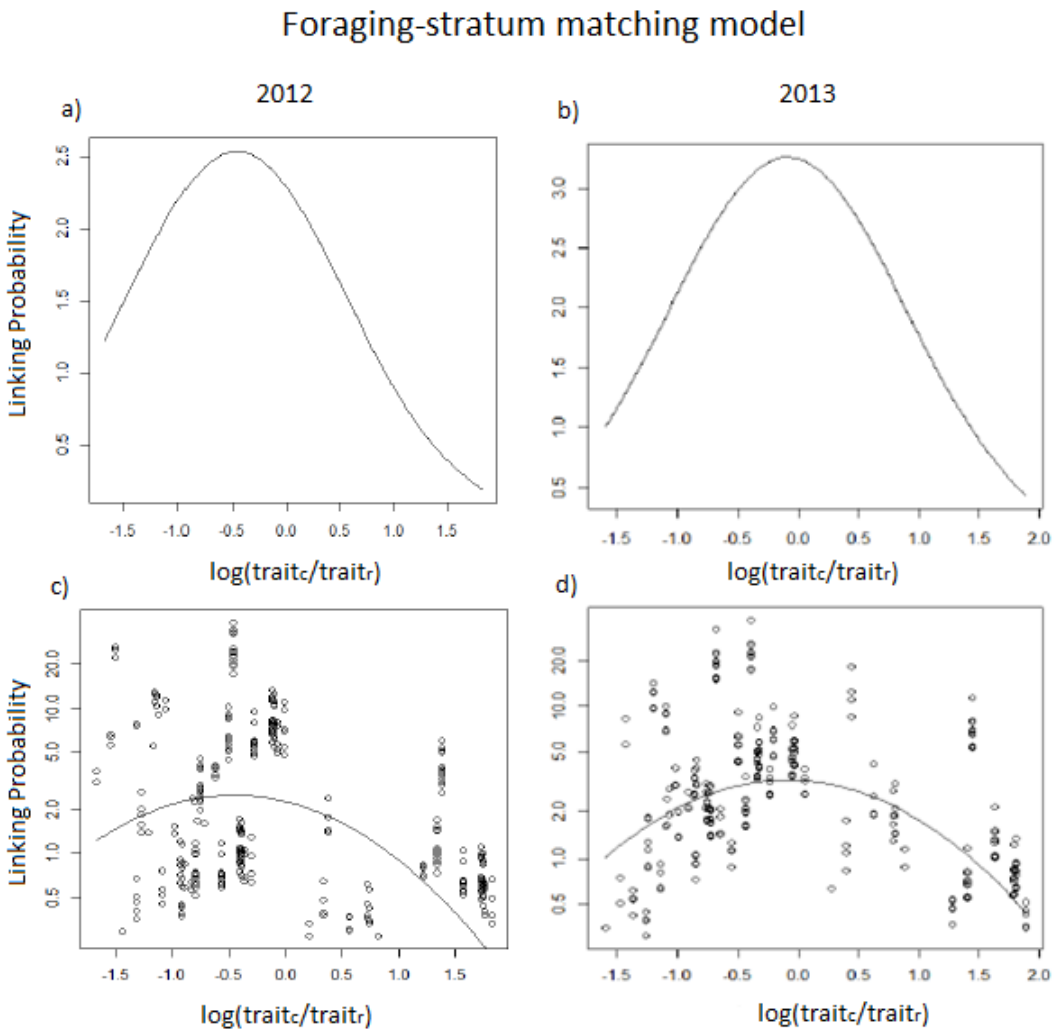

Figure S3.2 The black curves illustrated the part of the fitted linking probabilities contributed by the ratio terms of the corresponding foraging-stratum model of matching for each sampled year, a) 2012 and b) 2013); c-d) White circles correspond to the observed pairwise interactions between plants and birds ($log(trait_c/trait_r)$ data was scaled to zero mean and unit variance; max-min ($trait_c/trait_r$) = 0.01 - 0.23; mean ± SD = 0.06 ± 0.07, median= 0.03).

APPENDIX 4- Relationship between species relative abundances and values of matching traits for (a-b) fleshy-fruited plants and (c-d) avian frugivores of the Cantabrian Range (northern Iberian Peninsula).

