Oikos

o19592

Gilarranz, L. J., Pastor, J. M. and Galeano, J. 2012. The architecture of weighted mutualistic networks. – Oikos 121: 1154–1162.

Appendix 1

Table 1. Analyzed networks: available from <www.nceas.ucsb.edu/interactionweb/resources.html>. For the networks from Vázquez and Simberloff (2003), an * represents grazed sites.

	Network	No of animals	No. of plants	Total no. of species	Data type
plant-pollinator	Kato et al. (1990)	679	93	772	individuals caught
	Elberling and Olesen (1999)	118	23	141	no. visits
	Inouye and Pyke (1988)	91	42	133	individuals caught
	Barrett and Helenurm (1987)	102	12	114	individuals caught
	Memmott (1999)	79	25	104	fequency of visits
	Ollerton et al. (2003)	56	9	65	individuals caught
	Motten (1982)	44	13	57	no. visits
	Small (1976)	34	13	47	individuals caught
	Vázquez and Simberloff (2003) - 4 - Mascardi	35	8	43	no. visits
	Vázquez and Simberloff (2003) - 2 - Cerro Lopez *	33	9	42	no. visits
	Schemske et al. (1978)	32	7	39	no. visits
	Vázquez and Simberloff (2003) - 1 - Arroyo Goye *	29	10	39	no. visits
	Vázquez and Simberloff (2003) - 3 - Llao Llao	29	10	39	no. visits
	Vázquez and Simberloff (2003) - 6 - Safariland	27	9	36	no. visits
	Vázquez and Simberloff (2003) - 8 - Quetrihue *	27	8	35	no. visits
	Vázquez and Simberloff (2003) - 5 - Mascardi *	26	8	34	no. visits
	Vázquez and Simberloff (2002) - 7 - Quetrihue	24	7	31	no. visits
	Mosquin and Martin (1967)	18	11	29	individuals caught
	Olesen et al. (2002) - Azores	13	14	27	no. visits
	Olesen et al. (2002) - Mauritius	12	10	22	no. visits
plant-seed disperser	Schleuning et al. (2010)	95	26	121	no. visits
	Snow and Snow (1971)	65	14	79	no. visits
	Snow and Snow (1988)	19	29	42	no. visits
	Beehler (1983)	9	31	40	no. visits
	Sorensen (1981)	14	11	26	no. visits
	Poulin et al. (1999)	11	13	24	fruits removed
plant-ant	Blüthgen et al. (2004)	51	41	92	no. visits
	Fonseca and Ganade (1996)	25	16	41	no. visits
	Davidson and Fisher (1991)	6	4	10	no. visits

Table 2. Contains *β* exponents (exp ± error) obtained from the power-law fits in the plots of strength versus degree for animals, plants and all species together.

	Network	Animals		Plants		Total	
		exp ± error	R^2	exp ± error	R^2	exp ± error	R^2
plant-pollinator	Kato et al. (1990)	1.28 ± 0.23	0.910	1.09 ± 0.09	0.950	1.05 ± 0.10	0.931
	Elberling and Olesen (1999)	1.34 ± 0.37	0.894	1.18 ± 0.13	0.974	1.12 ± 0.18	0.927
	Inouye and Pyke (1988)	1.49 ± 0.56	0.716	0.99 ± 0.43	0.640	1.13 ± 0.38	0.712
	Barrett and Helenurm (1987)	1.60 ± 0.84	0.876	0.99 ± 0.57	0.670	0.92 ± 0.42	0.703
	Memmott (1999)	1.80 ± 0.25	0.953	1.64 ± 0.26	0.926	1.53 ± 0.24	0.907
	Ollerton et al. (2003)	2.53 ± 0.80	0.951	1.03 ± 0.75	0.652	1.34 ± 0.59	0.716
	Motten (1982)	2.39 ± 1.12	0.820	1.72 ± 0.53	0.874	1.63 ± 0.57	0.762
	Small (1976)	0.49 ± 0.53	0.364	1.15 ± 0.50	0.811	0.74 ± 0.34	0.630
	Vázquez and Simberloff (2003) - 4	1.76 ± 3.00	0.760	1.19 ± 1.26	0.750	1.19 ± 0.95	0.674
	Vázquez and Simberloff (2003) - 2	2.21 ± 2.30	0.895	-0.05 ± 1.43	0.003	0.48 ± 1.11	0.197
	Schemske et al. (1978)	2.40 ± 1.42	0.964	0.91 ± 0.69	0.852	1.13 ± 0.55	0.807
	Vázquez and Simberloff (2003) - 1	1.69 ± 3.27	0.712	0.99 ± 1.89	0.481	0.93 ± 1.19	0.447
	Vázquez and Simberloff (2003) - 3	1.83 ± 3.51	0.715	0.45 ± 1.76	0.183	0.87 ± 1.57	0.369
	Vázquez and Simberloff (2003) - 6	-1.28 ± 2.78	0.664	1.33 ± 2.12	0.571	0.88 ± 1.93	0.284
	Vázquez and Simberloff (2003) - 8	2.15 ± 1.60	0.859	-0.10 ± 1.13	0.014	0.89 ± 0.73	0.595
	Vázquez and Simberloff (2003) - 5	1.38 ± 2.60	0.722	0.03 ± 0.85	0.002	0.46 ± 0.78	0.312
	Vázquez and Simberloff (2003) - 7	1.90 ± 37.69	0.292	0.78 ± 3.10	0.177	0.80 ± 2.08	0.222
	Mosquin and Martin (1967)	1.07 ± 1.04	0.782	1.67 ± 0.92	0.862	1.14 ± 0.72	0.765
	Olesen et al. (2002) - Azores	1.15 ± 1.70	0.377	0.21 ± 1.18	0.040	0.96 ± 0.96	0.446
	Olesen et al. (2002) - Mauritius	1.40 ± 0.93	0.885	1.83 ± 1.12	0.900	1.41 ± 0.46	0.948
plant-seed disperser	Schleuning et al. (2010)	1.44 ± 0.43	0.743	1.58 ± 0.34	0.847	1.43 ± 0.25	0.853
	Snow and Snow (1971)	1.61 ± 0.61	0.800	1.76 ± 0.45	0.881	1.43 ± 0.29	0.847
	Snow and Snow (1988)	2.14 ± 0.68	0.781	2.33 ± 1.15	0.699	2.04 ± 0.54	0.788
	Beehler (1983)	1.95 ± 0.58	0.919	1.91 ± 0.84	0.807	1.63 ± 0.37	0.871
	Sorensen (1981)	0.88 ± 3.06	0.139	2.44 ± 1.91	0.683	1.54 ± 1.69	0.453
	Poulin et al. (1999)	1.80 ± 0.46	0.938	1.62 ± 0.91	0.808	1.77 ± 0.49	0.897
plant-ant	Blüthgen et al. (2004)	1.45 ± 0.14	0.969	1.35 ± 0.14	0.965	1.40 ± 0.12	0.973
	Fonseca and Ganade (1996)	1.03 ± 4.64	0.312	1.24 ± 1.55	0.550	1.03 ± 1.08	0.636
	Davidson and Fisher (1991)	0.49 ± 2.34	0.876	0.21 ± 0.44	0.673	0.40 ± 0.46	0.717

Table 3. Fit parameters of interaction-weight distribution to a power-law $P(w) \approx w^{-\gamma}$ or to a truncated power-law $P(w) \approx w^{-\gamma} \exp(-w/w_c)$