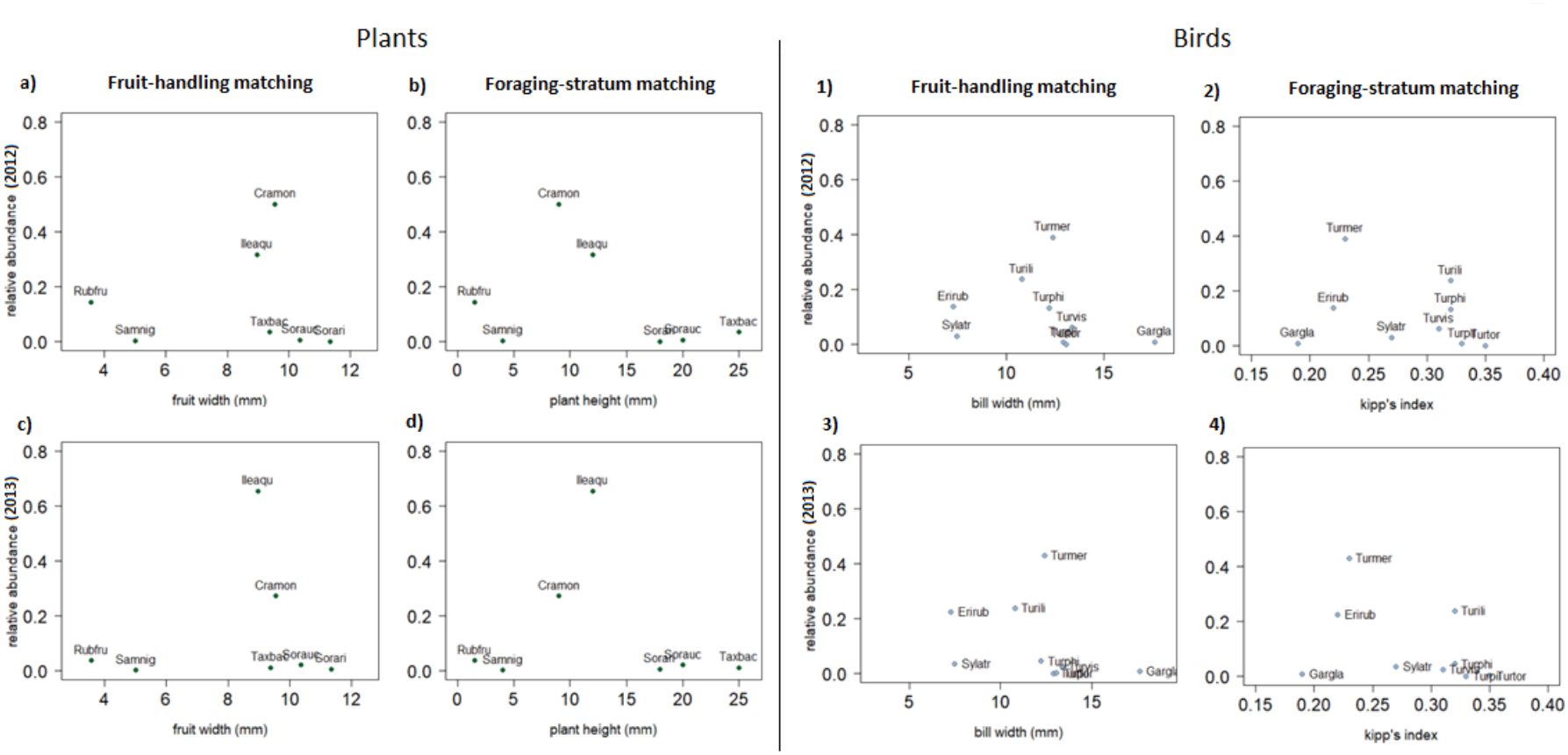

Figure S4.1 Relationship between relative abundances for each sampled year, 2012 (bottom) and 2013 (dawn), and values of species functional traits used for estimating fruit-handling and foraging-stratum trait-matching (see Methods) between fleshy fruited plants (a-d) and avian frugivores (1-4). Points represent each species, and species names are indicated by their acronyms (see tables S1.1 and S1.2).