	Network	γ ± error	w_c ± error	R^2	Best fit
plant-pollinator	Kato et al. (1990)	-1.58 ± 0.03		0.995	power-law
	Elberling and Olesen (1999)	-1.93 ± 0.06		0.996	power-law
	Inouye and Pyke (1988)	-1.01 ± 0.03		0.990	power-law
	Barrett and Helenurm (1987)	-1.03 ± 0.04		0.991	power-law
	Memmott (1999)	-0.81 ± 0.02		0.996	power-law
	Ollerton et al. (2003)	-0.90 ± 0.03		0.990	power-law
	Motten (1982)	-0.73 ± 0.01		0.996	power-law
	Small (1976)	-0.36 ± 0.02	12 ± 0.7	0.997	truncated power-law
	Vázquez and Simberloff (2003) - 4	-0.57 ± 0.02		0.993	power-law
	Vázquez and Simberloff (2003) - 2	-0.61 ± 0.02		0.994	power-law
	Schemske et al. (1978)	-0.99 ± 0.04		0.990	power-law
	Vázquez and Simberloff (2003) - 1	-0.58 ± 0.01		0.998	power-law
	Vázquez and Simberloff (2003) - 3	-0.54 ± 0.03		0.990	power-law
	Vázquez and Simberloff (2003) - 6	-0.55 ± 0.04		0.970	power-law
	Vázquez and Simberloff (2003) - 8	-0.53 ± 0.03		0.985	power-law
	Vázquez and Simberloff (2003) - 5	0.76 ± 0.05		0.980	power-law
	Vázquez and Simberloff (2003) - 7	-0.52 ± 0.03		0.990	power-law
	Mosquin and Martin (1967)	-0.94 ± 0.02		0.999	power-law
	Olesen et al. (2002) - Azores	-0.12 ± 0.03	35 ± 5	0.970	truncated power-law
	Olesen et al. (2002) - Mauritius	-0.52 ± 0.08	150 ± 60	0.980	truncated power-law
plant-seed disperser	Schleuning et al. (2010)	-0.6 ± 0.01	37 ± 3	0.997	truncated power-law
	Snow and Snow (1971)	-0.48 ± 0.02	25 ± 2	0.996	truncated power-law
	Snow and Snow (1988)	-0.29 ± 0.01	300 ± 20	0.930	truncated power-law
	Beehler (1983)	-0.48 ± 0.02	32 ± 4	0.996	truncated power-law
	Sorensen (1981)	-0.54 ± 0.02		0.980	power-law
	Poulin et al. (1999)	-0.63 ± 0.04	25 ± 6	0.996	truncated power-law
plant-ant	Blüthgen et al. (2004)	-1.46 ± 0.02		0.999	power-law
	Fonseca and Ganade (1996)	-1.1 ± 0.12		0.970	power-law
	Davidson and Fisher (1991)	-0.09 ± 0.08	16 ± 4	0.970	truncated power-law

Table 4. Contains θ exponents (exp ± error) for average weight as a function of link end point degree.

	Network	Exp ± error	R^2
plant-pollinator	Kato et al. (1990)	0.17 ± 0.06	0.116
	Elberling and Olesen (1999)	0.21 ± 0.10	0.196
	Inouye and Pyke (1988)	0.24 ± 0.17	0.078
	Barrett and Helenurm (1987)	0.20 ± 0.23	0.070
	Memmott (1999)	0.85 ± 0.17	0.474
	Ollerton et al. (2003)	0.62 ± 0.39	0.266
	Motten (1982)	0.87 ± 0.38	0.358
	Small (1976)	-0.18 ± 0.27	0.035
	Vázquez and Simberloff (2003) - 4	0.46 ± 0.80	0.124
	Vázquez and Simberloff (2003) - 2	-0.51 ± 0.50	0.223
	Schemske et al. (1978)	0.37 ± 0.47	0.166
	Vázquez and Simberloff (2003) - 1	-0.12 ± 0.72	0.012
	Vázquez and Simberloff (2003) - 3	-0.01 ± 0.81	0.000
	Vázquez and Simberloff (2003) - 6	-0.49 ± 1.10	0.118
	Vázquez and Simberloff (2003) - 8	0.20 ± 0.74	0.019
	Vázquez and Simberloff (2003) - 5	-0.45 ± 0.73	0.119
	Vázquez and Simberloff (2003) - 7	-0.24 ± 1.70	0.020
	Mosquin and Martin (1967)	0.36 ± 0.35	0.207
	Olesen et al. (2002) - Azores	0.73 ± 0.76	0.207
	Olesen et al. (2002) - Mauritius	0.46 ± 0.43	0.362
plant-seed disperser	Schleuning et al. (2010)	0.56 ± 0.12	0.321
	Snow and Snow (1971)	0.70 ± 0.23	0.305
	Snow and Snow (1988)	1.16 ± 0.42	0.281
	Beehler (1983)	1.10 ± 0.34	0.554
	Sorensen (1981)	0.23 ± 1.20	0.012
	Poulin et al. (1999)	0.84 ± 0.43	0.368
plant-ant	Blüthgen et al. (2004)	0.48 ± 0.09	0.470
	Fonseca and Ganade (1996)	-0.03 ± 0.80	0.001
	Davidson and Fisher (1991)	-0.67 ± 0.66	0.509

Table 5a. Exponents of power-law fits (exp ± error) of the weighted average degree of nearest neighbors, K_{nn}^{w} fit, for animals, plants, and all species together.

	Network	Animals		Plants		Total	
		exp ± error	R^2	exp ± error	R^2	exp ± error	R^2
plant-pollinator	Kato et al. (1990)	-0.39 ± 0.22	0.506	-0.28 ± 0.13	0.415	-0.73 ± 0.20	0.633
	Elberling and Olesen (1999)	-0.07 ± 0.27	0.047	0.10 ± 0.22	0.087	-0.49 ± 0.22	0.620
	Inouye and Pyke (1988)	-0.13 ± 0.13	0.269	0.08 ± 0.19	0.056	-0.09 ± 0.12	0.133
	Barrett and Helenurm (1987)	-0.25 ± 0.68	0.201	0.11 ± 0.29	0.092	-0.75 ± 0.33	0.712
	Memmott (1999)	0.04 ± 0.10	0.046	0.02 ± 0.14	0.008	-0.31 ± 0.17	0.428
	Ollerton et al. (2003)	0.06 ± 0.23	0.103	-0.01 ± 0.36	0.001	-0.69 ± 0.48	0.505
	Motten (1982)	-0.08 ± 0.31	0.059	-0.00 ± 0.09	0.001	-0.44 ± 0.22	0.612
	Small (1976)	0.13 ± 0.11	0.450	0.05 ± 0.24	0.030	-0.32 ± 0.30	0.298
	Vázquez and Simberloff (2003) - 4	-0.09 ± 0.96	0.081	-0.04 ± 0.45	0.024	-0.71 ± 0.49	0.736
	Vázquez and Simberloff (2003) - 2	-0.89 ± 1.28	0.816	-0.17 ± 0.28	0.426	-0.72 ± 0.36	0.837
	Schemske et al. (1978)	-0.21 ± 0.72	0.431	-0.06 ± 0.13	0.424	-0.72 ± 0.43	0.740
	Vázquez and Simberloff (2003) - 1	-0.68 ± 0.72	0.891	0.03 ± 0.48	0.016	-0.72 ± 0.21	0.937
	Vázquez and Simberloff (2003) - 3	-0.21 ± 0.28	0.837	0.13 ± 0.61	0.137	-0.48 ± 0.50	0.641
	Vázquez and Simberloff (2003) - 6	-0.56 ± 0.92	0.775	-0.09 ± 0.40	0.143	-0.76 ± 0.74	0.667
	Vázquez and Simberloff (2003) - 8	-0.35 ± 0.64	0.503	-0.18 ± 0.40	0.271	-0.39 ± 0.17	0.838
	Vázquez and Simberloff (2003) - 5	-0.56 ± 2.74	0.282	-0.00 ± 0.26	0.001	-0.63 ± 0.42	0.748
	Vázquez and Simberloff (2003) - 7	-0.77 ± 0.49	0.998	-0.11 ± 0.33	0.263	-0.75 ± 0.60	0.754
	Mosquin and Martin (1967)	0.11 ± 0.20	0.475	0.08 ± 0.19	0.269	0.00 ± 0.20	0.000
	Olesen et al. (2002) - Azores	-0.24 ± 0.22	0.616	-0.39 ± 0.76	0.260	-0.31 ± 0.32	0.426
	Olesen et al. (2002) - Mauritius	-0.08 ± 0.23	0.271	-0.07 ± 0.25	0.195	-0.10 ± 0.07	0.795
plant-seed disperser	Schleuning et al. (2010)	0.04 ± 0.08	0.064	0.34 ± 0.24	0.340	-0.08 ± 0.11	0.090
	Snow and Snow (1971)	-0.05 ± 0.26	0.021	-0.04 ± 0.08	0.093	-0.35 ± 0.16	0.524
	Snow and Snow (1988)	-0.07 ± 0.07	0.305	-0.14 ± 0.10	0.508	-0.20 ± 0.21	0.185
	Beehler (1983)	-0.19 ± 0.11	0.742	-0.07 ± 0.12	0.208	-0.46 ± 0.21	0.634
	Sorensen (1981)	0.31 ± 0.82	0.222	-0.16 ± 0.35	0.224	-0.06 ± 0.41	0.024
	Poulin et al. (1999)	-0.09 ± 0.14	0.275	-0.05 ± 0.13	0.184	-0.15 ± 0.19	0.294
plant-ant	Blüthgen et al. (2004)	-0.03 ± 0.10	0.030	-0.09 ± 0.08	0.269	-0.06 ± 0.08	0.104
	Fonseca and Ganade (1996)	-0.22 ± 0.67	0.500	-0.04 ± 0.09	0.269	-0.29 ± 0.28	0.682
	Davidson and Fisher (1991)	-0.32 ± 4.04	0.500	0.06 ± 0.80	0.042	-0.31 ± 0.46	0.607

Table 5b. Exponents of power-law fits (exp ± error) of the unweighted average degree of nearest neighbors, K_{nn} fit, for animals, plants, and all species together.

	Network	Animals		Plants		Total	
		exp ± error	R^2	exp ± error	R^2	exp ± error	R^2
plant-pollinator	Kato et al. (1990)	-0.40 ± 0.20	0.569	-0.39 ± 0.09	0.710	-0.82 ± 0.19	0.707
	Elberling and Olesen (1999)	-0.15 ± 0.17	0.322	0.02 ± 0.22	0.002	-0.59 ± 0.20	0.747
	Inouye and Pyke (1988)	-0.14 ± 0.11	0.341	-0.11 ± 0.14	0.184	-0.24 ± 0.10	0.612
	Barrett and Helenurm (1987)	-0.47 ± 0.25	0.872	-0.04 ± 0.32	0.013	-0.89 ± 0.29	0.821
	Memmott (1999)	-0.25 ± 0.05	0.897	-0.17 ± 0.10	0.487	-0.50 ± 0.13	0.792
	Ollerton et al. (2003)	-0.25 ± 0.08	0.946	-0.22 ± 0.22	0.502	-0.85 ± 0.36	0.735
	Motten (1982)	-0.20 ± 0.21	0.472	-0.13 ± 0.11	0.474	-0.60 ± 0.20	0.777
	Small (1976)	0.07 ± 0.10	0.278	0.05 ± 0.16	0.075	-0.30 ± 0.24	0.365
	Vázquez and Simberloff (2003) - 4	-0.21 ± 0.56	0.576	-0.17 ± 0.41	0.371	-0.81 ± 0.46	0.804
	Vázquez and Simberloff (2003) - 2	-0.20 ± 0.04	0.995	-0.19 ± 0.35	0.374	-0.72 ± 0.24	0.924
	Schemske et al. (1978)	-0.29 ± 0.53	0.735	-0.17 ± 0.11	0.892	-0.82 ± 0.40	0.805
	Vázquez and Simberloff (2003) - 1	-0.38 ± 0.60	0.787	-0.04 ± 0.40	0.028	-0.79 ± 0.48	0.780
	Vázquez and Simberloff (2003) - 3	-0.49 ± 0.18	0.986	-0.12 ± 0.51	0.149	-0.69 ± 0.49	0.796
	Vázquez and Simberloff (2003) - 6	-0.40 ± 0.19	0.977	-0.12 ± 0.20	0.556	-0.75 ± 0.49	0.823
	Vázquez and Simberloff (2003) - 8	-0.22 ± 0.38	0.525	-0.45 ± 0.14	0.953	-0.58 ± 0.30	0.791
	Vázquez and Simberloff (2003) - 5	-0.40 ± 1.25	0.486	-0.15 ± 0.26	0.385	-0.76 ± 0.35	0.859
	Vázquez and Simberloff (2003) - 7	-0.53 ± 3.77	0.764	-0.22 ± 0.37	0.546	-0.89 ± 0.68	0.767
	Mosquin and Martin (1967)	-0.06 ± 0.20	0.238	-0.06 ± 0.22	0.122	-0.16 ± 0.20	0.447
	Olesen et al. (2002) - Azores	-0.27 ± 0.16	0.786	-0.52 ± 0.34	0.755	-0.38 ± 0.12	0.890
	Olesen et al. (2002) - Mauritius	-0.16 ± 0.32	0.463	-0.16 ± 0.25	0.581	-0.20 ± 0.06	0.955
plant-seed disperser	Schleuning et al. (2010)	-0.15 ± 0.07	0.514	0.23 ± 0.24	0.190	-0.25 ± 0.09	0.580
	Snow and Snow (1971)	-0.25 ± 0.17	0.544	-0.09 ± 0.06	0.487	-0.52 ± 0.19	0.620
	Snow and Snow (1988)	-0.11 ± 0.03	0.796	-0.38 ± 0.07	0.943	-0.25 ± 0.17	0.368
	Beehler (1983)	-0.25 ± 0.10	0.860	-0.15 ± 0.08	0.718	-0.53 ± 0.20	0.709
	Sorensen (1981)	0.18 ± 0.62	0.142	-0.29 ± 0.09	0.938	-0.19 ± 0.21	0.449
	Poulin et al. (1999)	-0.19 ± 0.09	0.824	-0.26 ± 0.13	0.846	-0.28 ± 0.15	0.698
plant-ant	Blüthgen et al. (2004)	-0.24 ± 0.10	0.610	-0.22 ± 0.05	0.863	-0.23 ± 0.06	0.769
	Fonseca and Ganade (1996)	-0.27 ± 0.70	0.580	-0.18 ± 0.19	0.636	-0.41 ± 0.33	0.755
	Davidson and Fisher (1991)	-0.23 ± 2.21	0.635	0.10 ± 0.45	0.330	-0.28 ± 0.44	0.582

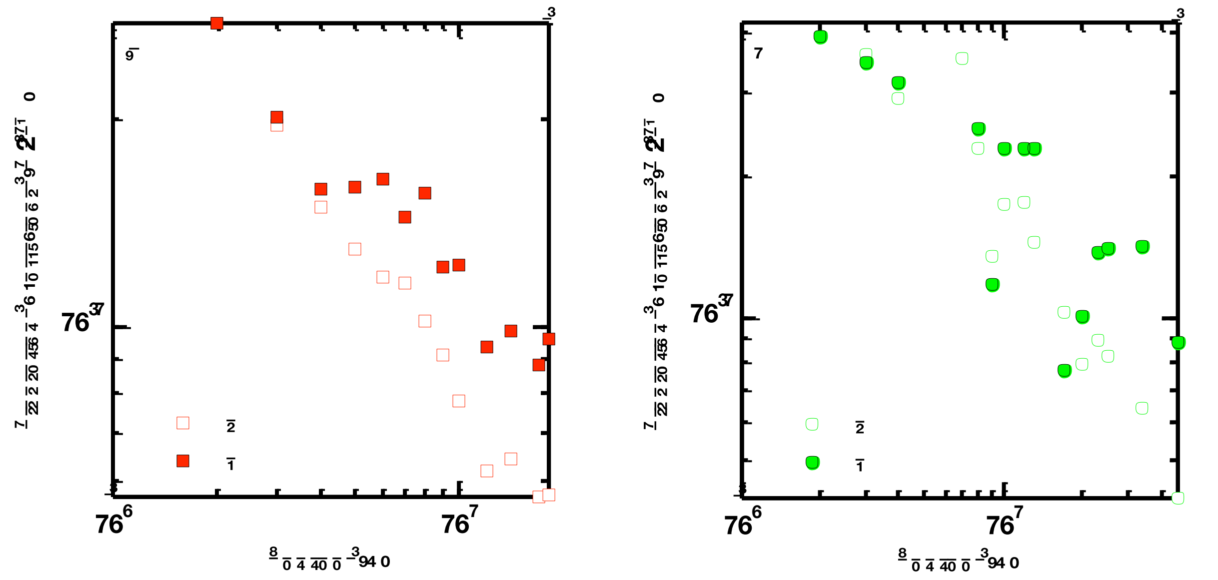
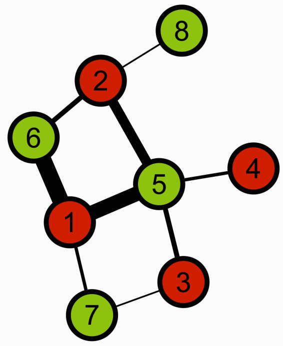


Figure A1. Average binary and weighted bipartite clustering coefficient of nodes with the same degree for the network of Memmott (1999). Filled symbols represent data calculated with the weighted bipartite clustering coefficient. Open symbols represents data calculated with the binary bipartite clustering coefficient. (a) Red squares, represents data for animals. (b) Green circles represent data for plants.

a Matrix representation (w)

	5	6	7	8
1	9	10	2	0
2	6	3	0	1
3	3	0	1	0
4	2	0	0	0

b Graph representation



c

Unweighted $$k_{nn}(1) = \frac{1}{k_1}(k_5 + k_6 + k_7) = \frac{1}{3}(4+2+2) = \frac{8}{3} = 2.667$$

Weighted $$k_{nn}^{w}(1) = \frac{1}{s_1}(w_{15} \cdot k_5 + w_{16} \cdot k_6 + w_{17} \cdot k_7)$$
$$= \frac{1}{21}(9 \cdot 4 + 10 \cdot 2 + 2 \cdot 2) = \frac{60}{21} = 2.857$$

Figure 2. Schematic illustration of how to compute weighted and unweighted average nearest-neighbors' degree, following Eq. 8. (a) The example graph is represented as a matrix *w*, where 0 represents no interaction and non-zero values indicate the weight of the link between two species. In the matrix representation animals appear in rows and plants in columns. The colored boxes contain

the nodes' labels, red for animals and green for plants. (b) The network can also be represented as a graph, where species are linked by lines with their width proportional to link weight. (c) In this example, we calculate both average nearest-neighbors degree for the species labeled i=1, which is the animal corresponding to the first row of *w* matrix, with $k_1 = 3$; $s_1 = 21$. In the example weighted nearest-neighbors degree' is greater than unweighted nearest-neighbors' degree.

References of networks datasets

Barrett, S. C. H. and Helenurm, K. 1987. The reproductive-biology of boreal forest herbs.1. Breeding systems and pollination. – Can. J. Bot. 65: 2036–2046.

Beehler, B. 1983. Frugivory and polygamy in birds of paradise. – Auk 100: 1–12.

Blüthgen, N. et al. 2004. Bottom–up control and co-occurrence in complex communities: honeydew and nectar determine a rainforest ant mosaic. – Oikos 106: 344–358.

Davidson, D. W. and Fisher, B. L. 1991. Symbiosis of ants with *Cecropia* as a function of light regime. – In: Huxley, C. R. and Cutler, D. F. (eds), Ant–plant interactions. Oxford Univ. Press, pp. 289–309.

Elberling, H. and Olesen, J. M. 1999. The structure of a high latitude plant–flower visitor system: the dominance of flies. – Ecography 22: 314–323.

Fonseca, C. R. and Ganade, G. 1996. Asymmetries, compartments and null interactions in an Amazonian ant–plant community. – J. Anim. Ecol. 66: 339–347.

Inouye, D. W. and Pyke, G. H. 1988. Pollination biology in the Snowy Mountains of Australia: comparisons with montane Colorado, USA. – Aust. J. Ecol. 13: 191–210.

Kato, M. et al. 1990. Insect–flower relationship in the primary beech forest of Ashu, Kyoto: an overview of the flowering phenology and seasonal pattern of insect visits. – Contr. Biol. Lab. Kyoto Univ. 27: 309–375.

Memmott, J. 1999. The structure of a plant–pollinator food web. – Ecol. Lett. 2: 276–280.

Mosquin, T. and Martin, J. E. H. 1967. Observations on the pollination biology of plants on Melville Island, N.W.T., Canada. – Can. Field Nat. 81: 201–205.

Motten, A. F. 1986. Pollination ecology of the spring wildflower community of a temperate deciduous forest. – Ecol. Monogr. 56: 21–42.

Olesen, J. M. et al. 2002. Invasion of pollination networks on oceanic islands: importance of invader complexes and endemic super generalists. – Divers. Distrib. 8: 181–192.

Ollerton, J. et al. 2003. The pollination ecology of an assemblage of grassland asclepiads in South Africa. – Ann. Bot. 92: 807–834.

Poulin, B. et al. 1999. Interspecific synchrony and asynchrony in the fruiting phenologies of congeneric bird-dispersed plants in Panama. – J. Trop. Ecol. 15: 213–227.

Schemske, D. W. et al. 1978. Flowering ecology of some spring woodland herbs. – Ecology 59: 351–366.

Schleuning, M. et al. Specialization and interaction strength in a tropical plant–frugivore network differ among forest strata. – Ecology, in press.

Small, E. 1976. Insect pollinators of the Mer Bleue peat bog of Ottawa. – Can. Field Nat. 90: 22–28.

Snow, B. K. and Snow, D. W. 1971. The feeding ecology of Tanagers and honeycreeperes in Trinidad. – Auk 88: 291–322.

Snow, B. K. and Snow, D. W. 1988. Birds and berries. – Calton.

Sorensen, A. E. 1981. Interactions between birds and fruit in a temperate woodland. – Oecologia 50: 242–249.

Vázquez, D. P. and Simberloff, D. 2003. Changes in interaction biodiversity induced by an introduced ungulate. – Ecol. Lett. 6: 1077–1083.